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16. Abstract

This rail technology review provides assistance to a number of rail technology programs initiated by the Transportation Systems Center (TSC) for the Federal Railroad Administration (FRA). The results of a search and review in four specific areas in the field of rail technology are presented in the form of a bibliography with descriptive abstracts, source acknowledgments, and availabilities. The geographic scope of the review was worldwide with particular emphasis on the literature of the United States, Canada, the United Kingdom, Western Europe, the Soviet Union, and Japan.

The technical scope of investigations for which abstracts are presented include such important topics as the nondestructive examination of rails, the determination of rail stresses and strains and factors affecting them, rail failure behavior and the analysis of rails-in-service, and the metallurgical aspects of rail steel and its production.

The time period covered by the review is 1965 through 1975, with particular emphasis on the past five years. Types of literature covered include: journal articles, conference papers, reports, textbooks, handbooks, and unpublished papers. Indices for the identification of the abstracts are provided.

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PREFACE

The Transportation Systems Center (TSC) is conducting a number of programs in rail technology for the Office of Research and Development of the Federal Railroad Administration (FRA). These programs include studies relating to rail inspection, wheel/rail load characterization, analysis of stresses in rail, development of a computational rail-failure model, rail-steel metallurgy, and rail-steel production. It was anticipated that these programs would draw heavily upon the related research information from both domestic and foreign sources. As a part of Contract No. DSA-900-75-C-1803, TSC contracted with the Metals and Ceramics Information Center of Battelle's Columbus Laboratories (BCL) to conduct a review and to prepare a bibliography of selected documents. This work was conducted under the technical direction of Mr. Roger K. Steel, Dr. Donald P. McConnell, and Mr. Harry L. Ceccon of the Transportation Systems Center.

The major topic areas of rail technology that were reviewed were: (1) nondestructive inspection of rail; (2) rail stresses and strains, including factors affecting their development and distribution within the rail; (3) rail-failure behavior and analysis of rails in service, and (4) the metallurgy of rail steel and methods of production. Secondary consideration was given to documents on related topics such as rail joints, welded rail, track-geometry inspection, ballast, subgrade, ties, rail fasteners, frogs, switches, and track-vehicle dynamics where it was determined that the data and information presented would provide a better understanding of the major topic areas.

The review covered the open literature and, to the extent possible, unpublished reports, and private documents. The time period covered was the past 10 years, with particular emphasis on the last 5 years; however, in several instances, older documents, which were believed to offer a significant contribution to the technology, were included. The geographic scope of the review was worldwide with emphasis placed on the literature of the United States, Canada, the United Kingdom, Western Europe, the Soviet Union, and Japan.

Extensive use was made of computerized data-base systems including: DDC, TRIS, NTIS, RASIS, and RRIS to identify pertinent literature. Also, various indices, such as the Engineering Index and the Applied Science and Technology Index, were screened for relevent literature. These efforts were complemented by a search of the extensive holdings of journals, books, and reports of the libraries at Battelle-Columbus. All of the documents originating in the Soviet Union and satellite countries which are cited in this bibliography were provided by Battelle's Foreign Science Library.

The Association of American Railroads (AAR) provided listings of their published reports and was a valuable source of rail technology documents. In addition, the Library of Congress, the Department of Transportation Library, and numerous university libraries were searched for relevent literature.

Valuable assistance was provided by Central Technology, Inc. (CENTEC), in the acquisition and review of rail literature from AAR, AREA, and industry, and in screening the Soviet journals. Battelle-Frankfurt was responsible for the screening, acquisition, and abstracting of rail technology documents of Western Europe. Mitsubishi Research Institute, Inc., performed the screening, acquisition, and abstracting of appropriate Japanese rail-technology literature.

The authors appreciate the assistance of the Metals and Ceramics Information Center Staff for their contributions to this study: Rose Leibbrand and Carolyn Green for the typing and index preparation; and Dorothea Johnson, Eleanor Smith, and Richard Weirich for conducting the literature searches.

This bibliography contains references to and descriptive abstracts for over 1500 reports, journal articles, and conference papers. In each citation the title is given first in capital letters (English titles are given for foreign language documents), followed by the abstract; author(s) and affiliation(s); document source (journal, book publisher, Government or industrial report identification, etc.); acknowledgment; and availability (point of purchase). The latter item also indicates the form in which the document may be obtained, i.e., paper copy, microfilm, or microfiche.

For user convenience four cross indices are provided: subject term, author, journal and corporate sources, and foreign sources. The complete address is given for each of the referenced document sources in the index. Each citation has been assigned a four-digit number for cross-referencing in the various indices.

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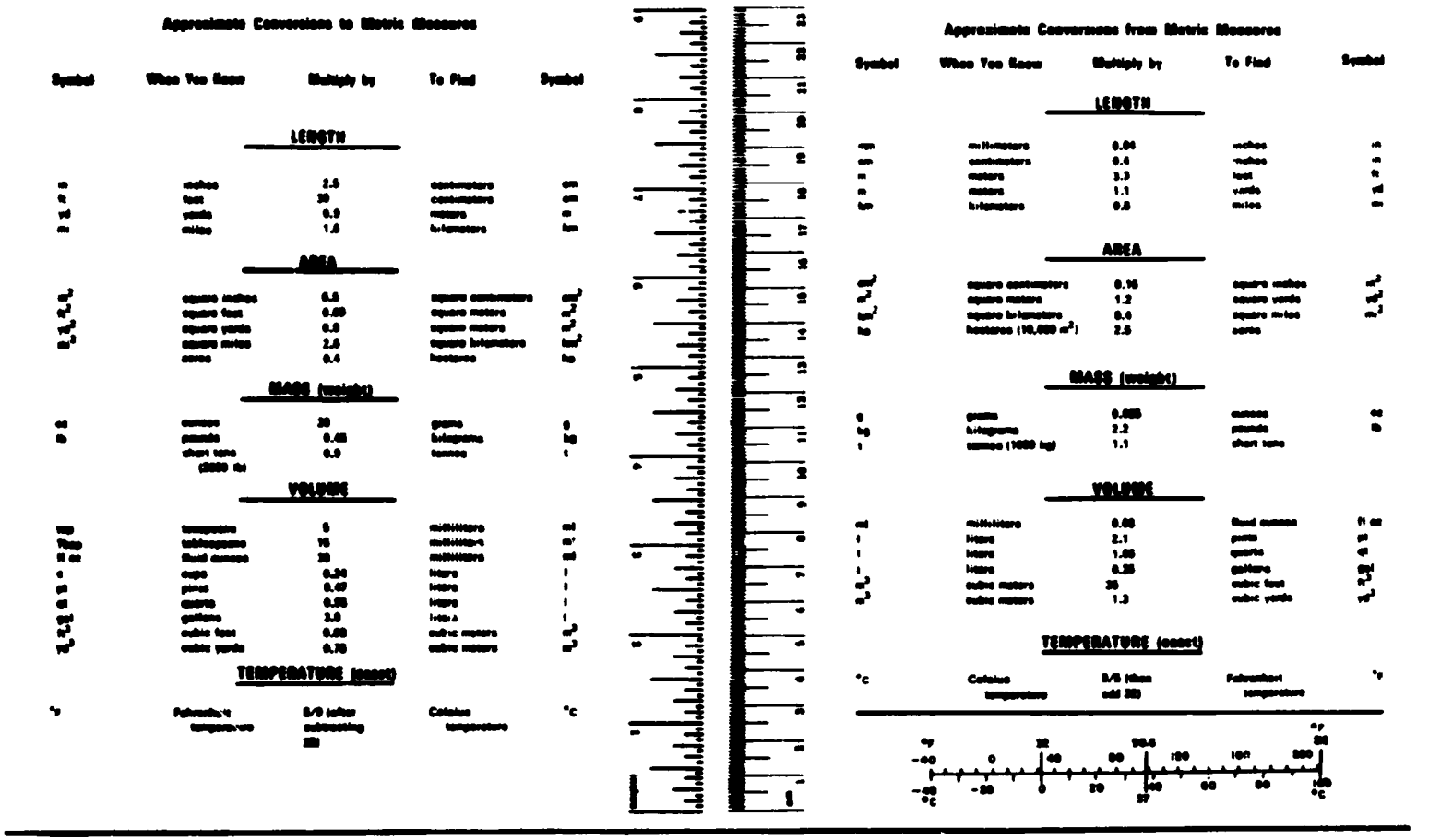
METRIC CONVERSION FACTORS



RAIL TECHNOLOGY ABSTRACTS

0001

DEVELOPMENT OF A LARGE AUTOMATIC ULTRASONIC PLATE TESTING INSTALLATION WITH ONLINE COMPUTER DATA OUTPUT

An automatic, ultrasonic plate testing apparatus for plate up to 16 in. (40 mm) thick is described. The installation is integrated into the plate production line of the Hoesch Steelworks in Dortmund, West Germany. Test data are processed into an AEG online computer. Transmitting transducers are 2-MHz frequency lead zirconate elements. The computer recognizes and classifies defect areas, compares the number of defects with the mill specifications, then produces test reports and new instructions for production-line use.

Kuenne, G. (Hoesch Huettenwerke A.G., Dortmund, Germany), Materials Evaluation, Vol 33, No. 4, April 1975, pp 73-80, 16 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0002

WEAR AND CORROSION OF RAILS

The use of the Shaw Rail Contourography by the British Railways to measure vertical rail wear is described. Rail wear tends to increase in areas of high humidity. Wear is increased due to surface corrosion in areas of heavy atmospheric pollution. Graphs are used to show the relationship between wear and traffic load for various atmospheric conditions. The influence of steel composition, axle loading and braking on vertical wear is described. Lateral rail wear is more difficult to measure than vertical wear; however, lateral wear is less often the cause of rail replacement. Rail lubrication as a method of reducing lateral wear is discussed. Rail wear in tunnels and corrosion protection by means of coatings or the addition of copper to the rail steel are also discussed.

Deerden, J. (British Railways Research Department), The Railway Gazette, Vol 121, No. 1, January 1, 1965, pp 18-21, 3 figs., 1 photo, 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0003

ACOUSTIC EMISSION FROM FLAWED HEAVY SECTION STEEL PLATES

Acoustic emission technology is investigated as a tool for safety inspections of pressure vessels and piping by studying acoustic emission data from flawed steel plates during tensile testing. The 6-in. (15.24 cm) -thick plates were from A533-B steel and contained flaws between 2.25 in. (5.71 cm) and 2.5 in. (6.35 cm) deep perpendicular to the direction of applied stress. Tests were conducted from 37 to 104 C. Acoustic emission rate, which peaks prior to the elastic limit, is plotted as a function of applied stress. The rate of emission change with strain is temperature dependent. A theoretical model based on dislocation theory is used to describe this temperature dependence. Results show that the maximum emission occurs prior to elastic limit and reaches a plateau near the elastic limit. The results are believed to be applicable to most flawed carbon steels tested at low strain rates and under similar test conditions.

Ying, S. P., and Grigory, S. C. (Southwest Research Institute, San Antonio, Texas), Materials Evaluation, Vol 33, No. 2, February 1975, pp 30-36, 6 figs., 14 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0004

ULTRASONIC 'EYES' ABOARD BRITISH TESTING TRAIN LOCATE RAIL DEFECTS

A British rail testing car utilizing ultrasonic equipment and capable of operating at speeds up to 25 mph is described. The rail-scanning probes are carried on a trolley mounted between the wheels of the test car. The ultrasonic equipment console contains two banks of flaw detectors, each bank containing four flaw detectors. One tests fail fittings; a second detects horizontal defects; a third detects inclined defects by reflecting waves from the bottom rail surface; the fourth detects vertical defects occurring in the rail head or top half of the railweb. The test information is recorded on film which is later analyzed. This document is in the Railroad Research Bulletin as RRIS No. 01072813.

Materials Evaluation, Vol 30, No. 6, June 1971, pp 16A-18A, 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0005

DEFORMATION OF RAILWAY TRACK UNDER HIGHSPEED TRAIN - MEASUREMENTS ON THE TEST-RUN SECTION OF THE NEW TOKAIDO LINE

Deformation of track structure was determined by trial runs of high-speed trains. Measurements were made of acceleration on rail, sleeper and ballast, pressure between rail base and sleeper (rail pressure), rail depression, relative displacement between rail and sleeper, and stress at rail base and rail-fastening spring clip. Ground measurements included rail deflections, rail stress, stress on fastening devices, track vibration acceleration, and sleeper stress. Car measurements included wheel side thrust, wheel load, bogie stress, car-body vibration, axle-box vibration. Of major importance were measurements of lateral deflection of the rail and lateral forces. Field tests were conducted on ordinary ballasted track, solid bed track, rail turnouts, and expansion and insulation joints. The effects of flat wheels as related to rail bending stresses and running stability tests were also considered.

Satoh, Y., and Toyoda, M. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 7, No. 2, 1966, pp 20-23, 6 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kam-yuaha, Inc., (repr., PC).

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0006

RAIL FAILURE DETECTION IN THE UNITED STATES

Rail flaw detection techniques employed in the U.S.A., including rail detector cars using inductance, residual magnetic, and ultrasonic methods, are reviewed. Statistics are presented on: (1) service and detected failures from transverse defects, (2) failures of controlled cooled rails - failure rate per 100 track miles, (3) analysis of various types of failure, and (4) recorded web failures.

The Railway Gazette, Vol 121, No. 16, August 20, 1965, pp 665-666, 1 fig., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0007

STATUS OF NONDESTRUCTIVE TESTING FOR TRANSPORTATION INDUSTRIES

The article comments on nondestructive testing as applied to the automotive railroad, and marine transportation systems since the turn of the century. Mention is made of NDT systems for railroad rails, railway car axles, railroad car wheels, "hot boxes", railroad trackage, rail car frames and bodies, and railroad bridges and tunnels. With regard to modern transportation industries, the need is expressed for new forms of NDT systems and for continuously operating diagnostic tests of system functions, including continuous monitoring of the physical elements of such systems.

McMaster, R. C. (The Ohio State University, Columbus, O.), Materials Evaluation, Vol 33, No. 7, July 1975, pp 181-186, 192, 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0008

DETECTED RAIL DEFECTS SHOOT UP

Well over 119,000 rail defects were detected during 1970 through use of ultrasonic testing equipment developed by Sperry Rail Service. The equipment is designed specifically for the detection of web defects in the joint areas. The technique also provides reliable detection of defects outside joint-bar limits. During 1970, it was found that 59% of all defects were hidden inside the limits of joint bars.

Railway Age, Vol 170, No. 7, April 12, 1971, p 25, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp., (repr., PC).

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0009

METAL PLATE TESTING USING AIRBORNE ULTRASOUND

The properties of Lamb waves are discussed and a method for using them in the nondestructive testing of metal plates is described. In this method, waves, generated from air without touching the sample, are excited in metal plates. By this means, contactless nondestructive, "on-line" testing of metal plates within a thickness range from 0.2 mm to several millimeters is possible. The method has limited defect resolution and is best in very thin plates. Examples of copper and aluminum plate testing are given. The method can be extended for testing tubes, fiberglass laminates, veneer, etc.

Luukkala, M., and Meriläinen, P. (University of Helsinki, Helsinki, Finland), Ultrasonics, Vol 11, No. 5, September 1973, pp 218-221, 7 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press Limited (repr., PC).

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0010

PREVENTION AND CURE OF RAIL CORRUGATION

A number of tests were conducted using an Amsler wear testing machine with discs made of wheel and rail steels. The specimens were from two classes of wheel steel: one for carriage and wagon wheels, and the other for locomotive wheels. The rail-steel discs used in the tests were from steel made in different countries and were of various makes, heats, years of rolling, and years of use. The tests established the existence of a lower limit of maximum shear stress at which corrugation appeared, and an upper limit at which corrugation was possibly a function of track modulus and wheel loading. It is thought that there is a critical range of shear and compressive stress within which each rail corrugation takes place, but below or above this range the phenomenon is absent because wear particles are either not generated or they are removed altogether.

Srinivasan, M. (Indian Railways), The Railway Gazette International, Vol 131, No. 3, March 1975, pp 97-101, 4 figs., 1 photo, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Transport Press Ltd., (repr., PC).

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0011

DYNAMICS OF THE REMAGNETIZATION OF TWO INTERACTING FERROMAGNETIC PLATES

Mathematical expressions are developed for magnetic fields for remagnetized plates and adjacent ferromagnetic plates. Experimental data are presented in graphical form for frequencies ranging between 1000 and 8000 Hz.

Burtsev, G. A. (Institute of the Physics of Metals, Academy of Sciences of the U.S.S.R.), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 2, March-April 1966, pp 118-120, 2 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0012

PROPERTIES OF ISOTHERMALLY QUENCHED CARBON AND ALLOY STEEL RAILS

In laboratory- and production-scale trials, rails were subjected to austenitizing temperatures of 850 to 900 C (holding for 1-1/2 hr), cooling for 35 to 45 minutes in a molten bath of 50% KNO_3 and 50% $NaNO_3$ with a water addition of 9.68% to increase cooling efficiency. The temperature of the molten bath varied between 280 and 320 C according to the chemical composition of the steel. The rails were rinsed in hot water (50 C) after quenching. Properties of sections from carbon, silicon, chromium, and Cr-Si-Mn steel rails were investigated. The isothermally quenched rails had a high tensile (130 to 160 kg/mm^2) and fatigue strength (53 to 68 kg/mm^2), and with optimum structure showed good resistance to brittle failure. Ductile and impact properties were satisfactory, and a more favorable pattern of internal residual stresses was obtained.

Kazarnovskii, D. S., Pridantsev, M. V., Bobich, A. P., Gurenko, V. D., Biryukova, V. N., and Aref'ev, B. V., Stal, No. 5, May 1970, pp 465-468, 3 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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0013

THE PROSPECTS OF MAGNETOGRAPHIC DEFECTOSCOPY OF ROLLED IRON

Magnetic techniques, in particular the magnetographic technique, for inspecting ferromagnetic products are reviewed and discussed in relation to perfecting defectoscopy for inspecting rolled iron having rough dimensions and other products with complex geometries, large masses of metal, and poor surface conditions. The magnetographic method employs elastic magnetic tape which is superposed on the controlled surface or is fed through synchronously with the moving test specimen in an applied d-c magnetic field. Magnetic impressions of the defects forming on the carrier repeat the length and configuration of the defects. Forster's technique which employs the magnetic search coils/probes developed by him, is emphasized.

Feshchenko, Yu. B. (Scientific-Research Institute of Automatic Ferrous Metallurgy), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 7, No. 2, March-April 1971, pp 121-127, 5 figs., 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0014

MAGNETIC MONITORING OF BULK HARDENING AND TEMPERING OF RAILS

The authors show the potential and importance of using a continuous magnetic technique for quality control of bulk hardening and high tempering of rails by measuring the field or the field-gradient from the residual magnetization after magnetizing the head and the foot of a rail heated to 250 to 300 C by using a d-c excited electromagnet. Efforts were aimed at establishing, in the process of rail manufacturing, a reliable nondestructive, continuous method permitting sampling and 100% inspection of rail hardness and certain mechanical properties along the entire length of the rails on a production line. With this approach, the time-consuming process of measuring Brinell hardness could be avoided. The use of eddy-current techniques was judged infeasible, and so efforts were extended to use residual magnetic techniques.

Aronson, E. V., Vinokurov, I. Ya., Kompaniets, G. M., Rabinovich, D. M., and Tomilov, G. S. (Institute of the Physics of Metals, Academy of Sciences of the U.S.S.R., V. I. Lenin Nizhne-Tagil Metallurgical Combine), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 3, May-June 1968, pp 203-206, 5 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories

PURCHASE FROM: Consultants Bureau (repr.,

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0015

FERROPROBE METHOD OF RECORDING THE PROCESS OF DEVELOPMENT OF FATIGUE CRACKS IN VOLUME-HARDENED RAILS

The possible use of electromagnetic inspection techniques for observing the process of development and propagation of fatigue cracks in rails is investigated. The objective is to show that there are advantages in using applied magnetism as opposed to residual magnetism. Part of the experimental work included rail loading to determine the fatigue strength of rails. The type of magnetic search coil employed is described as well as the source for its excitation. Diagrams of the recording of detector data are shown for volume-hardened and raw rails.

Shcherbinina, V. A., Sokolov, P. S., and Stakanova, A. A., (Ural Branch, All-Union Scientific Research Institute of Railway Transport), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 1, January-February 1968, pp 50-53, 6 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories

PURCHASE FROM: Consultants Bureau (repr., PC).

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0016

MEASUREMENT OF LOCAL STRESS ON OUTER RAIL HEAD

Measurement technique for determining stresses, and conditions of rail loading that ultimately can produce fatigue cracks are described. Stress measurements were made in the laboratory using strain gauges mounted on an outer rail location. The distribution of outer rail head stress is shown in relation to the rail cross section. When work was completed in the laboratory, and experiment was conducted on a section of the Japanese National Railways (JNR) track system, and the results are provided in the form of a correlation between lateral pressure and stress on the outer rail head.

Sugiyama, T., Yamazaki, T., and Umeda, S. (Japan National Railways), Railway Technical Research Institute, JNR Quarterly Reports, Vol 12, No. 1, 1971, pp 11-13, 5 figs.

ACKNOWLEDGMENT: Japanese National Railways.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0017

INTRODUCTION OF RAILWAY TECHNICAL RESEARCH INSTITUTE OF JNR: Laboratories for Fundamental Research

A brief general description of the laboratories of the JNR's Railway Technical Research Institute for nondestructive testing of all railway associated components is given. The Institute incorporates a materials investigation laboratory which conducts research in wheel-rail dynamics, various steels for railway component construction, and collects and maintains data, both domestic and foreign, on all facets of materials. Their physical testing laboratory conducts both destructive and nondestructive testing using gamma/X-ray equipment and, to a certain extent, the photoelastic techniques that are employed in stress analysis.

Ueda, M. (Japan National Railways), Japanese Railway Engineering, Vol 7, No. 3, September 1966, pp 28-29, 4 phocos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineers' Association (repr. PC).

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0018

DYNAMIC LOADING AT RAIL JOINTS

Information is provided on the dynamic loading of rails and rail joints. Data were obtained by installing strain gauges and associated test equipment and observing the loading when locomotives and loaded freight cars passed over the rail ends. Peak rail stresses were measured and are shown in accompanying tables and graphs. A mathematical model is used to provide incremental dynamic load estimates. Efforts were made to show the relation between dynamic wheel load and bolt-hole stresses.

Nield, B. J., and Goodwin, W. H. (British Railways Board), The Railway Gazette, Vol 125, No. 16, August 15, 1969, pp 616-619, 5 figs., 1 photo, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corporation (repr., PC).

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0019

RAIL RESEARCH-PROBLEM DEFINITION

A background study of rail design, chemical composition, and heat treatment of rail, manufacturing and rolling processes is presented, and rails defects and means for their measurement and detection are discussed. A brief history of the evolution of rail designs is given along with associated rail steel metallurgy and manufacturing. Induction, a residual-magnetic, and ultrasonic rail flaw detection methods are discussed.

Schoonsberg, K. W. (Association of American Railroads, Chicago, Ill.), AAR Research Center, Report No. R-120, AAR Research Division Project No. 70-R-66, March 1973, 79 pp., 3 figs., 1 table, 45 refs.

ACKNOWLEDGMENT: AAR

PURCHASE FROM: AAR Research Center (repr., PC).

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0020

RAPID ELECTROMAGNETIC RAIL DEFECTOSCOPY

The author provides a brief survey of techniques used in nondestructive testing of railways rails in the USSR as well as in other countries. Information is given regarding the basic stages of development of the flaw and defect inspection systems and devices. Among those discussed are defectoscopes employing applied and residual types of magnetism, eddy-current systems, and ultrasonic systems. Mention is made of the degree of success experienced in the use of rail inspection systems for detecting transverse cracks and indications of contact fatigue.

Dovnar, B. P. (All-Union Scientific Research Institute of Railway Transport), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 6, November-December 1967, pp 436-443, 2 figs., 80 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0021

EVALUATION OF THE SURFACE EFFECT AND THE APPEARANCE OF INTERNAL DEFECTS IN RAILHEADS WITH RAPID MAGNETIC DEFECTOSCOPY

The authors present a quantitative evaluation of the surface effect in rail heads magnetized by a magnetic-field generator mounted on a rail vehicle. Comparative data are given showing the nonlinearity of the rail's magnetic characteristics. Mention is made of the difficulties encountered in developing exact mathematical models for magnetic conditions. Magnetization curves are shown for both calculated and experimental approaches. It is pointed out that the system performs fairly well for surface defects, but cannot penetrate to internal defects that are beyond a depth of 1 centimeter.

Dovnar, B. P., Sychev, Yu. D., Shcherbinina, V. A., and Ol'shanskaya, L. P. (Ural Branch, All-Union Central Scientific Research Institute, MPS), Defectoscopy: The Soviet Journal of Nondestructive Testing, (Translation by Scientific Information Consultants, London), No. 3, May-June 1967, pp 175-179, 6 figs., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0022

INVESTIGATION OF THE DEFECT FIELDS IN HIGH-SPEED ELECTROMAGNETIC TESTING OF RAILS

The fields of transverse fatigue fissures in rails were studied under both static and dynamic magnetization conditions. This involved the determination of effectiveness for detecting defects in rails by using a railroad-car inspection system to assess magnetic-field perturbances above the rail caused by defects in the rail head. Subsequent defect dimensions were confirmed and measured by using an ultrasonic test system. Details of the magnetic search coils are given along with results of the magnetostatic defect study in a graphical form.

Dovnar, B. P., and Shcherbinina, V. A. (Ural Branch, All-Union Central Scientific Research Institute, MPS), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 1, January-February 1965, pp 23-28, 5 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0023

NEW RESULTS OF NDT BY THE MAGNETIC LEAKAGE FIELD METHOD

Investigations are described that deal with nondestructive testing by means of magnetic leakage measurements in the region of surface defects. These investigations involved a variety of crack sizes and depths thus providing a comprehensive series of geometries of magnetic-field leakage. The author states that the effectiveness of the magnetic leakage field test method is improved when the theoretical and experimental principles which he describes are applied in the use of the test equipment. The results of experimental work with hot-rolled and descaled round billets are presented.

Forster, F., Non-Destructive Testing, Vol 4, No. 4, August 1971, pp 254-259, 8 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Science & Technology Press, Ltd.

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0024

USE OF ELECTRONIC TECHNIQUES IN THE SUPERVISION OF TRACK MAINTENANCE

Track maintenance in Japan is discussed at each level of administration. Flow charts show the basic system of track maintenance organization. Samples of maintenance record forms are shown for recording data on track and rail irregularities and the tolerances of these rail flaws and defects. In essence, the control of rails is of major interest to Japan National Railroad to the extent that such activities are in computerized control form.

Murayama, H. (Japanese National Railways), Japanese Railway Engineering, Vol 10, No. 4, 1969, pp 12-16, 11 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineers' Association (repr., PC).

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0025

NEW TYPE RUNNING PERFORMANCE TESTING CAR

The author provides a detailed technical description of the JNR test car in relation to its adequacy for use on high-speed tracks. The items measured by the test equipment consist of forces acting between the wheel and rail, relative movements of wheels against rails, rolling-stock vibration, stresses exerted on running-gear parts, and the temperature rise in running-gear parts. A general view of the testing car is shown, and a block diagram is provided to give information on data processing.

Miyoshi, K. (Japanese National Railways), Japanese Railway Engineering, Vol 11, No. 2, 1970, pp 28-30, 5 figs., 2 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineers' Association.(repr., PC).

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0026

MAGNETIC PROPERTIES, ELECTRICAL CONDUCTIVITY AND HARDNESS OF RAIL STEEL M75 AFTER ISOTHERMAL HARDENING AND TEMPERING

Magnetic, electrical, and mechanical properties of M75 steel rails were investigated after isothermal quenching from 870 C in a salt bath at 250 to 500 C. This heat treatment was followed by isothermal tempering between 350 and 600 C. Coercive force measurements were made at lower temperatures and in a liquid-nitrogen temperature. Graphical illustrations are given for the various processes showing the effects of tempering conditions on the coercive forces, hardness values, and electrical conductivity.

Temilev, G. S., and Matveev, V. I. (Institute of Physics of Metals, Academy of Sciences, U.S.S.R.), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 1, January-February 1965, pp 55-63, 11 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0027

SOME PROBLEMS ASSOCIATED WITH INCREASING THE EFFICIENCY OF HIGH-SPEED MAGNETIC DEFECTOSCOPES

The processes associated with high-speed electromagnetic track defectoscopes are analyzed, and the necessity and potential for creating an automatic magnetic railroad car defectoscope are shown. Functional diagrams are given for providing recordings or identification of the tie and geographical coordinates where the defects are detected. Because of problems relative to data processing, primarily the limited processing capability of the operator, the inspection speed is currently 60 km per day. With the newer concepts, it is envisioned that this rate would increase to 70 km per hour.

Glagolev, E. V. (Ural Branch, All-Union Central Scientific Research Institute, MPS), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 5, September-October 1968, pp 332-335, 4 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0028

IMPROVING INSPECTION OF RAILROAD RAILS

The Soviet Union employs many magnetic, electric-current, and ultrasonic flaw detectors that operate at travel speeds of 3 km/hr on rail inspection duties. They claim to have 37 flaw-detector cars in service that inspect rails at travel speeds of 60 to 70 km/hr and which function by using the electromagnetic inspection concept. Current research involves attempts to increase the travel speed to between 100 and 120 km/hr and the reliability of the car's performance. They believe that this can be achieved by a combination of ultrasonic and electromagnetic concepts. The various Soviet research institutes engaged in such activities are mentioned. Work is continuing on the use of ultrasound for quality control of rails in metallurgical plants.

Shuvalov, V. I. (Central Institute of Scientific and Technical Information of the Ministry of Means of Communication), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translated by Scientific Information Consultants, London), No. 5, September-October 1965, pp 439-440.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0029

AUTOMATIC RECORDING OF THE CONFIGURATION OF A TRANSVERSE FATIGUE CRACK IN THE HEAD OF A RAIL

The All-Union Scientific- Research Institute of Railroad Transport inspected 34 fractured rails in order to determine the area of transverse fatigue cracks that occur in the rail head. The modern laboratory defectoscopes can detect transverse fatigue cracks that encompass between 2 and 5% of the rail head cross section. For field inspection, it appears that the defect would have to represent approximately 25% of the rail head section area. The results of fractured-rail study are presented graphically in the form of a distribution function. Transverse fatigue crack propagation was studied using an automatic recording system that employs ultrasonics. A sketch of the apparatus is given with some discussion as to its functioning components.

D'yakonov, V. N., Kolotushkin, S. A., and Kamshitskii, Yu. V. (All-Union Scientific Research Institute of Railroad Transport), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 1, January-February 1969, pp 93-94, 2 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0030

EXPERIMENTAL DEVICE FOR MAGNETOGRAPHIC INSPECTION OF ROUND BILLETS

An experimental device for flaw detection in ferromagnetic billets which is intended for detecting cracks, rolling laps, hair cracks, and other surface defects has been developed. The device consists of a magnetic search head using a magnetic tape, electronic monitoring equipment, and noise filters. It has capabilities for automatic marking of the defect. The main component parts of the inspection system are shown, and a basic electrical diagram is provided. Typical oscillograms of signals resulting from scanning over both flawless and defective sections are included. Technical characteristics of the flaw detecting system are tabulated with certain specifications as to power requirements and extent of error that can be encountered.

Feshchenko, Yu. B., Shutylev, F. M., Starkov, K. A., and Ivanushkin, E. S. (Scientific-Research and Experimental Design Institute for Automation in Ferrous Metallurgy, Dnepropetrovsk), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 9, No. 5, September-October 1973, pp 622-625, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0031

CHOICE OF TESTING CONDITIONS FOR GAMMA RADIOMETRY METHODS

The kinetic, geometric and radiological factors affecting the detection of flaws are discussed and checked against experimental data. Diagrams are presented showing the testing of objects of varying thicknesses. The radiation spectrum is shown for three thicknesses between 60 and 120 mm, and again for zero thickness. Laboratory experimentation consisted of using steel plates up to 200 mm thick with imposed flaws. The experimental data are presented graphically.

Godlewski, Z. (Institute for Electrotechnics, Warsaw, Poland), Nondestructive Testing, Vol 4, No. 2, April 1971, pp 126-132, 12 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0032

NONDESTRUCTIVE METHODS FOR TESTING PRODUCTS AT THE URALVAGONZAVOD RAILWAY-CAR FACTORY

The Urals Railway-Car Factory employs many of the modern techniques associated with nondestructive testing of metal products in the various stages of production inspection. Among these are: electromagnetic, thermoelectric, ultrasonic, radiation, and dye-penetrant methods. The types of steels commonly used in their manufacture of railcar components are mentioned. General comments are made with regard to heat treatments and temperatures at which hardness is inspected. Magnetic-powder nondestructive testing techniques are highly emphasized. Thermoelectric techniques are generally used to determine the content of residual austenite and the study of processes approaching completeness in alloys in the course of heat treatment. Importance of the use of the thermoelectric method is stressed as a means for observing possible fluctuations in chemical composition.

Bashkirov, Yu. P., Mikheev, M. N., and Kuznetsov, I. A. (F. E. Dzerzhinskii Urals Railway-Car Manufacturing Plant, and A. M. Gor'kii Ural State University), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 8, No. 5, September-October 1972, pp 534-537, 24 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0033

MAGNETIC METHOD OF TESTING THE QUALITY OF THE QUENCHING AND TEMPERING OF RAILS

Studies were conducted on quenched and quenched-and-tempered rail steel samples after application of magnetic energy using d-c electromagnets for the purpose of testing the microstructure and hardness during the manufacturing process. Laboratory tests of the rail steels studied, Types R-50 and K-53, showed that the readings for the edges and the bases served as reliable quality checks for badly quenched rails and rails quenched to martensite.

Tomilov, G. S. (Institute of the Physics of Metals, Academy of Sciences of the U.S.S.R.), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 6, November-December 1966, pp 476-481, 2 figs., 6 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr. PC).

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0034

DEVICE FOR NOISE SUPPRESSION IN RAPID ELECTROMAGNETIC DEFECTOSCOPY OF RAILS

Operational features of a device (defectoscope) for the rapid detection of railway defects in relation to signal processing and conditioning are described. The main concern is for a low signal/noise ratio and signals from minor defects. All signals are recorded by means of an oscillograph on movie film prior to digitizing.

Uspenskii, E. I. (All-Union Central Scientific Research Institute), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 4, July-August 1967, pp 307-309, 3 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0035

ELECTROMAGNETO-ACOUSTIC NON-DESTRUCTIVE TESTING IN THE SOVIET UNION

The paper describes the theory and operation of the electromagneto-acoustic (EMA) method of ultrasonic nondestructive testing. As a combination of the ultrasonic and eddy-current methods, EMA has some specific advantages such as: (1) noncontacting, (2) providing for simple excitation and shear wave reception normal to the surface of the item to be tested, and (3) wide thermal testing range. Data are given for the amplitudes of the first reflection of EMA ultrasound for various metals such as aluminum, copper, 30-steel, and stainless steel.

Butenko, A. I., Ermolov, I. N., and Shkarlet, Y. M. (Ultrasonics Laboratory, CNIITMASH, Moscow, U.S.S.R.), Non-Destructive Testing, Vol 5, No. 3, June 1972, pp 154-159, 7 figs., 2 tables, 30 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0036

NEW PHASE-SENSITIVE EDDY-CURRENT METHOD OF DETECTING SURFACE CRACKS IN METAL PRODUCTS: I. PHYSICAL PRINCIPLES; II. CONSTRUCTION OF FLAW DETECTOR

A method based on eddy currents and the use of a contact-type search system for detecting surface cracks in metal products is discussed. Existing eddy-current flaw detectors are unsatisfactory because of their excessive susceptibility to various interfering factors such as local surface irregularities, local fluctuations of electrical conductivity and permeability of the material, variation in distance between the tested product and the search system, etc. The proposed method takes a new approach to the problem of eliminating these interfering factors by taking into account the qualitative difference between the emf's induced in the detecting system by the flaws proper and by the interfering factors. Distinctive features of the proposed detector are: a relatively extended (with respect to crack length) and relatively narrow (in the crosswise direction) pickup system which is built into the induction coil, and a unique auxiliary device which senses the response of this system to cracks. The detector is capable of revealing cracks irrespective of changes (within quite wide limits) in the electrical conductivity and magnetic properties of the inspected products. All of these features make the detector highly sensitive to cracks in ferrous-metal products.

Vlasov, V. V., and Subbotin, Yu. S. (Institute of Metal Physics, Academy of Sciences of the U.S.S.R.), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 3, May-June 1965, pp 257-268, 12 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0037

ULTRASONIC MONITORING OF RAILWAY RAILS SET IN PLACE USING ELECTROMAGNETIC-ACOUSTIC CONVERTERS

A proposed concept for employing magneto-acoustic methods for exciting and receiving ultrasonic signals for rapid monitoring of rails that are a part of an operating railroad system is discussed. Consideration is given to the use of a mass-produced magnetic system for car inspection and its deficiencies. The electromagnetic-acoustic converter (transducer) is described and examples of oscillogram recordings of flaw dection signals are illustrated.

Vlasov, V. V., Lonchak, V. A., Glukhov, N. A., Ivanov, I. F., and Runov, I. N. (All-Union Scientific-Research Institute for Non-destructive Testing, Institute of Metal Physics, Academy of Sciences of the U.S.S.R.), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), Vol 7, No. 3, May-June 1971, pp 320-323, 4 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0038

DISCRIMINATING ABILITY OF A SUPERPOSED DETECTING SYSTEM FOR SURFACE CRACKS IN INDUCTIVE TESTING OF STEEL COMPONENTS: IV. THE DEFECTOSCOPE CIRCUIT

An approach involving the use of an electromagnetic defectoscope is described for detecting surface cracks in rolled steel components. The device is not affected by interference from decarburized and cold-worked areas. The defectoscope reacts to tangential components of the eddy-current field in the defect. The electronic equipment is described briefly and some basic electronic components parts are described according to their importance to the circuitry. The data are given in the form of holographs for bar steels with and without surface cracks.

Vlasov, V. V., Kamarov, V. A., and Kop'ev, N. A. (Institute of Metal Physics, Academy of Sciences of the U.S.S.R.), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 2, March-April 1970, pp 155-160, 4 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0039

CALCULATING THE EDDY-CURRENT COMPONENT OF THE FIELD OF A DEFECT IN THE HIGH-SPEED ELECTROMAGNETIC DEFECTOSCOPY OF RAILS

The authors provide an approximate calculation of component values associated with the eddy-current contributions to the pattern of magnetic fields when the rail inspection magnetic probe scans a rail with a transverse fissure. A schematic presentation of eddy currents in the rail head is given with a vector illustration of the magnetic-field parameters. Several examples of rail defects are shown adjacent to displays of coordinate system used for calculating the magnitude of the magnetic field. A mathematical model for determining the amplitudes and signs of three components of the eddy-current defect field is included.

Shcherbinina, V. A., Vlasov, V. V., and Dovnar, B. P., (Ural Branch, All-Union Scientific-Research Institute of Railroad Transport), The Soviet Journal of Non-destructive Testing (Translation by Scientific Information Consultants, London), Vol 9, No. 2, March-April 1973, pp 132-138, 3 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0040

EFFECTIVENESS OF NEW METHODS FOR DETECTING FLAWS IN RAILWAY TRACKS

The effectiveness of current flaw detectors was studied primarily to determine their economic advantages. Calculations were made aimed at determining the differences of effectiveness for detecting flaws between old and new methods of nondestructive testing of rails. The newer models of NDT systems were found to be 5.4 times better than the old models. Data obtained during investigation of rail conditions on the Odessa-Kishinev railway systems in 1969 are used as an example in the mathematical formulations derived for the purposes of this comparison study.

Rikel'man, I. L., and Siruk, N. M. (All-Union Scientific-Research Institute of Petroleum Processing, Kishinev), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 10, No. 2, March-April 1974, pp 230-232, 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0041

USING FERROPROBES FOR TESTING THE RAILS OF ELECTROMAGNETIC WAGON/DEFECTOSCOPES

The possibility of using ferroprobes to widen the range of operating speeds of electromagnetic defectoscopes is investigated. Parameters of the transducer for rail-defect search are given with the magnetic properties of the core and the configuration of its exciting coils. Approximate calculations and mathematical derivations are shown and data are presented graphically. A sample run was made and the defects in a rail head were tabulated. Both calculated and experimental data are shown for comparison purposes. Oscillograms of the recording of signals by the magnetic probe are included. Studies were made to determine the amplitude of signals as a function of inspection car speeds.

Shcherbinina, V. A., Vlasov, V. V., and Dovnar, B. P. (Ural Branch, All-Union Scientific-Research Institute of Railroad Transport), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 8, No. 6, November-December 1972, pp 641-647, 6 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0042

EXPERIMENTAL INVESTIGATION INTO THE DYNAMIC FIELD OF A DEFECT DURING THE HIGH-SPEED ELECTROMAGNETIC DEFECTOSCOPY OF RAILS

The results of an investigation of the magnetic field for rail defects under simulated and actual conditions by using a high-speed track inspection car are presented. The roles of magnetization and eddy currents in creating the dynamic field adjacent to the rail defect are studied and analyzed in detail. The magnetostatic and current components of the defect field were observed in the laboratory on short sections of rail heads containing transverse contact-fatigue cracks. Each of the three components of the magnetic field, measured with electromagnetic search probes, is shown. Oscillograms of transverse cracks and indications of split rails are included. Actual tests were conducted with the rail inspection car speed at between 40 and 45 km/hr.

Dovnar, B. P., Vlasov, V. V., and Shcherbinina, V. A. (Ural Branch, All-Union Scientific-Research Institute of Railroad Transport), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), Vol 9, No. 2, March-April 1974, pp 139-143, 3 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0043

BASIC PARAMETERS OF ULTRASONIC CONTROL OF WELDED JOINTS, AND THE PRINCIPLES OF THEIR STANDARDIZATION AND STANDARDIZING (SURVEY)

A detailed review of the basic parameters of the echo and mirror-shadow methods of ultrasonic defectoscopy of welded joints is provided with numerous figures and equations. For the echo method, the basic control and apparatus parameters include ultrasonic wavelength, control sensitivity, direction of probe field, accuracy in measuring reflecting surface coordinates, the ultrasonic beam's angle of admission to the metal, the dead zone, and the resolving power with respect to distance and angle. For the mirror-shadow method, three sensitivity concepts are distinguished. Methods for standardizing the basic parameters and standards for measuring those parameters, are discussed. The All-Union State Standard 14782-69, "Seams of Welded Joints. Ultrasonic Defectoscopy", is described.

Gurvich, A. K., and Kuz'mina, L. I. (Scientific-Research Institute of Bridges of the V. N. Obrastsov Institute of Railway Transport Engineers), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 6, November-December 1970, pp 635-652, 16 figs., 3 tables, 24 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0044

MEASUREMENT OF THE DAMPING OF ULTRASONIC VIBRATIONS IN THICK-WALLED PARTS

Measurement of the damping of ultrasonic vibrations is of scientific interest because such data contain useful information on elastic energy losses associated with the mechanism of absorption and dissipation of ultrasonic vibrations. In practical applications, such measurements are used in investigating structure and grain size of polycrystalline materials. The authors describe a method of determining the damping constant by analyzing the spectral density of a series of multiple reflected pulses (spectral representation). This method is recommended for determining the damping constants when: (1) the accuracy in measuring small damping constants by conventional methods is low because of interference phenomena in the zone close to the transmitter; (2) the condition of a monochromatic pulse signal is difficult to achieve with conventional methods; and (3) developing automatic devices for detecting structural heterogeneities of a material under industrial conditions.

Tokarev, V. A., and Gitis, M. B. All-Union Scientific-Research Institute of Nondestructive Testing, Kishenev), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 2, March-April 1969, pp 211-214, 2 figs. 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0045

RESULTS OF INDUSTRIAL TESTS OF A MAGNETIC METHOD OF ON-LINE MONITORING OF THE HARDNESS AND STRENGTH LIMIT OF VOLUME-HARDENED RAILS

Prototype industrial equipment for continuous magnetic monitoring of the hardness and strength limit of rail heads was used to inspect more than 150 rails from one production run, plus 25 test rails subjected to heat treatment intended to give deviations from normal technology. Inspection data on hardness, strength, and magnetic properties are tabulated. Using the methods of correlation analysis, it was found that the nondestructive method of determining strength properties by means of previously magnetized rails heated to 400 C and subsequently measured for residual magnetic field has an error not exceeding the error of standard methods for testing for strength properties.

Tomilov, G. S., Rabinovich, D. M., Vinokurov, I. Ya., Kompaniets, G. M., Aronson, E. V., Pichkalev, V. A., and Slobtsova, N. A. (Institute of Metal Physics, Academy of Sciences of the USSR., V. I. Lenin Nizhnii Tagil Metallurgical Combine), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 5, September-October 1969, pp 642-644, 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0046

INDUCTION DETECTION OF SMALL SURFACE FLAWS IN STEEL PARTS

The principles associated with eddy-current nondestructive testing of steel parts are discussed with regard to the detection of surface flaws and shallow defects. The circuitry for the eddy-current method is discussed and shown. Illustrations are presented for components with defects where clear registrations are revealed on waveform signals. A slot-type transducer was found to exhibit the greatest sensitivity to defects and to produce the least interference. A step-by-step procedure is described for operation of the test equipment. It is concluded that this technique permits the observation of defects to depths of 1 to 2 μm, and that it is fairly reliable despite the poor correlation between the depth of the defect and the signal magnitude.

Burtseva, V. A., and Vlasov, V. V. (Institute of Metal Physics, Ural Scientific Center, Academy of Sciences of the U.S.S.R.), The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 1, 1974, pp 99-101, 2 figs., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0047

ULTRASONIC RAIL INSPECTION CAR

The development of a rail inspection car equipped with an ultrasonic rail reflectoscope is described. Details of the rail detection system are given along with sample waveforms derived from signal processing.

Nakamura, H. (Japanese National Railways), Japanese Railway Engineering, Vol 7, No. 3, September 1966, pp 14-15, 5 figs., 1 photo.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineers' Association (repr., PC).

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0048

ULTRASONIC RAIL FLAW DETECTOR

The article describes ultrasonic rail flaw detectors used by JNR and the kinds of rail inspections scheduled. A table of features, a wiring diagram, and photographs provide details of the portable-type detector (structurally the same as the large type). JNR schedules two kinds of inspection: (1) general inspections in which the detector is mounted on a frame and, while traveling on the rail, performs an overall inspection; and (2) minute inspections in which the detector is dismounted and, using the 37° search arm alone, performs flaw detection around the bolt hole. Examples of flaws detectable by each search arm are illustrated. Rail inspection with this detector is characterized by high detection rate, high penetration, and high reliability, but it has the drawback of being confined to the area of search-arm application. Several problems, including dimensional reduction of search arms and usage techniques, require further work.

Murayama, H. (Japan National Railways), Japanese Railway Engineering, Vol 11, No. 2, 1970, pp 28-30, 2 figs., 2 photos, 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineers' Association (repr., PC).

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0049

APPLICATION OF AC BIAS TO THE MAGNETIC TAPE METHOD OF INSPECTING BILLETS

Some of the problems associated with the utilization of the magnetic tape method for defect inspection of square steel billets are reviewed, and the effect of adding AC bias to the recording process is discussed. The method consists of placing a magnetic tape in contact with the billet surface while an electrical current is flowing in the billet. The leakage fields caused by inherent defects are then imprinted on the tape. Graphical illustrations of the defect leakage fields as functions of defect depth, magnetizing current, and defect placement are given. The advantage of using AC bias is that all defects, regardless of their position on the billet can be recorded at lower levels of magnetizing current. Graphs show comparisons between the biased and unbiased approaches.

Lorenzi, D. E., Aguilu, G. E., and McClurg, G. O. (Magnaflux Corporation, Chicago, Ill.), Materials Evaluation, Vol 26, No. 1, January 1968, pp 13-16, 12 figs., 1 table.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0050

DETECTION OF RAIL FAULTS ON SNCF

Methods of nondestructive testing utilized by the French National Railways (SNCF) are described for rails in service. Rail testing vehicles carrying ultrasonic and magnetic transducers detect and monitor failures in rail heads to ensure replacements prior to breakage. Rail surface fractures normally comprise: (1) transverse cracks due to wheel burn in the area of maximum shearing stress, (2) horizontal or vertical longitudinal and transverse cracks in rail heads or electrically-welded joints, (3) transverse cracks under areas built up by welding, and (4) horizontal and transverse shelling cracks.

Deutsch, R. (French National Railways), The Railway Gazette, Vol 125, No. 12, June 20, 1969, pp 459-464, 3 figs., 6 photos, 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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0051

RAILS ARE CLASSIFIED, TESTED AUTOMATICALLY

A Sperry-designed, ultrasonic system, installed on the L&N at Nashville, sorts and tests new and relay rails. Internal flaws, kinks, bends, and wear are detected and information fed automatically into the computer system which activates warning signals and ejecting devices. The cleaned rail, varying in length from 25 to 39 ft and in weight from 90 to 155 lb, travels through the detection system via conveyor at a rate of 120 ft/min. Rails failing the kink and bend specifications are straightened and retested. Rails cannot indicate wear of more than 1/2-in. in any dimension. The rails which pass the wear test are separated into three groups by degree of wear so they can be matched for future use. The internal flow test utilizes two roller search units each containing three transducers. The search units locate transverse defects, detail fractures, engine-burn fractures or transverse separations from thermal cracks, horizontal and vertical split heads, head and web separations, and joint defects. Defects are marked automatically with a paint spray. One person can monitor the entire inspection system.

Railway Track and Structures, Vol 67, No. 7, July 1971, pp 20-22, 1 fig., 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

0052

RAIL DEFECT TESTING IN THE UNITED STATES

Railways with high standards of rail testing and rail maintenance have had the least number of accidents. During the past 20 years, Sperry Rail Service has tested nearly 300 million rail joints by ultrasonic techniques. A Sperry fleet of 25 self-propelled magnetic-inductance rail testing cars monitors over 130,000 miles of track in the USA annually. The number of detected defects from 1940-67 is presented graphically. The defects are classified as joint defects, transverse defects, defective rails, and longitudinal and miscellaneous defects.

The Railway Gazette, Vol 125, No. 5, March 7, 1969, pp 180-182, 184, 4 figs., 3 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr. PC).

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0053

ELECTRONIC EQUIPMENT TO ESTIMATE THE STANDARD DEVIATION OF TRACK IRREGULARITIES

Electronic data processing equipment to perform statistical analyses of data accrued from track inspections is described. Some of the equipment used in the Japanese track inspection car, MAYA 341 is shown. Data obtained during inspections of the Tokaido line are used to illustrate the output format of the data processing equipment. It is concluded that the mean value of track irregularity depends on slack and cant as well as on other factors.

Nakamura, I., and Wada, K. (Japanese National Railways), The Railway Technical Research Institute, JNR, Quarterly Reports, Vol 6, No. 3, 1975, pp 27-28, 5 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr. PC).

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0054

ULTRASONIC FLAW DETECTION TRAIN ON THE DB (GERMAN FEDERAL RAILWAY)

The German Federal Railway track inspection car has been used to test over 12,000 miles of track annually in Western Europe. The first test vehicle, used in 1956, was capable of inspecting 6 km of track per day. The present test vehicle travels at the rate of 40 km/hr, however, testing speeds up to 60 km/hr have been used. The test car design utilizes the concepts of ultrasonic pulse-echo techniques. Successive displays appear on a screen and are reproduced in permanent form on rolls of photosensitive paper or film driven from one of the axles of the test car. The test car is equipped to develop or process the film immediately. Types of flaws observed on the cathode-ray tube display consist of oblique and transverse cracks and fissures in the head and web regions. Examples are given which show oscilloscope traces of signals indicating the presence of web cracks and bolt-hole irregularities.

The Railway Gazette, Vol 124, No. 1, January 5, 1968, pp 29-32, 5 figs., 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Science & Technology Press, Ltd., IPC Inc. (repr., PC).

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0055

DETERMINATION OF THE RESOLVING POWER AND ULTRASONIC FREQUENCY OF ANGLE-BEAM TRANSDUCERS

The resolving power of a 2-MHz, 70-degree probe and a 4-MHz, 45-degree probe is given. A steel IIW calibration block with two converging buttress grooves, which are 10.5 to 0.5 mm apart and 0.75 mm deep, was used in the test. The resolving power can be determined from the pulse width without the use of the test block; however, use of the test block is advantageous because different angles of incidence can be used.

Bosselaar, H., and van Bokhorst, E. (Konin Klyke/Shell-Laboratorium, Amsterdam, Holland), Non-Destructive Testing, Vol 4, No. 6, December 1971, pp 382-384, 4 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0056

ON-SITE ULTRASONIC RAIL TESTING

The evolution of the ultrasonic, hand-held detectors developed by the Deutsche Bundesbahn is discussed. The most recently developed detector, which weighs 30 lb, contains probes to test the two rails simultaneously for longitudinal as well as transverse failures. It can be operated by one man while testing 6 to 8 km of rail in a work day. Rail test cars are used once a year to test tracks with an average daily load exceeding 40,000 tons. The measuring unit for the test car is similar to that used in the hand-held device. The test car is operated at a speed of 30 km/hr. Ultrasonic pulse repetition rate is 3.5 kHz, compared to the 100 to 1000 Hz of the hand-held devices to give as high an information density as possible. Eight transmitters are used to differentiate signals. Failure reports are generated as the rail defects are detected. An average daily work load by an experienced operator is examination of 15 km of track.

Block diagrams, schematics, recordings, and photographs of the various detector devices are given in the article.

Egelkraut, K. (Deutsche Bundesbahn, Minden, West Germany), Non-Destructive Testing, Vol 1, No. 5, August 1968, pp 297-305, 19 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0057

A PRELIMINARY STUDY OF THE EFFECT OF DEFECT SHAPE AND ROUGHNESS ON ULTRASONIC SIZE ESTIMATION

Investigations concerning attempts to develop defect shape references on surface or planar inspection by using ultrasonic flaw detectors are described. Experimental work and analysis of data were aimed at exploring the hypothesis that a defect can be measured qualitatively by scanning with an ultrasonic probe and detecting the point where the amplitude of the reflection falls below a chosen value on a flaw detector screen. The instrumentation is described with block diagrams, and some comparative results are shown graphically for different sizes of artificial defects scribed on the surfaces of half-round and flat steel bars. Contrasts between output amplitudes and degree of defect shape and depth are shown with indications that some qualifications and references can be established between rough, medium coarse, and smooth surface defects.

Silk, M. G., and Lidington, B. H. (Atomic Energy Research Establishment, Harwell, England), Non-Destructive Testing, Vol 8, No. 1, February 1975, pp 27-31, 11 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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0058

ON THE ULTRASONIC DETECTABILITY OF THIN SLAG INCLUSIONS IN STEEL PLATES

Ultrasonic detection of thin slag inclusion layers in rolled steel is considered possible, and investigations along theoretical and experimental lines are discussed. Mathematical derivations are provided using Rayleigh's theory, and an analysis of reflection and transmission coefficients as functions of the slag steel indicates that air-filled cracks or gas inclusions can be detected. Laboratory investigations demonstrated the feasibility of detecting thin layers of slag inclusions in steel plates even though the slag has an acoustic impedance very similar to that of steel. From the laboratory tests, it was concluded that there was always a thin layer of gas or vacuum associated with the slag. Echo ratios as a function of reflection coefficients are shown graphically, and some microphotographs of the test samples are given.

Szilard, J. (University of Birmingham, Birmingham, England), Non-Destructive Testing, Vol 1, No. 1, August 1967, pp 45-47, 4 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0059

NEW REFINEMENTS FOR RAIL-DETECTOR CARS

The article describes refinements and improvements in the ultrasonic systems in the Sperry Rail Service rail-flaw detector cars, particularly the introduction of additional ultrasonic channels and an electronic data processing system which is programmed to indicate web defects of a pre-set size by an alarm system. The ultrasonic systems installed in Sperry cars beginning in 1959 are reviewed. Simple diagrams illustrate the system for detecting centrally located transverse defects in rail heads and the separate system for detecting web defects in joint-bar areas.

Railway Track and Structures, Vol 62, No. 5, May 1966, pp 24-25, 2 figs., 1 photo.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0060

ACOUSTIC EMISSION - 5: APPLICATIONS OF ACOUSTIC EMISSION TO INDUSTRIAL PROBLEMS

This paper presents examples of non-destructive techniques drawn from literature sources for detecting flaws, and quality control methods useful in industrial applications. Comparisons of acoustic emission response and photomicrographs of welds are shown for purposes of comparison where each weld had different formations and contamination. The results of acoustic emission tests for panels are discussed and comparisons are drawn between ultrasonic scan test records and those that used holography. Dynamic pressure vessel tests are also mentioned in which acoustic emission scanning was performed to observe indications of fatigue-crack initiation and propagation.

Harris, D. O., and Dunegan, H. L. (Dunegan/Endevco, San Juan Capistrano, Calif.), Non-Destructive Testing, Vol 7, No. 3, June 1974, pp 137-144, 13 figs., 23 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0061

AUTOMATIC INSPECTION OF STEEL BILLETS

The Billetscan system for automatic inspection of hot-rolled steel billets at Republic Steel Corporation is described. This eddy-current system was put into service in 1969. The predecessors to this system in use at Republic are briefly discussed. The Billetscan system has the ability to inspect the entire surface, including corners, in one pass with a single probe and electronic circuit. The probe must maintain relatively constant spacing with the surface to be inspected and be tangent to the surface; the space is normally 0.040 in. Shape and size of the billets can vary widely. High speed is possible; one probe can cover between 70 to 160 ft/min. Defects are marked automatically. Calibration is quick and convenient, and maintenance is relatively low.

Black, W. A. (Republic Steel Corporation, Cleveland, Ohio), Non-Destructive Testing, Vol 4, No. 5, October 1971, pp 323-329, 11 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0062

ACOUSTIC EMISSION ENERGY AND MECHANISMS OF PLASTIC DEFORMATION AND FRACTURE

The author describes experimental and theoretical work on acoustic emissions from plastic deformation and fracture of various test pieces. The concern here is that the limited knowledge of the significance of parameters, such as total count, to characterize the emissions hinders the use of acoustic emission as a non-destructive test technique by industry. Chemical composition of a 12-mm-thick steel plate used in the tests is given, and photomicrographs of the specimens are shown prior to and after the detection of fractures. Emission characteristics are presented in graphic form. The graphic illustrations which show the total count as a function of displacement reveal significant jump and arrest in fracture propagation that is shown by the sudden release in acoustic emission. Ductile fracture mechanics is discussed and some study results are shown.

Mirabile, M. (Centro Sperimentale Metallurgico, Rome, Italy), Non-Destructive Testing, Vol 8, No. 2, April 1975, pp 77-85, 17 figs., 2 tables, 21 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0063

NON-DESTRUCTIVE TESTING IN INDUSTRY, THE BRITISH STEEL CORPORATION

This article, the third in a series on nondestructive testing in industry, outlines the present role and future course of nondestructive testing in British Steel Corporation's four product divisions - Special Steels, Strip Mills, General Steels, Tubes - with their multiplicity of products. The organizational philosophy is that ideally NDT systems should be fully integrated into the production flow lines, particularly when NDT is used for quality control where rapid information feedback is essential. NDT techniques are used for checking product parameters, detecting material conditions likely to be detrimental to satisfactory service, customer acceptance testing, and inspecting items of production equipment on a planned maintenance basis. There are brief discussions of the selection of NDT techniques and relationship with other testing methods, some achievements and problems, information feedback, acceptance standards, management and economics, and research and development. NDT systems discussed are those that utilise eddy-current, ultrasonic, and radiological concepts. Photographs showing the various stages of quality control and acceptance testing are included.

Lewis, R. (British Steel Corporation, Corby, England), Non-Destructive Testing, Vol 4, No. 6, December 1971, pp 391-395, 4 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0064

THE CALIBRATION OF EQUIPMENT USED IN ULTRASONIC FLAW DETECTION IN STEEL

The performance of the following types of ultrasonic calibration blocks is compared in the determination of probe index and beam angle of shear-wave probes: IIT Post-1957, IIW Pre-1957, IIW 1954 aluminum, CERL proposed block, Sulzer block, rectangular block with hole, hemisphere, British Standards Block (1/2 in. thick), 1- and 2-in.-thick plate. The probes used had nominal beam angles of 45, 60, and 75 degrees, and frequencies of 1.25 and 2.25 MHZ. The differences existing between the results obtained for probe index and beam angle for the various types of block are believed caused by experimental error, differences in block material, differences in block shape, and nonhomogeneous beam conditions.

Legge, R. D., and Carson, H. L. (Central Electricity Research Laboratories, Leatherhead, England), Non-Destructive Testing, Vol 1, No. 1, August 1967, pp 35-44, 20 figs., 7 tables, 14 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0065

STRESS AND THE ULTRASONIC DETECTION OF FATIGUE CRACKS IN ENGINEERING METALS

An investigation of surface fatigue cracks induced by tension-tension loading flat plates of steel, titanium, and aluminum alloys in a [illegible]int bending configuration at a frequency of 28 Hz and under constant load and R-factor is described. The effects of material properties and fatigue parameters on the detection of fatigue cracks by ultrasonic methods are discussed. Results indicate that the size of fatigue crack detectable on an assembled structure by ultrasonic shear wave or delta-scan depends on material type, crack-growth history, the amount of creep or stress relaxation, and the induced stresses due to the weight of the assembled structure and other induced stresses such as those resulting from interference fitted fasteners.

Yee, B.G.W., Couchman, J. C., Hagemeyer, J. W., and Chang, F. H. (General Dynamics, Convair Aerospace Div., Fort Worth, Texas), Non-Destructive Testing, Vol 7, No. 5, October 1974, pp 245-250, 10 figs., 3 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., (PC).

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0066

ON THE LIFE OF RAIL

In 1963 rail end breaks accounted for more than 60% of JNR rail failures. Such breaks occurred more frequently in tunnels as a result of conditions conducive to corrosion. End breaks usually occur as the result of rail fatigue. Rail stress varies according to train speed, wheel load, lateral force, and position of wheel contact on the rail. An equation is given from which the total number of stress actions inducing fatigue fracture may be calculated. Stress measurements at rail ends indicate that: (1) when joint bolts are loosened, local rail stress increases greatly; (2) if joint bolts are tightened, stress is not so great; and (3) local stress increases proportionally with axle load. The influence of worn rail head as well as rail-head height and a new rail design are briefly discussed.

Setoh, Y., and Sato, Y. (Japan National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 7, No. 1, 1966, pp 28-31, 9 figs., 1 table.

ACKNOWLEDGMENT: Battelle Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0067

THE RAIL FOR HIGH INTENSITY MINERAL TRAFFIC

As a result of the mining boom of Australia, there has been increased pressure on railway transportation to handle large tonnages of mining products in long, heavy trains. Consequently, there has been some damaging effects on both rail and wheel structures. The article discusses the problems encountered in terms of shear stresses, fatigue, rail yield strength, and wheel/rail contact pressures. Tables and curves presented show wheel/rail contact pressures and rail yield strengths of various ore-hauling railways, maximum shear-stress profile under new wheel and new rail conditions, rail fatigue life, and some economic data.

Read, R. G., (Minenco Pty. Ltd., Mining & Engineering Consultants, Melbourne, Vic., Australia), American Railway Engineering Association, Bulletin 639, Proceedings, Vol 74, September-October 1972, pp 38-51, 9 figs., 8 refs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0068

STRESS ANALYSIS OF RAILS

This paper describes the experimental stress analysis of a range of rail sections carried out by means of a loading frame which accommodated a short length of track, hydraulic jacks with load cells, and electrical-resistance strain gages. The most detailed test was that of the British Standard 110A rail which after being tested "as rolled" was successively tested at states representing six stages of rail-head wear, simulated by planing the rail head. The stress ranges determined under various loading conditions were compared with those for a bullhead rail planed to represent its known safety limit of wear and gave a guide to the permissible head wear of the rail from stress criteria. The B.R. 116 thick web rail was tested for comparison with the B.S. 110A, and rails representing three weights of the new B.S.A series were compared with three of the older B.S.R.-series rails of the same weights. The relationships between rail weight, head wear, and fillet stresses, and the effect of different fastenings are discussed. Photographs and schematic diagrams of the loading frames are shown, as well as the placement of strain gauges. Data are tabulated giving upper and lower fillet stresses for vertical and lateral loads.

Babb, A. S. (United Steel Companies Ltd., Swinden Labs., Rotherham, England), Proceedings of the Institution of Mechanical Engineers, Part 1, Vol 180, No. 41, 1965-1966, pp 949-969, 21 figs., 6 tables, 15 refs., 1 appendix.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0069

THE THERMAL ELONGATION OF RAILS ON ELASTIC MOUNTINGS

Elongation and contraction of rails, which occurs as a result of temperature changes, represents one of the principal factors affecting the variation in length of rails and their associated strains and stresses. A step-by-step analysis of longitudinal loads on elastic rail mounting is presented in the first section of the report and, in the second section, a theory is developed in which the elasticity, as well as the creep resistance of rail mountings is assumed to be continuously distributed along the rail. The results obtained in Section II are applied to a practical case (the Delft Viaduct in Holland), and the numerical parameters given for this track are used to calculate rail displacement and rail forces, as well as rail mounting loads for a 10 C temperature rise, as can be recorded in practice, compared with the "as filled" unstrained state. The calculations are repeated for a hypothetical temperature rise of 30 C.

Varga, O. H. (Seetru Limited, England), American Railway Engineering Association, Bulletin 626, Proceedings, Vol 71, February 1970, pp 621-643, 3 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0070

STRESS DISTRIBUTION IN THE PERMANENT WAY DUE TO HEAVY AXLE LOADS AND HIGH SPEEDS

Theoretical and experimental consideration of the following were undertaken in this investigation: (1) shear stress distribution in the rail head and in the ballast, (2) tensile bending stresses in the rail head and lateral forces, (3) tensile bending stresses in the rail foot, and (4) measured deflections, stresses, and vibrations.

On the basis of the data obtained from the investigation, the German Railways developed a new type of permanent way comprising prefabricated concrete slabs mounted on a subbase which protects the subsoil from frost penetration. Usual type rails are fastened to the slabs, and a soft rubber pad is placed between the slab and rail to act as a substitute for the elastic properties of ballast. The damping characteristics of the pads and the mass of the slab prevent the vibrations and do not permit diminishment of the subgrade's bearing capacity.

Measurements taken at a test track using this type of structure show that the scattering of stresses in the rail is quite small, e.g., standard deviation for the stress at the rail foot is as low as 5 to 10 percent. Moreover, it does not vary with the driving speed. In addition, the tests show that the track requires no maintenance for a long period, thus, it is very well suited to high driving speeds (>120 mph) and large axle loads.

It is concluded that the use of concrete, cast in place, decreases costs when building new track, and a continuously reinforced concrete slab should perform especially well.

Eisenmann, J. (Technical University of Munich, Munich, West Germany), American Railway Engineering Association, Bulletin 622, Proceedings, Vol 71, September-October 1969, pp 24-59, 29 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0071

STRESS DISTRIBUTION IN TRACK STRUCTURE

This study, undertaken for the Canadian National Railways, involved investigation of soil characteristics and conditions on a 103-mile long Canadian National Railway line in Western Canada to determine their effect on track structure performance and to recommend corrective measures to meet increased track loading conditions.

The test program assessed the performance of the track structure in terms of the rail stresses, the deflection of the ballast, and the deflection of the subsoil. Five variables were included: weight of rail, thickness of ballast, density of ballast, quality of ballast (the performance of crushed gravel was compared to that of pit-run gravel), and weight of traffic.

The study points up the necessity to consider all elements of the track

structure in assessing the effect of increased traffic, and shows that modern techniques of soil mechanics and instrumentation now available can greatly assist in predicting the performance of track structure.

Numerous graphs and charts are included.

Hardy, R. M. (University of Alberta, Alberta, Canada), American Railway Engineering Association, Bulletin 614, Proceedings, Vol 69, June-July 1968, pp 924-940, 11 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0072

HEAVIER CAR LOADS PUT NEW PRESSURE ON TRACK UPKEEP

The effect on track and rail structures of the use of heavier freight cars and the various problems encountered with their use are discussed. A committee was appointed by the Association of American Railroads to develop recommendations for the maximum weight of car that can be handled as a general interchange car, taking into consideration both mechanical and engineering factors. As a result of the study, weights of rail in all main tracks for Class I railroads have been compiled and are presented in this article. Suggestions are advanced as to the type of track inspection that is vital to promote rail safety. Information is included on the demands of rail loads between 1920 and 1970. Various aspects of the rail strength are discussed such as rail modulus, and bending strength and its relation to rail weight. Welded rail is highly favored to eliminate bolted joints and to provide adequate bending strength.

Magee, G. M. (Association of American Railroads, Chicago, Ill.), Railway Age, Vol 164, No. 11, March 11, 1968, pp 28-30, 4 figs., 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp., (repr., PC).

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0073

ULTRASONIC MEASUREMENT OF STRESS IN RAILROAD WHEELS AND IN LONG LENGTHS OF WELDED RAIL

Stress-related failures that occur as the result of seasonal variations of temperature and emergency braking of high-speed trains are emphasized to highlight the need for reliable nondestructive measurements of stress in thick steel. An applicable method using ultrasonic velocity measurements is described in this report. Problems occurring with material variability transducer coupling techniques and calibration procedures are discussed. Locations of transducers on rail-head segments are pictorially shown. The stress constants for selected rail-head specimens are tabulated.

Clotfelter, W. N., and Risch, E. R. (NASA-Marshall Space Flight Center, Alabama), Report No. NASA TM X-64863, for NASA, Washington, D.C., July 1974, 29 pp, 13 figs., 9 tables, 5 refs.

ACKNOWLEDGMENT: NASA-Marshall Space Flight Center.

PURCHASE FROM: NTIS, (repr., PC, microfilm), N74-31359.

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0074

ELECTROACOUSTIC TRANSDUCER FOR CONTACTLESS EXCITATION OF ULTRASONIC OSCILLATIONS IN METALS AT HIGH TEMPERATURES

The limitations associated with the use of piezoelectric transducers in materials studies are briefly discussed. A diagram of an acoustic transducer for contactless excitation of metals at temperatures on the order of 1000 C is shown, and a graph that displays the function of temperature and signal amplitudes is presented.

Kruglov, L. D., Shkarlet, Yu. M., Bertman, A. A., and Smyrev, G. D. (A. A. Baikov Institute of Metallurgy, Academy of Sciences of the U.S.S.R.), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Consultants Ltd., London), No. 6, 1972, pp 750-751, 3 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0075

THE POTENTIAL OF SCATTERED OR DIFFRACTED ULTRASOUND IN THE DETERMINATION OF CRACK DEPTH

An investigation aimed at exploring a technique for determination of crack depth in metal structures is discussed. The primary concern was to compare results reported by Bottcher, et al., and those observed in a parallel experiment performed by a Harwell team. The apparatus and instrumentation used in both instances are described and judged reasonably similar. The data are presented by a series of graphical illustrations based on the relationship between the relative signal amplitude and the crack depth. Some consideration is given to the influence of inclusions adjacent to a crack which tends to affect the scattered ultrasound significantly. It is concluded that the scattering approach developed by Bottcher, et al., appears to be a valid technique for determining crack depth in high-quality steels, but unsatisfactory for use with lower quality materials.

Silk, M. G., and Lidington, B. H. (Atomic Energy Research Establishment, Harwell, England), Non-Destructive Testing, Vol 8, No. 3, June 1975, pp 146-151, 14 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0076

INVESTIGATION OF CONTACTLESS METHODS FOR EXCITING AND RECORDING ULTRASONIC VIBRATIONS

Theoretical computations and descriptions of the construction of converters for contactless excitation and reception of ultrasonic vibrations in metals are presented, and directivity diagrams for electromagnetic and piezoelectric converters are experimentally evaluated. A current filament, windings, and a flat spiral coil are the excitation sources considered; and capacitive and inductive methods for contactless recording of ultrasound, and the problems relating to their use are investigated. The authors conclude that they have succeeded in establishing the mechanisms for contactless methods of exciting and recording ultrasonic vibrations in metals, but that the problem is complex and requires further study.

Sazonov, Yu. I, and Shkarlet, Yu. M. (Central Scientific-Research Institute for Machine-Building Technology), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants Ltd., London), No. 5, 1969, pp 509-517, 3 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0077

INFLUENCE CHART FOR MOMENTS IN RAILWAY RAILS

A graphical method for determining moments in rail, developed by the author, is described. The method is based on a beam-on-an-elastic-foundation analysis and is implemented by calculating a number of parameters including wheel loading, rail modulus of elasticity, moment of inertia, modulus of rail supports, and the distance between loads. An example, using 132-lb rail, is given. Moment influence charts and diagrams are included.

Martin, G. C. (University of Illinois, Urbana, Ill.), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1968, pp 710-718, 9 figs., 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0078

RAILWAYS WHEEL NDT AT 30 MPH

Defect detection in railway wheels has been accomplished by an automatic ultrasonic inspection system (Wheelfax, developed by Scanning Systems, Inc.). The inspection unit fits into a special rail assembly. As a wheel passes over the unit, measurements reflect thermal and fatigue cracks in tread, flange, rim back or rim front face, excessively thin wheel rims, excessive wheel wear, and high flanges. The signal outputs from the unit can be used to operate spray paint guns, alarms and recorder chart pens, or computerized identification systems. The disadvantage of this concept is that the system only indicates that a defect exists; no precise location or size of the defect is indicated. Graphs are presented which show the signal outputs of two transducers used in the pulse-echo and through-transmission modes of operation.

Ultrasonics, Vol 12, No. 6, November 1974, pp 239-241, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science & Technology Press, Ltd. (repr., PC).

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0079

HARD-CASE RAIL

After Union Carbide Corporation's Linde Division opened its first plants for flame hardening rail in 1963 and 1964, a decision was made to act on a suggestion by the AAR research staff that it might be advisable to produce a hardness pattern with a greater depth in the rail head. In order to do further intensive study and research into the process as well as plan and put into practice extensive revisions of plants, production equipment, and techniques, the company shut down the three plants until late in 1965. Results of laboratory tests on rail produced in the reopened plants are briefly discussed.

Railway Track and Structures, Vol 61, No. 11, November 1965, pp 22-23, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0080

CORROSION PREVENTION OF TRACK MATERIALS

The results of five-year anti-corrosion tests of tie plates with reference to corrosive wear and electrolytic corrosion of track materials are outlined. Corrosion-prevention techniques involving zinc-base paint, nylon lining, molten zinc plating, and the use of stainless steel were used. The tie plates tested were laid in tunnels used by electrified and nonelectrified lines. Corrosive wear, expressed in terms of weight loss, is greatest in tunnels of nonelectrified lines. Nylon-coated, chromium-impregnated tie plates exhibited excellent performance, and a considerable extension of service life is expected. Rail wear environments in Great Britain in various rail tunnels are shown/graphically.

Kose, Y. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 11, No. 3, 1970, pp 129-136, 6 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0081

THE RAIL SHELLY CRACK IN JAPAN

In 1952, Sanyo Trunk Line rails developed shelly cracks peculiar to Japan: "the rail crack with the black spot caused by the repeated rolling of wheels under heavy load". To establish the mechanism of shelly crack occurrence and growth, extensive studies were undertaken of track and operating conditions, friction and wear, the effects of watering and sanding, rail steel quality, and wheel contact stress on rail surface. In discussing methods of prevention, recommended practices include: (1) heat treating rail, (2) decreasing differences of curvatures in the contact part of wheel and rail, and (3) totally eliminating or using restraint in watering and oiling the rail.

Nakamura, R., Owaku, S., and Enomoto, N. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 6, No. 3, 1965, pp 34-44, 21 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0082

UNIT TRAINS AND THE TRACK; THE PROBLEMS AND THE ANSWERS

There are special rail requirements for areas where unit trains are operating because of the increased load factor. Superelevated curves are a particular point of high rail wear. Good results have been obtained with 123 to 140-lb CWR for straight track and 78-ft rail for curves exceeding 3 degrees. For curved track, high-silicon or fully heat-treated rail is suggested. The heavy wheel loading and uniformity of unit-train equipment increases rail corrugation and shelling. Rail grinding, lubrication, and frequent inspections are suggested to maintain the rail.

Railway Track and Structures, Vol 70, No. 10, October 1974, pp 22-23, 26, 1 photo.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0083

STUDIES ON CORROSION FATIGUE BY POTENTIAL MEASUREMENT

Fatigue testing of mild steel specimens in air and a corrosive medium of sodium sulfate was conducted at the Japanese Railway Technical Research Institute. During the testing, the corrosion potential of a specimen was recorded and the rate of corrosion was determined by colorimetric analysis of the waste solution for iron content. In Japan, the number of rail corrosion fatigue occurrences inside tunnels is several times that occurring outside tunnels.

Kose, Y., and Ogawa, Y. (Japan National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 8, No. 1, 1967, pp 3-6, 5 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Japanese National Railways.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0084

PRODUCING 78-FT RAILS IN CANADA

The long-rail production facility at Sydney Steel Corp., Sydney, Nova Scotia, is described. Vacuum degassing is used to reduce the hydrogen gas content in the molten steel to eliminate shatter cracking. Vacuum degassing is also expected to yield more uniform casting temperatures, improved chemical homogeneity, and greater steel cleanliness. A flow chart and description of the vacuum degassing system are given. Production-line inspections are carried out visually and ultrasonically. The ultrasonic equipment measures the rail length, and two probes on the rail head and two probes on the web test for shatter cracks, pipe cavities, and nonmetallic inclusions at the web ends. This document is in the Railroad Research Bulletin as RRIS No. 072815.

Railway Track and Structures, Vol 70, No. 4, April 1974, pp 24-26, 1 fig., 1 photo, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0085

HOW THE UP FIGHTS SHELLY RAIL WITH SPECIAL TIE PLATES

This article reviews efforts by Union Pacific in combatting shelly rail which is a condition mainly affecting outer rails on curves. The shelly condition results from the flow of metal brought about on the gauge sides of rails by heavy loads imposed by wheels. Special Hi-Cant tie plates used in conjunction with flame-hardened rail, known as Hi-Si rail, have been effective in reducing the incidence of shelly rail in both curved and tangent track.

Railway Age, Vol 170, No. 9, May 10, 1971, pp 36, 60, 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0086

END-HARDENED RAIL

Specifications for end-hardening 40N and 50N rails are given. Four heat treatments and three variations of hardened lengths were tried and compared. Prototype test results are shown graphically for spray quench hardening with medium-frequency induction heating. All heat treatments tested satisfied the specifications. Service testing was done on the Tokaido Line after a traffic passage of 70 million tons. The wear of the end-hardened rail was definitely improved over that of common rail. Of the hardened lengths tested (40, 100, and 300 mm), 100 mm was best.

Katayama, M. (Japan National Railways), Japanese Railway Engineering, Vol 9, No. 4, December 1968, pp 17-19, 3 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0087

NEW WAY TO FIGHT RAIL SHELLING

Rail shelling begins when car wheels concentrate pressure on a narrow area of the rail near the upper limits of the gauge corner. The intense pressure at this point is forced, by transmission of wheel load, on and through a diminished contact area. Studies by Western Pacific personnel which led to the development of special tie plates with an unusually high angle of cant (Hi-Cant patent) to reduce shelling are described.

Railway Age, Vol 166, No. 5, February 10, 1969, pp 21-23, 2 figs., 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0088

HYDRAULIC TENSIONING OF CONTINUOUS WELDED RAIL

The GTG (Greenside Thompson Group) rail tensor equipment is discussed as a rail maintenance technique. The hydraulic destressing equipment has the capability to adjust rails to counteract rail creep, to push rail joints apart for fish plate and end post replacements without special attachments, and to hold continuous welded rail during cutting operations.

MacLeod, N. J. (British Railways), and Martyn, P. H. (Greenside Hydraulics Ltd.), The Railway Gazette, Vol 125, No. 1, January 3, 1969, pp 31-33, 2 figs., 3 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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0089

LD RAIL (PURE OXYGEN-BLOWN CONVERTER STEEL)

Production statistics for LD (Linz and Donawitz process) steel for Japan and the world are given for FYs 1955 through 1967, and the steps for LD steel production are illustrated. Chemical composition, surface defects, and mechanical properties of LD and OH (open hearth) rail steels are compared. The carbon and manganese contents of trial LD steel for 50N rail were slightly higher than in OH steel rails, to compensate for the possible loss of hardness and hardenability by reduced levels of the floating elements, nickel and chromium. Surface defects were equal for both types of rail steel. LD steel exceeds OH steel in tensile strength, fatigue strength, hardness, and Charpy impact. Since the brittle transition temperature for LD steel is about 20 C lower than for OH steel, the LD steel has better low-temperature characteristics.

Ban, Y. (Japan National Railways), Japanese Railway Engineering, Vol 9, No. 2, March 1968, pp 6-9, 5 figs., 7 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0090

SIGNIFICANCE OF A DETECTION OF DEFECTS IN RAILS

The principal types of rail defects are described and indication is made of those rail flaws which are due to: (1) manufacturing processes, (2) installation errors, and (3) applied rail dynamic loads and service conditions. The types of defects discussed are rail piping, split head or web defect, star crack failure, fractures of broken thermit welds, transverse fractures, wheel burn cracks, shelling, and rail lapping. The principles of resonance and pulse-echo techniques of ultrasonic flaw detection as applied to rails are reviewed, along with descriptions of manual and vehicle mounted types of equipment. Current rail testing programs at British Rail are described.

Johnson, P. C., and Wise, S. (Railway Technical Centre, Derby, England). British Journal of Non-Destructive Testing, Vol 3, No. 2, April 1970, pp 111-116, 14 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC, Inc. (repr., PC).

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0091

RAIL FAILURES ON BRITISH RAILWAYS

Rail failures originate from fatigue cracking processes as cumulative damage resulting from repeated application of loads associated with period of service, traffic carried, axle loads, and speed and track maintenance. The paper discusses rail failure analysis; failures on Class A lines (lines subject to speed over 60 km/hr and carrying 12 or more express passenger trains per day); comparisons of failure rates; types and causes of failure; distribution of failures according to type; effect of geographic regions; manufacturing defects; and transverse failures.

Dearden, J. (British Railways Research Department), The Railway Gazette, Vol 121, No. 4, February 19, 1965, pp 148-150, 4 photos, 4 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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0092

THE BASICS OF TRACK INSPECTION--PLUS OTHER HELPFUL KNOWLEDGE FOR THOSE WITH NEW RESPONSIBILITIES IN TRACK MAINTENANCE

This article (Part 1 of three parts) acquaints a new track supervisor of track maintenance with track defects, how to detect and recognize them, and the action needed to prevent failures. The rail defects described are transverse fissures, horizontal split heads, piped rails, rail shelling, engine burns, base fractures, rail head flaws, corrugation and rail cracks. A brief mention is made of rail inspection cars. Other track defects mentioned involve the ties, ballast and fill problems, and drainage. Some solutions, such as the use of joint bars and rail anchors, are suggested to the rail inspector for various critical flaws.

Blanchard, L. C., Railway Track and Structures, Vol 71, No. 5, May 1975, pp 38-40, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC)

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0093

RAIL DEFECT MANUAL

The Sperry Rail Defect Manual provides a history of rail development and the early usage of rails followed by a listing of rail manufacturers and a thorough description of the processes used in the production of rails. Rail steelmaking descriptions include controlcooling, hardening of rail ends, and the heat treating of rails. Development of defects in rails is discussed, and these include such flaws as transverse, longitudinal, piping web, base, surface, and head defects. Each of the surface-type defects such as shelling, flaking, engine burns corrosion, corrugation, mill, and crushed head is described. Defects in rail welding are discussed. Sperry's rail testing service description is included in the Manual with some statistical data indicating the extent of defect detections since the service began. The main emphasis is on the ultrasonic rail testing cars.

Rail Defect Manual, prepared by Sperry Rail Service, a Division of Automation Industries, Inc., Danbury, Conn., 4th Printing, April 1968, 75 pp, 78 figs.

ACKNOWLEDGMENT: Sperry Rail Service.

PURCHASE FROM: Sperry Rail Service (repr., PC).

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0094

SUMMARY OF HEAT-TREATED AND ALLOY RAIL SERVICE TEST INSTALLATIONS ON CURVES WITH SHELLY HEADS-1972

The program being conducted by the Association of American Railroads (AAR) in the field of rail research for study and analysis of rails in service that show some potential for improvement in performance is described. The program involves field inspections of rails in curved track that show greater wear resistance and the quality of the advent of shelling. The test curves used in this investigation were on the Burlington Northern, Inc., railway system. Rail wear, head checks, rail flaking, engine burns, and crushed heads were detected and discussed. Rail steel metallurgy is also discussed in detail for each curve examined. The rail gross tonnage for each section of track tested is given.

Schoenberg, K. W., AAR Research Center, Report No. R-121, April 1973, sponsored by Association of American Railroads, 56 pp, 28 figs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: AAR Research Center (repr., PC).

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0095

FIELD TEST OF CORROSION PREVENTED RAIL ON THEIR ENDURANCE LIMIT TO RAIL END FRACTURE

Track materials such as rail and fasteners, which generally are given no protection coating or treatment, are subject to attack by corrosion, in particular in tunnels, and fractures and cracks result. Twenty-five preventive measures were selected for preliminary testing and of these four were selected for life testing in rail tunnels. Test results showed that only 17.7% of the treated rail ends fractured, while 54% of the untreated rail ends exhibited fractures and/or fatigue cracks.

Hirose, S, Kose, Y., Sato, Y., Takihara, M., Tomita, K., Takeuchi, Y., and Tsuyuki, S. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 9, No. 1, 1968, pp 17-20, 2 figs., 5 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0096

CAUSES OF SHELLY SPOTS AND HEAD CHECKS ON RAIL: METHODS FOR THEIR PREVENTION

The results of inspections conducted in 1967 of heat-treated and alloy rail service test installations on curves with shelly histories are summarized. Information concerning the manufacturing and installation of the test rails is given with the total tonnage carried over them during the testing period. Inspection revealed engine burns, rail shelling, rail flaking, head checks, and rail wear. Rolling-load tests were conducted on flame-hardened rails ranging in weight from 115 to 136 lb. No slow-bend tests were conducted during this period. Mechanical properties and data from rolling load tests are tabulated.

Parvin, C. F. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1968, pp 664-707, 29 figs., 3 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0097

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics based on service and detected rail failures occurring between 1957 and 1966 as reported by 47 railroads for all of their main track mileage are given. The number of track miles tested by rail inspection cars are also cited for each of these years. A study of the mill performance in regard to rail manufacture for these years is shown graphically. Comparisons are drawn between failures for old and new rails. The types of failures discussed are transverse fissures, rail shelling, base and web defects, engine burns, and rail head flaws. All of the data are tabulated by railroad and type of failure.

Faries, D. T. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1968, pp 632-651, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0098

DYNAMIC LOADING AT RAIL JOINTS - EFFECT OF RESILIENT WHEELS

Vertical track irregularities in the form of dipped or sagging rail joints are discussed in relation to wheel loads. A vehicle and rail joint model is studied to provide an analysis of the vertical response of the vehicle and track. The approach used for studying the effects of track loading employs the concepts of semi-infinite beams on an elastic foundation, loaded at their free ends by varying forces and an equivalent oscillating system with a discrete mass under the force. The interaction between the wheel and rail after the load has shifted beyond the rail joint is explained. Models for minimum and maximum effective rail masses are discussed.

Bjork, J. (Svenska Aktiebolaget Bromsregulator, Malmo, Sweden), The Railway Gazette, Vol 126, No. 11, June 5, 1970, pp 430-434, 9 figs., 1 photo, 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Ltd. (repr., PC).

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0099

RAIL END BATTER: CAUSES AND REMEDIES

A rail-end build-up service test was installed on a track system that involved 30 consecutive rail joints, equally divided according to run direction. After ten months of service, the service test installation was inspected for porosity, transverse cracks, longitudinal cracks, and spot hardness. Welding procedures are tabulated for each of the rail joints. Brinell hardness readings and the results of visual examinations of defects are presented. Photographs showing indications of weld porosity and end failures are included.

Postels, R. C. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1969, pp 652-663, 11 figs., 2 tables, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0100

RAIL RESEARCH AND DEVELOPMENT (PART 1)

Part 1 of this committee report on Rail Research and Development, "Rail Research-Problem Definition", includes a brief review of the following:

- History and development of rail design showing how designs have changed to meet the need for greater strength and stiffness.
- Changes in chemical composition to produce a tougher, stronger rail steel which will be better able to resist plastic deformation and head flow and retard the development of shelling.
- Heat treatment and surface hardening of rail steel to strengthen it and combat the early development of shelling.
- Manufacturing of rail steel and the rolling of rail with emphasis on related problems and resulting changes in production methods and advancement in steelmaking technology in an attempt to provide solutions to these problems.
- History and techniques of flaw detection and the possible origin of detected defects by induction, residual magnetic, and ultrasonic methods.
- Increased use of continuous welded rail and the problems encountered with its use.
- Problems with bolted and welded joints, plastic deformation of rail, and subsequent shelling.
- Joints (web defects in bolted joints; rail end straightness, metallurgical imperfections, and welding techniques in welded joints).
- Plastic deformation of the rail head, causing shelling.
- Rail defects and premature removal of rail from track.
- Appropriate selection of rail by section (weight) and kind (standard alloy, heat treated), based upon service requirement.

It is suggested that a comprehensive analysis and study of types of rail defects and failures would be helpful in guiding future efforts in seeking solutions to them and that efforts in the development of flaw-detection methods, in particular, ultrasonic methods, be continued and expanded. It is also recognized that there is a need for rail usage criteria or recommendations which will assist rail-road management in evaluating their present track and rail structure systems and in modifying/improving them to meet present-day needs and anticipated future demands.

A 45-item annotated bibliography is included.

Cruse, W. J. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 644, Proceedings, Vol 75, September-October 1973, pp 1-38, 3 figs., 1 table, 45 refs.

ACKNOWLEDGMENT: American Railway Engi-Engineering Association (repr., PC).

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0101

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST

One study is reported on: "Investigation of Failure in Control-Cooled Rails". During a 1-year period (October 1, 1965-October 1, 1966) metallurgical examination of 7 of the 18 failed control-cooled rails submitted to the AAR Research Center was completed. Results of the examination are given together with a table and photographs.

Weller, C. E. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967 pp 409-417, 14 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0102

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST

This progress report on a continuing investigation of failures in control-cooled rails covers the period from October 1966 to October 1967. Among the various rail failures reported, the most common were rail piping, transverse fractures, shelly cracks, and oxide inclusions. Photographs and photomicrographs of the defective rail sections are given.

Herrick, C. C. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1968, pp 620-631, 19 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0103

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST

This study deals specifically with examination of failures (both service and detected) in 13 control-cooled rails submitted to the AAR Research Center for examination. The results of the examination are detailed in a table and photographs and photomacrographs are included.

Bunjer, J. A. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 591, Proceedings, Vol 66, February 1965, pp 447-453, 7 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0104

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST

This subcommittee of the AREA included in their report information covering their investigation of failures in control-cooled rail between 1967 and 1968. This investigation was conducted by the metallurgical laboratory of the AAR's Research Center. Samples of rails that failed in service were submitted by seven railroads for tests. The types of defects observed in various inspections were: fatigue fractures, transverse fissures, engine burns, and welding defects. The welding defects occurred in areas having corrugations that were ultimately repaired. Sections of the failed rails were examined by using fractological procedures and results are shown in photographs. Detailed information is provided on the transverse-fissure failure such as the rail weight, manufacturer, heat number, and rail service.

Herrick, C. C. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 619, Proceedings, Vol 70, February 1969, pp 718-733, 18 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0105

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST (ADVANCE REPORT OF THE RAIL COMMITTEE)

The committee for this assignment is responsible for one study, "Investigation of Failures in Control-Cooled Rail", which is reported on here. In a two year period eight failures (both service and detected) in control-cooled rail were submitted to American Railroads Research Center for metallurgical examination. Investigation of six of these eight failures has been completed, and tabular and photographic data are presented to document the findings.

Hutcheson, T. B. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 446-451, 9 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0106

COLLABORATE WITH AISI TECHNICAL COMMITTEE ON RAIL AND JOINT BARS IN RESEARCH AND OTHER MATTERS OF MUTUAL INTEREST (ADVANCE REPORT OF THE RAILWAY COMMITTEE)

This advance report of the Rail Committee is presented in two parts. The first part of the report gives details of a study conducted by the Research Center of the American Association of Railways on continuously cast blooms which were made and rolled into rail by the Algoma Steel Corporation. Eight 6-ft lengths of 115-lb RE section and three electric flash butt-welded specimens were evaluated by means of the following tests: rolling load, slow bend, and drop. Chemical, physical, impact, and hardness properties were determined and macroscopic and microscopic examinations were conducted. Tabular data are presented for all of the tests, determinations, and examinations. Diagrams of the testing machines, photographs of the specimens following testing, and photomicrographs of specimen grain structure are also presented.

The second part of the report was prepared by Algoma Steel Corporation as a non-technical summary of information on the metallurgical aspects of rail produced from strand-cast blooms. The characteristics of typical bloom and rail structure and some of the variations which sometimes occur are discussed and amplified with tabular data and photographs.

Hutcheson, T. B. (Chairman, Subcommittee), et al, American Railway Engineering Association, Bulletin 634, Proceedings, Vol 73, September-October 1971, pp 1-60, 48 figs., 11 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0107

RAIL END BATTER: CAUSES AND REMEDIES

A report of the work performed on this on-going study assignment being conducted by the AAR Research Center is presented in two parts. Part 1 is an evaluation of Linde's experimental 936-89 wire for battered rail-end build-up which was accomplished by means of rolling-load tests, hardness surveys, and metallurgical examination to determine weld quality. Heat treatment of joints prior to welding and welding procedures are described and illustrations (a table, photographs, photomicrographs, and photomacrographs) are given. A rail-end build-up service test, using the Linde experimental 936-89 wire was installed on the Norfolk & Western Railway for monitoring by them. Part 2 of the report describes a rail-end build-up service test which was installed in track of the New York Central System. All battered rail ends were built up by strip welding using experimental cored wire 921-85 on 26 joints and 921-88C wire on 4 joints. Insufficient data are available to permit any conclusions to be drawn regarding the suitability of these wires for rail-end build-up use. Observation of the installation will continue. A table and photographs are included.

Postels, R. C. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967, pp 437-458, 24 figs., 2 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0108

RAIL END BATTER: CAUSES AND REMEDIES

A rail-end build-up service test installation comprising 30 consecutive rail joints of the New York Central System located 15 miles east of Toledo, Ohio, is reported on. Heat treatments and welding procedures for reconditioning the battered rail ends are described. Photographs of the equipment used and of the built-up rail joints are included.

Postels, R. C. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 473-477, 8 figs., 1 table, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0109

MODERN METHODS OF HEAT TREATING CARBON STEEL TRACKWORK AND REPAIRING SUCH TRACKWORK BY WELDING

The report describes a program for investigating heat-treated rail and flame-hardened rail used in crossing frogs by means of service installations. Three test panels consisting of eight simulated crossing intersections were installed: three of carbon steel rail with various heat treatments; three of flame-hardened carbon steel rail; one panel of carbon steel control-cooled rail (as rolled); and one panel of used chrome-vanadium rail. The processes used in the flame-hardening are described. End-batter and hardness readings were observed in various positions of the rails before and after welding. A listing of the rail manufacturers is included.

Poore, S. H. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1969, pp 564-571, 1 fig., 2 tables.

ACKNOWLEDGMENT American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association, (repr., PC).

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0110

METALLURGICAL EFFECT OF RAIL CROPPING METHODS

Service failure of four electric-flash butt welded rail joints was investigated by the AAR Research Center at the request of the Florida East Coast Railway. As a result of the investigation it is believed that the failures were caused by cutting the rail ends with a petrogen torch, which led to incipient cracking, or by incomplete removal of existing bolt-hole cracks, or a combination of both. The failures do not appear to be related to rail quality or weld soundness. Photographs of the specimens are included.

Hall, V. E. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967, pp 460-462, 4 figs., 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0111

METALLURGICAL EFFECT OF RAIL CROPPING METHODS

This study is being conducted in response to the railroad industry's interest in cropping relay rail and rail-end preparation, particularly for butt welding by the oxyacetylene pressure process. This report deals specifically with rail cropping by the wet abrasive wheel method. Following cropping, the rail is butt welded and then subjected to slow-bend and drop tests to determine weld integrity. Description of the cropping, welding, and testing procedures are given and supplemented by tables and photographs.

Hall, V. E. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 591, Proceedings, Vol 66, February 1965, pp 471-478, 10 figs., 2 tables, 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0112

METALLURGICAL EFFECT OF RAIL CROPPING METHODS

This study dealt with the use of the oxygen-gasoline (petrogen) cutting torch and of the wet-abrasive cutting method for rail cropping and the determination of detrimental effects (if any) resulting from these methods. For the petrogen test, three 5/8-in. rail slices were cut and subjected to a metallurgical microscopic examination. The examination revealed an excess of cementite in a thin layer of skin which may cause fatigue failure, weld failure, and other types of failure. In the wet-abrasive cutting test, six 1-in. slices of used 115-lb rail were cut with a 26-in. N.C.G. No. 310 abrasive cut-off wheel. Metallurgical investigation indicated that the cut surfaces had been subjected to a critical temperature, and microscopic examinations were conducted to determine the depths of transformed (untempered martensite). The presence of untempered martensite is of concern during oxyacetylene pressure butt welding because it may promote conditions leading to fatigue failure. It was recommended that rolling-load tests and further metallurgical examination be conducted in order to more fully determine the effects of these two cropping methods.

Hall, V. E. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 483-492, 14 figs., 2 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0113

SUMMARY OF HEAT-TREATED AND ALLOY RAIL SERVICE TEST INSTALLATIONS ON CURVES WITH SHELLY HISTORIES---1969

Results of the inspection of track curves on the Great Northern Railway are reported for surface-hardened and fully heat-treated rails. The purpose of this study was to examine the results with rail tracks that were lubricated and others nonlubricated at curves. Rail profiles are shown with regard to rail wear patterns. Some statistics are given for total tonnage hauled on these rails. Some indications of engine burns were evident, as well as rail flaking.

Wisnowski, M. J., and Byrne, R. (Association of American Railroads), American Railway Engineering Association, Bulletin 626, Proceedings, Part 2, Vol 71, February 1970, pp 688-709, 16 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0114

RAIL FAILURE STATISTICS COVERING (a) ALL FAILURES, (b) TRANSVERSE FISSURES, (c) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1965, by 45 railroads on all of their main track mileage, constituting approximately 90 percent of the main track of Class I railroads in the U.S., are presented in the forms of tabulations, charts, and graphs. Specific data on the following types of failures are included: transverse fissure, web (in joint and other), bolt hole, welded engine burns, vertical and horizontal split head, compound fissure, detail fracture, and broken base. Data for the various rail fabrication mills are also given that show the types of failures occurring on various railroads as related to the mill producing the rail. Some failure data for Canadian National are included.

Faries, D. T. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967, pp 418-435, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0115

RAIL FAILURE STATISTICS COVERING (a) ALL FAILURES; (b) TRANSVERSE FISSURES; (c) PERFORMANCE OF CONTROL-COOLED RAIL

The stated purpose of the statistics is to show the effectiveness in improving rail performance of detector car testing, the use of control-cooled rail, and mill quality, and to detect any indications of effect on rail performance of increased wheel loads or other changes in operating conditions. Statistics are given for transverse fissure failures and detected transverse defects. Some aspects of rail reliability dealing with failure rates are mentioned. Typical failures listed include web

and base failures, welded engine burns, and compound fissures.

Parles, D. T. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 626, Proceedings, Vol 71, February 1970, pp 661-681, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0116

CAUSES OF SHELLY SPOTS AND HEAD CHECKS IN RAIL: METHODS FOR THEIR PREVENTION

This on-going study of the AAR Research Center is conducted in two phases: (1) inspection of heat-treated rail and alloy rail service test installations on curves with shelly histories, and (2) laboratory investigations of shelly rail involving rolling-load and slow-bend tests. Results of field inspections of the following rail service test installations are given in the report of the Phase 1 study:

- Norfolk & Western - Curvemaster and fully heat-treated rails
- Chesapeake & Ohio - fully heat treated rails
- Great Northern - rails rolled from continuous cast blooms; fully heat-treated, 78-ft electric-flash butt welded and 39-ft columbium-treated rails; Curvemaster and fully heat-treated rails, high-silicon rails
- Pennsylvania - high-silicon and -carbon rails.

The laboratory investigation findings resulting from the rolling-load tests (no slow-bend tests were conducted during this period) are given in the Phase 2 report. Effects of welding prior to flame hardening and flame hardening prior to welding were studied.

Tables and photographs are provided.

Parvin, C. F. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967, pp 464-487, 3 figs., 3 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0117

CAUSES OF SHELLY SPOTS AND HEAD CHECKS IN RAIL; METHODS FOR THEIR PREVENTION

An investigation was made as to the cause of the white-etching regions outlining subsurface cracks in rail heads. The cracks, known as shells, may propagate into deep spalls, usually in the gage corner in rail heads. White etching regions were found to be stress-induced microstructural changes that resulted from rolling-contact fatigue in rail heads. The mechanism accounting for formation of the white etching areas outlining some shell-type cracks in rail heads is probably local plastic deformation. Some general aspects of rail-steel metallurgy and chemical compositions associated with the tests are discussed.

Parvin, C. F. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 626, Proceedings, Part 1, Vol 71, February 1970, pp 682-687, 3 figs., 12 refs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0118

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1963, by 47 railroads on all of their main track mileage, constituting approximately 90 percent of the main track of Class I railroads in the U.S., are presented in the forms of tabulations, charts, and graphs. Specific data are presented on the following types of failures: transverse fissure, web (in joint and other), bolt hole, welded engine burns, vertical and horizontal split head, compound fissure, detail fracture, and broken base. Data for the various rail fabrication mills are also given that show the types of failures occurring on various railroads as related to the mill producing the rail.

Parles, D. T. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 591, Proceedings, Vol 66, February 1965, pp 454-470, 4 figs., 9 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0119

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1964, by 47 railroads on all of their main track mileage, constituting approximately 90 percent of the main track of Class I railroads in the U.S. are presented in the forms of tabulations, charts, and graphs. Specific data on the following types of failures are included: transverse fissure, web (in joint and other), bolt hole, welded engine burns, vertical and horizontal split head, compound fissure, detail fracture, and broken base. Data for the various rail fabrication mills are also given that show the types of failures occurring on various railroads as related to the mill producing the rail. Some Canadian National failure data are included.

Faries, D. T. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 451-472, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0120

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1970, by 38 railroads covering approximately 230,000 miles of Class I Railroad main track are presented in the form of tabulations, charts, and graphs. Specific data on the following types of failures are included: web (in joint and other), bolt hole transverse fissure, welded engine burns, vertical and horizontal split head, compound fissure, detail fracture, and broken base. Data for rail fabrication mills are also given showing types of failures occurring on various railroads as related to the mill producing the rail. Some Canadian National failure data are included.

Bush, R. F. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 630, Proceedings, Vol 73, June-July 1972, pp 723-740, 4 figs., 11 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0121

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics, based on the rail failures reported to December 31, 1967, are submitted as information. They include the service and detected failures reported by 45 railroads on all their main track mileage. Tables and diagrams indicating the extent of control of the transverse fissure problem that has been obtained by the use of control-cooled rail and detector car testing are presented. The data include the quality of each year's rollings for the various rail fabrication mills, and show the types of failures that are occurring on the various railroads as related to the mill producing the rail. Failure rates accumulated per 100-track-mile-years and the types of failures are given.

Faries, D. T. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 619, Proceedings, Vol 70, February 1969, pp 734-754, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0122

FIELD HANDBOOK ON CONTINUOUS WELDED RAIL

This document provides a guide and reference on field procedures for the handling, laying, and maintenance of continuous thermite-welded rail (CWR). Recommended procedures for handling and transporting CWR, laying CWR existing track, construction of new lines, inspection and maintenance of CWR in track, and transporting CWR, are contained in this report. Procedures for handling rail failures are discussed in step-by-step detail.

Terrill, V. R. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 646, Proceedings, Vol 75, January-February 1974, pp 614-625. 2 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC)

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0123

CONTINUOUS WELDED RAIL--COMMITTEE REPORTS ON FABRICATION, FASTENINGS, AND FIELD WELDING

The report describes a study conducted by Penn Central with the objective of obtaining a correlation between rail defects shown by radiographs of thermite butt welds and results obtained in roll-loading tests. A tabulation is included which shows butt-weld failures from 1962 through 1968. The study revealed that the correlation between radiographs and loading tests is not so good as might be desired and that additional study of the radiographic examination technique in determining whether thermite weld defects are severe enough to impair the serviceability is needed. Acoustic emission tests were demonstrated as a feasible quality control method for electric flash pressure, oxyacetylene pressure, and thermite welds.

American Railway Engineering Association, Bulletin 626, Proceedings, Vol 71, February 1970, pp 646-655, 3 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0124

FABRICATION (INVESTIGATION OF SERVICE AND DETECTED BUTT WELDED RAIL JOINT FAILURES)

There were seven service failures and no detected failures in butt-welded rail joints investigated by the metallurgical laboratory of the AAR Research Center during the period October 1966 through October 1967. The report provides a history of each defective rail beginning with the manufacturing process, and a tabulation is provided of the type of defect along with the name of the mill producing the rail. Electric-flash and thermite-type welds are discussed. The types of defects revealed through metallurgical examination included rail piping, formation of martensite resulting from rail grinding, fatigue fissures, and inclusions. Rolling-load tests were also performed on butt-welded joints, and the results are shown. Accumulated butt-weld failures to December 1966 are given.

Galbraith, A. H. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 612, Proceedings, Vol 69, February 1968, pp 574-598.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0125

FABRICATION

The report of this investigation conducted by the AAR Research Center is presented in five parts:

- Manual Recommendations, including specifications for fabrication of continuous welded rail
- Investigation of Service and Detected Butt-Welded Rail Joint Failures
- Rolling-Load and Slow-Bend Test Results of Butt-Welded Rail Joints
- Butt-Weld Failures
- Thermite Welding.

Sketches are presented showing tolerances for inspection of rails that have surface end bent conditions. Service and detected failures of butt-welded rail joints reported between 1965 and 1966 are tabulated. Photomicrographs and photographs of fractures are given. The results of rolling-load and slow-bend tests are presented by tabulation for a total of 22 tests. The failure rate for thermite butt welds is higher (one failure in 167 per year in new rail) than the rates recorded for the oxyacetylene- and flash-pressure welds.

Galbraith, A. H. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 605, Proceedings, Vol 68, February 1967, pp 368-488, 29 figs., 4 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0126

FABRICATION

The report on fabrication is given in three parts: Part 1 deals with the specifications for fabrication of continuous welded rail, Part 2 is a report on the investigation of service and detected butt-welded rail joint failures, and Part 3 covers the results of rolling-load and slow-bend tests of butt-welded rail joints. Sketches are provided to show tolerances of side-bent conditions of rails. Tabulations of service and detected failures of

butt-welded rail joints and photographs are presented, indicating the extent of fractures through the welds. Data are given in tabulation form for both rolling-load and slow-bend tests.

Galbraith, H. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 419-437, 18 figs., 5 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0127

FABRICATION

This report is in three parts: Part 1 is a progress report on the development of specifications for fabricating continuous welded rail; Part 2 covers the examination of service and detected failures of butt-welded rail joints, and Part 3 gives the results of rolling-load and slow-bend tests of butt-welded joints. Tables and photomacrographs are included.

Galbraith, A. H. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 591, Proceedings, Vol 66, February 1965, pp 508-516, 4 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0128

FABRICATION

This section on continuous welded rail involves an investigation of service and detected thermite, electric flash, and oxyacetylene pressure butt-welded rail-joint failures. Photo-micrographs are included which show a layer of martensite on the surface and alumina particles in the weld. Brittle fractures were observed on several sections of jointed rails. Results of rolling-load tests of butt welded rail joints were also reported. For these tests, three samples were submitted for X-ray examination. The examination revealed the presence of shrinkage cracks, scatter porosity, gaseous cavities, and a large void. In rolling-load tests, all samples withstood the minimum requirement of 2,000,000 cycles without failure. Data are shown in tabulations for all rolling-load tests.

Galbraith, A. H. (Chairman, Subcommittee), American Railway Engineering Association, Bulletin 619, Proceedings, Vol 70, February 1969, pp 681-712, 38 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0129

STANDARDIZATION OF RAIL SECTIONS

Information is presented in tabular form on the rail rolled, by weight and section, by Canadian and U.S. mills during the period 1963-1964.

Clark, J. B. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, p 509, 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0130

REVISION OF MANUAL (SPECIFICATIONS FOR STEEL RAILS)

This section of the Bulletin is concerned with the Manual Recommendations reported by the rail committee on tolerances for inspection. The recommendations specify requirements for heat-treated carbon-steel tee rails as produced by U.S. Steel Corporation, and deal with the classification of rails according to length, heat treatment, testing (Brinell hardness), and retreatment (retreatment involves those heat-treated rails that fail to meet the Brinell hardness requirements). Welding to repair service-damaged Curvemaster rails is also mentioned. Similar specification recommendations for rails produced by Bethlehem Steel Corporation are also provided. In addition to specification requirements for welding of damaged rails, recommendations are made with respect to grinding of rails.

Brown, R. M. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 645, Proceedings, Vol 75, November-December 1973, pp 479-487, 2 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Association (repr., PC).

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0131

CAUSES OF SHELLY SPOTS AND HEAD CHECKS IN RAIL: METHODS FOR THEIR PREVENTION

This continuing study, conducted at the AAR Research Center, comprises two phases: (1) inspection of heat-treated rail and alloy rail service test installations on curves with shelly histories, and (2) laboratory investigations of shelly rail involving rolling-load and slow-bend tests. Results of inspections of the following heat-treated and alloy rail test installations (Phase 1) are presented: continuously cast blooms; 115-lb RE fully heat-treated rails; 115-lb RE fully heat-treated 78-ft flash-butt welded, and 39-ft columbium-treated rails; and 115 RE Curvemaster and fully heat treated. The second phase of this study is primarily concerned with rail resistance to shelling and to wear and flow. Two methods are presently used to improve resistance: addition of alloying elements and heat treatment. The results of rolling-load tests of various flame-hardened and alloy rail specimens are given in tabular form. Hardness surveys and photographs of the test specimens are presented. No slow-bend tests were conducted.

Parvin, C. F. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 598, Proceedings, Vol 67, February 1966, pp 493-508, 16 figs., 3 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0132

CAUSES OF SHELLY SPOTS AND HEAD CHECKS IN RAIL: METHODS FOR THEIR PREVENTION

This study, conducted at the AAR Research Center, comprises two phases: (1) inspection of heat-treated and alloy rail service test installations on curves with shelly histories, and (2) laboratory investigations of shelly rail involving rolling-load and slow-bend tests. Results of inspections of service test installations on the Chesapeake & Ohio, Great Northern, Pennsylvania, and Norfolk & Western are discussed in the Phase 1 portion of the report. Installation of induction-hardened rail on the Great Northern and Norfolk & Western and high-carbon rail with blue-end rail on the Pennsylvania were of particular interest during this reporting period. The laboratory investigation in Phase 2 covers new developments in induction and flame hardening of rails to increase their shelling resistance.

Parvin, C. F. (Chairman, Subcommittee), et al., American Railway Engineering Association, Bulletin 591, Proceedings, Vol 66, February 1965, pp 479-493, 7 figs., 2 tables, 2 appendixes.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0133

SURVEY OF RAIL FAILURES ON JNR

An examination of 675 defective rails from the JNR, which failed within five years of service life, indicated that 62 percent of the failures were caused by manufacturing defects. A table gives a matrix of the types of failure versus the cause of failure. The major causes of failure were: segregation of elements such as manganese and sulfur, shatter cracking, and stress corrosion. The major types of failure were: transverse cracking of the head or base, horizontally split heads, vertically split heads, rail-end failure, and welded-joint failure. Corrosion fatigue failure is much more rapid in tunnels than elsewhere. Improved rail compositions reduce the corrosion problem. Transverse cracking can be caused by corrosion, inclusions or faulty welding; the web cracks are more disastrous than the head cracks. Vertically split webs usually occur in lightweight rails. Distribution of impurities is important in this type of failure. Addition of titanium or zirconium to control hydrogen content, or controlled cooling of rails has been responsible for greatly reducing shatter cracking in recent years. End hardening by induction heating to a depth of 40 mm is recommended to control end-batter. Rail chemical compositions to reduce cold shortness are discussed. Rail profiles are shown.

The Railway Gazette, Vol 124, No. 13, July 5, 1968, pp 505-508, 4 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0134

ICG FAVORS CORED-WIRE ELECTRODE FOR RAIL AND FROG MAINTENANCE

A York 350 welder for hard facing frogs, switches, rail ends, and engine burns is described. The diesel-driven, alternator-type welder weighs about 2000 lb, uses 3/32-in.-diameter, cored-wire electrode semi-automatically fed from a 50-lb spool, and is mounted on a trailer or truck. The weld deposit hardens to 350 BHN on steel rail. This method reduces the probability of overheating common with stick electrode welding. Welding a 1-in.-wide strip in the wheel path to repair end batter requires about 10 minutes. Insulated joints do not need to be disassembled and end posts are not damaged with this method due to the low heat input. The initial cost of the York 350 is higher than a stick-type electrode welder; however, savings in labor and materials more than offset this cost difference.

Railway Track and Structures, Vol 71, No. 9, July 1975, pp 18-19, 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0135

FLANGE AND RAIL LUBRICATION

Because of higher running speeds, the problem of tyre and rail wear continues to demand considerable attention. The development of flange and rail lubrication has been actively pursued in Japan since 1930 when a report on early tests drew attention to economies in power consumption and to reduced wear obtained. Illustrations of the area of maximum wear between wheel flange and rail and of the components of wheel rolling resistance accompany a discussion of sliding friction and the various problems of lubrication. Three approaches to meet these requirements are site lubrication, flange lubrication equipment, and automatic lubrication of the inside running edge of rails on curves. Various designs of lubricating equipment are discussed and illustrated. Tables provide data on rail-head wear before and after oiling and on savings per annum.

Fujinami, I. (Kinki Nippon Railway), The Railway Gazette, Vol 123, No. 23, December 1967, pp 899-902, 10 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Ltd., London, (repr., PC).

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0136

COMPARISON OF QUALITY OF RAILS BETWEEN MANUFACTURED BY LD PROCESS AND BY OH PROCESS (REPORT 1)

The quality of rail steel produced by the open-hearth (OH) and by the basic oxygen converter process (LD) was compared. Study results indicated that the steels had equivalent tensile strength, hardness, fatigue strength, microstructure, and wear resistance; however, LD steel is superior in that it shows less spotlike segregation and lower gas content. The chemical composition and gas content of rail steel produced by both processes are tabulated, and their mechanical properties (tensile strength, yield point, elongation, Brinell hardness, drop tests, impact values, and fatigue strength) are enumerated.

Ito, A., and Kurihara, R. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 9, No. 4, 1968, pp 185-186, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0137

ARC WELDING OF AUSTENITIC MANGANESE STEEL RAIL TO CARBON STEEL RAIL: IN CASE OF WELDING WITH COVERED ELECTRODE

The procedure for welding manganese crossing to carbon steel rails is described. This practice has been avoided in the past because of difficulties resulting from the difference in properties of the steels. Studies were conducted to aid in the selection of the appropriate welding method and surface preparation techniques. After the welding processes were completed, the welded rails were subjected to various tests such as bending and drop-weight. The chemical composition and mechanical properties of the base metal tested are listed as well as similar properties of the welding electrodes. Shapes of welds and processes leading up to the bonding are illustrated diagrammatically. The results of heat treatment and the tests are tabulated.

Ando, A., and Kimata, N. (Japanese National Railways), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 9, No. 4, 1968, pp 186-191, 6 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0138

RECLAMATION OF RAILS BY POWDER WELDING

In situ repair welding to correct defects in the running surface of continuous welded rail is economically and practically attractive using a powder deposition process. British Railways has obtained service experience with a patented powder welding process with the trade name MicroFlor, testing it on worn crossing noses and wing rails, on rails with wheel burns, on cupped thermit welds, and as a linear deposit to obtain electric continuity for track circuits on little used connections. Some details of surface preparation, powder weld metals, and repair procedures are given.

Cookson, C., and Shawe, F. (British Railways Board), Railway Gazette, Vol 126, No. 9, May 1, 1970, pp 350-351 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0139

ULTRASONIC EXAMINATION OF WELDS: COMPARISON OF ASME AND AWS PROCEDURES

Comparisons are drawn between the procedures used for ultrasonic inspection by the American Society of Mechanical Engineers and those used by the American Welding Society. Decibel ratio of amplitudes, distance and sensitivity calibration, and amplitude curves are presented for the purpose of comparison between the two procedures. Requirements of the ASME and AWS procedures are discussed in detail.

McGaughey, W. C. (Automation Industries, Inc., Danbury, Conn.), Materials Evaluation, Vol 30, No. 2, February 1972, pp 44-48, 10 figs., 2 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0140

A COMPUTER-PROCESSED ULTRASONIC PULSE-ECHO NDT SYSTEM

A computer-aided ultrasonic nondestructive test system designed to improve resolution and signal-to-noise ratio is described. The effective bandwidth of the ultrasonic transducer is increased by using a compensation technique. The data-processing scheme, which uses the raw data obtained from the spectrum of an ultrasonic pulse reflected from a target, is described. A schematic diagram of the instrumentation used to obtain and process ultrasonic pulses reflected from a defect is provided. A comparison is drawn between reflectoscope and computer-processed displays of an echo from two targets. A schematic diagram of a proposed mathematical model of the system is presented.

Seydel, J. A., and Frederick J. R. (University of Michigan, Ann Arbor, Mich.), Materials Evaluation, Vol 31, No. 11, November 1973, pp 223-228, 5 figs., 2 tables, 8 refs., 1 appendix.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing, (repr., PC).

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0141

FACTORS GOVERNING RADIOGRAPHIC CRACK DETECTABILITY IN STEEL WELD SPECIMENS

A pressure vessel steel weld containing a 1/16-in.-deep crack was radiographed through filler plates at five separate energy levels. The filler plates were used to cover the cracks to determine the depth of penetration of the radiation source versus the energy. The X-ray energy levels were used 250, 275, and 300 kV. Gamma radiation from Ir-192 and Co-60 was also used. The crack detectability and penetration sensitivity are given in tables for the various radiation energies and for four radiation source angles. Crack detectability increased as the energy level decreased or as the source angle decreased.

Becker, G. L. (E. I. DuPont de Nemours & Company, Inc., Wilmington, Del.), Materials Evaluation, Vol 30, No. 7, July 1972, pp 149-152, 2 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0142

ULTRASONIC DATA ANALYSIS USING A COMPUTER

A standard ultrasonic flaw detector using a 5-MHz transducer is interfaced with a digital computer to examine welds at the Oak Ridge Y-12 Plant. The test piece is immersed in demineralized water during testing and the transducers are placed at an incident angle of 45 degrees. The computer indicates the size and location of flaws. Flow charts are shown for the information flow of both the computerized system and a manual scan system. The computerized system requires the metal parts to be moved only one-third as fast past the ultrasonic transducer as with the manual system. Both systems were similar in the flaw-detectability results. The FOCAL computer program used in the computerized system is described.

Sachs, R. D., Elkins, J. D., and Smith, J. H. (Union Carbide Corporation, Oak Ridge, Tenn.), Materials Evaluation, Vol 30, No. 6, June 1972, pp 121-125, 135, 9 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0143

FLAW DETECTION AND CHARACTERIZATION USING ACOUSTIC EMISSION

An evaluation of acoustic-emission techniques for detecting fatigue cracks in rocket-motor cases was made in conjunction with NDT for the same items but with the use of standard radiographic and magnetic-particle techniques. The results of tests on surface-flawed specimens derived from the use of radiographic and magnetic-particle inspection data are given. Graphical illustrations show acoustic emission and strain as a function of stress for a wide variaties of alloys and steels ranging in thicknesses between 0.118 and 0.257 in. Fracture mechanics data are tabulated.

Corle, R. R., and Schliessmann, J. A. (Lockheed Propulsion Company, Redlands, Calif.), Materials Evaluation, Vol 31, No. 6, June 1973, pp 115-120, 10 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing, (repr., PC).

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0144

A COMPUTER STUDY OF DYNAMIC LOADS CAUSED BY VEHICLE-TRACK INTERACTION

A computer analysis of vehicle and track interaction regarding dynamic loads and the manner in which various parameters of the vehicle and structure affect these rail loadings is discussed. The relationship between the information resulting from the analysis and solutions of problems concerned with the high wheel/rail stresses caused by the nature of current traffic and track conditions is emphasized. The case of rail corrugation under four levels of track stiffness is examined. The effect of wheel-rail load on service life is reviewed in connection with rail failures such as yielding, cracking, pitting, and/or flaking. Photographs are given of transverse sections of corrugated rails showing severe cracking and flow of surface metal. The relationship of peak surface compressive stress at the wheel-rail interface to the wheel diameter, wheel load, and rail crown radius is shown graphically.

Meacham, H. C., and Ahlbeck, D. R. (Battelle, Columbus Labs., Columbus, O.), Journal of Engineering for Industry, Trans. ASME, Vol 91, No. 3, August 1969, pp 808-816, 14 figs., 2 tables, 11 refs.

ACKNOWLEDGMENT: American Society for Mechanical Engineers.

PURCHASE FROM: American Society for Mechanical Engineers (repr., PC).

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0145

APPLICATION OF MAGNETIC AND ELECTROMAGNETIC NONDESTRUCTIVE TEST METHODS FOR MEASURING PHYSICAL AND TECHNOLOGICAL MATERIAL VALUES

Electromagnetic methods for measuring physical properties of metals, such as hardness, strength, and alloy composition, are discussed. It is shown how to determine physical parameters with the aid of magnetic-inductive methods at relatively low frequencies by exploiting the magnetic properties. Examples which illustrate physical and metallurgical parameters of metals are shown. By means of eddy-current methods at higher frequencies of the expended electromagnetic energy, it is shown to be possible that corrosion and fatigue processes in metals can be observed. The thermoelectric method as used for hardness measurements is also described.

Forster, F., and Stumm, W. (Institut Dr. Forster, Reutlingen, Germany), Materials Evaluation, Vol 33, No. 1, January 1975, pp 5-11, 14-15, 16 figs., 13 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0146

AN AUTOMATIC MAGNETIC INSPECTION METHOD USING MAGNETORESISTIVE ELEMENTS AND ITS APPLICATION

The authors have developed an automatic high-speed, high-sensitivity magnetic system [Sumitomo Automatic Magnetic (SAM) System] for surface inspection of hot-rolled round steel bars and hot-finished seamless steel tubes. The system, which uses a highly sensitive magnetoresistive element, offers many advantages over the currently used fluorescent magnetic particle inspection method, which is dependent on the skill of the operator for its efficiency and which is incapable of estimating flaw depth.

The SAM system has proved very dependable in operation and can detect a fine crack 0.1 mm deep on rough-surfaced bars with S/N of approximately 3. The inspection rate is approximately 100 pieces per hour for 40 to 100-mm-diameter tubes and bars. In the near future, the system will be applicable to round billet and large-diameter tubes.

Shiraiwa, T., Hiroshima, T. (Sumitomo Metal Industries, Ltd., Amagasaki, Japan), and Morishima, S. (Shimadzu Seisakusho, Ltd., Kyoto, Japan), Materials Evaluation, Vol 31, No. 5, May 1973, pp 90-96, 10 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing, (repr., PC).

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0147

STRESS AND STRAIN IN ROLLING BODIES IN CONTACT

The objective of this study was to find a three-dimensional solution for the stresses and strains in the contact area of a rolling wheel which carries normal, lateral, and tangential loads on fixed, supported structures. As a preliminary approach to the problem, a study was conducted of two spheres of similar material rolling on each other and, although a final solution was not obtained, the results can be adapted to the case of a wheel rolling on a surface of dissimilar material. The solution to the problem is important to high-speed rail travel, because it will permit calculation of forward and sidewise creep and rolling stresses (wear, fatigue). Equations and boundary conditions were formulated and the stress distributions were found by solving simultaneous equations through use of a computer.

Paul, I. L., and Nayak, P. R. (Massachusetts Institute of Technology, Cambridge, Mass.), Report No. DSR-76109-4, for the U.S. Department of Commerce, Washington, D.C., Contract No. C-85-65, November 1, 1966, 38 pp, 9 figs., 10 refs., 1 appendix.

ACKNOWLEDGMENT: Massachusetts Institute of Technology.

PURCHASE FROM: NTIS (repr., PC, microfilm), PB 173 651.

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0148

APPLICATION OF THE OPTICAL CORRELATION MEASUREMENT TO DETECTION OF FATIGUE DAMAGE

An optical correlation measurement technique which can be used for detecting and evaluating minute changes in surface structure resulting from strain cycling has been developed. With this system, the cross-correlation between the structure of a given surface area before and after strain cycling is measured in terms of the light intensity output of the coherent optical system. A change in surface structure produces a decrease in correlation intensity, and incipient crack propagation is indicated by a break in the plot of correlation intensity versus number of strain cycles. The technique can be used with three-dimensional objects, and no special surface preparation is required. An example of the use of the system with aluminum alloys is given.

Chuang, K. C. (Bendix Research Laboratories, Southfield, Mich), Materials Evaluation, Vol 26, No. 6, June 1968, pp 116-119, 8 figs., 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0149

THE EDDY-SONIC TEST METHOD

A distinct disadvantage to the use of automated scanning-recording ultrasonic devices is the need for a liquid couplant to provide an interface between the transducer and the test specimen. A recently developed NDT system, "Eddy-Sonics", which is based on the premise that a mechanical force is associated with the flow of eddy currents, has a major advantage in that it utilizes an air couplant instead of the conventional liquid couplant, and requires access to only one surface. The author describes the basic operating characteristics of the system and provides some test data. Graphic information on spectral responses and defect sensitivity is shown.

Botsco, R. (North American Aviation, Inc., Los Angeles, Cal.), Materials Evaluation, Vol 26, No. 1, January 1968, pp 21-26, 12 figs., 2 tables, 15 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0150

DETAILED FLAW INFORMATION AVAILABLE THROUGH ULTRASONIC TESTING OF WELDS

The intent of this paper is "to help every person working in the field of ultrasonic weld testing to better understand the method and enable him to do a more precise job...". The author states that the principal difficulty encountered in ultrasonic weld testing is the need for operators who are well-trained and capable of correctly interpreting the information provided by the instrument or system. He lists and describes seven

different pieces of information which can be obtained about a flaw during a weld test, and which enable sorting of the weld defects according to their geometrical positions and dimensions. Eighteen drawings supplement the discussion.

Walther, K. G. (Dr. J. & H. Krautkramer Gesellschaft fur Elektrophysik, Cologne, Germany), paper in Proceedings of the 1966 Symposium on Non-destructive Testing of Welds (edited by T. F. Drouillard), sponsored by IIT Research Institute, Chicago, Ill., February 3-4, 1966, pp 145-154, 18 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IIT Research Institute (repr., PC).

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0151

ULTRASON C EXAMINATION OF WELDMENTS

This paper presents a basic study of and instructions for the use of ultrasonic techniques for the examination of welds. The author discusses the factors to be considered in the selection of the proper nondestructive test method for weld examination, lists the advantages offered by ultrasonic weld testing, and describes the specific requirements and procedures for employing ultrasound. He also discusses test sensitivity determinations and how they are established, and an example of the selection, calibration, and use of ultrasonic testing equipment for an ordinary butt-weld examination is given. Numerous photographs and drawings are included.

Berry, F. C. (Chicago Bridge & Iron Company, Chicago, Ill.), paper in Proceedings of the 1966 Symposium on Nondestructive Testing of Welds (edited by T. F. Drouillard), sponsored by IIT Research Institute, Chicago, Ill., February 3-4, 1966, pp 102-120, 15 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IIT Research Institute (repr., PC).

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0152

ELECTROTHERMAL NONDESTRUCTIVE TESTING OF METAL STRUCTURES

The principles of electrothermal NDT and some experimental data that demonstrate potential applications are presented. The method is described as one with capabilities of detecting such flaws as voids, cracks, waviness (surface defects), and slag inclusions. The approach involves subjecting a test specimen to an electrical current pulse to develop a surface-temperature distribution that is indicative of internal defects. Infrared and other thermal-imaging techniques are used for mapping. The results of laboratory tests on welded test bars and weld inclusions in thick plates are shown.

McCullough, L. D., and Green, D. R. (Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, Washington), Materials Evaluation, Vol 30, No. 4, April 1972, pp 87-91, 8 figs., 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing, (repr., PC).

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0153

DEVELOPMENT OF A LARGE AUTOMATIC ULTRASONIC PLATE TESTING INSTALLATION WITH ONLINE COMPUTER DATA OUTPUT

The ultrasonic system used in the steel mills of Germany for testing 1-1/2-in.-thick steel plates is described. A schematic arrangement of principal machine components and transducers in this ultrasonic testing approach is given. The data- and signal-processing systems are described in the accompanying block diagrams. The function of the computer hardware and peripheral equipment is discussed with examples showing plate-defect classifications.

Kuenne, G. (Hoesch Huttenwerke, A.G., Dortmund, Germany), Materials Evaluation, Vol 33, No. 4, April 1975, pp 73-80, 14 figs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0154

COMPUTER-BASED DISPLAY OF NONDESTRUCTIVE EVALUATION DATA

The problem of handling large amounts of data accumulated from NDT equipment, is discussed. The computer graphic techniques discussed include: three-dimensional pictorial and area-modulated plots, contour plots, use of color as a display enhancement technique, and multisectional plots. Test systems include radiation density, infrared scanning, and ultrasonics. Standard Fortran programs running on a CDC-6600/SC4020 have been developed.

Stiefeld, B. (Sandia Laboratories, Albuquerque, N.M.), Materials Evaluation, Vol 31, No. 11, November 1973, pp 222-228, 12 figs., 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0155

BILLETSCAN—A NEW EDDY CURRENT DEVICE FOR TOTAL SURFACE INSPECTION OF SQUARE BILLETS

An eddy-current inspection device (Billetscan) which automatically inspects the entire surface of a round-cornered square billet without requiring operator judgment is described. The concept employed involves the use of a flexible search-probe assembly that maintains continuous contact with the billet periphery. Photographs showing the various features of the billet inspection operation and details of the search probe are included. The system incorporates a defect marking system. A chart recording of the electronic signals from a test sample is shown.

Mandula, J. M. (Republic Steel Corporation, Electrochemical Research Center, Cleveland, O.), Materials Evaluation, Vol 30, No. 3, March 1972, pp 49-54, 11 figs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0156

ACOUSTIC EMISSION TRANSDUCER CALIBRATOR

A method for calibrating an acoustic-emission transducer is described. The acoustic emission transducer is calibrated by comparing its output signal with that of a primary standard transducer. A primary standard calibration equipment layout is shown with a photograph of the transducer. Facilities for the calibration of transducers are described showing the block and related test equipment. Some of the results from experiments are revealed in an acoustic emission transducer calibration curve.

Leschek, W. C. (Westinghouse Research Laboratories, Pittsburgh, Pa.), Materials Evaluation, Vol 32, No. 2, February 1975, pp 41-48, 9 figs., 19 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0157

APPLICATIONS OF FREQUENCY ANALYSIS IN ULTRASONIC TESTING

Applications and theory associated with control of ultrasonic test variables, identifying and sizing flaws, and improving resolution both for thickness measurements and detection of near-surface flaws are presented. The advantages of spectral analysis techniques in reproducibility, precision, simplicity, and evaluation of importance of discontinuities in materials are discussed. Examples of discontinuity spectra for welds are shown in graphic form with the corresponding oscillographs.

Whaley, H. L., Cook, K. V., Laszlo, A. and McClung, R. W. (Oak Ridge National Laboratory, Oak Ridge, Tenn.), Materials Evaluation, Vol 33, No. 1, January 1975, pp 19-24, 6 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0158

IMAGE QUALITY IN RADIOGRAPHY

The lack of a precise and uniform specification for the quality of images obtained by the various radiographic inspection techniques has long been a problem. The gauges ("penetrameters") employed to define radiographic sensitivity expressed it as a percentage of the thickness being examined; however this definition gives no indication of image quality, or the visibility of the defect, and the significance of the defects likely to be detected. The International Institute of Welding (IIW), recognizing this complex problem, suggested, as a first step, that the term "penetrameter" be replaced by the more precise term "Image Quality Indicator" (IQI) to describe the gauges. The IIW then recommended, as a result of extensive studies conducted by the French, that two types of IQI be adopted: a wire type, to make allowance for standard practice, and a step-wedge type, consisting of a wedge divided into steps, with each step having one or more holes whose diameter is equal to its depth. In both types, the element thicknesses are in geometric progression. This article describes the tests which have been conducted by the French on steel specimens up to 200 mm thick to establish specifications for these IQI's. Graphic and tabular data give results for the smallest hole visible for various thicknesses of steel using various radiographic techniques (X-rays, and gamma rays from cobalt-60 and iridium-192). The authors conclude that IQI's are not strictly equivalent, and that the definition of quality in percent sensitivity in terms of thickness should be avoided.

Evrard, M., and Dubresson, J. (Institut de Soudre, Paris, France), Non-Destructive Testing, Vol 4, No. 6, December 1971, pp 396-400, 4 figs., 2 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0159

A CLOSER LOOK AT ULTRASONIC FLAW DETECTION CALIBRATION

Ultrasonic flaw-detection calibration is discussed not for the purpose of providing general or conventional information relating to calibration but to attempt to clarify some of the points that are not so well understood by a majority of operators. Accuracy or distance measurements of flaws in welding tests and the thicknesses are discussed to emphasize the error potential arising from misjudging echoes when the test item possesses inclusions. Examples of good and bad response echoes are shown, and some experimental data are presented for location of the probes in various positions. Notes for guidance on decibel values are presented to show differences between two or more echoes.

Wells, C. D. (Wells-Krautkramer Ltd., Letchworth, Herts., England), The British Journal of Non-Destructive Testing, Vol 8, No. 4, December 1966, pp 84-91, 15 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0160

MAGNETIC METHODS OF NON-DESTRUCTIVE TESTING, PART 2

This article (Part 2 of a two-part report) is concerned with the differences, advantages, and limitations of the magnetic methods of NDT which were introduced in Part 1 of the report, including alternating- and direct-current and magnetic flow and coil methods. Descriptions of commercial flaw-detection equipment and the techniques utilized in testing various components are given. A number of photographs of equipment, flawed components, and inspection techniques are included.

Bezer, H. J. (Manchester Oil Refinery Ltd.), The British Journal of Non-Destructive Testing, Vol 6, No. 4, December 1964, pp 109-114, 119-122, 11 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Non-Destructive Testing Society of Great Britain (repr., PC).

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0161

ON-LINE AUTOMATIC ULTRASONIC INSPECTION

In 1970, the Keihin Works of NKK, Kawasaki, Japan, installed an automatic ultrasonic testing system (based on the pulse reflection method with double crystal probes) on the finishing line of their 134-in. heavy plate mill. The system has a combination of four automatically controlled testers and is capable of testing a portion over a width of 2 in. on the periphery and over 25 percent at the center portion. Plates to be tested for interior defects were from 6 to a maximum of 19 mm thick, the range capable of being sheared on the line. Efforts were directed toward solving problems related to high-speed testing at elevated temperatures and flaw-distance dependence on testing sensitivity. The resulting system operates without precooling equipment with plate temperatures up to 200 C and at a speed of 40 m/min. Distance-amplitude correcting circuits in the receiving section permit proper evaluation of flaws, including surface flaws. Test information is fed back to the rolling and steelmaking operation by a computer, thus contributing to improved plate quality.

Matsumara, Y., and Katsuyuki, N. (Keihin Works, Nippon Kokan K.K., Kawasaki, Japan), Iron and Steel Engineer, Vol 52, No. 4, April 1975, pp 75-79, 12 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Association of Iron and Steel Engineers (repr., PC).

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0162

THE ROLE OF HIGH RESOLUTION FIELDS AND FILTERING IN EDDY CURRENT TESTING

A definition of noise as it applies to electromagnetic testing is given as "any signal that interferes with the purpose of the test". The solution to the problem of eliminating noise signals or establishing adequate signal/noise ratios is suggested in the use of proper filtering techniques. The relationship between transducer resolution and the optimum filter is discussed. Transducer responses are discussed, and illustrations of their spectra are included. Signal information losses in the filtering are explained.

Renken, C. J. (Metallurgy Div., Argonne National Laboratory, Argonne, Ill.), Materials Evaluation, Vol 26, No. 9, September 1968, pp 191-195, 13 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0163

ULTRASONIC TESTING OF STRUCTURAL WELDS

Ultrasonic testing of fully penetrated welds for plates of thicknesses ranging from 5/16 to 5 in. has been conducted by Bethlehem Steel Corporation since the early 1960's. The various couplants used (glycerine, oil, water) were evaluated and data on transmission efficiencies are given. Data are also presented showing the effect of test angle on defect-detection reliability. A listing of defects and their lengths in relation to plate thicknesses and angle of scan is given. Schematic drawings of the testing equipment and the positioning of the transducers are shown with corresponding oscillographs associated with defects. Defect location charts based on the depth of defects, distance between the transducers and the defect, and the angular positioning of the sound source, are included.

Olsson, D. A. (Bethlehem Steel Corporation, Bethlehem, Pa.), paper in Proceedings of the 1966 Symposium on Nondestructive Testing of Welds (edited by T. F. Drouillard), sponsored by IIT Research Institute, Chicago, Ill., February 3-4, 1966, pp 121-144, 16 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IIT Research Institute (repr., PC).

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0164

ULTRASONIC THEORY APPLIED TO THE AUTOMATIC INSPECTION OF WELDS

The three most important factors relating to the success of angle-beam ultrasonic testing are: (1) the beam pattern of the transducer, (2) the scattering pattern of the defect, and (3) the transmission properties of the probe-to-weldment interface. Each of these factors and the procedure for the determination of the defect location were studied to establish the basis for requirements for the design and development of an automatic ultrasonic inspection system. The resulting system, which comprises and ultrasonic flaw detector, control unit, mechanical drive unit, and digital recorder, has been tested extensively. Test results show that the system detects cracks and lack of fusion along the weld beval with greater reliability than shown by standard radiographic techniques. Operator error, although not completely eliminated, since the operator must set up and calibrate the equipment, has been minimized, and the digital printout of the scan is an additional advantage of the system.

Lovelace, J. F., and Luini, L. A. (General Dynamics Corporation, Groton, Conn.), Materials Evaluation, Vol 26, No. 10, October 1968, pp 204-210, 9 figs., 6 refs.

ACKNOWLEDGMENT: American Society for Non-destructive Testing.

PURCHASE FROM: American Society for Non-destructive Testing (repr., PC).

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0165

MAGNETIC METHODS OF NON-DESTRUCTIVE TESTING, PART 1

This paper (Part 1 of a two-part report) provides an introduction to the fundamental principles of magnets and magnetizing techniques beginning with the earliest recorded history of electromagnetic phenomena. The theory of magnetic properties of materials is reviewed, permanent magnets and electromagnets and their application to NDT are discussed, and magnetization by current flow and by induction (threading bar method for tubes and rings, magnetic flux, and magnetizing coil) methods are described. The paper concludes with a description of the technique for demagnetizing a component following inspection. Drawings and tabulations are included.

Bezer, H. J. (Manchester Oil Refinery Ltd., Manchester, England), British Journal of Non-Destructive Testing, Vol 6, No. 3, September 1964, pp 85-93, 8 figs., 2 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Non-Destructive Testing Society of Great Britain (repr., PC).

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0166

SOME RECENT DEVELOPMENTS IN MAGNETIC CRACK DETECTION

Two techniques for magnetic detection of cracks have been developed: Magneprint and Magnestamp. Magneprint gives a permanent, visible record of magnetic perturbations caused by surface or subsurface flaws in magnetizable material plus a record of topographic features which permits precise location of the defect. The device can be used on rough surfaces and in screw-threads, etc. Magnestamp, a variation of Magneprint, is small, portable and self-contained. When placed on the surface to be examined it provides information on surface magnetic perturbations which can be made invisible and permanently recorded in seconds. Photographs and drawings illustrating the design and use of the devices are included. Both devices are commercially available.

Birchon, D., Warren, R. H., and Wingfield, P. M. (Admiralty Materials Laboratory, England), British Journal of Non-Destructive Testing, Vol 10, No. 4, December 1968, pp 87-91, 12 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0167

ACOUSTIC EMISSION IN METALS AS AN NDT TOOL

A brief review of the concepts associated with nondestructive testing based on the use of acoustic emission is given. Basic characteristics of the detected signals and the acoustic signature of metallurgical events such as deformation, ductile and brittle fracture are discussed. The basic types of acoustic emission signals from steel - "continuous" and "burst" - are discussed, and oscillographs of plastic deformation and brittle and ductile fracture of steel provide examples of them. Data from an experimental study of steel-pipe burst tests are also presented. The author states that much work still remains to be done in the characterization of failure mechanisms, in terms of acoustic emission, for typical materials of interest.

Hutton, P. H. (Pacific Northwest Laboratories of Battelle Memorial Institute, Richland, Washington), Materials Evaluation, Vol 26, No. 7, July 1968, pp 125-129, 6 figs., 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0168

DATA PROCESSING IN ULTRASONIC TESTING

The various factors involved in processing the data obtained from ultrasonic testing - recording the data, concentration of the data, and classification of the test piece - are discussed along with photographic, strip-chart, and magnetic recording concepts. A simulated B-scan presentation for rail testing and the screen images with flaw echoes are shown. The first step in concentration of the data is selection according to echo amplitudes, and for long testing distances (e.g., bars, billets, strip, sheet, and tubes), the concentration of the longitudinal coordinate (scanning distance) may be used as the second step. Strip testing is given as an example of this procedure. With the strip testing technique only one additional step is required for evaluation of the test piece; this is illustrated with a recording obtained with a two-trace recorder.

Krautkramer, J. (Wells-Krautkramer, Ltd., England), The British Journal of Non-Destructive Testing, Vol 10, No. 2, June 1968, pp 40-44, 6 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0169

THE NEED FOR FRACTURE CONTROL: FRACTURE MECHANICS SERIES 6

This paper, the last in a series of six, deals with the causes of catastrophic brittle fracture. Specific cases involving large-scale brittle fracture (in ships, pressure vessels, turbo-generators, etc.), which have occurred in the U.S., Germany, Great Britain, and Japan are cited along with some statistics. The economic aspects of catastrophic failures are also considered. The work of various authors on specifications for fracture avoidance, safety, and reliability are reviewed. A number of photographs showing fractured structures are presented.

Barnby, J. T. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 5, No. 4, August 1972, pp 229-234, 5 figs., 26 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc., Science and Technology Press, Ltd. (repr., PC).

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0170

EVOLUTION OF RAIL STEEL AND RAIL SECTIONS AND WHAT IS BEING DONE RELATIVE TO THIS MATERIAL TODAY

The historical aspect of rail design and rail steel composition is reviewed, and the evolution of rail shapes and designs is shown by year. Numerical values of high localized stresses on the various portions of the rail are given, and the resultant changes in designs according to rail weights are briefly discussed. Chemical composition and changes in manufacturing processes over the years are mentioned and some AREA specifications are listed. With respect to the R&D being conducted, information is presented on 12 different rails that were studied for their tensile properties. The results of an investigation on heat-treated rails in relation to tension and dynamic fracture toughness tests are presented along with the function of temperatures. A brief summary is given of the AAR on-going project involved with ultrasonic testing using a mobile vehicle for determining the trade-offs among vehicle speed, flaw location, flaw size, and orientation.

Schoenberg, K. W. (AAR Technical Center, Chicago, Ill.), American Railway Engineering Association, Bulletin 653, Proceedings, Vol 76, June-July 1975, pp 653-664.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0171

SUMMARY OF PERFORMANCE OF STANDARD-CARBON AND VARIOUS WEAR-RESISTANT RAILS IN TEST CURVES ON THE CHESSIE SYSTEM-PART 2

This report contains the summary of the first annual inspection of a service test installation of fully heat-treated, induction-hardened, intermediate-manganese, and standard control-cooled rail on the Chessie system. The field inspection is part of the cooperative effort on rail research of the AREA, the American Iron and Steel Institute, and the AAR to observe and analyze those rails in curved track that display some potential for improvement in wear-resistance and retarding the onset of rail shelling. Measurements were made and recorded of curvature, super-elevation and gage, and general track conditions were noted on four service test curves. Rail head cross-section contours of 80 test rails contained in these curves were taken and recorded. Descriptive information on the test rails covers heat-treatment, head-hardening, and cooling control. Rail profiles of all samples indicate some degree of rail wear.

Schoeneberg, K. W. (AAR Technical Center, Chicago, Ill.), American Railway Engineering Association, Bulletin 649, Proceedings, Vol 76, September-October 1974, pp 99-124, 23 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0172

METALS. METHODS OF MECHANICAL AND TECHNOLOGICAL TESTING: GOST 12503-67. STEEL. ULTRASONIC TESTING METHODS. GENERAL STATUS

The standard for ultrasonic testing methods for steel (GOST 12503-67, effective date: 1 April 1967), as developed by the All-Union Scientific-Research Institute of Ferrous Metallurgy imeni Bardin, U.S.S.R., is given. It establishes the methods of ultrasonic control for sheet and strip 8 mm, and greater, in thickness; forged and rolled billets and rolled stock with round and square cross section 80 mm, and greater, in diameter or on a side, made of carbon alloyed and high-alloyed steel and alloys.

Metals. Methods of Mechanical and Technological Testing; GOST 12503-67. Steel. Ultrasonic Testing Methods. General Status, Report No. JPRS 59280, Joint Publications Research Service, U.S. Department of Commerce, Washington, D.C., June 14, 1973, pp 300-304, 4 figs.,

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Joint Publications Research Service (repr., PC).

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0173

THE MENACE OF BROKEN RAILS

The incidence of rail breakage on British Railways has shown a sharp increase since 1964. This article reviews the number and history of the breakages for the period 1964-1966, cites probable causes, and briefly describes steps which have been taken to reduce the failure rate.

Engineering, Vol 17, No. 204, November 17, 1967, pp 781-782, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC).

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0174

RAIL QUALITIES FOR SPECIAL STRESSES IN RAIL TRACK AND POINT CONSTRUCTION [IN GERMAN]

The history of the development of rail steels and rail design is outlined. Special rail qualities are described with particular reference to the functions and stresses of various types of rails. Examples from practice are enumerated and discussed, the properties of welded rails are examined, and some defects, particularly in manganese steel, rails are discussed. Brinell hardness data for rail heads are presented. Defects such as shelling and rail fractures are shown, and rail metallurgy, chemical composition, and manufacturing are covered.

Laisner, H. (Oesterrichisch-Alpine Montangesellschaft, Austria), Berg und Huttenmannische Monatshefte, Vol 113, No. 3, March 1968, pp 93-104, 16 figs., 2 tables.

ACKNOWLEDGMENT: Berg und Huttenmannische Monatshefte.

PURCHASE FROM: Springer Verlag (repr., PC).

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0175

DEVELOPMENT OF RAIL STEEL SMELTING AT THE LINZ-DONAWITZ STEELWORKS [IN GERMAN]

Three methods for carburizing rail steel during production are discussed: the addition of pig iron in the crucible, the termination of decarburization at about 0.5% C, and the addition of pig iron in the ladle. All three have disadvantages, and the choice between them depends on the local price of the pig iron, the cost of running time, the speed of analysis per sample, the importance of wear in the ladle, and the difficulty of adjusting chemical composition precisely in the ladle.

Kammerhofer, E., Dobrowsky, F., and Schober, G. (Oesterreichisch-Alpine Montangesellschaft, Austria), Berg und Huttenmannische Monatshefte, Vol 113, No. 11, November 1968, pp 444-449, 8 figs., 3 tables, 1 ref.

ACKNOWLEDGMENT: Berg und Huttenmannische Monatshefte.

PURCHASE FROM: Springer Verlag (repr., PC).

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0176

THE MAGNETIC FLUX LEAKAGE TECHNIQUE OF NON-DESTRUCTIVE TESTING

Measurements of magnetic leakage flux from machined slots in mild steel are described, and a theory which agrees with observations is discussed. In the initial series of experiments a search coil, described in the article, was fabricated and mounted on a drive mechanism that enabled searching to be done at a rate of 10 ft/sec. Output voltages from the search coil and leakage flux as functions of position are plotted for scans on specimens containing fatigue cracks and imposed slots. A second series of experiments involved measurements of leakage flux adjacent to slots cut in round steel bars. Derivation of the leakage-flux equations is given.

Owston, C. N. (Cranfield Institute of Technology, Cranfield, England), British Journal of Non-Destructive Testing, Vol 16, No. 6, November 1974, pp 162-168, 12 figs., 3 tables, 1 ref., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0177

MECHANICAL PROPERTIES OF RAIL STEELS AS AFFECTED BY FLASH BUTT AND THERMITE WELDING [IN GERMAN]

To determine the effect of flash-butt and thermite welding on the mechanical properties of rail steels, test welds were made on three types of rail with the indicated minimum tensile strengths: crane rail (60 kg/mm^2), normal-quality rail (70 kg/mm^2), and wear-resistant rail (90 kg/mm^2). Temperature changes occurring in the rail during welding and cooling were measured, and TTT diagrams for continuous cooling were prepared. The effect of the welding operations on hardness, yield point, tensile strength, elongation, reduction in area, fatigue strength, notch impact strength, and microstructure was measured. Correlations were established for changes in the mechanical properties resulting from the transformation characteristics of the specific steels.

Heller, W., and Janiche, W. (Hutten- und Bergwerke Rheinhausen AG, Germany), Archiv fur das Eisenhuttenwesen, Vol 36, No. 5, May 1965, pp 351-363, 20 figs., 1 table.

ACKNOWLEDGMENT: Archiv fur das Eisenhuttenwesen.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0178

ULTRASONIC INTERNAL FLAW DETECTION SYSTEM FOR SLABS, BLOOMS, AND BILLETS

Rolling mill nondestructive inspection needs are discussed with particular emphasis on the detection of piping. The use of automatic ultrasonic inspection is discussed to demonstrate inspection improvements in relation to on-line speed and good quality control. Descriptions and specifications for prototype ultrasonic testing machines for blooms, billets, and slabs are given. A sketch of the bloom testing machine is provided, and arrangement of the ultrasonic probes is shown. The machine incorporates a marking system that provides identification for three different types of defects.

Shaw, D. (Davy Instruments, Ltd., Sheffield, England), Iron and Steel Engineer, Vol 52, No. 7, July 1975, pp 38-41, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Association of Iron and Steel Engineers (repr., PC).

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0179

STRESS-CORROSION CRACK DETECTION AND CHARACTERIZATION USING ULTRASOUND

This paper provides a description of an experimental test technique for the development of acceptable standards that could be used in stress-corrosion crack detection. The problems associated with past efforts and their related inadequacies are reviewed to make selections regarding mode of wave propagation, angle of waves, size and type of crystal transducer, and the most suitable couplant. Further considerations as to the use of simulated defects are also explored. The ultrasonic test equipment and basic instrumentation are described as well as the machined flaws to be used to establish a geometry of stress-corrosion cracks. The metallographic analysis of the test specimens includes a visual examination, fracture analysis, and a study of microstructure sections. Macrographs of the fractured specimen faces are shown to reveal the stress-corrosion areas.

Weil, B. L. (Lockheed-Georgia Co., Marietta, Georgia), Materials Evaluation, Vol 27, No. 6, June 1969, pp 135-139, 144, 12 figs., 3 refs.

ACKNOWLEDGMENT: American Association for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0180

RESEARCH ON ELECTRIC ARC WELDING AND THE ARCOSARC METHOD OF HARD [illegible]ACING RAILS [IN GERMAN]

Rail workpieces of varying quality are arc deposit welded with 450 Philips electrodes and hard faced according to the Arcosarc method. The mechanical properties of rail steel are unfavorably affected by hardening during the welding. Observed variations in the weld hardening have a pronounced influence on welding conditions, especially the preheating with correct through-heating. Results also show that it is possible to hard surface the various rail grades using electrodes. Arcosarc hard-surfaced rails have good mechanical properties and high heat yields especially for rail grades which are slow to transform.

Heller, W. (Huttenwerkes Rheinhausen, Rheinhausen, W. Germany) and Simon, W. (Oberbau bei der Bauabteilung der GD der SBB, Bern, Switzerland), Schweizer Archiv fur Angewandte Wissenschaft und Technik, Vol 33, No. 8, August 1967, pp 229-238, 15 figs., 2 tables.

ACKNOWLEDGMENT: Schweizer Archiv fur Angewandte Wissenschaft und Technik.

PURCHASE FROM: Voght-Schild A.G., Buchdruckerei und Verlag (repr., PC).

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0181

TRANSFORMATION CHARACTERISTICS OF RAIL STEELS AND THEIR EFFECTS ON WELDING AND FLAME CUTTINGS [IN GERMAN]

The chemical composition, mechanical properties, and welding behavior of a large number of commercial casts for rails in all qualities of the International Standard are evaluated. The compositional limits required to meet the specified strength levels in the hot-rolled condition are established. Properties after welding or flame cutting depend primarily on the carbon range but may be influenced by segregation. To suppress martensite formation preheating is essential for the grades with higher ultimate tensile strength. Grain growth near the weld is a serious problem. Operating and cooling conditions for Thermit and gas butt welding are given. Thermit welding may lead to hydrogen pickup and flake (fish-eye) formation. Welded rails have tensile stresses in the rail face and compressive stresses in the base.

Heller, W., and Beck, G. (Fried. Krupp Huttenwerke AG, Germany), Archiv fur das Eisenhuttenwesen, Vol 39, No. 5, May 1968, pp 375-386, 15 figs., 2 tables.

ACKNOWLEDGMENT: Archiv fur das Eisenhuttenwesen Eisenhuttenwesen.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0182

DETECTION OF FATIGUE CRACK GROWTH BY ACOUSTIC EMISSION TECHNIQUES

The occurrence of unstable fracture in structural materials is reviewed in relation to stress-intensity factors and materials toughness. The irreversibility characteristic of acoustic emission is described as a feature utilized in practical nondestructive testing. A model for analytical prediction of the total number of emission counts for monitoring fatigue-crack propagation in cyclically loaded structures was developed, and the mathematical equations associated with it are given. Data are presented in the forms of graphic illustrations and tabulations that show stress-intensity factors as a function of crack-growth propagation, and acoustic emission versus loading.

Dunegan, H. L. (Dunegan Research Corp., Livermore, Cal.), Harris, D. O. (Lawrence Radiation Laboratory, Livermore, Cal.), and Tetelman, A. S. (University of California, Los Angeles, Cal.), Materials Evaluation, Vol 28, No. 10, October 1970, pp 221-227, 9 figs., 2 tables, 6 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0183

CLASSIFYING SEAM DEPTHS IN STEEL BILLETS BY THE MAGNETIC TAPE METHOD

Data are presented covering the experimental results obtained in a study for determining seam depths in steel billets by using the magnetic tape method of nondestructive testing. The objective of this experimental work was to evaluate the seam-depth-indicating capability of the tape method for square-billet inspection. Tests were conducted on 29 as-rolled billets, 15 ft long by 4-1/8-in. square having a wide range of seam depth. Photomicrographs of defect cross sections are shown, and the data analysis is provided by graphical treatment of tape signal plots. Flow charts showing the group classifyings at seams with inspection accuracies and graphs that provide statistical summations of the data are given.

Lorenzi, D. E., Aguilu, G. E., and McClurg, G. O. (The Magnaflux Corp., Chicago, Ill.), Materials Evaluation, Vol 27, No. 11, November 1969, pp 238-243, 20 figs., 2 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0184

A NEW VIEW OF THE ELASTIC THEORY UPON WHICH ULTRASONIC TESTING IS BASED

The steps followed in developing the mathematics of elastic wave propagation are described by defining displacements, strains, forces, and the law which relates stresses to strains. Displacement vector diagrams for five potential functions of the boundary conditions (longitudinal source, longitudinal reflected wave, shearing reflected wave, longitudinal refracted wave, and shearing refracted wave functions) for total displacement of Lucite and aluminum are shown. Spherical wave solutions are also discussed and are recommended by the author for incidence angles that are equal to or greater than the first critical angle.

Nickerson, R. A. (Lawrence Radiation Laboratory, University of California, Livermore, Cal.), International Journal of Nondestructive Testing, Vol 2, No. 2, September 1970, pp 81-97, 20 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0185

THE GENERATED REACTION FIELD METHOD OF DETECTING DEFECTS IN STEEL BARS

This paper describes an inspection method--the generated reaction field method--which eliminates the requirements for high currents to magnetize the test specimen or sophisticated instrumentation to isolate defect indications in the testing of hot-rolled steel bars and tubes. The inspection technique is explained by dc generator theory and involves rotating the test specimen in a uniform dc magnetic field. Leakage fields resulting from surface and subsurface materials' discontinuities are detected with a Hall device and their topographies are recorded. The theory of operation is explained by illustrating flux distributions in a generator and shown through mathematical derivations using the Lorentz force equation. To explore the theories in the laboratory, a machined steel bar was rotated in a dc magnetic field at a speed of 1225 rpm. A Siemens Hall generator was moved along the circumference of the bar from pole tip to pole tip and the magnitude of the radial component of the resultant magnetic field was recorded. Positioning of the Hall probes is shown for different sensitivities, and data are plotted to show the relationship between defect signals, magnetization currents, and defects depths.

Lord, W. (Colorado State University, Fort Collins, Colo.), and Oswald, D. J. (Taylor Instruments, Rochester, N.Y.), Materials Evaluation, Vol 29, No. 2, February 1971, pp 21-27, 13 figs., 8 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0186

THE MAGNETIC TAPE RECORDING OF ULTRASONIC TEST INFORMATION

A method of recording primary ultrasonic test information is described in this paper. The "A" scan from an ultrasonic tester is directly recorded, together with the operator's voice giving the location, transducer position, and interpretation of the data with a video tape recorder which has been converted into a wideband instrumentation recorder. Sketches of the video head drum and tape recording are given. Schematic arrangement and a circuit diagram for the differential amplifier, video receiver, and oscilloscope are shown. Oscilloscope displays of ultrasonic signals showing defect indications are included.

Youshaw, R. A., Criscuolo, E. L., and Dyer, C. H. (U.S. Naval Ordnance Laboratory, Silver Spring, Maryland), Materials Evaluation, Vol 27, No. 2, February 1969, pp 34-36, 41, 4 figs., 6 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0187

THE TESTING OF HOT STEEL BY ULTRASONICS

The basic principles and problems involved in the ultrasonic testing of steel billets and blooms at high temperatures are discussed. Arrangement of processes for a system using ultrasonic inspection of hot steel billets on line is shown schematically. The coupling problem is discussed in relation to the types of transducers normally used for ultrasonic inspection and their inadequacies. A description of a laboratory-constructed machine for detecting pipe in steel billets is given. In this test machine, the ultrasonic probes are housed in the lower roll of the machine and a thin layer of oil serves as a couplant. Various approaches to the problem in France, Japan, and other countries are briefly discussed.

Andrews, K. W., and Bruce, M. (British Steel Corporation, Rotherham, England), British Journal of Non-Destructive Testing, Vol 14, No. 1, January 1972, pp 6-10, 6 figs., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0188

USING A FOCUSSING SYSTEM WITH THE CONTACT METHOD OF ULTRASONIC FLAW DETECTION

Some special characteristics of the ultrasonic inspection of steel rails and other similar objects are discussed with particular reference to the advantages of using a focussing system. The passage of ultrasonic beams through a spherical interface between two solid materials is analyzed on the basis of the laws of geometric acoustics. In order to reduce the solid angle of the beam it is considered best to arrange the interface on the optical axis in the short-range zone of the radiator field. A diagram of the focussing system showing the couplant, transducer, and object is given as well as an illustration of the ultrasonic paths.

Zhidenko, G. L., Industrial Laboratory [translation from Zavodskaya Laboratoriya], Vol 34, No. 6, June 1968, pp 828-830, 3 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0189

ACOUSTIC EMISSION MONITORING SYSTEM FOR DETECTION OF CRACKS IN A COMPLEX STRUCTURE

A description of an acoustic emission monitoring system designed to detect, in real time, initiation and propagation of cracks in a complex structure during static as well as fatigue testing is given. Information on the arrays of acoustic transducers, logic circuits and output devices, and signal processing equipment is provided. A spatial- and frequency-filter combination allows the use of the system under conditions of heavy background noise frequently encountered in the nondestructive testing of complex structures. The frequency range of acoustic-emission signals from structures being tested was from 300 to 600 kHz. Noise-signal relationships during the tests are

illustrated with chart strips, and a photograph of the test equipment is given.

Nakamura, Y. (General Dynamics Corp., Fort Worth, Texas), Materials Evaluation, Vol 29, No. 1, January 1971, pp 8-12, 9 figs., 3 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0190

PROPERTIES OF CARBON RAIL STEEL AND 40KhN STEEL AFTER QUENCHING WITH TEMPER AND ISOTHERMAL TREATMENT

An investigation was conducted to determine possible means for improving service behavior of two types of rail steel: carbon steel (0.66C-0.71Mn-0.23Si-0.024S-0.026P) and 40KhN steel (0.40C-0.54Mn-0.22Si-0.021S-0.11P-0.64Cr-0.99Ni-0.13Cu) with austenite stability times of 1-1.5 and 5 sec, respectively. Data are given for hardness and other mechanical properties of the specimens after various quenching, tempering, and isothermal treatments. Calculations are also given for the plastic strain resistance. The results indicate that isothermally heat-treated low-alloy steels offer improved resistance to contact fatigue and brittle fracture.

Pridantsev, M. V., and Nikonov, A. G., Izvestiya Akademii Nauk SSSR Metally (Russian Metallurgy - Abridged Translation), No. 1, 1967, pp 34-39, 3 figs., 4 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press Ltd. (repr., PC).

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0191

NONDESTRUCTIVE TESTING HANDBOOK, SECTION 35: TESTS OF RAILROAD RAILS

The basic principles of electromagnetic testing and inspection of rails are described. The Sperry system of rail testing, in which current is introduced into the rail head setting up a magnetic field, is discussed and shown. Various Sperry rail detector cars are illustrated, and the functions of some of the subcomponents of the inspection system, such as magnetic search coils, power supplies, amplifiers, and data processing are explained. Typical rail defects that can be detected, such as transverse fissures, engine burns, rail fractures, and fatigue cracks, are shown.

McMaster, R. C. (Editor) (The Ohio State University), edited for the Society for Nondestructive Testing, The Ronald Press Company, New York, N. Y., Vol 1, Section 35, 1959, pp 35.11-35.22, 10 figs., 10 refs., bibliog.

ACKNOWLEDGMENT: Society for Nondestructive Testing.

PURCHASE FROM: The Ronald Press Company (Handbook).

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0192

ULTRASONIC NONDESTRUCTIVE TEST FOR DETECTION OF IMPROPER HEAT TREATMENT OF STEEL

Many of the effects resulting from the improper heat treatment of steel cannot be detected by surface tests. The influence of microstructure and grain size on ultrasonic attenuation is the basis of a proposed test to determine where the heat treatment which has been given the steel has been correct or faulty. By means of an empirical correlation, it is possible to determine limits to the attenuation of acceptable parts. The technique, when used in conjunction with a surface hardness test, provides unambiguous results. It can be employed at any stage in the heat treating process or following completion of the process. The three phases of heat treatment, i.e., heating into the austenite regio , quenching to form martensite,

and the tempering to hardness, are reviewed. Data are presented graphically that show ultrasonic attenuation changes that occur for various steels and heat treatments.

Papadakis, E. P. (Bell Telephone Laboratories, Allentown, Pa.) Materials Evaluation, Vol 23, No. 3, March 1965, pp 136-139, 5 figs., 8 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0193

RAIL RESEARCH AND DEVELOPMENT: PART 1. METALLURGICAL EXAMINATION AND PHYSICAL TEST RESULTS OF CHROMIUM AND MANGANESE-VANADIUM ALLOY RAIL STEEL INVESTIGATION

This report contains the results of metallurgical examinations and laboratory accelerated testing of samples of chromium and manganese-vanadium alloy rail steels to determine their quality and strength. The investigation consisted of rolling-load tests, drop tests, slow-bend tests, physical-property determinations, Charpy impact tests, chemical analysis, Brinell hardness surveys, and macroscopic and microscopic examinations. All test data are tabulated. The testing procedures are described and test equipment and loading diagrams are shown. Photographs showing transverse sections of the specimens and rail breakages during tests are included along with plots of Charpy impact test results.

Schoeneberg, K. W. (AAR Technical Center, Chicago, Ill.), Advance Report of Committee 4 - Rail Report on Assignment 5, Rail Research and Development, American Railway Engineering Association, Bulletin 649, Proceedings, Vol 76, September-October 1974, pp 65-98, 23 figs., 9 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0194

"ENGINEERED" TRACK: PART 1, EFFECTIVE SUBGRADE AND BALLAST

This is the first of a two-part article on track structure from subgrade to rail. The importance of subgrades and ballast is pointed out, and the criteria for establishing the stability of new construction and for maintaining or improving the stability of existing construction are given. Inadequate foundation support results in excessive track deflection. The differential movement between rails, ties, fastenings, ballast, and subgrade that arises from such excessive deflection accounts for a large portion of track maintenance costs. Modulus of track stiffness as given by Talbot is a lumped parameter for soil, ballast, and tie support and is defined as the load on 1 in. of rail that causes 1 in. of rail deflection; it is also the load required of a group of wheels to depress the rail 1 in. divided by the tie spacing. It is stated that a value of 2000 psi has been considered normal for stable well-maintained track, but it can be as low as 500 psi for a poorly supported track and as high as 6000 psi for hard rock ballast.

May, W. W. (University of Illinois, Urbana, Ill.), Progressive Railroading, Vol 18, No. 3, March 1975, pp 42-43, 46, 48, 2 figs., 1 photo, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Murphy-Richter Publishing Co. (repr., PC).

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0195

"ENGINEERED" TRACK: PART 2, BALLAST STABILITY AND PROLONGED RAIL LIFE

This article, the second of two on track structure, deals with the identification of qualities which lend high stability to ballast, the role of ties in transmitting loads and holding gauge, and the factors tending to produce rail failure. The importance of the ballast is briefly reviewed and the qualities and mechanical properties that lead to long crosstie lives are discussed.

Rail defects are enumerated and values of bending stresses, wheel loads, track modulus, and margins of safety are given. Defects that are related to the quality and toughness of the rail steel are defined as head checking, spalling, flaking, shelling and corrugation. Emphasis is placed on effects of over-stressing (50,000 psi) of rails by the 100-ton cars being used at the present time.

Hay, W. W. (University of Illinois, Urbana, Ill.), Progressive Railroading, Vol 18, No. 4, April 1975, pp 49-50, 52, 2 photos, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Murphy-Richter Publishing Co. (repr., PC).

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0196

APPARATUS FOR DETERMINING DYNAMIC MODULUS OF ELASTICITY AND INTERNAL DAMPING CAPACITY

The apparatus described has been developed to measure damping capacity of metals and alloys over wide ranges of temperature and frequency at limited (low) stress ranges, and to provide elastic modulus data over corresponding temperature, frequency, and stress ranges. Modulus variations can be correlated with magnetic and structural transformations, nucleation and growth, shear transformations, corrosion, ordering, and recrystallization and recovery processes. A block diagram of the apparatus for measuring the dynamic modulus and internal damping, based on investigations of Forster, is presented. Various methods by which internal damping can be calculated such as the use of data from resonance curves and free-decay charts are described. A step-by-step explanation of specimen preparation and the operation of the test equipment and related apparatus is given.

James, D. W. (Westinghouse Research & Development Center, Pittsburgh, Pa.), Materials Evaluation, Vol 27, No. 5, May 1969, pp 102-106, 4 figs., 7 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0197

THE ELECTRICAL POTENTIAL METHOD AND ITS APPLICATION TO NON-DESTRUCTIVE TESTING

The basic principles of the electrical potential method and its application to non-destructive testing are reviewed. Practical examples are given of results obtained, and the performance of commercially available instruments is described. The course of potential and current lines in cases of obliquely oriented cracks is illustrated. Crack-depth measurements are discussed through use of mathematical expressions giving potentials and potential surges, and by showing curves of the data plotted as a result of experiments using specimens with known flaws.

Gille, E. (Institut fur Zerstorungsfreie Werkstofprufung, Angermund, West Germany), Non-Destructive Testing, Vol 4, No. 1, February 1971, pp 36-44, 22 figs., 17 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0198

FRICTION AND CREEP IN ROLLING CONTACT

Experimental and analytical studies of friction and creep in rolling contact are reported. Factors examined for their influence on friction (adhesion) and creep are surface roughness, surface vibration, surface contamination, dynamic loading due to irregular track, and rolling velocity. Surface roughness does not influence the creep coefficients at operating loads. However, surface roughness influences the tractive capacity when the wheel and rail surfaces are either very clean or flooded with a contaminant. An investigation of the effects of loads on the truck and axle mass, the foundation stiffness and the primary suspension damping is reported. An analysis of both the tractive capacity of the wheelset and the probability of damage to the rails is presented. The analysis involves the contact geometry of a wheel moving over a rail, and its

mathematical expression deals with wheel and rail irregularities and nominal surfaces from a fixed reference.

Nayak, P. R., Hariharan, S., Stern, R., Abilcock, R., March, P. A., and Gupta, P. K. (Bolt, Beranek and Newman Inc., Cambridge, Mass.), Report No. FRA-RT-71-64, for DOT/FRA, Washington, D.C., November 1970, 255 pp, 71 figs., 8 tables, 169 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 196 707.

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0199

DOT TEST TRAIN PROGRAM SYSTEM INSTRUMENTATION MANUAL

This report describes current instrumentation installed aboard the DOT Test Train. The instrumentation is designed to gather data on various rail research projects. The major discussion in this report covers the Track Geometry System aboard the test train, and the operation and calibration of this system. Descriptions of the electronic data-processing systems are provided with a detailed discussion of the transducers and their associated signal-processing circuitry. Digital and analog recording equipment as part of the data processing is covered.

Gerhardt, C. L., and May, J. T. (KISCO, Inc., Springfield, Va.), Report No. DOT-FR-72-1, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-00015, 156 pp, 75 figs., 4 tables, 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfilm), PB 209 709.

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0200

SOME ASPECTS OF RADIOGRAPHY AND ULTRASONIC TESTING OF WELDS IN STEEL WITH THICKNESSES FROM 100-300MM

The advantages of using both ultrasonic testing and radiography for nondestructive testing of welds in steel are briefly discussed. Comparisons of image qualities obtained with different radiation sources for a range of steel thicknesses, and the X-ray scattering ratios per unit thicknesses are graphically illustrated. The various radiation-source generators are described in accordance with their capabilities to produce streams of particles at high energy levels. Examples of small inclusions detected ultrasonically are given with some information that enables the determination of physical characteristics. Surface defects and irregularities are also examined through the use of ultrasonic procedures, and the results are shown for a variation in the angles of refraction. Weld defects are also portrayed. The Krautkramer ultrasonic test equipment used in this study is described and shown integrated with other laboratory facilities.

de Sterke, A. (Wells-Krautkramer, Ltd., Letchworth, Herts., England), British Journal of Non-Destructive Testing, Vol 9, No. 4, December 1967, pp 94-107, 24 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0201

ULTRASONIC DETECTION OF INCLUSIONS IN STEEL

This paper represents the results reported by the New Departure-Hyatt Bearings Division of the General Motors Corporation on the development of ultrasonic techniques used to detect and evaluate nonmetallic inclusions in bearing steel. The inadequacies of the methods that use shallow stress waves are shown by illustrations of recordings of

scans of cylindrical parts with ultrasonic transducers. A task force comprised of personnel from the steel and bearings industries was established for the purpose of standardizing techniques for the ultrasonic inspection of billets. Results of the task force findings are summarized with graphic illustrations of distribution patterns of inclusion indications, and inspection comparisons of defect depth responses.

Bayre, W. W., and McCormack, D. D. (General Motors Corp., New Departure-Hyatt Bearings Div., Sandusky, Ohio), Materials Evaluation, Vol 28, No. 2, February 1970, pp 25-31, 10 figs., 2 tables, 11 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0202

THE MAINTENANCE AND REPAIR OF CURVES, RAIL ENDS, RAIL CROSSINGS, SWITCH POINT BLADES AND STOCK RAILS BY GAS WELDING DEPOSITION [IN GERMAN]

Weld deposition to repair rails or other parts of track is performed by manual welding with a neutral flame. An excess of oxygen leads to oxidation of alloying elements and too much gas causes carburization. Detailed instructions are given for conducting the rest of the welding process. Repair by weld deposition of worn spots of rails, broken rail ends, switch point blades, and stock rails is discussed in detail, with welding torch positions, wire selection and feeding and general procedures given. A specially designed automatic grinder is recommended for finishing.

Fries, F. (Abteilung Schienenschweissender Beratungsstelle fur Autogen-Technik eV), Schweissen und Schneiden, Vol 17, No. 9, September 1965, pp 483-487, 8 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Schweissen und Schneiden.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0203

MODERN APPLICATIONS OF THERMIT WELDING: PART 2. RAIL WELDING

Thermit welding provides a quick, economical method for producing continuous lengths of rail. The history of Thermit welding in Europe, in particular in Germany and Great Britain, is reviewed along with rail-welding requirements, rail-welding methods, the Thermit principle, and the Thermit Quick Welding Method. Buckling and slow-bend tests conducted on Thermit welded rail are also described.

Ailes, A. S., Welding and Metal Fabrication, Vol 32, No. 11, November 1964, pp 414-419, 10 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Metals (repr., PC).

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0204

DYNAMIC MEASUREMENT OF ABSOLUTE TRACK PROPERTIES

A description of a transducer which is mounted on the truck of a railway vehicle for track parameter measurements and a discussion of its application to track maintenance are given. The development and field trials of the transducer (accelerometer) are discussed in detail. Schematic diagrams of physical mountings and electrical wiring are shown. Some information on the signal processing of the transducer outputs is also provided. Dynamic rail profiles were plotted at 20 mph with the sensors in a track inspection car.

Cass, R., Berthiaume, P. P., Kalita, R. E., and St. Louis, L. (CN Technical Research Branch, Montreal, Quebec, Canada), Journal of Engineering for Industry, Trans. ASME, Vol 91, No. 3, August 1969, pp 855-860, 16 figs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0205

THE USE OF WELDING IN THE FABRICATION OF CONTINUOUS RAILS [IN GERMAN]

Flash butt welding is used for the fabrication of continuously welded railroad rails in the shop. With a cross-sectional area of 12,000 mm^2, a pressure of 30 to 50 tons (3 to 4 kg/mm^2 is applied; the time required is 80 to 120 sec, with 2 min for weld preparation. Automatic, hydraulic machines are used to deburr the welds and the welds are subsequently bend tested. Thermit welding is employed on-site by preheating with a propane-oxygen burner and molds are hardened with water glass (sodium silicate) and CO_2. Broken rails are repaired by Thermit welding without preheating. Open electric-arc welding and gas welding are employed only very occasionally. Special procedures used in the welding of wear-resistant, high-strength rails are described. Cracks in the rails or joint do not open wider than 15 to 20 mm and are thus harmless.

Birmann, F. (Dezernent fur Oberbau-Forschung im Bundesbahn-Zentralamt Minden), Schweissen und Schneiden, Vol 17, No. 9, September 1965, pp 480-482, 7 figs., 9 refs.

ACKNOWLEDGMENT: Schweissen und Schneiden.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0206

FACTORS INFLUENCING SURFACE DEFECTS ON RAILS PRODUCED BY THE ACID BESSEMER PROCESS

A marked rise in the defect rate for 110 lb/yd permanent-way rails manufactured by the Workington Iron and Steel Co. (Cumberland, U. K.) led to an investigation by the Company of individual steelmaking variables with a view toward the development and application of controls. A combination of metallurgical and statistical techniques was used, which confirmed earlier empirical work and resulted in the formulation of a strategy for controlling the Bessemer process and teeming methods.

A metallographic survey revealed that the principal source of defects was the ingot, and the principal causes of these defects were blowholes and ingot cracks. Shell arising from splash and from entrapped nonmetallic material was of minor concern. Defects directly related to the rolling mill (guide marks, fins, fast teeming, and rolled-in scrap) were slight. Ingot cracking was found to result from fast teeming and high sulfur content; while, conversely, blowhole incidence and depth increased with low sulfur content (higher sulfur content reduces nitrogen pickup) and slow teeming. Although not optimum, the practice of a fast teem and low sulfur content was adopted. The study was continued, and adjustments in teeming temperatures and teeming methods, redesign of ladle nozzles and stoppers, and other modifications have resulted in an encouraging reduction in defect level. Work is continuing on nitrogen control and other factors.

Morgan, E. L. (Workington Iron and Steel Co., Moss Bay, Workington, Cumberland, U.K.), Journal of the Iron and Steel Institute, Vol 206, No. 1, January 1968, pp 39-46, 16 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0207

THE REPEATED BEND TESTING OF GAS PRESSURE WELDED RAIL JOINTS [IN GERMAN]

Rail sections of steel containing 0.47% C, 0.26% Si, 1.06% Mn, 0.077% P, 0.025% S and 0.14% N_2 with given mechanical properties were test welded by gas-pressure welding operations. The welds were investigated by macrosection and microsection analysis, by hardness tests across the seam, by tensile tests, and by bending fatigue tests. The bending fatigue tests were evaluated in terms of Wohler lines and the characteristics of the structure

surfaces obtained. Results led to the conclusion that gas-pressure welding yields satisfactory welds for joining rails.

Drost, A. (Mitarbeiter im Staatlichen Materialprufamt Dortmund, West Germany), Schweissen und Schneiden, Vol 18, No. 1, January 1966, pp 13-17, 10 figs., 3 tables, 7 refs.

ACKNOWLEDGMENT: Schweissen und Schneiden.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0208

SYSTEM INSTRUMENTATION MANUAL: DOT TEST TRAIN PROGRAM

This report describes instrumentation currently installed aboard the DOT Test Train to gather research data on the various rail research projects. The major discussion in this report covers the operation and calibration of the Track Geometry System which measures, records, and displays data for right and left rail alignment, right and left profile, gauge, and cross-level. The transducer measurement, automatic location detection, speed and distance, digital tape recorder, and the d-c power subsystems are also discussed in detail.

Gerhardt, C. L., and May, J. T. (ENSCO, Inc., Springfield, Virginia), Report No. DOT-FR-71-1, for DOT/FRA, Washington, D.C., January 1971, 114 pp, 69 figs., 4 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 203 110.

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0209

INNOVATIONS IN THE FIELD OF ROLLING ON UNIVERSAL MILLS [IN GERMAN]

The advantages of rolling in universal mills are outlined, and the principle of universal rolling in 3-high stands, as applied to the rolling of symmetrical sections such as parallel-flange beams and asymmetrical sections such as rails, is discussed. The rolling of rails in a reversing universal mill and in the continuous finishing train is described, and the use of semi-continuous rolling for smaller beams is discussed and illustrated by examples.

Stammbach, R. (Wendel & Cie, S. A., Usine de Hayange, Hayange, France), Berg- und Huttenmannische Monatshefte, Vol 113, No. 3, March 1968, pp 124-131, 13 figs.

ACKNOWLEDGMENT: Berg- und Huttenmannische Monatshefte.

PURCHASE FROM: Springer Verlag (repr., PC).

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0210

DEVELOPMENT AND USE OF A TRACK QUALITY INDEX

A track inspection car currently used on the Southern Railway System and the track rating index developed from the data obtained by the car are discussed. The car's measurement capabilities for twist, surface, superelevation, gauge, and alignment are described. Comparisons are drawn between the U.S. track inspection car and its counterparts in Germany, Japan, and the United Kingdom. The role that LVDT transducers play in the measurement of track irregularities is discussed.

Crane, L. S., Sullivan, J. J., and Kaelin, C. R. (Southern Railway Company, Alexandria, Va.), Journal of Engineering for Industry, Trans. ASME, Vol 91, No. 3, August 1969, pp 861-868, 7 figs., 2 tables, 4 refs., 1 appendix and discussion.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0211

TEST TRAIN PROGRAM: FOURTH PROGRESS REPORT

This progress report covers a 12-month period of engineering, and data management and analysis efforts related to rail research. Subjects include operation of the DOT Rail Research Cars, associated testing programs, test-car upgrading, expansion of the Rail Research Program, and data management and analysis tasks which have been undertaken to benefit railroad technology. The program primarily involves the operation and instrumentation of the DOT rail research vehicles, the DOT Test Cars. This research program is designed to provide high-speed measurement of railroad track characteristics, development of comprehensive instrumentation and measurement techniques, and data evaluation through analysis and electronic processing.

May, J., Kaufman, W., Yang, T., Frankowski D., and Holik, J. (ENSCO, Inc., Springfield, Va.), Report No. DOT-FR-72-09, for DOT/FRA, Washington, D. C., Contract Nos. DOT-FR-00015 and DOT-FR-20032, June 1972, 107 pp, 33 figs., 9 tables, 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfilm), PB 226 048.

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0212

TEST TRAIN PROGRAM, THIRD PROGRESS REPORT

This progress report covers a 12-month activity period covering engineering and data management in conjunction with operation of rail research test cars, and discusses research and analysis efforts in fields associated with rail research. Developments include an operational prototype track geometry measurement system, various track measurement techniques, and formalization of operating procedures. Existing data-processing routines were improved and new ones developed. Demonstration of, and routine testing with, the track geometry system was performed for a number of different organizations. Descriptions of signal-processing equipment and the modifications of rail sensing transducers are discussed along with the data-processing support.

Demuth, H., Gerhardt, C., May, J., and Trzaskoma, W. (ENSCO, Inc., Springfield, Va.), Report No. DOT-FR-71-2, for DOT/FRA, Washington, D. C., Contract No. DOT-FR-00015, June 1971, 115 pp, 71 figs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfilm), PB 209 762.

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0213

FUNDAMENTAL STUDY OF ROLLING TORQUES IN SHAPE PASSES: RECOMMENDED MEASURING EQUIPMENT [IN FRENCH]

Measurements were made on two-high, multistand reversing mills rolling standard I-, U-, and H-beams in various sizes, rails, and billets. Discussion includes: torque, rolling force, and rolling energy for each shape and pass; influence of grade of steel, elongation and deformation of material, rolling temperature and speed; comparisons between torque actually measured and that calculated by different methods; efficiency of mill and losses at bearings; distribution of torque between rolls, distribution of rolling force on screws and reaction on adjacent stands; torque-rolling force ratios; and comparisons between roll speed and travel speed of material.

Lachenait, C., and Albert, J. C. (L'Irsid, St. Germain-en-Laye), Revue de Metallurgie, Vol 62, No. 5, May 1965, pp 381-449, 10 figs., misc. charts and diagrams, 13 refs.

ACKNOWLEDGMENT: Revue de Metallurgie.

PURCHASE FROM: Revue de Metallurgie (repr., PC).

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0214

MAINTENANCE OF TRACK ON SHINKANSEN

Track maintenance of the Tokaido Shinkansen rail line (515 km Tokyo to Shin-Osaka) the first line in the planned nationwide, high-speed Japanese rail network is discussed. Maximum scheduled speed of the 25-m-long, 60-ton electric rail cars operating on the line is 210 km/hr (the 515 km between Tokyo and Shin-Osaka is covered in 3 hr, 10 min, including two station stops). Future plans call for operation at 250 km/hr. Long welded rails are used on the entire line with the exception of curves having a radius of curvature of <1000 m. The base rails (each 25 m) are welded by flash-butt, gas-pressure, enclosed arc, Thermit or high-frequency pressure methods. Track inspection is conducted by means of rail defect detection car primarily and by ultrasonic and visual inspection secondarily. Discussion of the various elements of track maintenance procedures and operations is supplemented by statistics presented in the form of charts, graphs, and tabulations.

Fukusawa, Y. (Civil Engineering Dept., Shinkansen Administration, Japanese National Railways), Japanese Railway Engineering, Vol 14, No. 1, 1973, pp 3-7, 5 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kem-Yusha, Inc. (repr., PC).

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0215

A CORRELATION STUDY BETWEEN ULTRASONIC, RADIOGRAPHIC AND VISUAL EXAMINATION OF HEAVY STEEL PLATE WELDMENTS

The objective of this study (conducted for the Navy) was to develop and construct an ultrasonic inspection system for butt welds in heavy steel plate. Ninety-five sections cut from eight welds in HY-80 steel plate were visually inspected, and the findings were compared with data obtained for ultrasonic and radiographic inspections at the same locations. It was found that both manual and automatic ultrasonic inspection are more reliable in the detection of weld defects than radiography. A description of laboratory procedures is given, and sketches are presented which show locations of defects in the welds detected using the three modes of inspection.

Lovelace, J. F., and Luini, L. A. (General Dynamics, Groton, Conn.), Materials Evaluation, Vol 26, No. 1, January 1968, pp 1-7, 8 figs., 9 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0216

IS IT GOOD ENOUGH?

This is a general article describing a 2-mile section of track of the Santa Fe route that carries 45 to 55 million gross tons annually which is to be used to test eight types of track structure. One 800-ft-long section will test 136-lb, 1440-ft continuous welded rail with string ends field-welded. The remaining seven sections will test new types of concrete ballast, slag ballast, and treated ties. These experiments are designed to produce a track structure to accommodate the increased loading caused by unit trains. New designs are aimed at reducing rail wear on curves and reducing braking damage. Track modulus is discussed in relation to rail loading.

Myers, E. T., Modern Railroads, Vol 30, No. 3, March 1975, pp 47-49, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Cahners Publishing Company, Inc. (repr., PC).

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0217

DERAILMENT ANALYSIS: WHAT PART DO RAIL FAILURES REALLY PLAY?

The data on train accidents in a DOT letter report of April 3, 1968, to the Federal Railroad Administrator, were analyzed by the AAR's Assistant Vice President-Research, G. M. Magee. In this article tables for the years 1961 (or 1962) and 1966 show: (1) derailments from all causes, (2) derailments from track conditions, (3) service rail failures by types of defect, and (4) train accidents due to defects in rails and joints. The AAR Engineering Division Rail Committee reviewed the analysis and made a number of recommendations for more meaningful analysis of the trend of t ·ain accidents due to defects in rails and joints and also to reduce the number of accidents due to such defects.

Railway Age, Vol 166, No. 9, March 10, 1969, pp 21-23, 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0218

HIGH SPEED TRACK INSPECTION CAR

The Japanese National Railway (JNR) test car, which can operate at a maximum speed of 120 km/hr on narrow-gauge lines and 160 km/hr on the New Tokaido Line, is described. Recordings are made from electronic signals from mechanical feelers moving on geometrically relative points on the rail under test car loading. The number of track irregularities exceeding 3 mm for every 0.3 m of track length is totaled and the probability of this excess indicating the track condition is calculated for every 500 m. A separate counter automatically makes the same counting for an arbitrary unit of track length (e.g., for each track maintenance depot) and displays it on the control panel. This type of test car has been operating since 1961.

Hiroi, K. (Japan National Railways), Japanese Railway Engineering, Vol 7, No. 4, December 1966, pp 40-41, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0219

...TRACK PRACTICES IN THE USSR

This final installment of a two-part general article, based on interviews with a group of U.S. railroad engineers and researchers, who made an 11-day tour of Soviet railroads, deals with mechanization of rail maintenance operations and rail research. The Soviets state that they are 86% mechanized in their maintenance operations. Members of the American delegation found Soviet track to be comparable to that in the U.S

One serious problem facing Soviet researchers is that of track buckling. Projects concerning this problem are being conducted at the Central Railroad Research Institute (CNII). Test tracks located at Shcherbinka (Moscow) are used to test prestressed concrete ties, concrete panels, concrete track-supporting frames, and various types of fastenings.

Railway Track and Structures, Vol 70, No. 10, October 1974, pp 28-30, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0220

COMPUTER SPOTS RAIL DEFECTS FAST

This is a general article on Penn Central's use of an IBM 1130 computer with peripheral equipment for processing rail-defect information. The computerizing of rail-defect data has resulted in many benefits in the production and manipulation of such information for various reporting requirements and for most useful management information, particularly for the utilization of rail supplies, scheduling material and manpower for relaying rail, and for long-range programming of rail renewals.

Railway Age, Vol 169, No. 1, July 13, 1970, pp 32-33, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0221

TRACK IRREGULARITIES - JNR STUDIES IN SEARCH OF NEW TOLERANCES FOR TRACK MAINTENANCE

In modernizing track maintenance systems, the prime task is to strengthen the track structure. It is also necessary to determine the conditions at which the track should be maintained for modernized rolling stock running at higher speeds and greater train loads. JNR decided to restudy track maintenance standards and established a Research Committee on Track Irregularities in 1961. This article contains a historical description of the establishment of track maintenance limits and associated problems and also discusses briefly research on track irregularities, theoretical analysis for relationship between various track irregularities, development of equipment to measure original waveform of track irregularities, field tests, and bases for establishing new tolerances for track irregularities.

Kitooka, H. (Japan National Railways), Japanese Railway Engineering, Vol 7, No. 3, September 1966, pp 10-13, 2 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Japan Railway Engineer's Association (repr., PC)

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0222

THE FRA TEST CARS - WHAT THEY ARE DESIGNED TO DO - HOW THEY ARE BEING USED - NEW CAPABILITIES IN THE OFFING

The FRA T2 test car provides an axle loading of 13 tons, which simulates actual track operating conditions during tests. Analog signals from noncontacting sensors used to measure sensor-to-rail displacements are processed into a CDC 6600 digital computer. Individual sensor values are combined into track geometry values which are displayed on a multichannel chart. The T2 system contains 14 noncontact, proximity-type sensors to define gauge, profile, and alignment, two linear displacement transducers, and a gyroscope for vertical reference. Superelevation is determined by combining the sensor signals with the vertical reference and the transducer signals. Sample data are taken every 2.4 ft of rail at speeds up to 150 mph. A flow chart shows the signal processing system and a sample display chart shows rail profiles for jointed rail, welded rail, and the Pueblo test track. The test car is self-propelled on electrified lines or can be incorporated into a regular train.

Railway Track and Structures, Vol 69, No. 1, January 1973, pp 26-28, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0223

COUNTING TRACK DEFECTS AT TRAIN SPEEDS

To meet the need for a simple device to measure track irregularities, a system was developed that is: (1) capable of operation at all passenger and freight train speeds, (2) designed for installation in any car, (3) capable of semiautomatic operation, requiring no crew, and (4) designed to produce statistical information directly by mile, division, or other geographical unit. Transducers are used to detect rail and track irregularities. These transducers measure displacements

and their output signals are conditioned and processed to be compatible with a readout printer.

Railway Track and Structures, Vol 62, No. 4, April 1966, pp 30-31, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM Simmons-Boardman Publishing Corp. (repr., PC).

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0224

WELDING JOINTS FOR HIGH-MANGANESE CROSSINGS

Hadfield's high-manganese steel points and crossings provide reduced wear in that portion of the track which is subjected to the most severe impacts and which is structurally weaker than plain line, but some of the advantages are lost if the cast sections have to be fishplated to adjacent track. The Budapest Research Institute for the Steel Industry has developed a technique for welding Hadfield's steel to ordinary rail steel so as to eliminate the fishplated joints. The process enables welding to be carried out without allotropic conversions taking place so that the two types of steel can be welded without difficulty. Joints welded by this process have been subjected to mechanical bending-rupture tests with 1-m separation of the supports and have withstood the specified 15-mm buckling without cracks. The first cracks occurred when buckling was as high as 25 to 31 mm; the break was initiated at some distance from the weld.

The Railway Gazette, Vol 123, No. 13, July 7, 1967, pp 510-511, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0225

WHAT AAR'S RESEARCH CENTER HAS BEEN DOING

A summary of AAR (Association of American Railroads) activities is presented for the year 1965. During that year, AAR prepared the first statistical tabulation of all rail failures, occurring in main track by rail section. Figures show 126,397 failures in 195,283 track-miles. Research findings and developments are summarized briefly for the following activities: studies on wheel loads and rail failures; butt-weld failures; testing of Thermite-welded bootleg rail bonds; findings with Hy-Cube test cars; tie-downs; track inspection cars; 100-ton hopper cars, derailments; performance of hotboxes; testing of concrete ties; stress in wood stringers; design of concrete box-girder; effect of forces in bridges; instrumentation for weighing cars in motion. The types of failures mentioned include progressive-type fractures in the rail head, transverse fissures, rail shelling, engine burns, vertical and horizontal split heads, and other head failures.

Magee, G. M. (Association of American Railroads), Railway Age, Vol 160, No. 10, March 14, 1966, pp 20-24, 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0226

A COMBINED REFLECTION-TRANSMISSION METHOD OF ULTRASONIC FLAW DETECTION

A new ultrasonic testing method combining the high resolving power and sensitivity of the reflection method with the reliability of the transmission method is presented, together with the theoretical foundations of the combined method and a block diagram of a flaw detector operating on this principle for pipe welds. The process of inspection by the transmission and reflection methods of a longitudinal pipe weld is examined and illustrated,

and mathematical expressions are developed. The flaw detector and its operation are described in detail.

Malinka, A. V. (Lenin Dorepropetrovsk Tube Plant), Defectoscopy: The Soviet Journal of Nondestructive Testing (Translation by Scientific Information Consultants, London), No. 3, (May-June 1966), pp 211-214, 2 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0227

ANALYSIS OF RESIDUAL, THERMAL, AND LOADING STRESSES IN A B33 WHEEL AND THEIR RELATIONSHIP TO FATIGUE DAMAGE

This investigation is concerned with service loading conditions that produce the highest stresses and the possibility of fatigue damage. Static loading, rim heating, residual stress measurements, and fatigue tests were conducted in the laboratory on representative B33 wheels. A series of simulated loading conditions were studied and the resulting stresses combined by superposition principles. The resultant stress patterns were compared with fatigue test results using the modified Goodman relationship. Calculated stresses from the loading tests are summarized and shown in tabulations. Fatigue data are also tabulated along with stress data given in the modified Goodman diagrams.

Bruner, J. P., Benjamin, G. N., and Bench, D. M. (Armco Steel Corp.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 89, May 1967, pp 249-258, 18 figs., 8 tables.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0228

ON THE EFFECT OF TRACK IRREGULARITIES ON THE DYNAMIC RESPONSE OF RAILWAY VEHICLES

An investigation of the steady-state response for models of a six-axle locomotive running on a sinusoidally irregular track is reported. Two mathematical models have been developed, a full model for the stationary vehicle in which creep between wheels and rails was neglected, and a full model for the moving vehicle in which creep forces, gravity stiffness effects, and wheel-tread profiles were considered. The results given in this paper are for the case of sinusoidal lateral track irregularities, but the method is general enough to allow also for vertical track irregularities. This paper illustrates and describes the mathematical models used and gives generalized form for the differential equations of motion and the method of solution. The equations of motion for the wheelsets are derived in detail including the creep forces and the wheel-tread profiles.

Dokainish, M. A., Siddall, J. N., and Elmaraghy, W. (McMaster University, Hamilton, Ontario, Canada), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 96, No. 4, November 1974, pp 1147-1158, 14 figs., 13 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0229

A COMPUTER PROGRAM FOR DETERMINING THE EFFECT OF DESIGN VARIATION ON SERVICE STRESSES IN RAILROAD WHEELS

Two computer analyses relating service stresses in railroad wheels to wheel shape and dimensions are described. One program computes the temperature distribution and stresses due to heat input by brake-shoe friction at the wheel tread. The other computes stresses in the wheel due to lateral, vertical, and tractional forces between the wheel and rail. This work is directed toward optimization of

wheel design, and elucidation of the nature and specific effects of excessive service loads.

The paper discusses each computer program in detail and describes input information in the form of wheel geometry and mechanical and physical properties of the wheel material as a function of temperature. The thermal analysis involved a step-by-step numerical integration where temperature distribution was calculated at 70 nodal points in the wheel. The stress analysis was based on the assumption that the wheel was comprised of 17 concentric structural rings. The paper describes the simple problems solved utilizing both programs to verify their usefulness and presents the results of one analysis of thermal and load stress analysis on a wheel.

Riegel, M. S. (American Iron and Steel Institute, Chicago, Ill.), Levy, S. (General Electric Corp., Schenectady, N. Y.), and Sliter, J. A. (General Electric Corp., Schenectady, N. Y.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 88, November 1966, pp 352-362, 18 figs., 22 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0230

EFFECT OF DESIGN VARIATION ON SERVICE STRESSES IN RAILROAD WHEELS

Two computer programs designed to simulate service braking and loading conditions in railroad wheels were applied to different wheel designs and the braking and loading stresses were computed for rapid stop and drag braking conditions. Several track loading conditions were simulated that included combinations of vertical and lateral loads. The results reported indicate that there is no one optimum wheel design for all service conditions, but several configurations show promise. Fatigue strength is an important consideration in wheel design, and a method is proposed for optimizing design for specific service conditions to guard against fatigue damage of wheel plates. The method utilizes modified Goodman diagrams to provide information concerning fluctuating stresses, fatigue strength, and heating and loading stresses.

The results of the analyses are summarized in several tables and show the effect on radial stresses of braking heat input, brake shoe location and lateral location of vertical load application (along tread surface). In addition the discussion describes two design features studied (plate slope and plate shape) and how heating and loading stresses are affected by the design changes.

Bruner, J. P. (Armco Steel Corp., Middletown, Ohio), Jones R. D. (Canadian Steel Wheel, Ltd., Montreal, Canada), Levy, S. (General Electric Co., Schenectady, N. Y.), and Wandrisco, J. M. (U. S. Steel Corp., Monroeville, Pa.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 90, February 1968, pp 187-196, 13 figs., 7 tables, 10 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0231

SIGNIFICANCE OF WELD DEFECTS IN RELATION TO FATIGUE FRACTURE

The author enumerates and briefly discusses the factors which are of significance in determining the fatigue behavior of welded structures, e.g., total number, magnitude, and type of stress cycles anticipated in the planned life of the structure; environmental factors such as corrosive media and temperature; and thermal fatigue. A listing is given of various types of welded structures, including rail vehicles, which failed prematurely as a result of fatigue fracture. Experimental procedures and results for determining the strength of welded joints under fatigue loading are presented along with a table showing relative fatigue strengths, various types of butt-welded and fillet-welded joints subjected to 2 million cycles of stress. Stress distributions

are shown for sections of weldments. The relationship between inclusion defect lengths and weldment fatigue strength is illustrated graphically.

Newman, R. P. (British Welding Research Association), British Journal of Non-Destructive Testing, Vol 7, No. 4, December 1965, pp 90-96, 4 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0232

THE "CREEP" OF LOCOMOTIVE DRIVING WHEELS (PART I)

The work of various authorities on the experimental and calculated values of tractive creep related to locomotive wheels and railway rails is briefly reviewed. The basic problem discussed is that of a wheel supporting a vertical load rolling on a rail and exerting some value of tractive force to the rail. The contact area between the wheel and the rail was assumed to be of rectangular geometry. The problem is treated as one of plain strain, and the equations of equilibrium in terms of dilation and rotation are given. Further mathematical treatment is given for derivation of expressions for traction, contact stresses, displacement, contact area, the value of surface strain over the locked area, and finally the expression for tractive creep. Diagrams are provided to describe the area of wheel contact and values of tractive force and strain.

Andrews, H. I., Rail Engineering International, Vol 5, No. 1, January 1975, pp 8-10, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Geerings of Ashford Ltd. (repr., PC).

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0233

DYNAMIC STABILITY OF A BEAM LOADED BY A SEQUENCE OF MOVING, MULTI-AXLE, MASS VEHICLES

An approximate method for determining the dynamic stability of the lateral response of a finite Bernoulli-Euler beam (rail) loaded by a continuous sequence of vehicles traveling at a constant speed is presented. The beam is uniform and rests on a massless, uniform elastic foundation. Damping for the beam and foundation is provided by a combined uniform viscous damping coefficient. The vehicles consist of a rigid body mass supported by two separate axles or wheel masses. They are identical, equally spaced, and attached to the beam. The Galerkin method is used to reduce the partial differential equations of motion for the beam to a coupled set of ordinary differential equations containing periodic coefficients. The equations of motion for dynamic stability of a beam (rail) are reduced to a Mathieu equation. The regions of stable and unstable motion associated with the Mathieu equation are shown, and a numerical example utilizing this equation is presented. Thus, critical vehicle speeds corresponding to dynamic instability are predicted in terms of the physical system characteristics.

Benedetti, G. A. (Applied Mechanics Division, Sandia Laboratories, Livermore, Calif.), High Speed Ground Transportation Journal, Vol 9, No. 1, 1975, pp 483-493, 5 figs., 8 refs.

ACKNOWLEDGMENT: High Speed Ground Transportation Journal.

PURCHASE FROM: Planning-Transport Association, Inc., Durham, North Carolina, (repr., PC).

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0234

INSTABILITY OF AN ELASTICALLY SUPPORTED BEAM UNDER A TRAVELLING INERTIA LOAD

The relevancy of the thermal buckling of continuous welded railway track to the occurrence of dynamic instability is discussed. The unstable lateral bending wave that can be excited in an elastically supported beam by a traveling inertia load is investigated. The theory of bending waves and the conditions for track instability are mathematically treated to show that the presence of a moving train interacts with the thermally induced compressive forces in the track to reduce the axial load at which buckling will occur. A numerical example taken from tests on straight welded railway track under various temperatures is given to show the effects of a moving train.

Newland, D. E. (University of Sheffield, England), Journal of Mechanical Engineering Science, Vol 12, No. 5, October 1970, pp 373-374, 1 fig., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0235

WHY METALS BREAK

The factors which control the fracture of metal components and how these factors come into play in rail service failures are discussed. The principal modes of failure associated with railway structural components such as rails, bolts, axles, wheel rims, and rivets are reviewed. These modes of failure are listed as buckling or yielding, fatigue, brittle fracture, creep, stress corrosion, corrosion fatigue, and shear failure. The author defines each of the failure modes in relation to its occurrence on the British Railways. Graphs are presented showing true stress-strain curves and the effect of temperature on yield and fracture stress. Defects are shown pictorially for the various structural components where they were detected. The author introduces the concept of fracture mechanics, discussing brittle fracture, fatigue crack growth, and the use of linear elastic fracture mechanics as a stress analysis tool.

Wise, S. (Railway Division Midlands Center/Institute of Mechanical Engineers), Journal of the I.Mech.E. Railway Division, Vol 2, Part 2, February 16, 1971, pp 162-188, 15 figs., 7 refs.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0236

THE STRESS AND STABILITY ANALYSES OF RAILROAD TRACKS

The paper presents a survey of the state of knowledge in the fields of stress and stability determination of a railroad track. The author discusses the evolution of railroad rail from its beginning to the present time. The problem areas in track mechanics, including those associated with bending stresses of the rails and crossties, and rail/wheel contact stresses are discussed to establish a design criterion. The early work of Winkler (1867) is reviewed along with that of other individuals who contributed to stress analyses. Track buckling as related to thermally induced stresses is discussed in connection with the use of longer rails and continuously welded track. Schematics of rail-buckling modes are shown.

Kerr, A. D. (Visiting Professor, Dept. of Civil Engineering, Princeton University, Princeton, N. J.), Journal of Applied Mechanics, Trans. ASME, Vol 41, No. 4, December 1974, pp 841-848, 11 figs., 54 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0237

RESIDUAL STRESSES IN ALUMINO-THERMALLY WELDED RAILS [IN GERMAN]

Residual stresses were measured experimentally in as-manufactured and in alumino-thermally welded rails with and without weld reinforcement. Foil strain gauges were used to measure the relaxation of components as they were sectioned. In as-manufactured rails tensile stresses were determined in the head and foot in the longitudinal direction, and compressive stresses were determined in the web. In welded rails, the pattern was reversed, with tensile stresses being determined in the web and compressive stresses in the head and foot. The stress pattern of the welded rail is fortuitous because it increases the capacity of the weldment to withstand applied tensile stresses arising from traffic loads.

Dohse, R. (Elektro-Thermit GmbH), Schweissen und Schneiden, Vol 19, No. 10, October 1967, p 471-476, 7 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Schweissen und Schneiden.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0238

FATIGUE DAMAGE INDUCED IN A STEEL PLATE BY OSCILLATORY HERTZIAN LOADING

One of the objectives of this study was to investigate the fundamentals involved in the failure of steel rails and various machine elements as indicated by checking, flaking, spalling, pitting and shelling. The fatigue testing equipment is described along with the procedures for performing tests. Nomographs are presented which show the field of shear-stress amplitudes under maximum pressure conditions. Subsequent to each test the test specimens were sectioned and examined for dislocation structures, hardness profiles, microcracks and fatigue striations. The observations are used to describe the formation of fatigue cracks under Hertzian loading conditions.

Gervais, E. (Noranda Research Centre, Point Claire, Quebec), and McQueen, H. J. (Associate Professor, Mechanical Engineering, Sir George Williams University, Montreal Quebec), Journal of the Iron and Steel Institute, Vol 210, No. 3, March 1972, pp 189-198, 10 figs., 37 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute, (repr., PC).

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0239

DEFECTS IN ENGINEERING MATERIALS AND THE NEED TO ASSESS THEIR SIGNIFICANCE: FRACTURE MECHANICS SERIES 1

This, the first of six papers in a series on Fracture Mechanics, describes some of the defects which occur in engineering materials and discusses their importance. The discussion is concerned principally with metals, since they are the chief materials of use for the majority of engineering applications. Illustrations are provided for cupping defects in steel, inclusions, shrinkage porosity, and piping. Photomicrographs of cracks in steel and aluminum resulting from overheating are shown, as are cracks in poorly quenched and tempered steel parts. Finally, the defects endemic to welding processes are described.

Whittaker, V. N. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 4, No. 10, October 1971, pp 318-322, 12 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0240

AN INTRODUCTION TO FRACTURE MECHANICS: FRACTURE MECHANICS SERIES 2

This is the second of a series of six papers covering the basic concepts of fracture mechanics. The early contributions to the subject of fracture stress by Irwin, Griffith, and Love are reviewed. Stress-intensity factors are functionally defined in terms of local tensile stress and the crack length. The paper discusses certain facets of linear elastic fracture mechanics: the significance of plastic zones at the cracktip, the effect of specimen width and of other geometric conditions, and the effect of thickness. An approach to measurement of toughness involving the use of several types of notched specimens is described.

Barnby, J. T. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 4, No. 12, December 1971, pp 385-390, 11 figs., 10 refs., bibliog.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0241

TOUGHNESS AND CRITICAL DEFECT SIZE: FRACTURE MECHANICS SERIES 3

This, the third in a series of six papers, describes how the critical defect size in a component can be calculated from a knowledge of the toughness of the material. The crack geometries considered are: a through crack in a large plate; embedded cracks, elliptical in plan view; semi-elliptical surface cracks; irregularly sharp embedded cracks; and groups of defects. The effect of local yielding that produces a plastic zone at the crack tip thus contributing to crack propagation is analysed. Numerical values showing the relationships for a variety of crack geometries are presented graphically and by tabulation. The mixed-mode stress systems (K_I, K_{II}, and K_{III}) are discussed, and mathematical expressions are derived for the failure condition due to combined tensile and shear stresses.

Barnby, J. T. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 5, No. 1, February 1972, pp 32-37, 7 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press Ltd. (repr., PC).

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0242

A REVIEW OF NON-DESTRUCTIVE MEASUREMENT OF FLAW SIZE: FRACTURE MECHANICS SERIES 4

Nondestructive testing techniques such as radiography, ultrasonics, and acoustic emission are reviewed from the standpoint of measuring the geometry of cracks and flaws in materials. This paper is the fourth in a series of six on the subject of fracture mechanics. The paper presents initially computations of flaw sizes in real materials given the fracture toughness and local stress for a variety of metals and configurations. The effect of initial surface-flaw sizes and their relation to crack propagation are discussed. The paper then discusses various NDT techniques to find their flaw sizes. Radiographic measurement of crack sizes is considered inadequate because of the lack of image-quality indicators; however, an approach using mathematical expressions for high- and low- energy radiation is reviewed. Data are included for NDT experimental work using radiography that show minimum detectable crack cross-sectional areas, and for cracks the surface of which are inclined to the beam, the angles of disappearance of small cracks. A similar treatment is provided for ultrasonics where emphasis is placed on the Krautkramer techniques that are being used in Britain. Other techniques, including eddy current procedures are briefly described. The paper concludes

with a tabular summary of flaw sizes that can be detected reliably by the various techniques reviewed.

Whittaker, V. N. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 5, No. 2, April 1972, pp 92-100, 14 figs., 8 tables, 30 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press Ltd. (repr., PC).

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0243

HOW TO USE FRACTURE MECHANICS TO ASSIST IN DRAWING UP REALISTIC ACCEPTANCE STANDARDS: FRACTURE MECHANICS SERIES 5

Details for drawing up realistic acceptance levels for defects are given for two engineering situations - steel castings and welds - using the principals of fracture mechanics. The use of radiography and ultrasonic inspection measurement of cracks is discussed to show the limitations and practical application of each technique. Data are presented for cases where critical defect sizes of surface cracks, internal, and through cracks are tabulated and plotted. Crack propagation caused by fatigue stressing is reviewed in relation to its evaluation by means of ultrasonics and radiographic techniques. Expressions for use in the calculation of the critical flaw size necessary to avoid brittle fracture are given with a numerical example of their application. Information from a number of fatigue tests is presented for use in establishing permissible design stresses for various weld quality levels.

Whittaker, V. N. (University of Aston, Birmingham, England), Non-Destructive Testing, Vol 5, No. 3, June 1972, pp 160-165, 9 figs., 8 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press Ltd. (repr., PC).

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0244

FRACTURE MECHANICS AND ITS APPLICATION TO DEFECT ACCEPTANCE STANDARDS

The fundamental concepts of fracture mechanics, involving stress concentration factors, are discussed. The three basic types of stress fields near crack tips (opening mode, sliding mode, and tearing modes) and their associated stress intensities (K_I, K_{II}, K_{III}) are described. Functional relationships associated with fracture mechanics, such as, critical stress intensities, material thickness, fracture toughness, Charpy energy, stress-corrosion cracking, fatigue crack propagation, defect density, failure stress and others are illustrated graphically along with their mathematical formulations. Limitations of nondestructive testing concepts as related to predictions of defect behavior are mentioned briefly.

Jones, G. T. (C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, England), British Journal of Non-Destructive Testing, Vol 13, No. 2, March 1971, pp 34-41, 15 figs., 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0245

EFFECTS OF PRODUCTION METHODS ON THE RESIDUAL STRESSES IN COMPLETELY QUENCHED RAILS

A study was conducted to determine the causes of residual stress in completely quenched rails. Tensile strain gages were attached to various portions of the head, web, and base of 1.3-m-long rail section specimens, the specimens were cut up, and the elastic deformation was measured. The specimens were examined at different stages of processing: complete quenching; quenching and tempering; and quenching, tempering, and straightening. Diagrams are given of the residual compressive and tensile stresses at the rail head, neck, and base at the various stages. Variations in the relative residual stresses and hardness in the various main sections of the rail at different temperatures

and stages of tempering are shown graphically.

Konyukhov, A. D., Rabinovich, D. M., Vinokurov, I. Ya., and Serebryakov, V. S. (Central Research Institute of the Ministry of Railways and Nizhnii Tagil Combine, USSR), Stal [in English], No. 6, 1969, pp 591-593, 3 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Inc. (repr., PC).

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0246

STRESS INTENSITY FACTORS FOR PENNY-SHAPED CRACKS: PART 1 - INFINITE SOLID

This paper considers the problem of a penny-shaped cracked embedded in an infinite elastic solid and subjected to nonaxisymmetric loading. An expression is first developed to obtain the stress intensity factor of the crack. The stress intensity factor can then be determined for similar shaped cracks in infinite or finite solids subjected to symmetric loading about the plane containing the crack. Results are also presented for two problems: a penny-shaped crack subjected to two symmetrically located concentrated forces and a penny-shaped crack in a large beam subjected to pure bending.

Smith, F. W. (Colorado State University, Fort Collins, Colo.), Kobayashi, A. S., and Emery, A. F. (University of Washington, Seattle, Wash.), Journal of Applied Mechanics, Trans. ASME, Vol 32, No. 4, December 1967, pp 947-952, 2 figs., 18 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0247

BONDED JOINTS AND NON-DESTRUCTIVE TESTING

The author contends that NDT of fusion-welded joints is not particularly useful during the final stages of fabrication, and could be used to better advantage to monitor quality during production. However, he further states that, with few exceptions, NDT techniques are not useful in either case to control quality of friction, pressure, and flash welds of ferritic steels, aluminum, and copper and suggests that sampling techniques and destructive tests must be used to assess quality on the basis of circumstantial evidence. He believes bend tests properly applied, to be the most useful of all destructive tests for revealing weld flaws.

Young, J. G. (The Welding Institute, Abington Hall, Abington, Cambridgeshire, England), Non-Destructive Testing, Vol 4, No. 4, August 1971, pp 242-245, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc., Business Press Ltd. (repr., PC).

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0248

STRESS-INTENSITY FACTORS FOR A SURFACE CRACK IN A FINITE SOLID

A solution to the problem of a circular crack partially embedded in a solid of finite thickness is presented. A superposition and iteration technique is use to determine the stress-intensity factor numerically. The stress-intensity factor is determined as a function of position around the crack front for a variety of crack depths. Comparisons are drawn between experimental data and data obtained in this study for a semielliptical surface flaw in a brittle material. The three-dimensional form of the Kapier equations is modified for use and the means used for obtaining numerical values of the stress components are discussed. Curves were plotted to show functions of

the stress-intensity factors and back-surface effects of crack depth.

Thresher, W. W. (Oregon State University, Corvallis, Ore.), and Smith, F. W., Colorado State University, Fort Collins, Colo.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 39, No. 1, March 1972, pp 195-200, 7 figs., 15 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0249

"MODELS" OF THE FATIGUE PROCESS

Instabilities in behavior of materials and the structural re-adjustments that alter the relationships between load and peak stress are discussed by visualizing each level of observation as a type of idealized model representing structural behavior. Nonlinear effects, encountered in models on the atomistic or crystalline scale, together with the statistical aspects of material behavior, load history, and manufacturing variables, are emphasized to illustrate the difficulty in present-day practice of making any quantitative prediction of fatigue life or fatigue strength of the final product. The author discusses the general concepts of models. Three models for material strength characteristics are depicted from the point of view of the physicist, the metallurgist, and the materials engineer, each seeking to understand parameters of importance in the development of materials with increased fatigue resistance. Three additional models are presented for elastic and plastic stress analysis and the modifying influences of fabrication and service conditions. The models serve to emphasize that what is "basic" to the designer is on an entirely different level of inference and observation from what is "basic" to the engineer or physicist. The need for different levels of research with a mutual exchange of knowledge and feedback of new information, techniques, and phenomena of common interest is pointed out.

Dolan, T. J. (University of Illinois, Urbana, Ill.), Experimental Mechanics, Vol 5, No. 6, June 1965, pp 20A-24A, 2 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0250

STRESS INTENSITY FACTORS FOR SEMICIRCULAR CRACKS: PART 2 - SEMI-INFINITE SOLID

The stress intensity factor for a semicircular edge crack is derived. The problem is divided into two parts which yield the full solution. The first part is the determination of stresses due to a completely embedded crack and the second part is the satisfying of stresses on the bounding plane. The authors perform a number of steps in solving the problem associated with edge cracks: (1) determination of the stress without a crack, (2) determination of the crack solution in an infinite body, (3) determination of the solution for a crack-free space on the bounding plane, (4) application of Steps (2) and (3) alternately to obtain the solution for the edge crack with surface loading, and (5) superimposition of the results from Steps (1) and (4). This paper details only the formulation and necessary methods for Steps (2) through (5). Numerical values for axial, bending, and thermal loads in half-spaces and plates are presented.

Smith, F. W. (Colorado State University, Fort Collins, Colo.), Emery, A. F., and Kobayashi, A. S. (University of Washington, Seattle, Wash.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 32, No. 4, December 1967, pp 953-959, 10 figs., 14 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0251

STRESS ANALYSIS OF CRACKED RECTANGULAR BEAMS

This paper is concerned with the solution of mixed boundary-value problems arising from the longitudinal shear and Saint-Venant torsion and flexure of cracked prismatic beams. The beams considered have a rectangular cross section with planar edge cracks extending along their lengths. Mathematical expressions are derived using Laplace's or Poisson's equation in two dimensions along with the utilization of the dual-series-solution method of Sneddon and Srivastav. This permits the further reduction of the problem to the numerical solution of a Fredholm integral equation. For the geometries considered in this paper, the approach adopted herein permits evaluation of the stress field and enables one to determine the effect of adjacent boundaries of the stress field. The mathematical solution of the resulting mixed boundary-value problem is discussed in detail, and numerical results are presented for stress and displacement fields, and stress intensity factors.

Westmann, R. A. (University of California at Los Angeles, Los Angeles, Cal.), and Yang, W. H. (University of Michigan, Ann Arbor, Mich.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 32, No. 3, September 1967, pp 93-101, 12 figs., 11 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0252

OCCURRENCE OF SHELLY RAILS

Rails shell most frequently on the high rails of curves. Shelling occurs as a result of the rail steel being subjected to stresses exceeding its strength. Shells occur on one segment of the rail section - along the top gauge corner toward the gauge side. Wheel loading in this area exceeds the strength of the rail and causes rail flow. Which wheels are most apt to concentrate this loading can be determined by matching the contours of new and worn rail heads with those of new and worn wheels. When this is done it becomes evident that new wheels with their 1-in-20 coning are overstressing the rails. To eliminate shelling, it is suggested that wheels be turned down to the worn-wheel contour and maintained to this outline.

Spencer, L. (Railroad Consultant, Scottsdale, Arizona), Railway Track and Structures, Vol 63, No. 6, June 1967, pp 31-32.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0253

THE PRODUCTION OF HIGH STRENGTH RAIL STEELS HAVING OPTIMUM CLEANLINESS LEVELS [IN GERMAN]

The requirements of high-strength rail steel to be met by the producer, including strength and composition range called for by specification, are indicated and discussed. Four different deoxidation treatments were investigated; in one, complex deoxidation with Mn- and Si-bearing alloys and 0.5 kg Al/ton was applied. In the other treatments, deoxidation with greater proportions of Al was effected and, in one case, was followed by flushing with N. The effects of the various treatments were assessed by study of macro- and micro-cleanness, drop in oxygen content, inclusion morphologies, oxygen distribution in the ingot, and by observations of mechanical properties. The results are presented in diagrams showing degree of cleanliness, number and class of inclusions, blue fracture indications of oxide content, oxygen segregation, etc., in relation to treatments of the melts.

Pochmarski, L., and Moser, A. (Oesterreichisch-Alpine Montangesellschaft, Austria), Berg und Huttenmannische Monatshefte, Vol 117, No. 9, September 1972, pp 307-316, 12 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0254

FAILURES OF RAILS AND TRACK SWITCHES [IN GERMAN]

Statistics of failures and investigation of the rail material point out the specific kinds of failure of rails. In particular, fractures occur in the form of the running edge peeling off as well as cross-fractures. Even rails manufactured from high-strength steels cannot sustain the heavy loading occurring in curves with a narrow radius. This has led to the development of rails with a yield point exceeding 600 N/mm^2 that are being successfully used. A method for the analysis of failures is suggested.

Laizner, A. H., and Schossmann, H. (VOEST-Alpine AG, Leoben, Austria), Berg- und Huttenmannische Monatshefte, Vol 119, No. 7, July 1974, pp 268-275, 22 figs., 9 refs.

ACKNOWLEDGMENT: Engineering Index.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0255

METRO TRACKWORK STUDY, VOLUME II: RECOMMENDED TRACKWORK STANDARDS

This study provided the Washington Metropolitan Area Transit Authority with recommendations for trackwork design standards and criteria for use as a basis for the final design of trackwork for the entire METRO rail rapid transit system. The recommendations were based on analytical studies and the experiences reported by operating properties. Using data and analytical methods obtained from the sources listed in the bibliography and other techniques, trackwork components were analyzed considering different combinations of components and varying physical parameters such as size, spacing, and estimated life of elements of the track structure. The report includes recommendations on rail weight, rail type, rail welding, fastener types and spacing, crosstie types and spacing, roadbed and ballast section, special trackwork, track appurtenances, track gauge, and in-service test installations.

Dunn, R. N., et al. (De Leuw, Cather and Company, Consulting Engineers, Washington, D.C.), Report No. UMTA-DCCO-TMS-2, for The Washington Metropolitan Area Transit Authority, August 1968, 294 pp, 33 figs., 24 tables, 134 refs., 3 appendixes.

ACKNOWLEDGMENT: De Leuw, Cather and Company.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 204 213.

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0256

EXAMINATION OF BASIC BESSEMER RAIL STEEL [IN GERMAN]

Examinations were conducted to determine the causes of black stains and vertical shatter cracks in rails made of basic Bessemer steel. The causes of nonmetallic inclusions and their detection by ultrasonic testing were investigated. Varying the oxygen content of the steel shortly before and at the end of teeming was studied to determine its effect on the development of nonmetallic inclusions. Efforts were also directed toward the detection and causes of stress cracks and surface defects.

Schmedders, H., Hammer, R., and Schrape, U., Archiv fur das Eisenhuttenwesen, Vol 37, No. 7, July 1966, pp 551-560, 19 figs., 2 tables, 14 refs.

ACKNOWLEDGMENT: Archiv fur das Eisenhuttenwesen.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0257

THE CONTINUOUSLY SUPPORTED RAIL SUBJECTED TO AN AXIAL FORCE AND A MOVING LOAD

Because of the lack of expansion joints in welded rails, considerable axial compression or tension forces may be created with changes in temperature. This, in turn, may possibly reduce the critical velocity for the track to the range of operational velocities of modern high-speed trains. The possibility was investigated in this study. The author analyzes an infinite beam resting on a Winkler foundation that is subjected to a moving concentrated transverse load and a constant axial force. Mathematical expressions are derived for the propagation of free waves in an infinite beam. The final equation for the constant axial force is plotted to obtain a value for the critical buckling load of an infinite beam. The response of a beam when it is subjected to a load that moves at a constant velocity is given further consideration which

leads to the derivation of the expression for the critical speed when the axial force leads to buckling.

Kerr, A. D. (Dept. of Aeronautics and Astronautics, New York University, New York, N.Y.), International Journal of Mechanical Sciences, Vol 14, 1972, pp 71-78, 5 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0258

ULTRASONIC EXAMINATION OF HOT STEEL

Two recently developed ultrasonic techniques for the examination of hot steel are described. One, developed by the French, provides a water-coupled probe and has been used on billets and blooms at 1050-1100 C. However, there are some problems with this technique: low speed of travel along the billet and danger of cracking in other than low-hardenability steels. The other technique, developed by the Japanese, uses a double probe, which overcomes the mode conversion interference encountered in the use of the single probe. Flaws in an 8-in. bloom at 1000 C have been clearly detected, but this technique, too, has disadvantages: very high amplification must be used for the test, test speed is low (20 to 40 ft/min), and it is not possible to estimate the shape and size of the flaw. Sketches of the various features of ultrasonic testing equipment and subcomponent parts are shown. Oscillograms are also given and placement of the transducer and/or transducers, the use of couplants, and the positioning of an ultrasonic tester over the hot billet are demonstrated. Comparisons are drawn between transmission with initially dry surfaces and using an oil couplant by showing functions of the transmission signal amplitudes at temperatures ranging from 0 to 1000 C.

Atkins, M., British Journal of Non-Destructive Testing, Vol 10, No. 3, September 1968, pp 53-55, 10 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0259

DEVELOPMENT OF A RANDOM LOAD LIFE PREDICTION MODEL

A mathematical model for estimating life under random fatigue loads is presented. Two approaches to the development of a predictive fatigue-life equation are briefly discussed: the basic, or fundamental approach, and the phenomenological, or behavioral approach. The important parameters are: maximum nominal stress, stress concentration factor, and the shape of the load spectrum. These parameters were investigated by an approach termed "design of experiments". A brief description of the unique features of the test equipment is followed by a statistical analysis of the test results and development of the fatigue model. Data and computed results are tabulated for life cycles to failure. Comparisons are drawn between actual and predicted lives under variable amplitude fatigue tests.

Bussa, S. L., Sheth, N. J. (Ford Motor Company, Dearborn, Mich.), and Swanson, S. R. (MTS Systems Corp. and Univ. of Minnesota, Minneapolis, Minn.), Materials Research and Standards, Vol 12, No. 3, March 1972, pp 31-43, 8 figs., 14 tables, 19 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Testing Materials (repr., PC).

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0260

A MODEL FOR DYNAMIC FRACTURE

The authors show that the dynamic fracture criterion for metals is equivalent to a Voigt body (parallel coupling of a spring and a dashpot) containing a non-Newtonian dashpot. Integration of the differential

equation yields a critical incubation time for fracture. Some consequences of the dynamic fracture law are applied to dynamic metal behavior at elevated temperatures, as well as to the size of the shock-loaded material. Fracture curves show the stress-rate dependence of spall criteria, and dimensionless plot of fracture stress versus fracture time is given. A graphic illustration of the temperature dependence of spall stress for aluminum shows that the viscosity exponent decreases generally with temperature. This is for the case of a material heated for a long time and then shock loaded. It is noted that markedly different curves may be obtained if the heat is applied instantaneously.

Steverding, B., and Werkheiser, A. H. (U.S. Army Missile Command, Redstone Arsenal, Alabama), Journal of Mechanical Engineering Science, Vol 13, No. 3, 1971, pp 200-204, 3 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0261

BEAM AND RAIL ROLLING MILL OF THE HAYANGE PLANT OF SACILOR [IN FRENCH]

This paper describes a production line for heavy rolled sections, whose construction and successive additions and modifications first aimed at the production of beams, then of rails by the Stenbach process have extended over a dozen years. Rolling schedules and pass designs are given.

Lossent, A. (SACILOR Fensch), Revue de Metallurgie (Paris), Vol 71, No. 10, October 10, 1974, pp 733-748, 12 figs.

ACKNOWLEDGMENT: Revue de Metallurgie (Paris).

PURCHASE FROM: ESL (repr., PC, microfilm).

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0262

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 1

This paper presents an introduction to basic metallurgy including a discussion of metal contraction during cooling, types of ingot moulds and considerations in their design, crystalline or grain structure of metals and modifications which can be effected in structure by casting procedures, and the development of internal stresses and treatments involved in relieving them.

Taylor, J. L. (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol 13, No. 4, July 1971, pp 116-120, 8 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0263

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 4

Part 4 of this series of 11 articles provides a detailed discussion of the structures predicted by the iron-carbon equilibrium diagram which arise when the cooling is slow, and also the structures which form when cooling is more rapid and equilibrium conditions are not achieved. The processes and apparatus employed in gathering data to plot the heating and cooling curves for steel are discussed and illustrated. Diagrams and photomicrographs of the various structures are included.

Taylor, J. L. (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol 14, No. 1, January 1972, pp 14-20, 18 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0264

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 5

This is the fifth in a series of 11 papers intended to provide a basic understanding of principles of metallurgy for those involved with nondestructive testing. Part 5 is concerned with metal joining, which is often the subject of nondestructive examination. The development of residual stress and the creation of tensile and compressive stresses during the heating and cooling process are discussed. Hydrogen embrittlement, hot and cold cracking, and weldability are discussed.

Taylor, J. L., (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol. 14, No. 2, March 1972, pp 51-56, 9 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0265

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 6

This paper is the sixth of a series of 11 articles intended to provide basic metallurgy information for specialists engaged in nondestructive testing. Part 6 provides a classification and description of such defects as cracks, cavities, or voids, solid inclusions, defective fusion and penetration of welds, and imperfections in shapes. The types of cracking reviewed here are solidification, hydrogen-induced heat-affected zone cold cracking, lamellar tearing, and reheat. Solid inclusions described are those identified with slag, flux, and oxides entrapped in weld voids.

Young, J. G. (The Welding Institute, Abington, Cambridge, England), British Journal of Nondestructive Testing, Vol 14, No. 3, May 1972, pp 80-86, 7 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0266

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 7

This is the seventh in a series of 11 articles devoted to providing a background in basic metallurgy to those engaged in nondestructive testing. The physical and metallurgical laws relating to the formation of flaws in steel castings are discussed in this paper. The three stages of metal solidification, viz., contraction of liquid steel, liquid to solid contraction, and contraction of the solid to room temperature, are discussed and graphically illustrated. The principal factors affecting the formation of columnar grains are also cited and shown in schematic diagrams. Macrosections of steel structures are presented showing columnar and equiaxed dendrites and shrinkage cavities. Hot tearing or cracks resulting from stresses developed near the solidification temperature and the formation of gas and pinhole flaws are discussed.

Lavender, J. D. (Steel Castings Research and Trade Association, Sheffield, England), British Journal of Non-Destructive Testing, Vol 14, No. 4, July 1972, pp 104-111, 20 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0267

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 8

This the eighth in a series of 11 articles dealing with basic metallurgy and directed toward the specialist engaged in nondestructive testing of metal structures, is concerned with an examination of what occurs at the atomic level when metals are deformed as a result of dislocations (crystal imperfections). Methods for reducing the effects of dislocations, such as alloying, work hardening, and precipitation hardening, are discussed. Schematic diagrams are

used to illustrate how cold working and annealing affect the recrystallization of metal.

Taylor, J. L. (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol 14, No. 5, September 1972, pp 137-142, 12 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0268

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 9

This paper is the ninth in a series of 11 articles covering basic metallurgy aimed at providing background information for nondestructive testing specialists. Some of the major defects occurring in steel forgings, their origin, and detection and identification by various nondestructive testing techniques are described. Defects originating in the ingot production stage are classified as shrinkage, segregations, inclusions, skull, and risings (gassiness). Defects originating from the forging operation are defined as forging bursts (shatter-cracks) and laps. The defects that occur in the heat-treatment stage include internal transverse stress cracks, thermal cracks, and hairline (hydrogen cracks, flakes) cracks. The results of defect investigations through use of basic crystallographic techniques are shown.

Fearn, G. A. (GEC Reactor Equipment Ltd., Whetstone, Leicester, England), British Journal of Non-Destructive Testing, Vol 15, No. 2, March 1973, pp 43-49, 12 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0269

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 10

This is the tenth in a series of 11 articles dealing with the metallurgical aspects which specialists in nondestructive testing of metal structures can use as background information. This paper is devoted to a review of the common test methods to determine the mechanical properties of metals. The hardness tests in most general use are based on indentation of the surface. In the Brinell Hardness test, which is typical, a hard steel ball is pressed into the surface to be measured under a known load. The mathematical expression for Brinell Hardness Number is given. The tensile test is discussed and sketches of the test pieces in sheet and cylindrical configurations are shown. Gauges used for measurement of strain are described and stress/strain curves are used to illustrate the location of permanent (plastic) strain prior to the yield point. The Izod, Charpy, and Brunsfield impact test machines are used to determine whether the metal will break in a brittle manner under an impact load. The processes of performing fatigue tests and the manner in which a failure occurs are discussed.

Taylor, J. L. (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol 15, No. 3, May 1973, pp 83-89, 16 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0270

BASIC METALLURGY FOR NON-DESTRUCTIVE TESTING - PART 11

This paper is the last in a series of 11 articles devoted to providing background information on metallurgy to specialists who engage in the nondestructive testing of metals. It is concerned with the oxidation and corrosion of metals and alloys. The oxidation process is briefly discussed in relation to its rate

at various temperatures. The pickling of iron in dilute sulphuric acid is cited as an example of the way in which ionic processes contribute to corrosion. Methods generally used for prevention of corrosion are listed as protective coatings, cathodic protection, insulation, choice of metal, and modification of the corrosive media.

Taylor, J. L. (University College, Cardiff, Wales), British Journal of Non-Destructive Testing, Vol 15, No. 4, July 1973, pp 115-120, 10 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0271

THE MAKING, SHAPING AND TREATING OF STEEL: CHAPTER 25, RAILROAD-RAIL AND JOINT-BAR PRODUCTION; CHAPTER 26, STRUCTURAL AND OTHER SHAPES; CHAPTER 50, NONDESTRUCTIVE INSPECTION OF STEEL

In Chapter 25, the historical development of rails is briefly reviewed prior to presenting a description of mills for rolling rails. A tabulation of representative chemical compositions for rails is given, and sketches are shown of cross-sections of rails from the earliest periods of railroading to the present and of the rolls used in rail mill rolling. The finishing operations for standard rails - cutting and cambering, marking and branding, controlled cooling, and testing - and the heat treatment associated with end hardening of U.S.S. "Curvemaster" rails are described. Chapter 26 (Section 1) discusses the equipment used for producing distructural and other shapes. A layout of a typical mill for rolling structural sections is shown, and procedures employed at a specific mill for hot sawing, cooling, and cold cutting operations are described. Chapter 50 covers nondestructive inspection of steel, including such techniques as radiographic, ultrasonic, electrical, magnetic, optical, and dye penetrant. Mention is also made of eddy-current inspection which is carried out at 2100 F and approximately 5500 ft/min.

McGannon, H. E., Editor (United States Steel Corporation), Ninth Edition, Herbich & Held Publishers, Pittsburgh, Pa., 1971, 1420 pp; Chapter 25: Railroad-Rail and Joint-Bar Production, pp 754-761, 6 figs., 1 table; Chapter 26: Structural and Other Shapes, Section 1, pp 763-765, 3 figs.; Chapter 50: Nondestructive Inspection of Steel, pp 1263-1274, 17 figs.

ACKNOWLEDGMENT: United States Steel Corporation.

PURCHASE FROM: Herbich & Held Publishing Co. (book).

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0272

THE ACCURACY AND PRECISION OF ULTRASONIC SHEAR WAVE FLAW MEASUREMENTS AS A FUNCTION OF STRESS ON THE FLAW

Quantitative estimates of crack length and crack depth, obtained from ultrasonic shear wave reflected peak intensities were correlated with actual values of crack length and depth as measured on the fracture surface. Part-through surface-fatigue cracks were initiated in 1/4-in.-thick sheet aluminum (7075-T6511) and grown by fatigue cycling to sizes ranging from 0.1-0.45 in. long and 0.02-0.125 in. deep. Precision of the flaw indications was determined for specimens in the stress-free condition and under several applied loads. The accuracy of crack length and depth was determined as a function of the load applied to the specimen.

It was found that the most accurate estimates of flaw size were obtained using natural fatigue cracks for calibration; artificially induced cracks did not provide highly accurate calibration.

The authors conclude that ultrasonic shear wave measurements do not measure the true depth of the flaw, but only the depth for which the crack opening displacement is greater than some critical amount; hence, upon stressing the flaw, the apparent indicated crack depth

increases. This increase appears to be a linear function of the stress.

Corbly, D. M., Packman, P. F. (Vanderbilt University, Nashville, Tenn.), and Pearson, H. S. (Lockheed Georgia Co., Marietta, Ga.), Materials Evaluation, Vol 28, No. 5, May 1971, pp 103-110, 12 figs., 3 tables, 10 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0273

AN ULTRASONIC CRACK GROWTH MONITOR

An ultrasonic nondestructive test has been developed to measure and record crack propagation encountered in fatigue and stress corrosion tests involving a "Wedge-Opening-Loading" standard fracture toughness specimen. Essentially, the technique relates the position of an ultrasonic transducer on the specimen surface to the tip of the propagating crack such that crack length can be interpreted in terms of transducer location. The instrumentation comprises commercially available ultrasonic flaw detector equipment and a test fixture which measures crack growth automatically. Crack length measurement sensitivity is ±0.011 in., and a continuous record of crack length versus elapsed time is provided. Comparisons are drawn between ultrasonic and visual measurements of crack growth. A schematic representation of the test technique, a photograph of the test fixture, and segments from a recording chart generated by the technique are included.

Clark, W. G., Jr., and Geschini, L. J. (Westinghouse Research Laboratories, Pittsburgh, Pa.), Materials Evaluation, Vol 27, No. 8, August 1969, pp 180-184, 6 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0274

BEAMS ON BILINEAR ELASTIC FOUNDATIONS

In this paper an attempt is made to present a series solution to the dynamical problem of a beam (Euler-Bernoulli) on a bilinear elastic foundation. Because of the complexity involved in dealing with a dynamical problem, it was decided to employ a unified approach in its solution: two separate governing differential equations are combined into one which is valid for the entire region under consideration. A perturbation solution to such a linear equation is presented. The response of the foundation is assumed to be different in compression and tension. Property difference of the foundation is symbolized by the perturbation (foundation) parameter used in the expansion.

Farshad, M., and Shahinpoor, M. (Pahlavi University, Shiraz, Iran), International Journal of Mechanical Science, Vol 14, No. 7, 1972, pp 441-445, 1 fig., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0275

DISCRETE DISLOCATION MODEL OF A FATIGUE CRACK UNDER SHEAR LOADING - PART I

In the initial stage of fatigue-crack propagation (Stage 1), in both polycrystal and single-crystal alloys, cracks initiate and propagate from slip lines of the crystallographic planes. A Stage 1 crack usually is thought to propagate solely by load shear stresses. In this study a computer model of a crack and its plastic zones is developed. The positions of a series of dislocations are calculated in order that their combined stresses satisfy equilibrium equations and crack boundary conditions. The range of the crack tip displacement per loading cycle is independent of the mean stress value for mean stress greater than one-half the maximum stress and the stress range small. For all mean stress levels

a minimum stress range is predicted by the model below which the cyclic tip displacement is zero.

Swenson, D. O. (Pratt & Whitney Aircraft, Middletown, Conn.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 36, No. 4, December 1969, pp 723-730, 12 figs., 29 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0276

MEAN STRESS EFFECT ON THE SHEAR FATIGUE CRACK MODEL - PART 2

In this paper, the author presents an expanded version of his previously developed shear crack fatigue model. This expanded dislocation model is presented for the purpose of determining the effect of mean stress by shear cyclic loadings. The basic assumptions for the discrete dislocation model are reviewed and additional assumptions for the extended model are stated. The resulting crack growth predicted by the new model for various mean stresses is shown, and comparisons are drawn with the models of Weertman and Lardner. The results of calculations are presented graphically and a summary of the mean stress effect is presented.

Swenson, D. O. (Pratt & Whitney Aircraft, Middletown, Conn.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 36, No. 4, December 1969, pp 731-735, 9 figs., 11 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0277

THE FINITE BEAM WITH A MOVING LOAD

In this investigation, the finite, simply supported Euler-Bernoulli beam, with and without an elastic foundation, is treated. A "method of images" series solution is obtained which converges rapidly for a simply supported, long beam with a high-velocity, moving concentrated load. Each term of the series is a Fourier integral solution for an appropriate semi-infinite beam problem. The integrals are evaluated in closed form for the beam without a foundation and have a simple asymptotic evaluation for the beam with an elastic foundation. In particular, the asymptotic results provide a solution for the "critical" load velocity for which a "steady-state" solution does not exist, and for the limiting case of infinite load velocity, for which the beam is given an initial uniform lateral velocity. Strip chart prints are provided for deflections of beams with foundations and curves are plotted for maximum deflection of a beam with foundation as a function of load position.

Steele, C. R. (Lockheed Aerospace Sciences Laboratory, Palo Alto, Cal.), Journal of Applied Mechanics, Transactions of the ASME, Series E, Vol 32, No. 1, March 1967, pp 111-118, 6 figs., 11 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0278

1975 ANNUAL BOOK OF ASTM STANDARDS, PART 4: STRUCTURAL STEEL; CONCRETE REINFORCING STEEL; PRESSURE VESSEL PLATE AND FORGINGS; STEEL RAILS, WHEELS, AND TIRES [STANDARD SPECIFICATION FOR CARBON-STEEL RAILS (DESIGNATION A1-68a)]

This specification covers carbon-steel standard TEE rails of nominal weights of 61 lb/yd (30.3 kg/m) and over, and is intended primarily for export and industrial use. The basic practices to be followed and requirements to be observed in the manufacture of rail steel are

specified. Included are specifications for: process, mill practices, discard, chemical requirements, average carbon, ladle analysis, check analysis, test specimens, drop test machine, drop test requirements, interior conditions, length, weight, drilling, finish, classification of rails, marking, classifications of markings, loading, inspection, acceptance, controlled cooling. Supplementary requirements, which apply only when specified by the purchaser, are also given.

1975 Annual Book of ASTM Standards, Part 4: Structural Steel; Concrete Reinforcing Steel; Pressure Vessel Plate and Forgings; Steel Rails, Wheels, and Tires [Standard Specification for Carbon-Steel Rails (Designation A1-68a)], American Society for Testing and Materials, Philadelphia, Pa., 1975, pp 1-6, 1 table.

ACKNOWLEDGMENT: American Society for Testing and Materials.

PURCHASE FROM: American Society for Testing and Materials (repr., PC).

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0279

ACOUSTIC EMISSION AS A TECHNIQUE FOR NON-DESTRUCTIVE TESTING

This paper describes a method for nondestructive testing and inspection by observing acoustic emission from materials when they are stressed. The potential usefulness of acoustic emission as a nondestructive testing tool for investigating the nucleation or propagation of cracks is discussed. The range of frequencies and amplitudes of acoustic emission encountered in nondestructive testing applications is described. Stress/strain and emission-rate curves plotted as a function of applied stresses are shown. Calculations were made to examine the relationship between stress intensity factor per crack and acoustic emission, and the results are plotted.

Frederick, J. R. (University of Michigan, Ann Arbor, Mich.), Materials Evaluation, Vol 28, No. 2, February 1970, pp 43-47, 11 figs., 13 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0280

FRACTURE MECHANICS AND NONDESTRUCTIVE TESTING OF BRITTLE MATERIALS

The fracture-mechanics approach to the development of nondestructive inspection requirements is presented. The basic concepts underlying the technology are reviewed, and the practical engineering aspects of this approach to the prevention of structural failure are demonstrated. Particular emphasis is placed on evaluating the effect of defect morphology (size, shape, orientation, distribution, etc.) on fracture behavior. A hypothetical inspection problem is included and the pertinent considerations associated with the development of a realistic nondestructive inspection specification are discussed in detail.

Clark, W. G., Jr. (Westinghouse Research Laboratories, Pittsburgh, Pa.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 94, No. 1, February 1972, pp 291-298, 10 figs., 13 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0281

UNCONVENTIONAL METHODS OF GENERATING, RECEIVING AND COUPLING OF ULTRASONIC WAVES FOR TESTING MATERIALS

This paper reviews possible new methods of generating, receiving, and coupling ultrasonic waves in specimens, for ultrasonic testing. The possibilities of noncontact, nonliquid coupling with piezoelectric probes and other means are discussed. Among these are shock waves by electric sparks and lasers, holographic receiving methods by laser beams, eddy-sonic methods in nonmagnetic and magnetic materials, and others. A tabulation showing classification of the methods used for nondestructive testing according to levels of usage, applications, and restrictions is presented.

Schematic illustrations show the principles of operation for each method.

Krautkramer, J. (Wells and Krautkramer Ltd., England), British Journal of Non-Destructive Testing, Vol 15, No. 3, May 1973, pp 76-82, 10 figs., 19 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0282

HIGH-RESOLUTION ULTRASONICS

The fundamental electronic and ultrasonic principles which define pulse-echo high resolution are presented in this paper. The need for the development of specialized electronic equipment and electro-acoustic circuitry is cited. The characteristics, performance, and general areas of application of the Sonic Pulse-Echo Instrument Designed for Extreme Resolution (SPIDER) are discussed. Echo resolution in terms of an A-scan presentation is defined along with a discussion of the requirements for good resolution. The circuitry of the SPIDER is described and an example of amplitude distortion of the multiple echo envelope caused by phasing problems is shown. Data are tabulated for sensitivity-resolution performance for hole diameters between 1/64 and 1/8 in., and depths between 0.015 and 0.100 in.

Botsco, R. J. (North American Aviation, Los Angeles, Cal.), Materials Evaluation, Vol 25, No. 4, April 1967, pp 76-82, 9 figs., 2 tables, 8 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0283

APPLICATION OF ULTRASONICS TO DETECTION OF FATIGUE CRACKS

An investigation was conducted to determine the adequacy of ultrasonic techniques for detection of in-depth cracks as well as surface types of flaws occurring during fatigue tests. An ultrasonic system was assembled and used to observe the formation of cracks in center-notched specimens in a variety of metals tested in axial tensile stress. The principles of crack detection associated with reflection and through-transmission techniques are discussed. Transducer design and positioning of the probes are shown along with variations of sensitivity across the face of a 1-in. transducer at a distance of 0.25 in. from the flaw. Fatigue data in the form of stress-life curves showing cycles to first detectable cracks and cycles to fracture are presented.

Klima, S. J., Lesco, D. J., and Freche, J. C. (NASA Lewis Research Center, Cleveland, Ohio), Experimental Mechanics, Vol 6, No. 3, March 1966, pp 154-161, 6 figs., 3 tables, 11 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0284

RESONANCES AND EFFECTS OF COUPLANT LAYERS IN ULTRASONIC CONTACT TESTING

A theoretical and experimental examination was conducted on the variation of echo amplitude as a function of liquid couplant layer thickness in direct-contact ultrasonic testing, using compression waves. The couplants studied were water, lubricating oil, glycerine, and oil. Amplitude differences of up to 20 db were measured for variations in liquid thicknesses of 0.1 mm. The echo amplitude was also measured as a function of thickness of the

protective layers of rubber. The test equipment is described and schematics are provided for the pressure block and device for varying the thickness of the couplant liquid. Data plots provide comparisons between theoretical and experimental values of transmission coefficients for pressure as a function of the thickness of the couplant liquid.

Canella, G. (Centro Sperimentale Metallurgico, Rome, Italy), Materials Evaluation, Vol 31, No. 4, April 1973, pp 61-66, 10 figs., 2 tables.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0285

STUDIES FOR RAIL VEHICLE TRACK STRUCTURES

Conventional (tie-type) and nonconventional rail vehicle track structures were studied, with the restriction that standard gage and rail-head contour be used. Computer programs were developed and used to analyze track response to both static and dynamic vehicle loading. The models of conventional track were validated by measurements on the Penn-Central high-speed track near Bowie, Maryland. The DOT research cars were used to obtain a series of controlled-speed passes at speeds up to 125 mph. Track response under Metroliner and regular freight traffic was also recorded, both at and away from a joint. The measurements showed the lack of consistency of track characteristics at different locations and at different times, and indicated the computer results to be as accurate as the degree to which track parameters could be defined. Following the analysis, performance specifications were written for rail fasteners, and three types of reinforced-concrete structures were recommended for further evaluation in field tests: cast-in-place slab, cast-in-place twin beams, and precast twin beams.

Meacham, H. C., Frauso, R. H., Ahlbeck, D. R. and Kasuba, J. A. (Battelle Memorial Institute, Columbus, Ohio), Report No. FRA-RT-71-45, April 30, 1970, for DOT/FRA/Office of High Speed Ground Transportation, Washington, D.C., Contract No. DOT-FRA-9-0021, 189 pp, 39 figs., 14 tables, 10 refs., 9 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 194 139.

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0286

STUDY OF NEW TRACK STRUCTURE DESIGN. PHASE I

Conventional (tie-type) and non-conventional rail vehicle track structures were studied with the constraint that standard gage and rail-head contour not be varied from current practices. Computer programs were developed and used to analyze track response to both static and dynamic vehicle loading. A major philosophy in the development of improved track structures was to reduce the magnitude and number of pressure cycles transmitted to the foundation by passing rail vehicles. This report contains detailed discussion of material summarized in: "Studies for Rail Vehicle Structures", NTIS Rept. No. PB-194 139, and is a reference source cited in that document. (Carried as RRIS Accession No. 039255.)

Meacham, H. C., Voorhees, J. E., and Eggert, J. G. (Battelle Memorial Institute, Columbus, Ohio), Report No. FRA-RT-72-12, for FRA/Engineering Research & Development Division, 130 pp, 47 figs., 6 tables, 21 refs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 202 272.

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0287

THE FINISHING OF HEAVY PROFILES [IN GERMAN]

This paper discusses the procedures used in existing finishing shops and plants for rails and heavy sections, and it describes the intermediate shop and material flow conditions. Sizes of orders and dispatch-shop conditions, staff cost, and construction costs of rationally operating plants are presented. The internal works transport and dispatch shop reorganization, change of organizational development, and the concept for the construction of fully continuous finishing shops are described.

Zimmermann, K. A., and Siegfried, D. (Walzwerksausschusses des Vereins Deutscher Eisenhuttenleute), Stahl und Eisen, Vol 85, No. 8, April 23, 1965, pp 464-471, 9 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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0288

BETTER ULTRASONIC RESOLUTION BY DATA UNFOLDING

Conventional ultrasonics techniques for detecting defects at any great depths in thick steel give poor resolution because of beam spread. One partial answer to the problem is the use of ultrasonic holography techniques in which an image is formed of the defect; resolution is limited only by wavelength factors. However, the drawback to this technique is that it is not very satisfactory for real time since there is a waiting period between the examination and the visual presentation of data. Attempts to computerize the holographic process have not been very successful. As an alternative, in cases where a short timescale is essential, the authors propose a simple means of improving the resolution in ultrasonic data by means of unfolding techniques. The results of the study were encouraging and indicate that, under some conditions, the techniques do improve resolution. More work is required to establish the approach with certainty and to investigate its limitations, especially with regard to defects having a more complex shape.

Silk, M. G., and Lidington, B. H. (Atomic Energy Research Establishment, Harwell, England), Non-Destructive Testing, Vol 8, No. 2, April 1975, pp 84-99., 13 figs., 4 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Inc. (repr., PC).

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0289

POSSIBILITIES OF AUTOMATING NON-DESTRUCTIVE TESTING OF HOT-ROLLED PRODUCTS DURING OPERATION [IN GERMAN]

The prospects for using automatic nondestructive testing for continuous quality control in the factory producing hot-rolled products are discussed. The techniques reviewed include X-rays, gamma-rays, neutron irradiation, supersonic, magnetic leakage flux, and electroinductive eddy currents. The automation of these nondestructive methods for continuous testing for internal faults, surface faults, and impurities in hot-rolled products, and the detection limits and testing rates attainable with them are discussed. Combinations of the various inspection methods to improve reliability of the tests are considered. Schematic drawings of equipment manufactured by Krautkramer and the magnetic technique used by Forster are presented along with descriptions of their operations. Emphasis is placed on careful maintenance of test apparatus and evaluation of test results as the premise for fully effective nondestructive testing in rolling-mill operations. A brief discussion is included on the research and development in the field of nondestructive testing.

Fink, Von K. [Vereinigte Hutten- und Rohrenwerke, Mulheim (Ruhr), Germany], Stahl und Eisen, Vol 85, No. 6, March 25, 1965, pp 353-372, 9 figs., 2 tables, 33 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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0290

HEAVY FOUR-AXLE CARS AND THEIR MAINTENANCE OF WAY COSTS

Along with the study of maintenance of way costs, the author provides specific information relative to rail car size and rail deflection, rail stress, and rail contact pressure. The computation of rail deflection and stress is explained by providing numerical values for three rail sizes (90, 115, and 132 lb). The rail bending stresses for good, average, and bad tracks are discussed. The ties, ballast, and associated track items are taken into consideration in this study, and sketches are provided covering five cases with varying conditions for each of the items associated with the track structure. Rail-deflection and bending-stress equations are given along with graphical illustrations showing the rail deflection as a function of tons capacity for car sizes. A similar treatment covering bending stresses is provided.

Ahlf, R. E. (Illinois Central Gulf Railroad), American Railway Engineering Association, Bulletin 673, Proceedings, Vol 76, June-July 1975, pp 622-642.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0291

SOME INTERACTION EFFECTS IN A PROBLEM OF PLASTIC BEAM DYNAMICS — PART 1: INTERACTION ANALYSIS OF A RIGID PERFECTLY PLASTIC BEAM

In this first part of a three-part article, an analysis is presented to determine the permanent deformation of a rigid-plastic clamped beam with constraints against axial displacements at the ends. The beam carries a concentrated mass at its center and is subjected to large transverse impulsive loading at the mass. Plastic interaction is considered for the combined action of bending moments, axial forces, and shearing forces, based on a fixed yield surface. This paper is directed toward obtaining a solution for the interaction problem of bending, extension, and shear. The existence of axial constraints is visualized in an interior span of a beam on many supports. The various phases of motion are discussed by using illustrations prior to the derivation of mathematical expressions leading to the formulation of equations that explain interaction effects. Curves are presented which show the dimensionless deflection plotted as a function of the input parameter for a variety of attached masses.

Nonaka, T. (Kyoto University, Kyoto, Japan), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 32, No. 3, September 1967, pp 623-630, 11 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0292

SOME INTERACTION EFFECTS IN A PROBLEM OF PLASTIC BEAM DYNAMICS — PART 2: ANALYSIS OF A STRUCTURE AS A SYSTEM OF ONE DEGREE OF FREEDOM

This article, the second in a series of three, presents a theoretical study of the permanent deformation of a clamped beam with constraints against axial displacements at the ends. As described in Part 1, the beam carries a concentrated mass at its center and is subjected to large transverse impact loading at the mass. The analysis is based on the assumption of one degree of freedom and takes into account the interaction between bending and extension, of strain-rate sensitivity, of elastic vibration, and of load duration, in an approximate manner. The interaction and slip stages are discussed in connection with assumed plastic regions and relative motion, and the stress distribution. A hypothetical example is presented.

Nonaka, T. (Kyoto University, Kyoto, Japan), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 32, No. 3, September 1967, pp 631-637, 8 figs., 11 refs., 2 appendixes.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0293

SOME INTERACTION EFFECTS IN A PROBLEM OF PLASTIC BEAM DYNAMICS -- PART 3: EXPERIMENTAL STUDY

This paper, the third in a series of three, discusses an experimental study of the permanent deformation of clamped beams with and without constraints against axial displacements at the ends. The beams carry a concentrated mass at the center and are subjected to blast loading at the central mass. The experimental results are compared with the theoretical predictions developed in earlier papers. The author concludes that permanent deformation is reduced considerably by the constraints against axial displacement for beams subjected to large dynamic loading or loads such that the deflection is an appreciable fraction of the beam depth or larger.

Nonaka, T. (Kyoto University, Kyoto, Japan), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 32, No. 3, September 1967, pp 638-643, 13 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0294

BUCKLING OF CONTINUOUSLY SUPPORTED BEAMS

The buckling of infinite beams continuously supported by a semi-infinite elastic continuum is investigated. The buckling loads were determined when the beam rests on a two-dimensional elastic continuum and also when the foundation extends beyond the width of the beam. The effect of the outside foundation is shown by comparing the obtained buckling loads. The author considered the use of the Winkler foundation in his buckling analysis, but because of its periodicity, chose to use the Fourier series and transforms for the transverse direction. The effect of extending the elastic continuum beyond the width of the beam is shown by a graphical comparison.

Murthy, G.K.N. (Department of Health, New York, N.Y.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 50, No. 2, June 1973, pp 546-552, 2 figs., 15 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0295

BETTER RAILS [IN FRENCH]

A patented heat treatment for eutectoid steel with higher carbon (increased from 0.4 to 0.7 percent) and manganese (increased from 1.0 to 1.8 percent) content to be used in producing steel rails is described. Rails which have undergone the heat treatment show little or no significant deformation, and are considered to be hard and fatigue resistant. The process involves an initial heat treatment after finish rolling, step quenching in a fluidized bed (e.g., metallic chromium and superheated steam) above the M_s, followed by isothermal bainitic transformation, and tempering. (Carried as RRIS Accession No. 01072803, and also contained in "A Bibliography on the Design and Performance of Rail Track Structures", September 1974, RRIS No. 072794.)

Pomey, J., Chevenas, R., Cornet, R., Rosenhole, S., and Leger, D., Revue de Metallurgie, Vol 67, No. 1, January 1970, pp 19-22, 2 figs., 2 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0296

MOVING LOAD ON A PLATE RESTING ON AN ELASTIC HALF SPACE

In this study an elastic plate supported by a semi-infinite elastic continuum is subjected to a moving line load. Both welded and smooth contact between the plate and foundation are considered. Dynamic solutions for the bending moments in the plate are presented that are time invariant relative to a coordinate system moving with the load. Resonance effects at certain critical velocities are discussed. Response of the system depends significantly on the relative stiffness of plate and half space and on the type of contact. For the relatively stiff plate certain resonances occur for smooth contact but not for welded contact. For subcritical load velocities, the bending moments are calculated and compared with corresponding bending moments for a plate on a Winkler foundation. It is concluded that the Winkler foundation is adequate for smooth contact and small load velocities.

Achenbach, J. D. (Northwestern University, Evanston, Ill.), Keshava, S. P. (North Dakota State University, Fargo, N.D.), and Herrmann, G. (Northwestern University, Evanston, Ill.), Journal of Applied Mechanics, Trans. ASME, Vol 32, No. 4, December 1967, pp 910-914, 4 figs., 13 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineering (repr., PC).

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0297

ANISOTROPY OF FATIGUE CRACK PROPAGATION

The anisotropy of fatigue-crack propagation in hot-rolled steel plate was studied for three orientations: crack arrester, crack divider, and short transverse. The dependence of crack-growth rate on stress-intensity factor was shown to be sensitive to the microconstituents present and their orientation relative to the fracture plane and direction. It was noted that this dependence increased as the material toughness decreased and when the mechanical fibering was parallel to the fracture plane and direction. Typical photomicrographs are included that show the four different types of metallurgical structure investigated. Mechanical properties of the steel for each of the four structures and each of the three orientations are tabulated. Plots of the effect of stress-intensity factor range on fatigue-crack propagation rates are presented for each metallurgical structure and crack growth direction. Fractographic evaluations involving measurements of striation spacings from fracture surfaces of fatigue specimens for all orientations are discussed. The data show that striation spacing was independent of orientation and that the fracture of inclusions was primarily responsible for the observed crack-growth anisotropy.

Heiser, F. A. (Watervliet Arsenal, Watervliet, N. Y.), and Hertzberg, R. W. (Lehigh University, Bethlehem, Pa.), Journal of Basic Engineering, Trans. ASME, Series D, Vol 93, No. 2, June 1971, pp 211-217, 12 figs., 1 table, 23 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0298

TRANSIENT RESPONSE OF BEAMS

The response of beams to transient excitation applied through the supports is considered. A general method of analysis, based on the integral equation of motion, is developed, applicable to single- and multi-span beams; for non-uniform beams the conventional approximation of replacing the distributed mass by a number of discrete masses is made, and an equivalent matrix analysis is given. Response spectra, dependent upon bending moment or stress, are given for various pulse shapes for simple beams, and it is shown that for single pulse excitation the maximum response depends primarily on the rise-time of the pulse and

only marginally upon the shape of the pulse. The accuracy of approximate methods of determining response spectra is discussed. The effects on transient response of flexibility in the supports and of the support positions are considered.

Bradshaw, A. (Mirrlees-National Research Division, Hazel Grove, Stockport, England), and Warburton, G. B. (University of Nottingham, Nottingham, England), Journal of Mechanical Engineering Science, Vol 9, No. 4, 1967, pp 290-298, 10 figs., 14 refs., 3 appendixes.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0299

MAGNETIC FIELD PERTURBATION DUE TO METALLURGICAL DEFECTS

This paper presents a review of two nondestructive testing techniques: electric current injection and magnetic field perturbation, as applied by the Southwest Research Institute, to locate and characterize small defects in high-strength alloys. These techniques were developed in the course of work concerned with fatigue-crack nucleation, and the development of sensitive NDE instrumentation equipment for the location of fatigue-susceptible regions. The instrumentation aspects of the described techniques are discussed with emphasis on the characteristics and interpretation of the signals caused by inclusions and other surface defects. Changes in magnetic signal amplitude as a function of fatigue crack length are graphically shown. A portion of this paper is devoted to a discussion of applications such as the measurement of microcrack growth in vacuo, surface-oxidation effects, and advanced hardware development aspects.

Lankford, J., and Francis, P. H. (Southwest Research Institute, San Antonio, Tex.), Journal of Nondestructive Testing, Vol 3, No. 1, June 1971, pp 77-94, 9 figs., 4 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0300

ON THE EQUATIONS FOR A TIMOSHENKO BEAM UNDER INITIAL STRESS

The author's purpose in this Note is to contribute derivations of equations for a Timoshenko beam subjected to initial axial-stress based upon the two three-dimensional theories of Treffts and Biot. The shear correction coefficient corresponding to each formulation is determined. Nondimensional critical loads are plotted for the purpose of showing the relationship between buckling loads and the wavelengths, and for drawing comparisons between the theories of Euler, Biot, and Treffts.

Sun, C. T. (Purdue University, Lafayette, Ind.), Journal of Applied Mechanics, Trans. ASME, Vol 39, No. 1, March 1972, Brief Notes, pp 282-285, 3 figs., 7 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0301

A DIRECT NUMERICAL METHOD FOR STRESS AND STRESS-INTENSITY FACTOR IN ARBITRARY, CRACKED, ELASTIC BARS UNDER TORSION AND LONGITUDINAL SHEAR

A numerical method is proposed for a direct local determination of stresses in a twisted and sheared cracked bar. The method uses the integral approach concept of the potential theory with a modification that yields the stress components without numerical differentiations or interpolation from a potential function. A general expression for the stress-intensity factor at the crack tip is formulated. Computer running time and storage requirements for typical problems indicate the comparative efficiency of the method in addition to its relatively high accuracy near the crack tip. Tangential shear distribution of a cracked bar subjected to shear and torsion loading are illustrated as

well as normalized stress level contour lines.

Tirosh, J. (Massachusetts Institute of Technology, Cambridge, Mass.), Journal of Applied Mechanics, Trans. ASME, Vol 37, No. 4, December 1970, pp 971-976, 6 figs., 1 table, 4 appendixes.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0302

SOME FRACTURE MECHANICS CORRELATIONS

The results of tests on two high-strength steels, beryllium copper and perspex, together with some published data on high-strength steels, were examined to determine whether there was any relationship between the fracture mechanics parameter K_{Ic} (stress-intensity factor) and conventional mechanical properties. The experimental portion of the investigation involved tests on specimens with circular and rectangular cross-sections with loading in uniaxial tension and three-point bending. Specimens were either notched or they had a variety of edge and center cracks. The mathematical expressions used to calculate the stress-intensity factors are given for each type of specimen. Data analyses are presented in plots of area reduction versus stress intensity factors, and the correlation between Young's modulus and stress-intensity factors is shown.

Pook, L. P. (Fatigue, Wear and Stress Analysis Division, National Engineering Laboratory, East Kilbride, Scotland), Journal of Mechanical Engineering Science, Vol 10, No. 4, 1968, pp 329-336, 8 figs., 2 tables, 34 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0303

FRACTURE MECHANICS IN FATIGUE

This paper presents a review of the current state of the art in utilizing the fracture-mechanics approach to design against high-cycle-fatigue failure. Linear-elastic fracture-mechanics technology is used to define the stress intensity near a crack tip and to establish criteria for fracture instability in the presence of a crack. In the paper schematic illustration is shown of the elastic stress distribution near the tip of a crack and the corresponding stress-field equations are presented. General relationships are described relating stress-intensity with external loads, geometric constraints, stress and crack size. This relationship is quantified for three test specimen geometries that are used to measure fracture toughness. An understanding of both the critical combination of the stress and defect size for catastrophic fracture and the crack-growth-rate characteristics of the material under application conditions are considered essential to determining the useful life of a structure. Data are plotted showing crack-growth rate as a function of stress-intensity factors for Ni-Mo-V steel. The application of fracture-mechanics technology is briefly discussed, and an example problem is given.

Clark, W. G. Jr. (Research and Development Center, Westinghouse Electric Corporation, Pittsburgh, Pa.), Experimental Mechanics, Vol 11, No. 9, September 1971, pp 421-428, 10 figs., 17 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis (SESA).

PURCHASE FROM: SESA (repr., PC).

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0304

FATIGUE CRACK GROWTH AND SUDDEN FAST FRACTURE IN A RAIL

A study was made of fatigue-crack propagation and the critical fatigue-crack size associated with sudden fast fracture in center-notched plate specimens of a rail steel under pulsating loading. The crack growth rate was correlated with the range of the stress intensity factor. The Frost-Dugdale expression was found to hold for conditions of small crack lengths. The critical crack size was found to vary linearly with the maximum applied stress. A relation was obtained for predicting life in the finite range for a specimen containing an existing fatigue crack. The results have been correlated with the fracture modes in both stages of cracking. The relative merits of various approaches to enhancing overall performance under cyclic loading are discussed. The chemical composition and mechanical properties of the rail steel test specimen are given.

Evans, P.R.V., Owen, N. B., and Hopkins, B. E. (National Physical Laboratory, Teddington, Middlesex, England), Journal of the Iron and Steel Institute, Vol 208, No. 6, June 1970, pp 560-567, 12 figs., 2 tables, 21 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0305

A PROPOSED RESOLUTION TEST FOR ULTRASONIC ANGLE BEAM PROBES

Results are presented of a study on an experimental verification of a resolution test for ultrasonic angle beam transducers when used with a test sample containing three small in-line holes with a finished bore. The interaction between the pitch of the holes and the attitude of the largest group to the sound beam is shown. Test blocks are suggested that maintain a common probe-to-target distance which takes into account the frequency of the ultrasound as well as the attitude of the target to the sound beam. Schematic diagrams are presented for the resolution test which show relationships between the probe angle and the target angle as well as the optimization of the target group tilt. Data from the tests are included and these consist of tabulations and oscilloscope traces of signal amplitudes from the triple targets at three different intersection angles.

Chapman, N. (Canadian General Electric Co., Peterborough, Ontario), Materials Evaluation, Vol 29, No. 1, January 1971, pp 1-7, 14 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0306

MEASUREMENT OF RESIDUAL STRESSES IN RAILWAY RAILS MADE FROM HIGH-CARBON STEEL BY A NONDESTRUCTIVE METHOD (EXCHANGE OF EXPERIENCE)

This very brief article essentially cites two systems for determining the residual stresses in rail which the authors have investigated: one is based on measuring the anisotropy of the magnetic permeability, and the other on measuring the effective values of the magnetic permeability using the higher harmonics of the emf's from the signal of a pickup. In both cases superposed pickups are used. The measurement results obtained with the magnetic transducers are compared with those obtained with a strain gauge using a cutout template. Two figures show the distributions of residual stresses at the center of the testpiece cross section, as obtained with both transducers, and compare them with those obtained by the strain-gauge measurement.

Bakaev, N. A., Yankelevic, V. M., Fadeev, A. Yu., Gudyrya, V. A., Shal', N. M., Smiro', A. S., and Tokunov, V. F. (Ukraine Scientific-Research Institute for Metals, Khar'kov, USSR), Industrial Laboratory, Vol 40, No. 7, July 1974, pp 993-994, 2 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPS, Inc. (repr., PC).

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0307

ONSET OF SEPARATION BETWEEN A BEAM AND A TENSIONLESS ELASTIC FOUNDATION UNDER A MOVING LOAD

Load amplitudes that cause separations between supporting and supported elements, such as an Euler-Bernoulli beam that is subjected to a moving concentrated load and resting on a tensionless foundation, are investigated. In this work, the load amplitudes that bring the beam to the verge of separation from the foundation are examined through their relation to the velocity of motion. Formulation of the governing equation employing the Galilean transformation of the Dirac delta function, as well as its solution, is presented. Typical deflection curves for sub- and supercritical velocities are shown. A plot of the dimensionless load value associated with the onset of separation versus the dimensionless velocity is included.

Weitsman, Y. (Tel-Aviv University, Ramat-Aviv, Israel), International Journal of Mechanical Sciences, Vol 13, No. 8, 1971, pp 707-711, 909, 3 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0308

EIGENFUNCTION SOLUTION FOR BEAM ON ELASTIC FOUNDATION

A solution for the end problem of a rectangular beam resting on a simple elastic foundation is obtained as a series expansion in the eigenfunctions of the system. In this paper, the end problem of a rectangular beam in plane stress resting on a Winkler foundation is solved by expanding the Airy stress function in a series of eigenfunctions of the system. The first eigenfunction corresponds to that obtained by using the approximate beam theories, so that the accuracy of each may be ascertained. Comparisons are drawn between eigenvalues predicted by the elementary and Timoshenko theories and a beam theory of Boley and Tolins with the first eigenvalue of the series solution to assess the validity of each theory.

Hess, M. S. (Bell Telephone Laboratories, Allentown, Pa.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 36, No. 4, December 1969, pp 799-802, 3 figs., 5 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0309

CREEP OF A CARBON-MANGANESE STEEL UNDER CYCLIC STRESS AND TEMPERATURE CONDITIONS

Test data obtained for carbon-manganese steel specimens under various stress cycles and/or various temperature cycles are presented. The chemical composition and tensile properties are given for the test specimens, and the equipment used for loading and for strain measurement is described. It is shown that the effects of temperature or stress cycling and of in-phase changes of both are predictable within reasonable limits. However, with out-of-phase changes in stress and temperature, i.e., high stress/ low temperature to low stress/high temperature conditions, very rapid acceleration of strain can occur.

Day, M. F., and Cummings, W. M. (High Temperature Materials Division, National Engineering Laboratory, East Kilbride, Glasgow, Scotland), Journal of Mechanical Engineering Science, Vol 10, No. 1, 1968, pp 36-47, 18 figs., 2 tables, 17 refs.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0310

A COMPARISON OF STRESS-CONCENTRATION FACTORS IN HYPERBOLIC AND U-SHAPED GROOVES

A two-dimensional photoelastic study was conducted of a statically loaded tension bar with symmetrical hyperbolic grooves in series with a section containing U-shaped grooves. The influence of the depth of grooves was examined and stress-concentration factors were determined using the self-calibrating source of stress concentration method. The test procedures using two photoelastic models are described, and composite prints of typical photoelastic patterns are shown. Stress-concentration data for the two models are given in tabular form. The resulting data are compared with theoretical values obtained by Neuber's analysis procedure.

Flynn, P. D., and Roll, A. A. (Frankford Arsenal, Philadelphia, Pa.), Experimental Analysis, Vol 7, No. 6, June 1967, pp 272-275, 3 figs., 4 tables, 9 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0311

THE CRACK OPENING DISPLACEMENT APPROACH TO FRACTURE MECHANICS IN YIELDING MATERIALS

This paper reviews the applicability of the fracture-mechanics approach employing the concept of crack-opening displacement to situations in which linear fracture mechanics is invalidated by yielding. The hypothesis of a critical crack-opening displacement to fracture was examined experimentally using mild steel specimens of vastly differing dimensions. Subsidiary experiments were conducted to define the factors responsible for the apparent effect of absolute size on the results. A theoretical analysis simulates elastic-plastic conditions to provide a relationship between applied stresses and strains, crack length, and crack opening displacement. Photographs and schematic drawings of the probe (codmeter) used for measuring crack-opening displacements are shown. Test results are presented in tabulations and curve plots. The model for this experimental and theoretical analysis for local plasticity is given.

Burdekin, F. M. (British Welding Research Association), and Stone, D.E.W. (The Royal Aircraft Establishment, Farnborough, England), Journal of Strain Analysis, Vol 1, No. 2, January 1966, pp 145-153, 10 figs., 1 table, 2 appendixes, 18 refs.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0312

MODES AND FREQUENCIES OF TRANSVERSELY ISOTROPIC SLIGHTLY CURVED TIMOSHENKO BEAMS

An analysis of the vibration of transversely isotropic Timoshenko beams, which have small constant initial curvature, is presented, and a closed-form general solution to the governing equations is derived. Natural modes and frequencies are determined for both clamped and simply supported end conditions, and comparisons are made. The combined effects of initial curvature, transverse shear deformation, and boundary conditions are evaluated and discussed. Specifically, it is shown in what manner the clamped beam tends to be more sensitive to shear deformation than the simply supported beam, and how initial curvature reduces the difference. Numerical results are given in graphical presentations showing the relation between the nondimensional frequency parameters and the shear parameters for three modes and types of supports.

Rosettos, J. N., and Squires, D. C. (Northeastern University, Boston, Mass.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 40, No. 4, December 1973, pp 1029-1034, 9 figs., 7 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0313

SHEAR DEFORMATION IN BEAMS ON ELASTIC FOUNDATIONS

The importance of the effect of transverse shear deformation in the flexure of an elastic beam of symmetric cross section, constrained by a Winkler-type elastic foundation, is found to depend upon both the elastic properties of the beam and the foundation and the geometry of the beam cross section. Under certain conditions the form of the solution is substantially modified and the periodic character predicted by the classical treatment is not present. The significance of the modifications (from the solution appropriate to the classical treatment) is found to be dependent upon the ratio of the square root of the second moment of the area of the cross section to the area of the cross section and the ratio of the foundation modulus to Young's modulus for the beam material. The practical significance of these modifications is illustrated by means of specific examples of an infinite beam under a concentrated load and an infinite beam under a concentrated couple.

Essenburg, F. (Illinois Institute of Technology, Chicago, Ill.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 29, No. 2, June 1962, pp 313-317, 8 figs., 6 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0314

SOME SIMPLIFIED SOLUTIONS FOR RELATIVELY STIFF BEAMS ON ELASTIC FOUNDATIONS

Maximum bending moments, rotations, and deflections of beams resting on elastic foundations and subject to central forces and bending moments are computed on the basis of a linear approximation to the foundation reaction. This reaction is determined from the rigid-body motion of the beam, and is thus statistically determinate. The results of these approximate analyses are compared with those obtained from the exact theory in terms of the "characteristic parameter" of the beam, which is a function of the relative stiffnesses of the beam and the foundation. It is shown that the approximate analysis introduces very little error if the beam is stiff as compared to the foundation on which it rests.

Shaffer, B. W. (New York University, New York, N.Y.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 85, No. 1, February 1963, pp 1-4, 2 figs., 3 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0315

ELASTIC-PLASTIC ANALYSIS OF A WHEEL ROLLING ON A RIGID TRACK

A consistent finite element model for a circular wheel is developed based on triangular and quasi-triangular domains and a piecewise linear displacement field. The minimum stress-rate principle of plasticity is used to obtain the solution of this two-dimensional continuum problem with internal unloading. A piecewise approximation of the Tresca yield condition is used. Elastic-plastic solutions of a wheel rolling on a rigid track under its own weight and a hub load are obtained for the first few revolutions until a steady-state condition is reached. Shake-down conditions for the wheel are demonstrated.

Garg, V. K. (General Motors Corporation, Lagrange, Ill.), Anand, S. C. (Clemson University, Clemson, S.C.), and Hodge, P. G., Jr. (University of Minnesota, Minneapolis, Minn.), International Journal of Solids and Structures, Vol 10, No. 9, 1974, pp 945-956, 4 figs., 3 tables, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0316

DYNAMIC RESPONSE OF BEAM ON VISCOELASTIC SUBGRADE

Considering that the foundation is linearly viscoelastic, the authors modify the Winkler foundation model assumptions to arrive at a linear differential relation that includes time derivatives of the local foundation pressure and the local beam deflection. The authors focus interest on the steady-state response of a beam to a rapidly moving load. Works of other authors who have used Winkler's assumption are briefly discussed. Emphasis is placed on investigations by Kenny who studied the dynamic response of an elastic beam on a foundation of Kelvin elements in which a subgrade of Kelvin elements corresponds to a limit case of a foundation of standard linear elements.

Achenbach, J. D., and Chin-teh, S. (Northwestern University, Evanston, Ill.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 9, No. EM 5, October 1965, pp 61-76, 8 figs., 1 table, 11 refs., 2 appendixes.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0317

CONTACT VIBRATIONS OF A WHEEL ON A RAIL

The purpose of this paper is to develop an analytical model for high-frequency contact vibrations caused when a wheel rolls over a rail that has a randomly wavy surface. The wheel is assumed to undergo only rigid-body motions, apart from the localized elastic deformation near the contact region. The rail is modeled as an infinite beam on a continuous, point-reacting foundation. With the rail roughness being assumed to be a locally stationary, Gaussian random process, a complete solution is presented to the linearized problem. Three phenomena of interest are investigated in detail: plastic deformations, loss of contact, and the formation of rail corrugations. The effects of various wheel and rail parameters on these phenomena are explored. (Carried as RRIS Accession No. 046065.)

Nayak, P. R. (Tata Engineering and Locomotive Company, England), Journal of Sound and Vibration, Vol 28, No. 2, May 1973, pp 277-293, 8 figs., 14 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Academic Press, Inc., London, England (repr., PC).

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0318

ON THE EFFECT OF HYDROGEN IN RAIL STEEL AND THE POSSIBILITIES OF HYDROGEN-DEPRESSING MELTING OPERATIONS [IN GERMAN AND ENGLISH]

The production of rail steel ingots is discussed in relation to hydrogen content and its importance in the production of wear-resistant rails. Hydrogen can lead to the formation of flakes in the rail head and, under operational loads, transverse fissure failures may result. Illustrations are provided that show flakes and segregation lines as well as coarse nonmetallic inclusions. The critical hydrogen content for Grades A through C of wear-resistant rail steel is given. Chemical analysis according to random analysis over the cross section and concentrations of alloying and accompanying elements in segregation lines in rails of various qualities is shown. The effect of the sulphur content on the susceptibility to flake formation and of hydrogen embrittlement on the mechanical properties of rails is discussed. It is concluded that hydrogen content can be reduced to a suitably low level by subjecting the rails to controlled cooling or by vacuum degassing of the molten steel. Low-hydrogen melting is stated to be even more advantageous. Technical Supply Specification 860 of the International Railway Association (UIC) covering rail

steel grades in the as-rolled condition is briefly reviewed.

Heller, W., Weber, L., Hammerschmid, P., and Schweitzer, R. (Krupp Huttenwerke A.G., Werk Rheinhausen, West Germany), Stahl und Eisen, Vol 92, No. 19, September 14, 1972, pp 934-945, 17 figs., 1 table, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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0319

CRITERIA OF FRACTURE INITIATION FROM THE VIEW OF FRACTURE MECHANICS [IN GERMAN]

A critical survey on fracture mechanics criteria for unstable crack growth is given. The limits of this concept are shown by consideration of the energy exchange during the fracture process and are discussed on the basis of "crack resistance". Additional restrictions result when judging the onset of fracture by crack opening displacement measurements. The experimental work, consisting of an investigation on the behavior of the crack opening of a single edge-notched specimen is discussed and results are shown in a stress-displacement diagram for the tensile tests.

Kerkhof, F., and Sommer, E. (Institute fur Festkorpermechanik der Fraunhofer-Gesellshaft zur Forderung der Angewandten Forschung, e.V. Freiburg/Br. West Germany), Materialprufung, Vol 14, No. 9, September 1972, pp 289-293, 5 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0320

ULTRASONIC MEASUREMENT OF HARDENING DEPTH ON STEEL ROLLS [IN GERMAN]

This paper deals with the use of highly sensitive ultrasonic detectors for determining the hardness depth of steel rolls. Information on the grain size of a polycrystalline material as a function of the distance from the surface can be obtained by measuring the backscattering of ultrasonic pulses caused by grain boundaries. Measurements on hardened steel rolls at frequencies between 20 and 60 MHz are discussed. Sufficiently accurate measurements for practical applications can be achieved if the statistical back-scattering of sound waves (grain-boundary noise) is averaged by moving the transducer probe in a suitable manner.

Koppelmann, J. (Physikalisch-Technischen Bundesanstalt, Braunschweig, West Germany), Materialprufung, Vol 9, No. 11, November 1967, pp 401-405, 9 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0321

QUALITY RAILS FROM CONTINUOUSLY-CAST CONVERTER STEEL [IN GERMAN]

Results of an examination of rails produced from continuously cast O-converter steel at a Russian works are discussed, and a comparison is made with rails produced by older processes. The rails satisfy specification requirements and possess superior cleanliness.

Lempitskij, W. W., Gurskij, G. L., Wlasov, W. I., Poljakov, W. W., and Kan, J. E., Neue Hutte, Vol 18, No. 1, January 1973, pp 52-63, 2 figs., 4 tables, 1 ref.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: ESL (repr., PC and microfilm).

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0322

LOAD/STRAIN CALCULATIONS FOR BENDING BEAMS [IN GERMAN]

The author investigates the premise that in strength calulation, the permissible load of statically stressed constructions of deformable material is normally considered to be dependent on the strain at the point of highest stress. The relation between external load and maximum strain in the case of elastic-plastic loading is discussed, and curves are presented for small bending deformation of beams with different cross sections, and for a bar with rectangular cross section under combined bending and tension. It is stated that the method of calculation, which was developed for perfectly plastic materials, is also applicable to materials with a continuously increasing stress/strain characteristics.

Dietmann, H. (Staatlichen Materialprufungsanstalt an der TH, Stuttgart, West Germany), Materialprufung, Vol 9, No. 2, February 1967, pp 50-56, 9 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0323

THE REFLECTION OF ULTRASONIC WAVES BY SURFACE CRACKS AND NOTCH-SHAPED REFERENCE DEFECTS--INTRODUCTION AND MODEL CONCEPTION [IN GERMAN]

The reflection of ultrasonic waves by surface flaws is investigated theoretically and compared with practical results, assuming that the probe and defect are ideal rectangular piston oscillators. An explanation is given for the influences of flaw depth and angle of orientation on flaw detectability and flaw-size determination in materials testing. It is revealed that precise correlation between flaw echo height and flaw depth cannot be expected for all flaw depths and angles of orientation. This correlation is achieved only with flaws oriented normally to the sound beam or normal to the surface of the specimen, and even then only within a limited range. Data from measurements of reflections on rectangular notches and natural cracks are plotted.

Werneyer, R., and Schlengermann, V. (Dr. J. u. H. Krautkramer, Gesellschaft fur Elektrophysik, Koln, West Germany), Materialprufung, Vol 13, No. 7, July 1971, pp 213-218, 8 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0324

INVESTIGATION OF 140 LB/YD RAIL MADE FROM VACUUM DEGASSED STEEL

This report describes tests performed by the Association of American Railroads (AAR) Research Department on 140 lb/yd rail sections rolled at U. S. Steel Corporation's Gary Mill from one heat of vacuum degassed steel ingots produced at the Chicago South Works plant.

At present rails are manufactured in 39-ft lengths. Longer lengths are considered desirable because of anticipated savings resulting from the reduction in the number of welded joints required; however, current practices, which involve control cooling in covered containers, are not suitable. The purpose of this study was to determine whether the properties of rail manufactured from vacuum degassed steel and air cooled are comparable to those of rail produced by the currently common practices.

The report includes results of rolling-load tests, slow-bend tests, drop tests, chemical analysis, physical-property determination, hardness survey, and a metallurgical macroscopic and microscopic examination. A description of the manufacturing process from the production of the heat to the rolling is given and tabulations of test data, schematic drawings and cross sections

of the test specimens, and drawings of the test equipment are provided.

Wisnowski, M. J., Johnson, H. B., and Britton, J. G. (Association of American Railroads, Chicago, Ill.), Report No. R-101, Project 70-R-58, June 1970, for the Penn Central Railroad Company, 42 pp, 29 figs., 15 tables.

ACKNOWLEDGMENT: American Association of Railroads.

PURCHASE FROM: American Association of Railroads (repr., PC).

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0325

PRODUCTION OF RAIL STEELS OF LOW HYDROGEN CONTENT ACCORDING TO THE BASIC OXYGEN CONVERTER PROCESS [IN GERMAN]

The effect of alloying and additional materials to oxygen steels containing 0.26 to 0.95 percent carbon, as well as the mode of melting, on the hydrogen movement during the production of normal- and wear-resisting (A and B as specified by the International Railway Association) grade, was investigated. The relationship between the mode of melting and low hydrogen content, chemical composition, cooling conditions on the hot bank, mechanical properties, as well as the results of ultrasonic tests of more than 10,000 tons of wear-resisting Grade B oxygen steel rail, is discussed.

Reinders, F., and Heller, W. (Krupp Huttenwerke A. G., Werk Rheinhausen, West Germany), Stahl und Eisen, Vol 90, No. 26, December 24, 1970, pp 1489-1496, 14 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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0326

MAGNETIC AND ELECTROMAGNETIC METHODS FOR NON-DESTRUCTIVE TESTING OF CASE DEPTH ON SURFACE HARDENED SEMI-FINISHED PRODUCTS AND FINISHED PARTS — 2. STUDIES AND TEST RESULTS [IN GERMAN]

This article concerns a study of magnetic and electromagnetic methods for nondestructive testing of case-depth hardness of semi-finished and finished products and parts. Three test methods - residual field, yoke flux, and alternating field - were employed to test groups of steel specimens having various compositions, heat treatments, and case-hardness depths (8 mm maximum), and the results obtained with each of the methods are compared. Examples of tests of case-depth hardness of crankshaft bearings and valve caps are also given to show how the methods might be employed in industry. Schematics and photographs of the test equipment are provided along with a description of their operating principles.

Jakel, T. (Institut Dr. Forster (IFR), Reutlingen, West Germany), Materialprufung, Vol 7, No. 8, August 1965, pp 289-295, 18 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH, (repr., PC).

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0327

THE ESTIMATION OF FATIGUE STRENGTH OF STEELS BY CORRELATION FORMULAS [IN GERMAN AND ENGLISH]

The author attempts to show that a linear dependence exists between fatigue and tensile strength of similar types of steel. With this hypothesis, this dependence is used to estimate the bending fatigue limit of four groups of steels by employing four correlation formulas. The relations between fatigue and tensile strength for various special cases and also for cases of correlation

lack are considered. The influence of tensile strength on the fatigue strength of notched specimens and surface-hardened machine parts is examined. The physical properties and chemical compositions of the test specimens are given. The data obtained in the study are analyzed and compared with data obtained in similar studies conducted by other researchers.

Buch, A. (Warsaw, Poland), Materialprufung, Vol 8, No. 9, September 1966, pp 325-330, 10 figs., 4 tables, 17 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0328

ULTRASONIC PROBE FOR THE DETECTION OF LONGITUDINAL AND TRANSVERSE FLAWS ALONG PREDETERMINED TEST TRACES [IN GERMAN]

This paper deals with suggestions for the use of ultrasonic techniques in the detection of longitudinal and transverse flaws in metal structures. Schematic diagrams are shown where single probes are used and positioned normally and at approximately 45 degrees to transverse and longitudinal cracks. An arrangement is illustrated where a dual probe is used for detection of flaws of both types simultaneously. Test equipment and oscilloscope traces are shown which indicate the levels of signal output obtained through the use of dual probes.

Bottcher, W., Kopineck, H. J., Schlussnus, K. H., and Sommerhorn, G., (Rohrenwerken der Hoesch A. G., Dortmund, West Germany), Materialprufung, Vol 12, No. 5, May 1970, pp 170-172, 6 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0329

AMERICAN RAILWAY ENGINEERING ASSOCIATION MANUAL FOR RAILWAY ENGINEERING (CHAPTER 4: RAIL)

Chapter 4 of the AREA Manual comprises four parts: Part 1 - Design, which includes design recommendations for rail sections, joint bars and assemblies, and miscellaneous hardware; Part 2 - Specifications, which deals with specifications for steel rails, welded rail, drop testing, joint bars, and for miscellaneous parts used in track assemblage Part 3 - Report Forms, provides samples of the forms used for reporting inspections, shipment, control-cooled rail record, rail failures, and rail wear; Miscellaneous Part - includes information on rail bond applications, rail purchasing, slotting and reconditioning of rail ends, and illustrations of rail shelling.

American Railway Engineering Association, Manual for Railway Engineering, Chapter 4, 1973, 80 pp, 38 figs., 2 tables, miscel. forms.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0330

MANUAL AND AUTOMATIC SCANNING WITH ULTRASONIC TESTING OF STEEL [IN GERMAN]

The techniques associated with nondestructive ultrasonic testing as performed by manual scanning and automatic guiding of the sonic probe are reviewed. The special advantages and, hence, a corresponding range of application of both methods are discussed. Photographs of the ultrasonic transmitter and receiver assemblies for inspection of round and flat parts are given. Graphic and CRT illustrations of the echoes produced by defects are included, and curves show the variation of the width of the indication range

with the height/amplitude of signal for different types of defects.

Michalski, F. (Rochling'schen Eisen- und Stahlwerken, Volklingen(Saar), West Germany), Materialprufung, Vol 7, No. 11, November 1965, pp 420-424, 6 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0331

MAGNETIC AND ELECTROMAGNETIC METHODS FOR NON-DESTRUCTIVE TESTING OF CASE DEPTH ON SURFACE-HARDENED SEMI-FINISHED PRODUCTS AND FINISHED PARTS, 1. PHYSICAL AND TECHNICAL FUNDAMENTALS OF METHODS

Selection of the most effective method for determining the thickness of the hardened zone of a case-hardened steel piece is discussed. Three applicable test methods are described: residual field, yoke flux, and alternating field. The magnetic processes common to each of them are outlined, and the physical laws governing the capability of each method are explained. The properties of the basic shapes of measuring coils are discussed by means of the equivalent diagram of their magnetic circuits. This analysis facilitates the development of a transition form of coils which may be adapted to special problems of practical testing.

Jakel, T. (Institut Dr. Forster, Reutlingen, West Germany), Materialprufung, Vol 7, No. 7, July 1965, pp 243-250, 10 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0332

INVESTIGATION OF SUBCRITICAL CRACK GROWTH WITH THE TOOL OF FRACTURE MECHANICS [IN GERMAN]

Two methods that allow the quantitative and continuous measurement of subcritical crack growth by fatigue or stress-corrosion cracking are described. Measurement of crack growth by recording the notch opening displacement while using conventional equipment for determining the critical stress intensity (K_{Ic}) is discussed. The investigation of the fatigue crack growth of a high-strength maraging steel yielded the relation $da/dN=C\Delta K^n$ over a wide range, where da/dN=crack growth per cycle, ΔK=cyclic alternation of the stress-intensity factor and C and n are material constants. Crack growth rates were determined microscopically by measuring the fatigue striation spacings on the fracture surface. These growth rates were in agreement with the macroscopic crack growth rates. The study indicates that the propagation of stress-corrosion cracks depends equally on the stress-intensity factor and below the critical value of K_{Iscc}, no stress corrosion cracking was observed.

Fuchs, A. (Institut fur Metallische Werkstoffe bei AEG-Telefunken, Frankfurt/Main, West Germany), Materialprufung, Vol 13, No. 6, June 1971, pp 181-186, 10 figs., 1 table, 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0333

AN ANALYSIS OF DATA ON NON-PROPAGATING FATIGUE CRACKS ON A FRACTURE MECHANICS BASIS

The author explores values of the range of stress-intensity factors to determine whether or not that it dictates the rate of propagation of fatigue cracks. The works of other investigators such as Paris, Gurney, Frost, and Erdogan are reviewed to examine the possibility

of whether cracks can exist without propagating under fatigue loading. An analysis using fracture mechanics covering the four basic specimen configurations is presented, and a numerical example is given with tabulated data for a variety of ferrous and nonferrous metals. The chemical composition and mechanical properties of the metals examined in this analysis are given. It was concluded that the experimental results published in the literature dealing with nonpropagating fatigue cracks can be represented by a law which states that cracks will only propagate if the range in fracture mechanics stress-intensity factor, K, exceeds a certain value. If this value is not exceeded, the cracks will not propagate.

Harrison, J. D., Metal Construction and British Welding Journal, Vol 2, No. 3, March 1970, pp 93-98, 3 figs. 4 tables, 24 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Fuel & Metallurgical Journal Ltd. (repr., PC).

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0334

INELASTIC RESPONSE OF BEAMS TO MOVING LOADS

This paper investigates a method of analysis for the inelastic response of beams under moving loads, and examines the inelastic behavior of simply supported beams traversed by heavy loads. The lumped parameters approach is used because it was felt that the lumped mass and lumped flexibility approach possesses the same order of accuracy as the other lumped parameters methods, and is more convenient to use. The model of a beam with a continuous distribution of flexibility and mass is shown and discussed. Equations of motion are derived and free-body diagrams are presented. Numerical results are given in curves describing deflection and interaction forces of the unsprung and sprung masses, deformed beam shapes and permanent sets, and the effect of speed on maximum deflections.

Toridis, T. G. (George Washington University, Washington, D.C.), and Wen, R. K. (Michigan State University, East Lansing, Mich.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 92, No. EM 6, December 1966, pp 43-62, 17 figs., 9 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0335

SOME PROBLEMS OF WHEEL/RAIL INTERACTION ASSOCIATED WITH HIGH-SPEED TRAINS

The objective of the study is to identify and evaluate potential problems involving wheel-rail interaction which could limit the speed of a high-speed rail (HSR) system. The study is based upon a survey of existing knowledge in the areas pertinent to wheel-rail interaction; no extensive analytical work is presented, but several approximate calculations are given. An attempt has been made to investigate possible wheel-rail speed limitations and to set aside some of the "non-problems" which may at first appear to constitute a serious constraint upon rolling HSR concepts. The results and discussion are concentrated in four main areas: estimation of the dynamic loads; wheel behavior and structural integrity; rail dynamics and structural integrity; adhesion, hunting, and related problems. (Carried as HRIS Accession No. 039140.)

TRW Systems, Washington Operations, Washington, D.C., Report No. 06818-W318-RO-00 for the Office of High Speed Ground Transportation/DOT, Contract No. C-353-66(Neg), March 1969, 57 pp, 15 figs., 43 refs.

ACKNOWLEDGMENT: TRW Systems.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 183 846.

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0336

BEAMS AND SHELLS WITH MOVING LOADS

The transient response of the Euler-Bernoulli beam and the Timoshenko beam on elastic foundations due to moving loads is reviewed, using, however, a considerably simpler vector formulation with a Laplace rather than Fourier transformation. The problem of a cylindrical shell with an engulfing axisymmetric pressure wave is shown to be generally quite analogous to the Timoshenko beam problem. However, in contrast to the Timoshenko beam, the bar velocity is a "critical" load speed for which the response can become large. This is due to the coupling between axial and radial motion in the cylinder for the long-wavelength modes. An approach to the problems in which material and geometric properties vary is also discussed. The transformed equation is solved by a method of asymtotic expansions; then the inverse Laplace transformation is evaluated by the asymptotic saddlepoint method.

Steele, C. R. (Stanford University, Stanford, Cal.), International Journal of Solids and Structures, Vol 7, No. 9, 1971, pp 1171-1198, 12 figs., 22 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0337

TRANSIENT STRESS INTENSITY FACTORS FOR A FINITE CRACK IN AN ELASTIC SOLID CAUSED BY A DILATATIONAL WAVE

The diffraction of a plane dilatational wave of arbitrary profile by a finite crack line in an infinite elastic medium is analysed by using the generalized Wiener-Hopf technique. Explicit expressions are derived for the dynamic normal and shear-stress intensity factors at each crack edge as functions of time, angle of incidence, and Poisson's ratio. These results are exact from the instant the incident wave arrives at a given edge until a diffracted P-wave reaches the opposite edge, is rediffracted, and then returns to the original edge, i.e., during two P-wave crack width transit times. Numerical results for an incident wave with a step-function stress profile are presented for several angles of incidence and the peak normal stress intensity is found to be 30 percent greater than the analogous static factor. The magnitude of the jump in the vertical displacement across the crack is also calculated for the case of normal incidence, during a single P-wave transit time and the crack is found to remain open in this period.

Thau, S. A., and Tsin-Hwei, L. (Illinois Institute of Technology, Chicago, Ill.), International Journal of Solids and Structures, Vol 7, No. 7, 1971, pp 731-750, 4 figs., 10 refs., appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0338

MOVING LOAD ON A FLEXIBLY SUPPORTED TIMOSHENKO BEAM

This paper investigates the response of a Timoshenko beam to a force moving with constant velocity over the beam. Solutions are obtained that are time variant in a coordinate system moving with the load velocity. The supporting foundation includes damping effects. The influence of the damping coefficient and the load velocity on the beam response is studied. The limiting case of no damping is included and the various resonance effects are clarified. The Winkler assumptions of elastic foundation and Bernoulli-Euler beams are also discussed. In this paper the complex Fourier transform is found to be a convenient method of analysis. The transverse foundation damping is shown to decrease the magnitudes of displacement and the bending moment.

Achenbach, J. D., and Sun, C. T. (Northwestern University, Evanston, Ill.), International Journal of Solids and Structures, Vol 1, No. 4, 1965, pp 353-370, 9 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0339

THEORETICAL STUDY OF STRESS CONCENTRATIONS AT CIRCULAR HOLES AND INCLUSIONS IN STRAIN HARDENING MATERIALS

Nonlinear boundary value problems of an infinite elastic-plastic plate with a circular hole subjected to pure tension and pure shear at infinity are solved by a method involving Fourier series and finite difference. On the basis of these solutions, the validity of Neuber's relationship between the stress and strain concentration factors for the plane stress problems is examined and a generalized Stowell formula for the stress-concentration factor is proposed for problems in which the applied loading may be pure shear as well as pure tension and, furthermore, other stress states. By the same method of solution, the stress distributions around a rigid circular cylindrical inclusion embedded in an infinite rigid-plastic matrix subjected to uniform transverse pure shear and tension are obtained.

Hwang, W-C. (Harvard University, Cambridge, Mass.), International Journal of Solids and Structures, Vol 8, No. 2, February 1972, pp 149-192, 24 figs., 8 tables, 16 refs., 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0340

PROPAGATION OF A BRITTLE CRACK AT CONSTANT AND ACCELERATING SPEEDS

The integral solutions for a symmetrical crack propagating at a varying speed in an elastic solid under the action of an arbitrary symmetrical crack pressure are obtained as sums of associated static solutions and stress-wave integrals. Two special cases are studied in detail. For the case of a symmetrical crack running at a constant speed under a uniform pressure, exact dynamic solutions for crack shape and stress distribution with singularities in the crack plane are obtained in closed forms that are easily comparable to associated static solutions. The difference between dynamic and static solutions for quantities such as crack shape and stress-intensity factors is governed by dynamic correction factors which are nondimensional functions of Poisson's ratio and the ratio between crack speed and shear-wave speed. The values of these dynamic factors are obtained for large range of crack speed and the difference can clearly be determined from the results obtained.

A study is made for the propagation of a crack at a constant acceleration. The quantities similar to those obtained for the above constant-speed crack are also obtained. The deviations of crack-shape and stress-intensity factors from the associated static state are relatively smaller for an accelerating crack than for a constant-speed crack propagating at the same speed.

Tsai, Y. M. (Iowa State University, Ames, Iowa), International Journal of Solids and Structures, Vol 9, No. 5, May 1973, pp 625-642, 2 figs., 19 refs., 4 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0341

A STUDY OF LARGE DEFORMATIONS BY MATRIX ALGEBRA

The mathematical properties of large deformations such as those occurring in rolling and extrusion are explored by matrix algebra. The relation between pure shear and simple shear, and hence the difference between tension and torsion tests, is explained. Mathematical expressions are derived, and illustrations shown, for pure shear with the principal strains inclined to and along the coordinate axis. A similar treatment is given for simple shear. The procedure for determining the

finite strain distribution characteristic of machining and forging processes is described for plane strain deformation processes and axi-symmetrical deformation processes. The procedure includes detailed measurement of deformed grids and the utilization of matrix methods to compute the distributions.

Hsu, T. C. (University of Edinburgh, Scotland), Journal of Strain Analysis, Vol 1, No. 4, July 1966, pp 313-321, 15 figs., 5 refs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0342

FATIGUE-WEAR TESTING OF RAILS UNDER ROLLING LOAD

This paper deals with fatigue-wear endurance model tests conducted on surface-hardened and untreated low-carbon steel rails. The author briefly reviews some of the work performed by the Hungarian State Railways in connection with rail-head hardening of low-carbon steel rails using induction heating, and the numerical values of hardness are given. The rolling-load fatigue-wear test equipment and procedures are described and shown in a photograph and a schematic diagram. The tests showed that the wear resistance of the surface-hardened rails was 8 to 10 times greater than that of the untreated rails, and their fatigue-load resistance was at least 4 to 6 times that of the untreated rails.

Toth, L. (Hungarian Academy of Sciences, Budapest, Hungary), Acta Technica Academiae Hungaricae, Vol 70, Nos. 3 & 4, 1971, pp 445-457, 14 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Publishing House of The Hungarian Academy of Sciences (repr., PC).

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0343

AREA MANUAL FOR RAILWAY ENGINEERING--CHAPTER 4: RAIL

Chapter 4 of the AREA Manual for Railway Engineering has four parts in its coverage of "Rail". Part 1 deals with recommended rail sections; joint bars and assemblies; rail drillings, bar punchings, and track bolts; and the design for track bolts and nuts. Part 2 includes specifications for the following: steel rails; the drop test machine, high-carbon and quenched carbon-steel joint bars; heat-treated carbon-steel track bolts and nuts; and spring washers. Part 3 presents the report forms to be used for reporting chemical and physical examinations of rails, certificate of inspection, shipment, record of control-cooled rails, rail failures, head and joint failures, web and joint bar failures, statistics of rails in the main track, and a diagram of lines of wear. Part 4 deals with miscellaneous data: application of rail bonds; requirements for rail joints; purchase of new rails; beveling or slotting of rail ends; reconditioning of rail ends; and illustrations of shells and related gage corner development.

American Railway Engineering Association Manual, 1973, Chapter 4, 82 pp, 30 figs., 8 tables, 13 forms.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0344

NONLINEAR EFFECTS IN THE PROBLEM OF THE BEAM ON A FOUNDATION WITH A MOVING LOAD

The author states that a "steady-state" solution of linearized equations for a beam on an elastic foundation (with no damping) with a load moving at a certain velocity, referred to as the "critical" velocity does not exist. In this paper, suitable perturbation solutions are obtained for equations for the steady-state motion which include the geometric and material nonlinearities. Secular terms are avoided by using the usual Poincare expansion for subcritical load speeds and a Lindstedt expansion

for supercritical speeds which may be extended to the critical velocity when the geometric nonlinearity dominates, as for a slender beam. For this situation, a successful expansion is found which gives a solution that is mainly periodic (with distance from the load) but with a slow monotonic decrease in the envelope. The results are the first nonlinear corrections to the linear solutions for noncritical load speeds and the solution for the critical speed which gives a strain which varies with the square root of the load. To indicate the plasticity effect, a simple solution for supercritical load speeds for elastic-plastic beam and foundation materials is also obtained. The solution consists mainly of the elastic waves but with a region of plastic flow of the foundation behind the load and two points of yielding of the beam bending ahead of the load.

Steele, C. R. (Lockheed Palo Alto Research Laboratory, Palo Alto, Cal.), International Journal of Solids and Structures, Vol 3, No. 4, 1967, pp 565-585, 5 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0345

A NOTE ON THE NONLINEAR RESPONSE OF AN ELASTIC BEAM ON A FOUNDATION TO A MOVING LOAD

The author discusses the journal article written by C. R. Steel, "Nonlinear Effects in the Problem of the Beam on a Foundation with a Moving Load", in this note and presents his approach to the solution to the problem of nonlinear response in an elastic beam to a moving transverse load. Solutions are obtained by using a special perturbation method which he states to be valid throughout some neighborhood of the critical speed of the linear beam theory. It is found that, in general, depending upon the type of dominant nonlinearity in the beam, either the subcritical response may be continued up to the critical speed and even beyond. The solutions also show how the transitions from a subcritical response to a supercritical response and vice versa take place near the critical speed.

Sing-Chih, T. (Ford Motor Company, Dearborn, Mich.), and Yen, D.H.Y. (Michigan State University, East Lansing, Mich.), International Journal of Solids and Structures, Vol 6, No. 11, November 1970, pp 1451-1461, 2 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0346

INTERACTION BETWEEN VEHICLES AND TRACK. GEOMETRY OF THE CONTACT BETWEEN WHEELSET AND TRACK. PART I: METHODS OF MEASUREMENT AND ANALYSIS

The geometry of the contact between wheelset and track introduces the equivalent conicity concept, which is one of the important parameters intervening in the study of the riding stability of railway vehicles. After having outlined a concise theory and after having described some devices permitting the recording of wheel and rail profiles, the calculation methods and the results obtained are described. (Carried as RRIS Accession No. 052547.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C116/RP 3/E, October 1973, figs., 4 refs., 14 appendixes.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).

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0347

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE. EXPERIMENTAL STUDIES: (1) WORK- HARDENING SPEED WITH THE EMS 60 MACHINE (ADDITIONAL MEASUREMENTS), (2) RESIDUAL STRESSES IN HARD-GRADE STEEL RAILS (ADDITIONAL MEASUREMENTS), (3) CHECKING OF FATIGUE CRITERION PROPOSED BY MR. DANG VAN

This report is in three parts: (1) Work-hardening speed examined with the EMS 60 machine: The development of the two principal residual stresses produced on the running surface of rails made of different grades of steel has been studied as a function of the repeated passages of a loaded wheel. It has been shown that this development ceases at about approximately 1 million cycles. (2) Residual stresses in hard-grade steel: These stresses have been measured inside two rails of hard-grade steel, one new and the other work-hardened in service. The use of the rail in the track produces severe longitudinal and transverse compressive stresses at the surface. The stress field is affected strongly throughout the height of the rail-head. (3) Checking of fatigue criterion proposed by Mr. Dang Van: The fatigue limits of a rail steel have been determined for different cases of stressing. The results have enabled the validity of the fatigue criterion proposed by Mr. Dang Van (see Report C53/RP 7) to be confirmed. (Carried as RRIS Accession No. 052533.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C53/RP 8/E, October 1973, 31 pp, 14 figs., 2 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands (repr., PC).

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0348

AN ANALOG-DIGITAL METHOD OF DETERMINING VERTICAL TRACK IRREGULARITIES AS THE EXCITATION OF A RAIL VEHICLE'S VERTICAL OSCILLATIONS

Unknown dynamic parameters of the track have been obtained by statistical calculations. The parameters are used to design an analog-system to determine a "substitute vertical track irregularity" as an excitation of vertical vehicle oscillations for the accepted model of the track. The signal recorded on the magnetic tape may also be used for an analog study of the vertical vibrations of other vehicles. The computations have been based on the correlation function method. (Carried as RRIS Accession No. 052572; see also No. 052511.)

Kosiradski, W., International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), paper presented at the 3rd ORE Colloquium, Amsterdam, Netherlands, Report No. A240/RP 5/E, May 8-10, 1973.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).]

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0349

OPTIMUM ADAPTATION OF THE CONVENTIONAL TRACK TO FUTURE TRAFFIC. DEFORMATION OF RAILWAY BALLAST UNDER REPEATED LOADING (TRIAXIAL TESTS)

This report describes the results of a series of laboratory triaxial tests concerning the deformation of dry limestone ballast under repeated applications of load. The results show that the deformation of ballast is: (1) proportional to the log of the number of load cycles, (2) proportional to the superimposed axial stress raised to an exponent within the range 1 to 3, (3) determined mainly by the largest load when two load levels are applied, (4) reduced if full load removal is not allowed between load cycles. The elastic properties

of the ballast are also examined, and the report con. udes with the practical implications of the test results. (Carried as RRIS Accession No. 052632.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D117/RP 5/E, October 1974, 24 pp, 32 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).]

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0350

INTERACTION BETWEEN VEHICLES AND TRACK. EQUATIONS OF MOTION OF A RAILWAY VEHICLE

The equations of motion of a railway vehicle are derived using Newtonian methods of summing all the forces acting on each mass element. An understanding of the dynamics of a wheelset is fundamental to the study of a complete vehicle, the equations of motion of a wheelset are derived first, followed by the equations of motion of three example vehicles. (Carried as RRIS Accession No. 052633.)

International Union of Railways (Office for Research and Experiment, Utrecht, Netherlands), Report No. C116/RP 4/E, October 1974, 52 pp, figs., 4 refs., appendixes.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).

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0351

DEVELOPMENT OF HEAVY RAIL-PROFILES. STUDY OF A NEW 71 KG/M RAIL (ORE 71 PROFILE)

The guiding principles for the study of heavy rail sections already having been defined in a previous report (D120/RP 1), calculations have been carried out on three heavy rail sections with a view to defining a new rail of approximately 70 kg/m. Two of these sections represented a synthesis of 10 preliminary rail-section designs and would have to be compared with a third one chosen by way of reference (140 lb AREA American rail). The results of the calculations and the rolling conditions have finally enabled a new rail of 71.27 kg metric weight to be proposed. (Carried as RRIS No. 062645.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D120/RP 3/E, October 1974, 29 pp, figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).

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0352

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT. PROPOSALS CONCERNING THE 6TH EDITION OF TECHNICAL SPECIFICATION 860-0 GOVERNING THE SUPPLY OF VIGNOLE (FLAT-BOTTOM) RAILS OF NON-TREATED STEEL

No abstract provided. (Carried as RRIS Accession No. 052525.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D49/RP 11/E, April 1969.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).

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0353

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE. CALCULATION OF THE COMPLEX STRESS CYCLES IN THE RAIL SUBJECTED TO ROLLING LOADS. ASSESSMENT OF THE DANGER OF DAMAGE (CONTINUED)

This study deals with new calculations of the composition of the residual stresses and the stresses induced in the rail during the passage of wheels, for different loading values, wheel diameters, and wheel-tire transverse curvatures. One thermal stress and three residual stresses have been considered. The latter have been calculated and then measured with the help of an original strain-gauge method. The danger of rail damage has then been evaluated by means of the damage line criterion proposed by Mr. Dang Van (see C53/RP 7 and C53/RP 8). It has been possible in this way to define the danger factor for each loading case. It has been shown that two types of danger exist, namely, fatigue and plastic deformation. (Carried as RRIS Accession No. 052555.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C53/RP 9/E, October 1973, 27 pp, 27 figs., 5 tables, 2 appendixes.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. (repr., PC).

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0354

DEVELOPMENT OF HEAVY RAIL-SECTIONS. DEVELOPMENT OF A 60 KG/M NEW RAIL-SECTION

The principles for the study of heavy rail-sections were defined in an earlier report (Report No. 1); tests were carried out on ten rail-sections weighing in the region of 60 kg, with a view to selecting the best one. Stresses under load were calculated by extensometric and photoelastic tests and then analysed using the finite element method. This method was proved to be completely valid by trial measurements. No new rail was recommended following the examination of the results; the advantages of the best designs were considered unsatisfactory in comparison with the standard UIC 60 rail. (Carried as RRIS Accession No. 054346.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D120/RP 2/F, April 1973, 115 pp, 68 figs., 12 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. [Available only at DOT Library, Washington, D.C. (repr., PC).

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0355

THE BEHAVIOR OF RAILS IN RELATION TO THEIR CONDITIONS OF USE

The principal rail failure statistics of five administrations have been analysed with a view to determining the respective influence of the different features involved in the behavior of rails in service. Some recommendations are proposed concerning the choice of rail-section as a function of the traffic, the grade and quality of the rail steel, and the construction of rail joints. The problems raised by welds in continuously welded rails, by the substructure and by the environment are also mentioned. It seems that the rail withdrawals for fatigue defects increase proportionally with the total traffic load on the one hand and with the cube of the average axle-load on the other. (Carried as RRIS Accession No. 054782.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D117/RP 3, April 1973, 34 pp, 27 figs., 8 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways, Utrecht, Netherlands. (repr., PC).

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0356

THE STRENGTH OF RAILS WITH PARTICULAR REFERENCE TO RAIL JOINTS

This three-part paper describes work on rails carried out by the Research Department of British Railways.

Part I details the rail sections considered, theoretical considerations of longitudinal bending strength and an analysis of failures in service.

Part II describes a site investigation which was made into the dynamic stresses experienced by rail joints under traffic. Stresses in both flat-bottom (FB) and bull-head (BH) rail joints have been measured with both normal and abnormal conditions of sleeper packing. Electrical-resistance strain gauges were used at the calculated positions of maximum stress in each fishbolt hole, and at the other positions in the joint.

The work initially covered the effects of steam locomotives and steam hauled stock, but was later extended to a second site so that electric locomotives and multiple-unit electric stock could be similarly covered.

The investigation brought out the marked influence of speed, wheel diameter, and axle load on the magnitude of the stresses induced; and in view of the prospective increase in speeds, and the employment of diesel electric and electric locomotives with heavy axle loads on smaller wheels than is usual, importance attaches to these results and their implications on the life expectancy of rail steel under fatigue loading.

Part III describes fatigue tests which have been made on BH and FB rails, both plain and when drilled with fishbolt holes. The susceptibility to cracks starting at bolt holes, due to shear stresses in the web, is compared for the two rail sections, and some consideration is given to various methods of increasing the resistance to cracking of this type. It is shown that ordinary atmospheric corrosion greatly reduces the fatigue strength of rails, and any proposed method of reducing bolt hole failures must therefore take this into account.

Wise, S., Lindsay, D., and Duncan, I.G.T. (British Transport Commission, British Railways Div.), Proceedings of the Institution of Mechanical Engineers, Vol 174, No. 9, 1960, pp 371-407, 36 figs., 11 tables.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0357

GENERAL METHOD FOR BEAMS ON ELASTIC SUPPORTS

This paper analyzes the effects of elastic supports on stresses in continuous beams. The author shows how the influence lines, or reactions for loading for continuous beams on elastic supports can be obtained from the corresponding values of the beam with vertically elastic immovable supports. This method is general in that variable span lengths, variable moments of inertia, and variable spring constants, as well as any number of spans may be analyzed. A numerical example is given which illustrates the method suggested for the unsymmetrical three-span beam with variable inertia and different spring constants for each support. The author states that the matrix formulation and the expressions used will lead to efficient computer programming, especially for beams with a variable moment of inertia.

Mozingo, R. R. (Pennsylvania State University, University Park, Pa.), Proceedings of the American Society of Civil Engineers, Journal of the Structural Division, Vol 93, No. ST 2, April 1967, pp 177-188, 3 figs., 1 table, 9 refs., 3 appendixes.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0358

A STAR-SHAPED CRACK DEFORMED BY AN ARBITRARY INTERNAL PRESSURE

An exact solution is obtained for a star-shaped crack, formed by n equal line cracks intersecting at a common point with an angle $2\pi/n$ between adjacent cracks, when each of the separate cracks is subjected to an equal but arbitrary pressure distribution. An expression is obtained for the stress-intensity factor, and the calculation of the normal displacement at the junction of the cracks is also examined. For the particular case of a uniform pressure it is shown that the stress-intensity factor can be expressed in terms of one integral, and numerical values are obtained for various values of n and the form of the stress-intensity factor as $n \to \infty$ is deduced analytically confirming the conjecture made by Westmann. Explicit simple forms are obtained for the crack energy and normal displacement of the crack junction in terms of the stress-intensity factor.

Williams, W. E. (University of Surrey, Guildford, England), International Journal of Engineering Science, Vol 9, No. 8, August 1971, pp 705-712, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0359

THE STRESS INTENSITY FACTORS OF A STAR-SHAPED ARRAY OF CRACKS IN AN INFINITE ELASTIC SOLID

The problem of determining the stress-intensity factors and crack formation energy of a radial system of line cracks in an infinite elastic solid is reduced to the solution of a singular integral equation. The equation is solved numerically for the special case in which cracks are opened by a constant pressure. Variations in stress-intensity factor and crack-formation energy ratios as a function of the crack coordinate ratios are shown for star-shaped arrays of cracks.

Tweed, J. (The University of Glasgow, Scotland), and Rooke, D. P. (The Royal Aircraft Establishment, Farnborough, Hants., England), International Journal of Engineering Science, Vol 12, No. 5, May 1974, pp 423-431, 4 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0360

ASPECTS OF STAGE II FATIGUE CRACK PROPAGATION IN LOW-CARBON STEEL

The transition from structure-sensitive to structure-insensitive Stage II fatigue-crack propagation, which has recently been observed in carbon steel, has been studied. The transition crack length is determined by the ratio of plastic zone radius at the crack tip to the grain diameter. An explanation of the transition in terms of constraint at the crack tip is suggested. No systematic change in fatigue-crack propagation rate is observed with changes in grain size. The test equipment and experimental procedures are described. Photomicrographs showing the general features of the Stage II fatigue-crack propagation are given.

Birkbeck, G., Inckle, A. E., and Waldron, G.W.J. (British Railways Research Department, Derby, England), Journal of Materials Science, No. 6, 1971, pp 319-323, 5 figs., 2 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Chapman and Hall Ltd. (repr., PC).

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0361

REGRESSION MODELS FOR THE EFFECT OF STRESS RATIO ON FATIGUE CRACK GROWTH RATE

Regression models, based on linear elastic fracture mechanics, are used to interpret the effect of stress ratio on fatigue-crack growth rate in 7075-T6 aluminum alloy. It is shown that fatigue-crack growth rate can be related to range and maximum values of stress-intensity factor. Statistical techniques are used to examine the error which may accumulate when regression equations are used to predict crack growth-versus cycles curves.

Mukherjee, B., and Burns, D. J. (University of Waterloo, Ontario, Canada), ASTM Special Technical Publication 511, paper presented at the Symposium on Probabilistic Aspects of Fatigue, 74th Annual Meeting of the ASTM, Atlantic City, N.J., 27 June-2 July 1971, pp 43-60, 14 figs., 2 tables, 9 refs.

ACKNOWLEDGMENT: American Society for Testing Materials.

PURCHASE FROM: American Society for Testing Materials (repr., PC).

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0362

DETERMINATION OF THE SIZE OF DEFECTS IN WELDS BY THE ULTRASONIC REFLECTION METHOD [IN GERMAN]

The possibility and accuracy of measuring the size of defects in welds by ultrasonic testing is investigated. The initial approach to the investigation was to develop a thorough understanding of the influences of the probe-to-specimen contact, the properties of the probes, the selection of the best angle of incidence, the adjustment of the ultrasonic detector at bore holes and grooves, and the comparative reflection of artificial and natural defects. A description of laboratory tests and the data obtained during measurements of defect sizes by metallographic techniques and through use of ultrasonic inspection techniques are given. Plots of data obtained by means of a variable-angle probe are presented. Comparisons between artificial defects of differing types are drawn through use of half-depth measurements. A nomogram for determining defect sizes is shown. The authors state that the size of defects can be determined with an accuracy of approximately ±50 percent using the technique.

Buken, G., and Krachter, H. (Forschungsinstitut der Mannesmann AG, Duisburg, West Germany), Materialprufung, Vol 10, No. 10, October 1968, pp 329-337, 12 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0363

ON THE ACCURACY OF THE BERNOULLI-EULER THEORY FOR BEAMS OF VARIABLE SECTION

This paper examines the particular case of a thin rectangular beam in pure bending, although the method of solution employed may be used for arbitrary loadings and arbitrary cross-sectional shapes. The stresses and deflections of the beams are obtained in the form of series; the first term of each series is identical with the strength-of-materials solution and the others represent the necessary correction to the Bernoulli-Euler theory for beams of variable sections. The Bernoulli-Euler theory is found to be quite accurate for thin beams and, when certain conditions are satisfied by the ordinates (and their spanwise derivatives) of the upper and lower edges of the beam. The theory was found to be ambiguous in prescribing the position of the axis of a beam of variable cross section; admissible choices for the axis are presented.

Boley, B. A. (Columbia University, New York, N.Y.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 30, No. 3, September 1963, pp 373-378, 2 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0364

DYNAMIC STRESS INTENSITY FACTOR FOR AN AXISYMMETRIC LOADING OF THE PENNY SHAPED CRACK

The response of a penny-shaped crack embedded in an infinite istropic, elastic medium to an oscillatory loading is considered. The loading is assumed to be in the form of a plane, harmonic, dilatational wave propagating along the axis of the crack. The singular behavior of the stress at the edge of the crack is discussed and an expression of the dynamic stress-intensity factor is obtained. In the low-frequency limit the magnitude of the stress-intensity factor is shown to be always larger than that in the corresponding static case.

Mal, A. K. (University of California, Los Angeles, Cal.), International Journal of Engineering Science, Vol 6, No. 11, November 1968, pp 623-629, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0365

DYNAMIC STRESS INTENSITY FACTOR FOR A NON-AXISYMMETRIC LOADING OF THE PENNY SHAPED CRACK

The response of a penny shaped crack embedded in an infinite, isotropic elastic medium to an incident plane harmonic shear wave is considered. The incident wave is assumed to be polarized in a plane perpendicular to the plane of the crack and to propagate along the axis of the crack. The problem is formulated in terms of a pair of coupled dual integral equations. These equations are then transformed into Fredholm equations of the second kind, suitable for iteration at low frequencies. The singular behavior of the stress components at the edge of the crack is discussed. It is shown that at low frequencies the stress-intensity factors are always greater than those for a uniform static shear loading of the crack.

Mal, A. K. (University of California, Los Angeles, Cal.), International Journal of Engineering Science, Vol 6, No. 12, December 1968, pp 725-733, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0366

STRESS INTENSITY FACTORS FOR A PENNY SHAPED CRACK IN A HALF SPACE

Stress intensity factors are presented for a circular crack approaching the surface of a semi-infinite solid. Results are presented for uniform tension and linearly varying loading. The solutions are used to derive stress-intensity factors for a circular crack near the surface of a beam in pure bending and an approximation of the thickness effect on the stress-intensity factor for a deep surface flaw in a plate is presented. A solution is also presented for the stress distribution in a half-space subjected to shear loading on part of its boundary.

Smith, F. W., and Alavi, M. J. (Colorado State University, Fort Collins, Colo.), Engineering Fracture Mechanics, Vol 3, No. 3, October 1971, pp 241-254, 9 figs., 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd., (repr., PC).

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0367

ELASTIC AND VISCOELASTIC FOUNDATION MODELS

This paper presents a critical study of a number of foundation models as well as a further development of some of the ideas involved. It is shown that the Pasternak foundation is a mechanical model for the so-called "generalised" foundation. It is also demonstrated that the kernel for the Pasternak foundation in plane stress or plane strain is identical with Wieghardt's exponential kernel, and that for the three-dimensional case the kernel is a modified Bessel function. It is also shown that the "nonsolvability" of the problem of a finite beam or plate resting on a continuous foundation as posed by Wieghardt and further elaborated by Pflanz is not correct, and that problems of this type are solvable for any load distribution permissible in classical plate theory. Throughout the paper, emphasis is placed on the proper mathematical formulation of the physical problems in question.

Kerr, A. D. (Princeton University, Princeton, N.J.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 31, No. 3, September 1964, pp 491-498, 18 figs., 31 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0368

METHOD OF ANALYSIS OF STATICAL AND DYNAMICAL STRESSES IN RAIL

The problem of stresses in rails contributed to by the constant tendency in railway practice of increasing the loading per axle is discussed. In this paper, a method is developed for calculating the vertical and lateral deflections of rails under the action of statical loading. The dynamical effects on the rail of a moving wheel due to unbalance or to low spots on the rail are discussed. Laboratory work was performed to validate equations derived for twist, and the procedure and test equipment used in the experiments are given. [The analysis presented here was conducted in connection with research work on track stresses being undertaken by the Westinghouse Electric & Manufacturing Co. for the purpose of obtaining data for the design of electric locomotives.]

The Collected Papers of Stephen P. Timoshenko, McGraw-Hill Book Company, New York and London (1953), pp 422-435, 13 figs. [This paper was originally presented at the Second International Congress for Applied Mechanics, Zurich, Switzerland, 1927.]

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: McGraw-Hill Book Company, Inc. (repr., PC).

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0369

BENDING OF AN INFINITE BEAM ON AN ELASTIC FOUNDATION

The elementary theory of the bending of a beam on an elastic foundation, based on the assumption that the beam is resting on a continuously distributed set of springs the stiffness of which is defined by a "modulus of the foundation", k, is reviewed. The author attempts to give a more exact solution of one aspect of this problem, i.e., the case of an infinite beam under a concentrated load. A notable difference exists between the results obtained from the assumptions of a two-dimensional foundation and a three-dimensional foundation. Bending-moment and deflection curves for the two-dimensional case are shown and a value of the modulus "k" is given for both cases by which the elementary theory can be used and leads to results which are fairly acceptable. These values depend on the stiffness of the beam and on the elasticity of the foundation.

Biot, M. A. (Harvard University, Cambridge, Mass.), Journal of Applied Mechanics, Trans. ASME, Vol 59, 1937, pp A-1-A-7, 10 figs., 6 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0370

ON THE THEORY OF BEAMS RESTING ON A YIELDING FOUNDATION

The purpose of this note is to advance the theory of the problem of an elastic beam of infinite length, loaded inside a finite region, and resting on a yielding foundation. M. A. Biot's paper which considers the foundation as represented by a semi-infinite elastic bond is reviewed. The author then attempts to show that the formal results of that paper can be obtained in a more general way by showing that it is possible to solve the problem explicitly for every type of foundation, whether elastic or having properties more difficult to describe, provided the deflection of the surface of the foundation due to a concentrated loading is known. It is demonstrated that the problem of buckling of a beam of infinite length, resting on a yielding foundation and on an infinity of equidistant supports, can be solved.

Reissner, H. E. (Massachusetts Institute of Technology, Cambridge, Mass.), Proceedings of the National Academy of Sciences, Vol 23, 1937, pp 328-333, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: National Academy of Sciences (repr., PC).

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0371

BENDING OF A FINITE BEAM IN BONDED AND UNBONDED CONTACT WITH AN ELASTIC FOUNDATION

Numerical methods are used to investigate the problem of a beam of finite length which rests on a continuous elastic foundation and which carries a central concentrated load. Two conditions are considered--in one case the beam is bonded to the elastic foundation, while in the second case the beam is not bonded to the elastic foundation. Values of the maximum bending moment and deflection induced in the beam are computed for both the bonded and unbonded condition and the magnitude of the contact length is calculated for the unbonded case. The dependence of these quantities on the dimensional parameters is also studied.

Conway, H. D., and Farnham, K. A. (IBM Systems Development Division, Endicott, New York, N.Y), International Journal of Mechanical Science, Vol 12, 1970, pp 997-1005, 3 figs., 5 tables, 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0372

STEADY-STATE VIBRATIONS OF BEAM ON ELASTIC FOUNDATION FOR MOVING LOAD

This paper presents an analytic solution and resonance diagrams for a constant-velocity moving load on a beam on an elastic foundation including the effect of viscous damping. The limiting cases of no damping and critical damping are investigated. The possible velocities for the propagation of free bending waves are found and their relation to the critical velocity of the beam is studied.

Kenney, J. T., Jr. (Sandberg-Serrell Corporation, Pasadena, Cal.), Journal of Applied Mechanics, Trans. ASME, December 1954, pp 359-364, 4 figs., 6 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0373

THE PRESTRESSED CONCRETE SLEEPERS ON THE SOVIET RAILWAYS

The standard C56 type of prestressed concrete sleeper adopted in the Soviet railways is described as a concrete beam containing pretensioned indented of 3 to 5 mm in diameter. The methods of fastening and padding are schematically shown. Experience in tests and usage of the concrete sleeper over a period of approximately 10 years is reviewed. The reinforced-concrete sleepers are characterized by increased rigidity which tends to increase the dynamic stresses in all parts of the superstructure and track formation. To reduce the effects of rigidity, the reinforced-concrete sleepers are, as a rule, used in conjunction with continuous welded track, which also has the effect of increasing the stability of such track by an average of 15 percent. One of the disadvantages of the greater rigidity of rails placed on reinforced concrete sleepers is the increased wear at the rail ends which results in defective joints and necessitates premature replacement of the rails.

Zolotarski, A. F., and Serebrennikov, V. V., Rail International, May 1970, pp 306-312, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Railway Congress Association (repr., PC).

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0374

DESCRIPTION OF THE FLAME HARDENING OF RAILS BY THE SANTE FE RAILWAY AND PHYSICAL AND METALLURGICAL TEST RESULTS OF FLAME HARDENED FLASH BUTT WELDED RAIL JOINTS

Physical tests and a metallurgical investigation of three flame-hardened (using the Santa Fe method) and flash-butt-welded (using the Schlatter process) rail joints are described. A description of the Santa Fe process of flame hardening, which was developed by the Santa Fe railway to provide rail with a harder running surface at reasonable cost, is also provided. The results of rolling load, bend and drop tests, and a Brinell hardness survey indicated that the Santa Fe flame-hardening process produces a satisfactory rail.

Association of American Railroads Research Department, Engineering Research Division, A.A.R. Research Center, Chicago, Ill., Report No. ER-35, April 1963, 12 pp., 6 figs., 3 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0375

CAPABILITY OF FASTENERS TO RESIST RAIL OVERTURNING

The purpose of this investigation was to determine the overturning resistance of the rail fastened to either wood or prestressed concrete ties when subjected to various lateral loading conditions. The investigation was conducted in the engineering laboratory of the AAR Research Center. To test the rail on the wood ties, a short piece of 136-lb rail and tie plate were fastened to a new treated oak tie. The rail on the prestressed concrete tie was fastened by two bolts and clips. Deflection and overturning loads are given for lateral-force applied at various angles.

Association of American Railroads (Engineering Research Division, AAR Research Center, Chicago, Ill.), Report No. ER-77, November 1967, 21 pp, 11 figs., 4 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0376

DIRECT MEASUREMENT OF STRESS RECORDED IN THE RAILS USING A HEAD FOR MEASURING CHANGES IN PERMEABILITY [IN GERMAN]

Elastic stresses and deformations can be measured on the basis of the relationship between their degree and the corresponding changes in magnetization by using either the direct method or the method of mechanical transmission of the deformation. Both methods are described, as is the use of a measuring head which records changes in permeability and measures the stresses occurring in the rails. This measuring head, which is still in the test stage, is intended for measuring stresses, particularly following changes in temperature at any point along a full track. (Carried as RRIS Accession No. 054347.)

Mazur, S. (Wroclaw Politechnic Institute of Railroad Engineering, Wroclaw, Poland), Eisenbahntechnische Rundschau, Vol 22, No. 7, 1973, pp 292-296, 4 figs., 3 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0377

STRENGTH AND TOUGHNESS IMPROVEMENT OF HIGH CARBON STEELS BY ISOTHERMAL TRANSFORMATION TREATMENT BELOW Ms TEMPERATURE

Structural changes of some high-carbon steels held isothermally at below the Ms point [martensite transformation initiation temperature (approximately 200 C)] and quenched from austenitizing temperature were investigated by measuring electrical resistivity and dimensional change. It was determined that isothermal transformation of austenite to bainite is initiated and completed at these temperatures. The results of the investigation indicate that strength and toughness of the steels given the isothermal treatment were superior to those of steels treated by ordinary quenching and tempering.

Iijima, K. (Railway Technical Research Institute, Japan National Railways), Quarterly Reports of the Railway Technical Research Institute, Vol 16, No. 1, March 1975, 8 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0378

SURFACE FINISHING ON RAIL HEADS ON THE GERMAN FEDERAL RAILWAY [IN GERMAN]

The author deals with the need for regular grinding of rail heads of railway tracks. Since 1968 the German Federal Railway has used the "Speno" rail-grinding train for this purpose. The design, application, and results obtained through the use of this rail head grinding system is discussed. (Carried as RRIS Accession No. 051367.)

Deckart, H. (German Federal Railway, Bundesbahndirektor), Eisenbahntechnische Rundschau, Vol 22, No. 7/8, July 1973, pp 284-291, 7 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0379

RAILWAY TRUCK RESPONSE TO RANDOM RAIL IRREGULARITIES

This paper discusses the random response of a seven-degree-of-freedom passenger-truck model to lateral rail irregularities. Power spectral densities and root-mean-square levels of component displacement and contact forces are reported. The truck model used in the study allows lateral and yaw degrees of freedom for each wheelset, and lateral yaw and roll freedoms for the truck frame. Linear creep

relations are utilized for the railwheel contact forces. The lateral rail irregularities enter the analysis through the creep expressions. The results described in the paper were obtained using frequency-domain techniques to solve the equations of motion. The reported results demonstrate that the guidance force needed when traveling over irregular rail at high speed utilizes a significant portion of the total available tangential force between wheel and rail.

Cooperrider, N. K. (Arizona State University, Tempe, Ariz.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 97, No. 3, August 1975, pp 957-964, 10 figs., 16 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0380

STRESS ANALYSIS OF CONCRETE TRACK SLABS ON AN ELASTIC FOUNDATION BY THE FINITE ELEMENT METHOD

In analyzing the track slab stress, it has been revealed that the beam theory has led to certain discrepancies and has left inexplicable parts in the actual phenomena. But it is found that these drawbacks can be eliminated by assuming that the rail supporting elasticity is concentrated at fastening devices and by considering the track slab as a plate, with the aid of a mechanical model analysis. For the analysis of the plate, the finite element method is employed for its flexibility in applying the boundary conditions. The slab track is divided into many triangular elements and analyzed by using the hybrid-type potential energy principle. The theoretical results thus obtained are in good agreement with those observed and they are practically employed in slab track designing. (Carried as RRIS Accession No. 084937.)

Saito, T. (Railway Technical Research Institute, Track Laboratory, Japan), Quarterly Reports of the Railway Technical Research Institute, Vol 15, No. 4, December 1974, pp 186-190 and 196, 4 figs., 2 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0381

FOR M/W, A BIGGER SHARE OF THE DOLLAR

For more than ten years both rail and tie renewals have traced a generally upward curve and for the next twelve months the rail-renewal curve is expected to continue upward. Tie renewals are projected to decline slightly but tie insertions in 1973 will be at a higher level than in 1972. In spite of the increases of recent years, tie renewals are running short of actual needs and insertion of new rails is running far below requirements. Apparently the FRA Track Safety Standards have had little effect so far on M/W programs. There seems to be a trend toward performing more spot work on track as opposed to out-of-face work and toward the use of insulated rail joints and new and improved M/W machines; and an effort is being made to determine the cause of cracks in concrete ties which occur shortly after they are inserted. (Carried as RRIS Accession No. 044561.)

Dick, N. H., Railway Age, Vol 174, No. 2, January 1973, pp 39-40, 4 figs.

ACKNOWLEDGMENT: Railway Age.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0382

FEATURES IN THE SELECTION OF WEIGHT OF RAIL FOR NEW OR REHABILITATED LINES

The three principal considerations in the selection of the weight of rail for a new or rehabilitated line are discussed. These include: (1) type and axle loading of motive power and cars, (2) physical characteristics of the line, (3) type, intensity, and speed of traffic. Recommendations are made regarding the approach to be used for calculating bending moment and stress for steam and diesel locomotives. Numerical values of bending stress are given. Requirements related to the modulus of elasticity of track supports are briefly discussed. Rail weights are suggested for various types of track loads and traffic (gross annual tonnage).

Code, C. J. (Pennsylvania Railroad, Philadelphia, Pa.), Proceedings of the 53rd Annual Convention of the AREA, Vol 55, 1954, pp 343-345.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0383

THE EFFECTS OF VARIATIONS IN HEAT TREATMENT ON THE STRENGTH AND TOUGHNESS OF RAIL STEEL

The purpose of this study is to determine the feasibility of developing a rail with improved mechanical properties by making only minor variations in the conventional method of processing. It is part of an overall program designed to investigate the fundamental metallurgical parameters involved in rail design and manufacture. The mechanical properties considered important to rail performance - strength, hardness, and toughness - are discussed. Tensile and impact tests were performed on each of 14 different heat-treated specimens and preliminary results are graphically shown as functions of austenization temperature and cooling rate, and the important parameters. (Carried as RRIS Accession No. 095213.)

Hyzak, J. M., Bernstein, I. M. (Carnegie-Mellon University, Pittsburgh, Pa.), and Stone, D. H. (AAR Technical Center, Chicago, Ill.), American Railway Engineering Association Bulletin 648, Proceedings, Vol 75, June-July 1974, pp 776-778, 2 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0384

CONDITIONS AFFECTING SERVICE LIFE OF RAIL, CAUSES OF RAIL FAILURES AND DEFECTS

This report presents the results of examinations conducted on 52 control-cooled rails which failed in service at various locations on 15 railroads. The types of failures identified are: transverse fissures from shatter cracks and hot torn steel, shelling and welded engine burns, head and web separation cracks, crushed heads and webs, inclusions, base defects, rail shelling, and bolt-hole cracks. Detailed information including the name of railroad and of the mill producing the rail, heat number, date of rolling, and classification of failure is provided in a tabulation. Photomicrographs of various defects in the failed rails are included.

McBrien, R. (Chairman, AREA Subcommittee), and Cramer, R. E. (University of Illinois, Urbana, Ill.), Proceedings of the 51st Annual Convention of the AREA, Vol 53, 1952, pp 843-866, 3 figs., 2 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0385

EFFECTS OF METHOD OF TEMPERING ON THE PROPERTIES OF, AND STRESSED STATE IN, RAILS QUENCHED AFTER HEATING BY HIGH-FREQUENCY CURRENT

The Ukraine Research Institute for Metals, in collaboration with the Soviet All-Union Research Institute for High-Frequency Current, has developed a technique for quenching R65 rail heads along their entire length. The rails are subjected to high-frequency (2500 Hz) induction heating, and after quenching with a mixture of water and air, they are self-tempered for 45 sec at between 400 and 450 C. While the rails are in the elastically stressed state during the heating and cooling they are only slightly distorted, and the residual stress level is low; there is a satisfactory margin of brittle strength, and the structure in the quenched layer (at a depth of about 15 mm) is tempered martensite. The chemical composition of the R65 rails is given along with the mechanical properties of the rail heads following the heat-treating process. Curves are provided which show Vickers hardness and fatigue strength for both conventionally heat-treated rails and those for which the new technique was employed.

Lenpitskii, V. V., Kazarnovskii, D. S., Tochilenko, V. S., Pliskanovskii, S. T., Zamnee, A. N. and Kisil', B. S. (Ukraine Research Institute for Metals and Asovstal' Works, U.S.S.R.), Stal [in English], No. 5, 1969, pp 499-501, 5 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0386

DOMINANCE OF SHEAR STRESSES IN EARLY STAGES OF IMPULSIVE MOTION OF BEAMS

The purpose of this paper is to show that all beams, even those which are statically much stronger in shear than in bending, will begin to yield in shear before yielding in bending, if subjected to sufficiently high initial velocity distributions. In order to draw comparisons between the magnitude of bending stresses and shear stresses in beams under the action of impulsive forces, the values of these stresses were determined from the known differential equations for the Timoshenko beam. It was found that in the early stages, soon after the initiation of motion, the shear stresses are of much larger magnitude than the bending stresses. This result indicates that for sufficiently large initial velocities first yielding will be in shear, a matter of consequence in plastic analysis.

Bleich, H. H., and Shaw, R. (Columbia University, New York, N.Y.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 27, No. 1, March 1960, pp 132-138, 7 figs., 4 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0387

WAVE PROPAGATION IN AN ELASTIC BEAM OR PLATE ON AN ELASTIC FOUNDATION

An analysis is presented of wave propagation in an infinite elastic plate or beam on an elastic foundation, based on a comparison of frequency spectra (or wave-train solutions) from the exact equations and existing approximate bending theories. The more exact theory of bending based on the analog of the Timoshenko beam theory, which includes the shear force and rotatory inertia of the plate element, is used to develop the governing equations. A distinct similarity was found between the spectrum representing the more exact theory of bending and the Rayleigh-Lamb spectrum for symmetric waves in a free elastic plate, including the existence of complex branches. Good agreement between the approximate theories and exact

equations is found for soft foundations under the usual restrictions on high-frequency, short waves.

Lloyd, J. R. (Union Carbide Corp., Pasadena, Cal.), and Miklowitz, J. (California Institute of Technology, Pasadena, Cal.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 29, No. 3, September 1962, pp 459-464, 3 figs., 12 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0388

FINITE DEFLECTION DYNAMICS OF ELASTIC BEAMS

Solutions are obtained for the problem of an infinite elastic beam subjected to essentially constant velocity boundary conditions at one point of the beam. The effects of finite deflections, normal force, rotatory inertia, and shear deformation are included. The equations of the problem are converted into nondimensional form and a perturbation approach is used to obtain a consistent approximation. Numerical solutions are obtained for the bending moment, shear force, and normal force for different velocities of impact. It is shown that the solution to the problem depends on a combined geometrical and material parameter which does not vary significantly for compact sections and a loading parameter which determines the amplitude of the response. Finally, the linear Timoshenko beam theory is shown to predict the bending moment and shear force when the deflections are large enough to cause appreciable stretching of the centroidal axis.

Ranganath, S. (Advanced Technology Center, Inc., Dallas, Texas), and Clifton, R. J. (Brown University, Providence, R.I.), International Journal of Solids and Structures, Vol 10, No. 6, 1974, pp 557-568, 4 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0389

IMPACTS OF TWO-AXLE SYSTEM TRAVERSING A BEAM

The problem of vibration of a simple beam carrying an elastic layer and with irregularities on the travel surface is studied. The vibrations are forced by impacts of a moving system of four degrees of freedom, which is an idealization of a two-axle vehicle moving along a bridge. The mathematical formulation of the problem is covered by a system of five differential equations with variable coefficients, which is solved numerically using a computer. The analysis of the effect of some dimensionless parameters gives several important results, e.g., the greatest dynamic effects due to an isolated unevenness arise at the low moment velocity. The Bernoulli-Euler beam-model associated with a uniform beam, simply supported, and damped proportionally to the velocity of vibrations is used.

Fryba, L. (Research Institute of Transport, Prague, Czechoslovakia), International Journal of Solids and Structures, Vol 4, No. 11, 1968, pp 1107-1123, 13 figs., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0390

PLANE STRAIN DISTRIBUTION IN PERFECTLY PLASTIC REGIONS AROUND CIRCULAR HOLES DUE TO UNEQUAL BIAXIAL LOADS

This paper presents a review of L.E. Galin's 1946 paper on the plane elastic-plastic problem associated with zones in the vicinity of circular holes which provides only the stress distribution for the plastic region. The author expands the work of Galin to provide a compatibility equation for the secant modulus. The strain distribution is obtained for the perfectly plastic region around the circular hole due to

unequal biaxial loads. Mathematical expressions are derived for the strain distributions and a numerical example is provided.

Tuba, I. S. (Westinghouse Research Laboratories, Pittsburgh, Pa.), Journal of Strain Analysis, Vol 1, No. 5, October 1966, pp 394-397, 1 fig., 6 refs.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0391

ON THE GRIFFITH ENERGY CRITERION FOR BRITTLE FRACTURE

The Griffith theory for unstable crack propagation is re-examined to investigate the difference of opinion as to the precise dependency of critical stress upon the elastic constant in a brittle material. The apparent disagreement arising from the calculation of strain energy stored in a cracked body loaded at infinity is resolved by the observation that the energy of the crack or cavity of certain shape is reasonably geometry independent. It is found from the solution of the concentric-annulus problem that the stresses and displacements on a closed contour about the cavity must be modified to yield the correct form of elastic energy. Clapeyron's theorem is employed so that the energy function may be derived from the work done by surface tractions. A general method for determining the strain energy in an infinite medium with cavities of arbitrary configuration is presented. Closed-form solutions to the problem of an elliptically shaped flaw are obtained and incorporated into a theory of brittle fracture. More specifically, critical stresses for an elliptical flaw or crack owing to biaxial tension and pure shear are provided.

Sih, G. C. (Lehigh University, Bethlehem, Pa.), and Liebowitz, H. (The Catholic University of America, Washington, D.C.), International Journal of Solids and Structures, Vol 3, No. 1, 1967, pp 1-22, 5 figs., 10 refs., 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0392

THE COMPUTATION OF STRESS INTENSITY FACTORS BY FACTORS BY A SPECIAL FINITE ELEMENT TECHNIQUE

A special finite element method, for the computation of stress-intensity factors, is presented in this paper. The special finite element consists of two regions. The stress and displacement distribution in the inner region is defined in terms of the singular stress field associated with the notch tip. The outer region of the special element contains conventional finite elements that are constrained to satisfy certain equilibrium and compatibility conditions on the interface between the two regions. The method should allow the solution of problems outside the scope of present techniques. The validity of the procedure is confirmed by comparison with published solutions of some simple plane stress situations.

Walsh, P F. (Division of Building Research, CSIRO, Melbourne, Australia), International Journal of Solids and Structures, Vol 7, No. 10, 1971, pp 1333-1342, 8 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0393

THE STRESS INTENSITY FACTORS FOR A GRIFFITH CRACK WHOSE SURFACES ARE LOADED ASYMMETRICALLY

Formulae for the calculation of the stress-intensity factors at the tip of a Griffith crack, and for the normal component of the surface displacement, are derived for a crack whose surfaces are subjected to completely arbitrary surface tractions.

Sneddon, I. N., and Ejike, U.B.C.O. (University of Glasgow, Glasgow, Scotland), International Journal of Solids and Structures, Vol 5, No. 5, 1969, pp 513-523, 1 fig., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0394

PLASTIC ASYMMETRICAL BENDING OF BEAMS

This paper discusses fully plastic bending which is considered to be asymmetrical whenever the axis of an applied bending moment is not parallel or perpendicular to an axis of symmetry of the cross section. The magnitude of the fully plastic moment about a given axis, and the direction of the corresponding neutral axis, are determined by a skew-symmetrical closed curve termed the "centroidal locus". It is established that for continuous cross sections of finite width the locus is convex outwards, and the bending couples, with no twisting component, can produce pure flexure. Finally, it is shown that every cross section has at least two directions for which the neutral axis will coincide with the axis of applied moment.

Brown, E. H. (Imperial College of Science and Technology, London, England), International Journal of Mechanical Science, Vol 9, No. 2, 1967, pp 77-82, 6 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0395

VARIATIONAL APPROACH TO BEAMS ON ELASTIC FOUNDATIONS

The various foundation models introduced by and/or associated with Winkler, Kerr, Wieghardt, Pasternak, Reissner, and others are briefly reviewed and inconsistencies and problems in their adaptation to beams on elastic foundations are pointed out. The authors, in this study of the theory of elastic foundations, use the foundation model proposed by Vlasov and Leontev in which the horizontal displacements in the elastic foundation are incorporated into the analysis, thus making the model more general. Equations presented are applicable to the analysis of foundations of finite or infinite thickness. The bending theory of beams on elastic foundations is developed using the proposed foundation model. Solutions for an infinite beam on an elastic foundation are presented and a method of initial parameters is developed for finite beam problems which leads to efficiency in computer programming, especially for beams with general configuration subjected to arbitrary loads and moments, for example. Solutions obtained are compared with existing results.

Rao, N.S.V.K., Das, Y. C., and Anandakrishnan, M. (Indian Institute of Technology, Kanpur, India), Proceedings of the American Society of Civil Engineering, Journal of the Engineering Mechanics Division, Vol 90, No. EM 2, April 1971, pp 271-294, 7 figs., 10 refs., 2 appendixes.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0396

ELASTO-PLASTIC RESPONSE OF TIMOSHENKO BEAMS

A method of analysis of the elasto-plastic vibrations of beams and the effects of shear and rotatory inertia are presented in this paper. The approach involves the use of a discrete physical model that handles beams with different loadings and boundary conditions. The reliability of the model is examined essentially empirically by the apparent convergence of the deflections, moments, and shears as the beam is divided into a larger number of panels. Extensive numerical results were obtained to consider the significance of shear deformation for steel I-beams. It is shown that as the length (or web thickness) is increased, results given by the "Timoshenko Model" converge to that of the (elasto-plastic) "Euler Model". This analysis indicated that shear and rotatory inertia effects become negligible for longer or thicker webbed beams. However, it is also shown that the shear effects are substantial and should be considered even for beams of quite usual proportions. It is further indicated that the effect of the inter-actions between shear and moment on the yield behavior play a significant role in the inelastic response, particularly in the case of beams with fixed ends.

Wen, R. K. (Michigan State University, East Lansing, Mich.), and Baylerian, H. (University of Puerto Rico, Mayaguez, P.R.), Proceedings of the ASME, Journal of the Structural Division, Vol 93, No. ST 3, June 1967, pp 131-146, 10 figs., 15 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0397

BENDING OF PLATES ON A VISCOELASTIC FOUNDATION

The concept of the classical Winkler-Zimmerman foundation has been extended in an earlier study to permit the introduction of a differential shear stiffness parameter in addition to the foundation modulus. The resulting system of differential equations is modified in the present paper to incorporate a different interface condition, and the significance of the shear stiffness parameter is examined. As an example, the solution for a concentrated line load on an infinite plate supported by a Voigt foundation is presented along with response curves of maximum deflection and moment for a step applied force.

Pister, K. S. (University of California, Berkeley, Cal.), and Williams, M. L. (California Institute of Technology, Pasadena, Cal.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 86, No. EM 5, October 1960, pp 31-44, 7 figs., 11 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0398

BENDING OF BEAMS RESTING ON ISOTROPIC ELASTIC SOLID

In the first part of this paper Biot's solution for bending, under a concentrated load, of an infinite beam resting on an isotropic elastic solid is brought to a complete form and extended to the case of loading by a couple. Integrals appearing in both solutions are evaluated numerically and approximated by analytical functions.

The second part of this paper contains an investigation of the reliability of the conventional approach to the problem by means of the coefficient of subgrade reaction. The realm of validity of Winkler's hypothesis and the amount of error induced by its application are determined. It is shown that this hypothesis is practically satisfied for beams of infinite length. Concerning beams of finite length, a criterion is given for distinction of cases where conventional analysis may give reasonably accurate results. An expression is derived for evaluation of the coefficient for the subgrade reaction in appropriate cases.

Vesic, A. B. (Georgia Institute of Technology, Atlanta, Ga.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 87, No. EM 2, April 1961, pp 35-53, 6 figs., 4 tables, 15 refs., 2 appendixes.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0399

VISCOELASTIC WINKLER FOUNDATION WITH SHEAR INTERACTIONS

The concept of the Pasternak foundation, consisting of the Winkler foundation with shear interactions, is extended herein to the case of viscoelastic behavior. The differential equation for the vertical surface displacements due to creep is formulated, and solutions for the several loading cases are worked out. In addition to the elastic constant, two material parameters enter the analysis: the viscosity parameter related to the shear deformations and a visco-compressibility parameter of the vertical foundation elements. A procedure to determine these parameters is suggested. The application of this analysis to the creep behavior of snow foundations is examined.

Kerr, A. D. (Princeton University, Princeton, N.J.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 87, No. EM 3, June 1961, pp 13-30, 14 figs., 8 refs.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0400

DYNAMIC RESPONSE OF BEAMS TRAVERSED BY TWO-AXLE LOADS

The response of beams traversed by two-axle loads is analyzed based on the assumption that the dynamic deflection is proportional to the static deflection due to the weights of the beam and loads. A model is shown which consists of a simply supported beam spanned by two rigid supports and approaches, and a two-axle load moving from left to right at a constant speed. The general procedure used for deriving the differential equations consists of beginning with energy expressions for the model and then substituting them into the Lagrange's equation in dynamics. Numerical results show quasi-resonance effects due to successive applications of loads and to wavy beam surfaces.

Wen, R. K. (Michigan State University, East Lansing, Mich.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 86, No. EM 5, October 1960, pp 85 and 91-111, 6 figs., 13 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0401

EXPERIMENTAL STUDY OF BEAMS ON ELASTIC FOUNDATIONS

The design and use of a structural model for the solution of shear and moment in a beam on an elastic foundation is presented. The study is based on numerical methods for solving the equation for the bending of a beam on a continuous elastic foundation that generally make use of an assumption by Winkler, viz., that the reaction forces of the foundation at any point are proportional to the deflection of the beam at the same point. The method of solution presented herein is an alternative procedure to numerical methods for finding deflections of a beam on an elastic foundation. The method used involves a structural model that is a physical adaptation of the Winkler beam which consists of an elastic beam supported by closely spaced coil springs. In the example problem presented in this study, the model was designed for the purpose of predicting the deflection curve of a laterally loaded pile foundation. Moment and shear diagrams, and the prototype pile data are presented.

Thoma, R. L. (University of Texas, Austin, Tex.), Proceedings of the American Society of Civil Engineers, Journal of the Engineering Mechanics Division, Vol 86, No. EM 3, June 1960, pp 107-118, 6 figs., 2 tables.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0402

M/W COSTS: HOW THEY ARE AFFECTED BY CAR WEIGHTS AND THE TRACK STRUCTURE

Using a combination of theory and actual field measurements, the author develops the relative maintenance costs associated with axle loads and the type and condition of the track. An approximate percentage of 53% has been established in studies of the Illinois Central Gulf Railroad as a part of the total MW&S (Maintenance of Way & Structures) expense and capital. How this portion of cost varies with car capacity and how the kind and condition of track structure affect its cost of maintenance are discussed. The 53% factor is made up of costs related to rail deflection, rail bending stress, rail life, and miscellaneous costs. Information is provided in graphs and schematic drawings of indexes of rail-support firmness, and how they relate to rail deflections and maximum allowable rail stress. Rail life as related to car size is shown by broad band curves which reflect the results of numerous tests and observations. The relationship between rail and rail maintenance costs and tonnage capacity of cars is shown.

Ahlf, R. E. (Illinois Central Gulf Railroad), Railway Track and Structures, Vol 71 No. 3, March 1975, pp 34-37 and 90-92, 6 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0403

NON-DESTRUCTIVE CHARACTERIZATION OF HYDROGEN-EMBRITTLEMENT CRACKING BY ACOUSTIC EMISSION TECHNIQUES

Acoustic emission techniques are used to determine the rate of cracking of high-strength steel due to hydrogen embrittlement, making it possible to predict failure in certain structural components undergoing hydrogen attack. The acoustic emission rate from a hydrogen-charged, linear-compliance, fracture-toughness specimen of high-strength 4340 steel was recorded as a function of the stress-intensity factor at the crack tip in the specimen. The structural component (a hydrogen-charged bolt of the same material) was then torqued down in a simple fixture and the acoustic emission was recorded as a function of time. The acoustic emission rate obtained from a

near-critical value of stress-intensity factor of the fracture-toughness specimen was used to predict within ±15 per cent the time for the onset of unstable failure of the bolt. The investigation indicated that regardless of the initial loading, nucleation time for cracking to begin, or any other factors related to geometrical differences in specimens, the acoustic emission rate can be used to determine the time for and the stress-intensity factor at the onset of rapid fracture.

Dunegan, H. L. (Dunegan Research Corp., Livermore, Cal.), and Tetelman, A. S. (University of California at Los Angeles, Los Angeles, Cal.), Engineering Fracture Mechanics, Vol 2, No. 4, June 1971, pp 387-402, 14 figs., 1 table, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0404

SIGNIFICANT VARIABLES IN CHECKING THE PERFORMANCE OF ULTRASONIC INSPECTION SYSTEMS FOR STEEL

A procedure which has been developed for checking the performance of an ultrasonic inspection system is described. The effects of numerous variables encountered in developing procedures and techniques for system checking, such as couplants, cables, and reference blocks, were studied. This investigation points to the need for checking the performance of ultrasonic equipment to insure that an adequate test is being conducted, and also to the urgent need for standardization. Data obtained in the laboratory in studies of the effects of couplants such as oil, water, and glycerine showed no appreciable differences. Graphs are presented for comparisons of the responses obtained with various instruments.

Morgan, J. B., and Johnson, H. H. (Allegheny Ludlum Steel Corp., Brackenridge, Pa.), Materials Evaluation, Vol 25, No. 9, September 1967, pp 206-213, 13 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0405

RAIL HARDENING METHOD AND APPARATUS - BRITISH PATENT SPECIFICATION

This invention relates to thermal hardening of rails, and more particularly to the hardening of the top zone in the head of a railroad rail in order to increase its service life. A method is provided for progressively surface hardening the head portion of rails, which comprises passing the rail in succession through a head quenching zone and simultaneously applying a bending moment to the rail which causes the rail during its passage to be curved in a direction opposite to that which it would normally assume upon quenching. The heating is performed in three stages of decreasing heat intensity in the direction of rail travel. The apparatus used for carrying out the process includes rollers adapted to apply a bending moment and designed to position the rail and propel it during the process.

Arnold, C. S., and Anthes, C. C. (Union Carbide Corporation, New York, N.Y.), British Patent Specification No. 1 256 013, December 8, 1971, 7 pp, 1 fig., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: U.S. Patent Office (repr., PC).

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0406

EXTENT AND ECONOMIC VALUE OF THE GERMAN FEDERAL RAILROAD'S USE OF CONTINUOUS WELDED RAILS AND SWITCHES (AS OF 31 DECEMBER 1971) [IN GERMAN]

The extent of use of continuous welded rails in the German Federal Railway System, the welding processes (joining and cladding) employed in producing them, as well as the costs involved are reviewed. The savings in maintenance costs achieved by continuous welding amount to 74.2 million DM/year for tracks (80% without gap) and 30.9 million DM/year for switches (77% welded). The savings are more

apparent in the case of heavily stressed tracks and switches than in the case of lightly stressed ones.

Birmann, F. (Technical University, Braunschweig, West Germany), Schweissen und Schneiden, Vol 24, No. 8, August 1972, pp 286-290, 3 figs., 6 tables, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0407

SOME PROBLEMS OF RAILWAY OPERATION AT HIGH AXLELOADS

The author presents a historical review of previous and present trends for increased axleloads brought about by changes in transportation of basic commodities such as coal, iron ore and various other raw materials, as well as passengers. Rail wear, shelling, corrugation, and deformations in the head are discussed with regard to causes. The weights and sizes of various traction units are given to illustrate their impact on the condition of the rails. Studies by leading authorities on wheel-to-rail contact stresses and their relation to rail wear are reviewed. Wheel and rail stress data are presented in relation to gross tonnage, distance traveled, and degrees of wear.

Koffman, J. L., and Fairweather, D.M.S. (Readel, Palmer & Tritton, Consulting Engineers, Australia), Rail Engineering International, Vol 5, No. 4, June/July 1975, pp 156-160, 10 figs., 19 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Gearings of Ashford Ltd. (repr., PC).

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0408

ON THE DETERMINATION OF NEAR-FIELD LENGTH OF ANGLE PROBES FOR ULTRASONIC MATERIALS TESTING [IN GERMAN]

A detailed description is given by the authors on how the near-field length of probes can be determined experimentally. With regard to angle probes, it is demonstrated that with the same probe the near-field length--when transmitting transverse waves in steel--corresponds exactly with that obtained when longitudinal waves are transmitted in water. It is, therefore, possible to determine the near-field length for longitudinal waves in water, and to calculate that for transverse waves in steel from the measured value. For angle probes, special AVG-diagrams (distance, amplification, diameter) were calculated by means of the near-field lengths (23 mm for Type MWB probe, 73 mm for Type WB probe) determined for steel, and suggestions for employing these diagrams are given.

Frielinghaus, R., and Schlengermann, U. (Laboratorium der Fa. Dr. J. und H. Krautkramer, Cologne, West Germany), Materialprufung, Vol 9, No. 12, December 1967, pp 437-442, 7 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0409

INVESTIGATIONS OF THE SERVICE BEHAVIOR OF RAILS [IN GERMAN]

Service problems with German rail steels are reviewed. Replacement of 349 B steel by UIC 60 is to be carried out since the former has appeared susceptible to service fractures, particularly at welds. Since 1969 only wear-resistant steels have been introduced and failures from rail-edge fracture, black flecks, and spalls have almost disappeared. Recent work has concentrated on fatigue behavior, and the endurance limit of materials in use is shown to rise with the

tensile strength. A detailed review of fatigue behavior is given.

Heller, W. (Krupp Huttenwerke AG, Werk Rheinhausen, West Germany), Stahl und Eisen Vol 94, No. 4, February 14, 1974, pp 149-151, 3 figs., 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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0410

FRACTURE MECHANICS AS A TOOL FOR UNDERSTANDING STRENGTH BEHAVIOR [IN GERMAN]

Characteristic numbers are presented which describe the resistance of a material to crack propagation that starts from the stress distribution around a single crack. The numbers characterize the material strength more accurately than the tensile strength or the transition temperature, since they are more directly related to the physical parameters involved. Such numbers are critical values of the stress-intensity factor, K, or the crack-extension force, G. The equivalence of K- and G-values can be shown. Test data for the determination of K_c- or G_c-values which were developed in the U.S.A. are tabulated showing the various types of notched test specimens and their corresponding formulas for stress-intensity factors. Descriptions of these tests, along with typical experimental conditions, are given.

Blauel, H.J.G., Kalthoff, J. F., and Sommer, E. (Ernst-Mach-Institute, Freiburg, West Germany), Materialprufung, Vol 12, No. 3, March 1970, pp 69-76, 7 figs., 3 tables, 47 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0411

GROUP PROPAGATION-TIME AND BEAM DISPLACEMENT IN INCLINED REFLECTION: THEIR EFFECT ON PRACTICAL TEST OF MATERIALS [IN GERMAN]

A discussion is presented of the phase jump that occurs between incident and reflected beams which is variable with the angle of incidence and/or frequency. This occurs in most cases in connection with angular reflection of sound beams at the free boundary surface of a solid medium. In the case of the phase angle, depending on the angle of incidence with oblique reflection of divergent sound beams, a beam displacement occurs along the boundary surface. In the case of frequency dependence of the phase angle, the reflection of sound pulses involves a gain or a delay in transit time. The beam displacement with inclined reflection of narrow transverse wave beams in thick plates is calculated for steel and aluminum and demonstrated by experiment. This effect was found to influence, significantly the location of weld flaws by ultrasonic testing. Furthermore, the studies of inclined reflection reveal the relationship between longitudinal and transverse waves on the one hand and Raleigh surface waves on the other.

Miklas, L., Materialprufung, Vol 7, No. 8, August 1965, pp 281-288, 10 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0412

ABRASION TESTS ON UNALLOYED WHEEL RIM AND RAIL MATERIALS AND ON AUSTENITIC WELD OVERLAYS FOR THE SIMULATION OF THE WEAR OCCURRING IN CURVES OF RAIL LINES [IN GERMAN]

Using a modified Siebel-Kahl abrasion-testing apparatus, the abrasion characteristics, under various conditions, of mild steel wheel rims, rails, and rails with Mn-Ni-alloy and Cr-Ni-Mo-alloy weld overlays were investigated. The results of model abrasion

tests and abrasion analyses are given and metallurgical explanations of the results are discussed. The significance of the investigation in terms of understanding wear and friction behavior, in particular of curved tracks, is stated to be considerable. The authors state that the wear of wheel rims and unalloyed steel rails in curves is approximately 6 mm/year for a running distance of about 60,000 km/year and 10 mm/year, respectively [average empirical values].

Uetz, H., Naunou, M. R. and Halach, G. (Staatlichen Materialprufunganstalt, Stuttgart, West Germany), Schweissen und Schneiden, Vol 24, No. 11, November 1972, pp 438-440, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0413

RAILS FOR HIGHLY STRESSED TRACKS [IN GERMAN]

Rail steels must have high tensile and fatigue strength, and good wear-resistance. In addition, they need to have good butt-weldability, adequate toughness, and a low susceptibility to hydrogen embrittlement. The increasing tonnage and speeds in grade operation, such as on the Gotthard line of the Swiss National Railways impose exacting demands on the quality of the rails. Qualification of Krupp's nominally 0.7 C-0.7 Si-1 Mn-1 Cr steel for such service is indicated by its tensile strength of 110 to 125 kp/sq mm, wear and shelling resistance, strain hardening, impact resistance, and weldability. A description is given of the flash-butt progression welding procedure for such rails. (Carried as RRIS Accession No. 071810.)

Heller, W., and Schumacher, G. (Krupp Huttenwerke A.G., West Germany), Technische Mitteilungen Krupp, Werksberichte, Vol 32, No. 1, March 1974, pp 21-27. 11 figs., 19 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Krupp Huttenwerke A.G. (repr., PC).

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0414

INVESTIGATION OF THE FORMATION OF CORRUGATIONS IN RAILS ON SELECTED TEST TRACKS UNDER CONDITIONS OF ORDINARY TRAFFIC [IN GERMAN]

This is an evaluation of a large amount of data collected on two tracks since 1951 and 1958, respectively. Emphasis was on determining the behavior of different steels as a function of composition, melting practice, and treatment after rolling. Examples of findings are that increasing tensile strength and Ni content increases corrugations, increasing Mn and Si decrease the defect. The kinds of rail-steel examined and the placing of rails for the tests are described; methods of wear measurement and assessment of the results including statistical work are presented. Corrugation-depth is considered in relation to UTS, period of use, C content and Si:N ratio of the steel. Performances of the different steels as regards susceptibility to corrugation formation are compared and discussed. (Carried as RRIS Accession No. 072800.)

Spieker, W. (Dusseldorf), Kohler, R. (Minden), and Kuhlmeyer, M. (Bochum), Stahl und Eisen, Vol 91, No. 26, December 1971, pp 1470-1487, 25 figs., 3 tables, 10 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0415

WEAR-RESISTANT RAIL PERFORMS WELL ON THE GOTTHARD

The operating conditions, including, types of terrain, traffic, axle loads, modes of traction, and speeds, leading to the need for using wear-resistant rails on the approaches to the Gotthard tunnel in Switzerland are described. Experience with less wear-resistant rails on the Swiss railway system is briefly reviewed. Data obtained from the Gotthard line over the past ten years indicate that the chrome-manganese rails produced by Friedrich Krupp Huttenwerke A.G. have yielded the best results. The mechanical properties and chemical composition of these rails are given, and comparisons

are drawn between the standard, wear-resistant, and special Cr-Mn grades of steel rail in regard to their tensile and bending fatigue strengths. Impact tests performed on the special-grade steel rails are described and the results are discussed.

Schumacher, W. (Swiss Federal Railways), and Heller, W. (Works Director of Krupp Huttenwerke), Railway Gazette International, Vol 129, No. 8, August 1973, pp 298-302, 3 figs., 2 tables, 17 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Geerings of Ashford Ltd. (repr., PC).

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0416

BROKEN RAILS: PROGRESS IN A LONG BATTLE AGAINST LONG ODDS

This article challenges the theme of the National Transportation Safety Board report entitled "Broken Rails: A Major Cause of Train Accidents". A controversial chart is reproduced from this report which shows the percent increase from 1962 to 1970 in the following curves: tons per carload up 22%, rail failures per track-mile up 44%, and train accidents caused by rail failure up 177%. This article stresses that many accidents in which rails are broken during derailment are charged erroneously to rail failure. The evolution of the Sperry test car is briefly described and a chart showing the number and type of defective rails found by the test cars from 1940 through 1973 is given. Joint defects have been the most common type of rail defect detected in recent years because of the increased sensitivity of the test cars to detect this type of defect and the improved rail fabrication technology, specifically, controlled cooling, which has reduced transverse defects.

Dick, M. H., and Bove, R. E., Railway Age, Vol 175, No. 5, March 11, 1974, pp 16-18 & 22, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0417

RAILROAD FAILURE PREVENTION PROGRAM

The objective of the program here is to establish an information base which will contribute to the understanding of causes of rail and rail component failure and assist in the development of more effective methods of controlling failures. Current emphasis is on the rail and freight car truck components. Eighteen activities currently underway in component evaluation and inspection are briefly noted and/or described. One of the activities, dealing with rail technology programs for fiscal 1975 involves an in-depth review and analysis of all published works during the past ten years in four specific areas of rail technology: nondestructive inspection, stress/strain measurements and analysis, material failure behavior, and rail production practices. Among the various concepts of defect and flaw detection, current ultrasonic rail methods are discussed. Information is given concerning an advanced ultrasonic transducer which is being developed to improve sonic detection of vertical split heads and weld defects. The transducer and associated signal processing equipment is intended to be incorporated in an existing rail inspection car for future tests.

Lavery, A. L., Steele, R., Lyons, J. W., and Ceccon, H. L. (DOT Transportation Systems Center), Materials Evaluation, Vol 33, No. 4, July 1975, pp 163-167, 3 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0418

COMPREHENSIVE TRACK MAINTENANCE SYSTEM

Use of long-welded rail has led to reduced maintenance costs and rail wear. Rail stress is dependent on the rail weight and the difference between the temperature of the rail when laid versus the service temperature. Alignment is a critical factor in the stability of track with long welded rails. Flaw detection in rails is normally carried out by ultrasonic equipment

in a test car. A typical trace from a track recording vehicle is shown which indicates twist, gauge, vehicle speed, rail alignment, cross level and top level for each rail. Methods used in Europe for track renewal are briefly discussed. Long-welded rails are laid by one of three methods at rates of from 200 to 250 mph. Each method requires only one track for removing the old track components and bringing new materials to the site. Ballast and tie-renewal methods are discussed.

Genton, D. (Swiss Federal Railways), Railway Gazette, Vol 126, No. 12, June 19, 1970, pp 465-467, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0419

AUTOMATED TRACK INSPECTION INFORMATION AND ITS USE

The type of track inspection information provided by the DOT railroad test cars and the way it is to be used are described. Samples of the information are provided, and a detailed description of a computer program from which gauge data are produced by the DOT car are given. The basic principles used in producing the gage data may be applied to the production of data for all track parameters-rail profiles, individual rail alignment, track irregularities, distance, and location. The concepts for data processing are described. The preferred formats for the presentation of track geometry data resulted from discussions with individuals in the railroad industry. In particular, track maintenance personnel were consulted regarding the form preferred by them for data presentation.

Woll, T. P. (Federal Railroad Administration), Report No. FRA-RT-72-02, paper presented at Roadmasters and Maintenance of Way Convention, Chicago, Illinois, September 29, 1970, 36 pp., 16 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 201 621.

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0420

TRACK INSPECTION - MECHANIZED - AUTOMATED - COMPUTERIZED

Southern's R-1 track measuring car is described. Measurement samples of seven track parameters: twist, rail surface (each rail), gauge, superelevation, and rail alignment (each rail), are made every 6 in. of track at speeds up to 80 mph. The fully loaded test car simulates loading by locomotives and 100-ton cars. Defects are separated according to priority limits and the more serious defects are noted on instantaneous printouts on a Teletype machine. Sample outputs of the system are shown in the figures along with defect limits for the parameters. All Southern's track is examined by the measuring car at least once a year. Track used by unit trains is examined by the car six times annually.

Railway Track and Structures, Vol 67, No. 3, March 1971, pp 18-21, 3 figs., 2 charts.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0421

M/W ACTIVITIES TO STAY AT HIGH LEVEL IN 1973

Class 1 railroads laid 685,000 tons of new rail in renewal in 1972, which is 6.5% higher than the 643,321 tons laid in 1971. Although renewal of ties represented a decline of 4.8% compared to 1971, tie renewal for 1972 exceeded 20 million for only the second time in 15 years. Looking ahead to the next 12 months, it is estimated that the Class 1 railroads will install 730,000 short tons of new rails in existing track in 1973, which will be an increase of 45,000 tons, or 6.6% compared to 1972. The estimate of tie renewal in the Class 1 railroads is that 19,500,000 new crossties will be installed in existing tracks in

1973, which is a reduction of 900,000 ties, or 4.4% compared with 1972. (Carried as RRIS Accession No. 044432.)

Railway Track and Structures, Vol 69, No. 1, January 1973, pp 22-23, 2 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0422

ADHESION CHARACTERISTICS

This report discusses the phenomenon of adhesion as it applies to the theoretical and operational performance of railway wheels in contact with rail. The term adhesion refers to the tangential friction force developed at the wheel-to-rail contact area; this force is active during acceleration, deceleration, and maintenance of train speed. The ratio between the adhesion force and the normal load transmitted by the wheel to the rail is called the coefficient of adhesion (analogous to coefficient of friction). The objectives of the study were to establish the adhesion limits anticipated on the BART (Bay Area Rapid Transit) system, taking into consideration significant variables, and to provide a general source of adhesion data for the transit industry. As background for the second objective, a history of the laws and theories of friction and a summary of railway adhesion research are included.

Parsons Brinckerhoff-Tudor-Bechtel (San Francisco, Cal.), Report No. 9, August 1968, for DOT/UMTA, Washington, D.C., 183 pp, 67 figs., 12 tables, 7 refs., misc. forms.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 180 572.

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0423

PHYSICAL AND MECHANICAL TEST RESULTS OF RAILS AND JOINT BARS PRODUCED BY THE BASIC OXYGEN STEEL MAKING PROCESS

This report describes an investigation conducted by the AAR Research Center of rails and joint bars produced by the CF&I Corporation from steel manufactured by the basic oxygen process. The investigation of the rails consisted of rolling load tests for shelling, rolling load tests in the 12-in.-stroke machine on flash and oxyacetylene pressure butt-welded rail joints, slow bend and drop tests as well as mechanical tests. The joint bars were tested in rail joints on the long-stroke rolling-load machines and mechanical tests were performed on the bars that failed. The chemical analysis of these bars was also checked. Results of all tests are presented in tabular form, and a brief description of the capabilities of the test equipment is also provided. From the test data obtained, it was concluded that there should be no basic difference in the performance of rail produced from basic oxygen steel and that produced from open-hearth steel.

Association of American Railroads Research Department (Engineering Research Division, A.A.R. Research Center, Chicago, Ill.), Report No. ER-33, April 1963, 11 pp., 1 fig., 8 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0424

A CONTRIBUTION TO THE THEORETICAL EXAMINATION AND EXPERIMENTAL TESTING OF RAILS [IN GERMAN]

The forces acting on rails under different conditions of service stress were calculated, and the calculations were compared with results of fatigue tests on S49 and UIC60 rails. The variables

investigated for their specific effects included locomotives versus freight cars and fast succession of trains. Fracture formation and propagation are discussed. It is concluded that high axle loads require a large rail section, and small wheel diameters also require a high tensile rail steel. The UIC60 rail steel with 900 N/mm^2 minimum tensile strength meets the two requirements and offers ample reserves. Illustrations of shatter and fatigue cracks of the rail head, and graphical presentations of relations between fatigue strength and tensile strength are given. (Carried as RRIS Accession No. 072770.)

Oberweiler, G. (Institut fur Bau von Landverkehrswegen, Munich, West Germany), Archiv fur das Eisenhuttenwesen, Vol 45, No. 8, August 1974, pp 545-550, 9 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0425

THE WEAR OF STEEL RAILS AND TYRES IN RAILWAY SERVICE

The wear of rails and tires is reviewed from the point of view of the railway engineer and metallurgist, and the subject is treated on the macro- rather than the micro-scale. Following a brief statement showing the magnitude and the economics of the problem as it affects British Railways, the author gives numerical values for rail and tire wear under different conditions. The factors having an influence on wear are discussed, and some of them evaluated. While both rails and tires have their rate of wear accelerated by atmospheric corrosion, tires are also reprofiled at intervals, and the metal removed in this operation is often greater than that removed by wear. Methods of reducing the wear of rails and tires are discussed.

Doerden, J. (British Railways Research Dept., Derby, England), Wear, Vol 3, 1960, pp 43-59, 10 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0426

AN INTRODUCTION TO RAIL WEAR AND RAIL LUBRICATION PROBLEMS

The future trend in railroad traffic toward long, heavily loaded, bulk-materials carrying trains is discussed. Experience in the effects of this type of traffic on rail life has been studied closely on the Q.N.S.&L. Railway, over the past 8 years of its ore-haul operations. A survey is made of the types of wear which have been observed: plastic metal flow, cold working, surface and subsurface metal rupture, and metal fatigue developments. Illustrations of such rail defects as crushed head, shelling, spalling, flaking, and head checks are given and discussed. Analysis of these developments indicates that they arise from an intimate interrelation of the magnitude of the wheel-loading to the load-carrying capacity of the rail with respect to both rolling contact and structural support, the dynamic effects of a complex wheel-to-rail relationship which is aggravated by damaging impact loading, the metallurgy of the rail steel, and the configuration of both the components and the assembly of the track structure.

Certain remedial measures are suggested which include improved track and roadway structure, improved rail metallurgy, rail-surface rehabilitation by grinding, and inhibiting rail wear by improved lubrication. The latter is dealt with at some length, and a current rail lubrication research program is described in detail.

Kilburn, K. R. (Quebec North Shore and Labrador Railway, Quebec, Canada), Wear, Vol 7, 1964, pp 255-269, 11 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0427

STRESSES DUE TO TANGENTIAL AND NORMAL LOADS ON AN ELASTIC SOLID WITH APPLICATION TO SOME CONTACT STRESS PROBLEMS

The results of a two-dimensional approach using a real variable method to Hertz's problem of contact of elastic bodies are presented. The magnitude of the intensity of the tangential load is assumed to be linearly proportional to that of the normal load when sliding motion of the body is impending. The stresses in the elastic body due to the application of these loads on its boundary are presented in closed form for both plane-stress and plane-strain cases. The significance of the stress distribution, across the contact area and in the body, is also discussed. It is shown that when the combination of loads considered in the paper is applied at the contact area of bodies in contact the maximum shearing stress may be at the surface instead of beneath the surface. The effect of range of normal stress and of shearing stress on the plane of maximum shear and on the plane of maximum octahedral shear on failure by progressive fracture (fatigue) is discussed. One of the many examples described involves the significance of contact stress in shelling failures of railroad rails.

Smith, J. O., and Liu, C. K. (University of Illinois, Urbana, Ill.), Journal of Applied Mechanics, Trans. ASME, Vol 75, No. 6, June 1953, pp 157-166, 18 figs., 15 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0428

STRESSES IN THE CONTACT ZONE

This paper deals with the contact-stress problem with particular reference to adhesion in the rail-wheel contact situation. The methods of calculation of the size, shape, and orientation of the contact area are described, and confirmed by the results of frozen-stress photoelastic tests. The test results are confined to the contact surface, since subsurface stresses are not directly relevant in the adhesion problem. The distributions of surface shear stress resulting from the application of tangential forces to different shapes of contact area are described for static and rolling conditions. Methods of calculating the creep of rolling bodies are also considered. The problem of bodies rolling and spinning about an axis normal to the contact area is not so well understood, but a brief description is given. The effects of bending stresses in rails and of the size of the contact area in relation to the railhead are discussed briefly.

Ollerton, E. (University of Nottingham, England), Convention of the Railway Engineering Group, London, Proceedings of the Institution of Mechanical Engineers, Vol 178, Part 3E, 1963-1964, pp 161-171, 11 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0429

RAILS ON ELASTIC FOUNDATIONS UNDER THE INFLUENCE OF HIGH-SPEED TRAVELING LOADS

This paper presents an electric-analog-computer technique for the analysis of beams on elastic foundations that are subjected to traveling loads. This method is applicable to the study of such conditions as nonuniform beams, load magnitude and velocity variations, and such nonlinear conditions as the beam leaving contact with the foundation for upward deflections. A general set of dimensionless solutions is presented for the specific case of a point load of constant magnitude and velocity traveling over an infinite uniform linear track beam. These show high values of deflection and moment for a rather narrow range of velocity above and below the critical velocities producing peak disturbances. It was found that quite high accelerations are required to produce significantly less disturbance than in the constant-velocity case. A range of nonlinear track-bouncing conditions was studied in connection with a specific design problem. For some of these cases could more severe conditions be produced than indicated by the linear solutions.

Crimer, M. E. (William Miller Corporation), and McCann, G. D. (California Institute of Technology, Pasadena, Cal.), Journal of Applied Mechanics, Trans. ASME, Vol 75, No. 3, March 1953, pp 13-22, 10 figs., 4 tables, 1 ref.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0430

THE CONTACT BETWEEN A LOCOMOTIVE DRIVING WHEEL AND THE RAIL

A study was made of the conditions of contact existing between locomotive driving wheels and the rail. Observations were made of such measurable quantities as contact area and shape, relative movement or "creep" in rolling, and limiting coefficient of friction, with different values of vertical load, wheel diameter, tractive force, etc. The results obtained were compared with the calculations of Hertz, Carter, and others. Whenever possible measurements were made upon actual wheels and rails, but when this was impossible the problem was simulated by a model in a material giving greater deflection under load. Consideration was also given to the effect of wear upon tires and rails. In general, reasonable agreement was obtained between actual and calculated values, except that the areas of contact could apparently be increased by roughness of the contacting surfaces, and in the case of creep there appeared to be some additional factor which has so far been neglected in calculation.

Andrews, H. I. (British Transport Commission, Marylebone, London, England), Wear, Vol 2, 1958-1959, pp 468-484, 15 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0431

MECHANICAL METHODS OF IMPROVING RAIL ADHESION

Methods of increasing adhesion between the wheels of driven axles and the rail are described. Although various mechanical means such as scrubbing, scouring, and abrading are discussed, the paper is almost entirely concerned with the method and effect of interposing hard granular material between the wheel and rail. The substance used in practice is sand, although the effect of other materials has been measured. The effect of sand upon adhesion and means of getting sand into the wheel-rail 'nip', are discussed in detail.

The effect of sand upon adhesion has been measured under controlled conditions in a laboratory. The frictional force required to initiate slip from a stationary condition has been measured on dry, wet, and oily rails. The results are discussed fully in conjunction with other laboratory tests and tests carried out with "fluid sand".

Experiments, carried out with the object of studying the utilization of sand ejected from a nozzle, are reported. The distribution of sand hitting a target placed at right-angles to the axis of the nozzle has been measured at various distances from the nozzle. The effect of cross winds and different nozzle designs has been measured.

Astle-Fletcher, H. W. (Research Department, British Railways Board, London), Convention of the Railway Engineering Group, Proceedings of the Institution of Mechanical Engineers, London, November 27-28, 1963, Vol 178, Part 3E, 1963-1964, pp 185-205, 26 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0432

M/W PROBE 1. CLOSE-UP OF POLICIES AND PRACTICES, UNION PACIFIC

Six related articles, all dealing with the maintenance of way (M/W) practices on the Union Pacific Railroad, are presented. Subjects covered include track standards, welded rail, organization of M/W gangs, the Track Recorder Car, and bridges.

Railway Track and Structures, Vol 69, No. 6, June 1973, pp 15-38.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0433

M/W EFFICIENCY OF THE UNION PACIFIC

The author states that the best means of measuring the success of a maintenance policy is to compare the quality of the track and roadbed structure, with the maintenance cost, based upon the tonnage of traffic and the speed. Charts are updated each year to compare UP maintenance-of-way operating expenses with those of six other major railroads which have comparable traffic volumes, operating conditions, and so forth. Equipment is updated each year with the latest generation of equipment available, without overmechanizing. The quality of day-to-day track-maintenance work that is done between the periods of out-of-face heavy program work has more to do to insure the best track conditions at the lowest over-all cost than any other single factor. Section gangs are assigned over the entire railroad to do the day-to-day maintenance work. The section forces mark the bad ties, and the number of ties marked in each area is tabulated before the annual tie-gang program is established. UP M/W department is having difficulty getting adequate on-track time for its mechanized track gangs engaged in out-of-face work. The only solution to the problem, according to the author, is to maintain close communication with operating department people to get just as much time on the track as possible. UP is a relative newcomer in the use of continuous welded rail. The road has firm rules governing the heating or cooling of the long strings. By vibrating the rail at the same time that it is being heated or cooled, frictional resistance is overcome and the rail is permitted to expand or contract the desired amount at the end of the string. Another area of pioneering for UP is in the use of glued or bonded insulated and closure joints between CWR strings. UP hopes to purchase a self-propelled car capable of testing track at 35 to 45 mph. (Carried as RRIS Accession No. 072823.)

Dick, M. H. (Engineering Editor), Railway Age, Vol 174, No. 11, June 11, 1973, pp 28-41, 4 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Xerox University Microfilms (repr., PC).

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0434

TRACK GEOMETRY MEASUREMENTS AND DATA PROCESSING DEVELOPMENTS IN THE RAIL RESEARCH PROGRAM

This report summarizes the FRA-sponsored Rail Research Program, and outlines many of the problems presently encountered by the railroad industry in providing safe, high-speed transportation; it also illustrates the vital role of cost-effective maintenance planning. This report was originally presented at the IEEE/ASME Joint Railroad Conference in St. Louis, Missouri, in April 1973.

The FRA Test Cars are described, with emphasis placed on the ability of the cars to measure all parameters of track geometry at high speed. Examples are included of the various types of computer-generated reports which are designed specifically for personnel who are responsible for maintenance planning and operations. (Carried as RRIS Accession No. 083026.)

Prem, L. (ENSCO, Inc., Springfield, Va.), Report No. FRA-ORD&D-75-14, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-20032, October 1974, 29 pp, 20 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 239 463.

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0435

A THREE-DIMENSIONAL PHOTOELASTIC STUDY OF CONTACT STRESSES IN THE HEAD OF A MODEL OF A RAILROAD RAIL

The shear difference method has been extended to three-dimensional problems which permits the determination of the principal stresses at any interior point of an arbitrarily loaded body. Using this recently developed method in combination with the stress-freezing process, the principal stresses in the head of a model of a railroad rail were determined photoelastically. The prototype was a 132-lb RE rail loaded through a wheel with the contour of a worn 33-in.-diameter wheel. Stresses were determined for a vertical load and for an oblique load transverse to the rail. Principal stresses and maximum shears were determined in the transverse section of the rail under the center of the wheel, i.e., in the plane of symmetry of the rail. The study was confined to the elastic state.

Frocht, M. M. (Illinois Institute of Technology, Chicago, Ill.), Proceedings of the Society for Experimental Stress Analysis, Vol 14, No. 1, 1956, pp 1-12, 15 figs., 11 refs., discussion.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0436

TRACK GEOMETRY SURVEY DEVICE FOR LIM RESEARCH VEHICLE TEST TRACK

A track survey device was designed, built, and operated to measure the geometry of the FRA Linear Induction Motor Test Track at Pueblo, Colorado. A laser beam is used for the measurement of profile and alignment, and an electronic level is used for the measurement of superelevation and mechanical sensors for both support rail and reaction rail gages. The measurement is stored in magnetic tape for processing.

Modecki, H., and Panunzio, S. (General Applied Science Laboratories, Inc., Westbury, N.Y.), Report No. FRA-ORD&D-74-36, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-10016, October 1973, 110 pp., 44 figs., 7 tables, 4 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 241 313.

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0437

ACQUISITION AND USE OF TRACK GEOMETRY DATA IN MAINTENANCE-OF-WAY PLANNING

This report describes data acquisition by the FRA Measurement Cars and subsequent use of the collected track geometry data by the Bessemer and Lake Erie (B&LE) and the Denver and Rio Grande Western (D&RGW) Railroads. These two railroads, in conjunction with HRSCO, Inc., have prepared this report for the Federal Railroad Administration. The major emphasis of this report is placed on use of the track geometry data by B&LE and D&RGW for immediate maintenance and maintenance planning. Also provided are descriptions of data processing reports, system and measurement repeatability data, and the Track Geometry Measurement System onboard the FRA Measurement Cars. The information provided is intended for use by maintenance-of-way personnel who are concerned with the utilization of track-geometry data collected by track-measurement cars and by management personnel who are involved in maintenance planning.

Bradley, K., Price, S., Woll, T., Bermes, R., and Gerber, R. (Bessemer & Lake Erie Railroad, Pittsburgh, Pa., and Denver & Rio Grande Western Railroad, Denver, Colo.), Report No. FRA-ORD&D-75-27, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-20032, March 1975, 120 pp, 75 figs., 7 refs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 241 196.

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0438

DOT TEST TRAIN PROGRAM SYSTEM: INSTRUMENTATION MANUAL—FIFTH EDITION

This manual describes track measurement instrumentation which has been developed during the reporting period (December 1972-November 1973), and covers all instrumentation currently installed aboard the FRA Test Cars. The major emphasis of the manual is on the operation and calibration of the Track Geometry Measurement System installed aboard Test Car T-3. Ancillary systems, and equipment aboard Test Cars T-1, T-2, and T-4, are also summarized.

The information provided is intended for use by technical personnel who are involved in the operation of FRA Test Car instrumentation, and by engineering and research personnel involved in the application of track-geometry measurement techniques.

Anderson, L., MacIntyre, S., and Kolcyzaski, M. (ENSCO, Inc., Springfield, Va.), Report No. FRA-ORD&D-75-04, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-20032, December 1973, 140 pp, 64 figs., 2 tables, 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 241 888

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0439

TRACKWORK STUDY, VOL I: TRACKWORK PRACTICES OF NORTH AMERICAN RAPID TRANSIT SYSTEMS

The report summarizes the trackwork practices of seven North American rail transit properties: Boston, Chicago, Cleveland, New York, Philadelphia, San Francisco, and Toronto. Responses to questionnaires sent to the properties covered construction standards for rail, rail welds, track gauge, rail fastenings, support spacing, rail anchorage, ties, roadbed and ballast sections, special trackwork and track appurtenances. The properties also reported their track maintenance criteria for rail wear, tie life, and ballast cleaning as well as test installations and recommendations for improving trackwork. The report contains a bibliography of over 100 publications on trackwork design, construction and maintenance. (Carried as RRIS Accession No. 039826.)

Dunn, R. H. (De Leuw, Cather & Company, Washington, D.C.), Report No. WMATA-DCCO-TWS-1, for Washington Metropolitan Area Transit Authority, November 1967, 149 pp. 74 figs., 8 tables, 100+ refs., 3 appendixes.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 204 212.

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0440

TEST TRAIN PROGRAM: FIFTH PROGRESS REPORT

This progress report covers a 12-month period of engineering, data collection and analysis efforts related to the Rail Research Program. Subjects include operation of the DOT Rail Research Cars, associated testing programs, test car upgrading, expansion of the Rail Research Program, data management and data analysis tasks which have been undertaken to benefit railroad technology.

The Rail Research Program primarily involves the operation and instrumentation of the FRA Test Cars. This research program is designed to provide high-speed measurement of railroad track characteristics, development of comprehensive track measurement techniques, development of special testing instrumentation and data evaluation through analysis and electronic processing.

ENSCO, Inc., Springfield, Va.), Report No. FRA-ORD&D-75-19, for DOT/FRA, Washington, D.C., Contract No. DOT-FR-20032, June 1973, 80 pp., 30 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 241 419.

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0441

INVESTIGATION OF FAILURES IN CONTROL-COOLED RAILROAD RAILS

The results of examination by the University of Illinois of 32 failed control-cooled rails are presented. Types of failures found were shatter cracks, inclusions, hot tearing, engine burns, bolt hole breaks, deep cracks, and faults resulting from the welding process. Each type of failure is discussed in detail and tabulations are provided that list all pertinent information including name of railroad, heat, mill, size, and failure classification.

Cramer, E. E. (University of Illinois, Chicago, Ill.), Proceedings of the 46th Annual Convention of the AREA, Vol 58, 1957, pp 965-971, 4 figs., 4 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0442

AN EXAMINATION OF THE EFFECTS OF SOME IDEALIZED MODELS OF FRACTURE ON ACCELERATING CRACKS

On the basis of a solution for a diffraction problem given by F. G. Friedlander, the authors present a new representation for the stress field produced by a semi-infinite accelerating crack in longitudinal shear field. This is employed to give an expression for the field at any point generated by an incident plane stress wave and also to obtain asymptotic expressions for the components of strain and velocity near the crack tip when the crack is loaded. Some effects of large-scale-yielding are investigated by adopting the Dugdale model, with a plastic zone of finite size, the motion of a crack subjected to a step load being investigated in detail. It is concluded that a crack with a finite plastic zone accelerates less rapidly than one for which the yielding is small-scale, although the accelerations predicted are still unrealistically high.

Glennie, E. B., and Willis, J. R. (University of Cambridge, England), Journal of the Mechanics and Physics of Solids, Vol 19, No. 1, February 1971, pp 11-30, 3 figs., 16 refs., 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0443

SHELLING IN RAIL HEADS

Results of the examination of 11 Type R-43 and 130 Type R-50 rails by the metallurgical laboratory of the Asovstal' Works (U.S.S.R.) are discussed in this article. It was found that 38.3% of the rails contained defects of metallurgical origin and 35.4% had defects associated with the formation of shelling on the railhead and resultant transverse fatigue fractures. On the basis of the examination, the author concludes that to prevent shelling in rails in heavily loaded sections of track it is essential to use alloy steel and suitable heat treatment, thus greatly increasing strength and ductility.

Kalashnikov, A. G. (Asovstal' Works, U.S.S.R.), Stal [in English], No. 9, September 1959, pp 695-698, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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0444

BEAM ON TENSIONLESS FOUNDATION

This paper is concerned with the classical engineering mechanics problem of the response of a loaded beam resting on a foundation. The authors comment on the approach to the problem taken by others, and state that in the approach it is generally assumed that the interface can support a tensile stress. Two statements given in support of the assumption are: (1) regions of tensile interface stress are small compared with compressive regions and, therefore, the errors induced are negligible; and (2) the beam has a unit weight not included in the analysis; the magnitude of the resulting compression is assumed to be greater than the tensile interface stresses resulting from the beam loading and, therefore, stress reversals do not exist. The authors question the second statement and say that it may be seen to be invalid when one considers the case of railroad tracks. This paper examines the validity of this statement and, in particular, the problem of determining the static response of a loaded, infinite beam on an elastic foundation is dealt with. The foundation is approximated by the Winkler model; however, the assumption of equal properties in tension and compression is relaxed. The foundation is treated as a bilinear material, the tensionless foundation then being examined as a special case. The problem is formulated in terms of a nonlinear differential equation, which is then converted to a nonlinear integral equation, and an iterative solution for the integral equation is presented. The iterative process is numerically evaluated and the results are graphically presented and compared with the classical solution.

Hsieh-chien, T., and Westmann, R. A. (California Institute of Technology, Pasadena, Cal.), Proceedings of the American Society of Civil Engineering, Journal of the Engineering Mechanics Division, Vol 93, No. EM 5, October 1967, pp 1-12, 5 figs., 8 refs.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0445

RAIL FAILURE STATISTICS COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1955, by 59 railroads on all of their main track mileage, constituting approximately 87 percent of all of the main line track in the U. S. and Canada, are presented in the forms of tabulations, charts, and graphs. Information is included indicating the extent of control of the transverse-fissure problem that has been achieved through the use of control-cooled rail and detector car testing. Specific data are presented on the following types of failures: vertical and horizontal split heads, engine burn fractures, head checks, web defects, base fractures, and bolt-hole cracks. Data for the various rail fabrication mills are also given that show the types of failures occurring on various railroads as related to the mill producing the rail.

Code, C. J. (Chairman, AREA Subcommittee), et al., Proceedings of the 46th Annual Convention of the AREA, Vol 58, 1957, pp 972-991, 4 figs., 9 tables,

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0446

RAIL FAILURE STATISTICS, COVERING (A) ALL FAILURES; (B) TRANSVERSE FISSURES; (C) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics are presented of rail failures to the end of 1950 as reported by 64 railroads on all their main line railway mileage which constitutes practically all of the main track in the United States and Canada. Tables and diagrams are given to indicate the extent of control of the transverse-fissure problem being attained by the use of control cooled rails and detector car testing. Data on

each year's rollings for the various mills are listed along with the types of failures that are occurring on the various railroads as they relate to the mill producing the rail. Types of failures and defects included in the statistics are vertical and horizontal head splitting, web defects, engine burn fractures, and base fractures.

McBrian, R. (Chairman, Subcommittee), et al., Proceedings of the 51st Annual Convention of the AREA, Vol 53, 1952, pp 849-866, 4 figs., 8 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0447

REHEATING RAIL-INGOTS IN REGENERATIVE SOAKING PITS

This paper describes a study made at the Kuznetsk Metallurgical Combine (U.S.S.R.) of the effect of ingot reheat temperature on scale formation, decarburization, the macro- and microstructure and ductility of the cast metal, and the mechanical properties of the cast and formed steel rail. The results of laboratory and industrial investigations are shown which indicate that raising the reheat temperature to 1300 C does not impair rail steel quality. By following the prescribed procedures, it was found that the throughput capacity of the soaking pits and the output of the blooming mills were increased.

Plekhanov, P. S., Radchenko, R. P., and Vishnyakova, M. P. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 9, September 1965, pp 736-739, 5 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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0448

TRACK TRAIN DYNAMICS: TO IMPROVE FREIGHT TRAIN PERFORMANCE

This manual provides recommended guidelines related to freight train operations which are based on the results of an analysis of the current operating policies and practices of North American Railroads. The major emphasis of the manual is on promoting proper train handling and those elements which insure this condition; successful train handling techniques and procedures; proper train make-up; track and structure considerations; and locomotive engineer training and/or retraining. The manual represents the joint effort of the Association of American Railroads and the Railway Progress Institute, in cooperation with the Federal Railroad Administration under the auspices of the National Research Project of Track-Train Dynamics. The manual was prepared as one assignment of the Project in which the objective was to "collect current information about successful railway operating policies and procedures relative to improved track-train dynamics." It is anticipated that revisions to the manual will be issued periodically.

American Association of Railroads, National Research Project of Track-Train Dynamics, Report No. R-122, 1973, 300 pp, 100 figs.

ACKNOWLEDGMENT: American Association of Railroads.

PURCHASE FROM: American Association of Railroads (repr., PC).

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0449

INVESTIGATION OF RAILS MADE FROM CONTINUOUSLY CAST BLOOMS BY ALGOMA STEEL CORPORATION

At the request of Algoma Central Railway, the Association of American Railroads Research Center conducted an examination of rail made from continuously cast blooms. The blooms were made and rolled into rail by the Algoma Steel Corporation. Eight 6-ft lengths of 115-lb RE section and three electric flash-butt-welded specimens (weld joint located in center of specimen) were submitted for evaluation.

The investigation consisted of rolling-load, slow-bend, and drop tests; chemical analysis; physical-property and impact-property determinations; and hardness and metallurgical surveys. Photographs of the specimens and tabulated data obtained from the tests and analysis are included.

Association of American Railroads, Research and Test Department, AAR Research Center, Chicago, Illinois, Report No. R-104, Project No. 69-T-26, October 1970, 51 pp, 35 figs., 8 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0450

RAIL VEHICLE DYNAMIC STUDIES

This paper deals with the application of simplified dynamic models to the problem of ride comfort in tracked vehicles for high-speed passenger travel. The studies reported are aimed at the adequate simulation of significant degrees of freedom in a railroad car in order that its optimum stiffness may be found. The mathematical models used for this purpose are a four-degree-of-freedom vertical model and a 10-degree-of-freedom lateral model. The vertical model is subject to vertical inputs applied simultaneously to both trucks, and the lateral model is subject to lateral and/or rocking displacements from the rail. Results of this study show that car bending flexibility and the stiffness and damping characteristics of vertical and lateral transformer mountings play significant roles in the search for optimum stiffness and damping properties of the model.

Sewall, J. L., Parrish, R. V., and Durling, B. J. (NASA Langley Research Center, Hampton, Va.), Report No. FRA-RT-72-03, for DOT/FRA, Washington, D.C., October 1969, 17 pp, 13 figs., 3 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 201 622.

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0451

DEVELOPMENT OF AN INERTIAL PROFILOMETER

This report covers the design, fabrication, and testing of an inertial profilometer system, developed for use on the FRA Test Cars. The profilometer is used to measure rail profile at high speeds, relative to an inertial reference. Design details and analysis of the profilometer are covered, and profilometer measurements, mid-chord measurements, and manual measurements made with stringline and roll-ordinator devices are compared to show the relative accuracy of the profilometer measurements.

The inertial profilometer offers several advantages over the currently used mid-chord system. The profilometer has proven to be quite accurate. Its operation is not degraded by inclement weather, and system components are not subject to damage by protruding objects in close proximity to the rail being measured.

This report is intended for use by engineering personnel and analysts who are involved in the design, testing, and utilization of instrumentation for the measurement of railroad track profile. (Carried as RRIS Accession No. 083027.)

Brandenburg, E. L., and Rudd, T. J. (ENSCO, Inc., Springfield, Va.), Report No. FRA-ORD&D-75-15, for DOT/FRA, Contract No. DOT-FR-20032, November 1974, 45 pp, 23 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 239 464.

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0452

METALLURGICAL, PHYSICAL AND ROLLING LOAD TEST RESULTS OF RAIL ROLLED FROM CONTINUOUSLY CAST BLOOMS

This report covers the investigation of the application of continuous casting in rolling rail. The continuously cast blooms were produced in France from steel that satisfied AREA and UIC specifications, and the blooms were rolled into rail sections at the Hutten-und-Bergwerke Rheinhausen, A.G., West Germany. The AAR Research Center conducted rolling-load, slow-bend, and drop tests to determine

physical/mechanical properties and performed metallurgical and ultrasonic examinations for defects. The mechanical properties and chemical composition of the rail and rail steel, as determined in the laboratory tests, were shown to satisfy AREA specifications. Brinell hardness tests of the rail showed that it conformed to the U. S. standard. Photomacrographs of the rail sections showed light to heavy segregation, which is considered typical in Type A and B rails. Detailed data are provided for all tests.

Association of American Railroads Research Department, Engineering Research Division, AAR Research Center, Chicago, Ill., Report No. ER-45, April 1964, 15 pp, 13 figs., 6 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0453

THE LATERAL AND LONGITUDINAL DISTRIBUTION OF LOADING OF STEEL RAILWAY BRIDGES

The primary purpose of this study was to review existing methods of analysis for bridge floor systems and related structures (rail and track), and then to develop a method of analysis which would aid in determining the distribution of wheel loads to the bridge floor system. The second aim of this investigation was to obtain, using the method of analysis developed, a number of solutions of simulated bridge floors. The third objective of this study was to arrive at a method of computing live load distribution which would be practical for use in design offices, and yet take into account all important factors affecting the distribution of live loads. Assumptions for the depth of ballast and the track loading are briefly discussed. The equation for rail deflection derived by A. N. Talbot in his 1918-1920 studies of a beam of infinite length and continuously supported on an elastic foundation is explained.

Sanders, W. W., Jr., and Munse, W. H. (University of Illinois, Urbana, Ill.), Association of American Railroads Research Department, Engineering Research Division, Chicago, Ill., Report No. ER-5, February 1961, 128 pp, 27 figs., 10 tables, 33 refs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0454

RAIL STUDY: BESSEMER AND LAKE ERIE RAILROAD

Since 1931 the Bessemer and Lake Erie Railroad has been using 90-ton-capacity hopper cars for transporting ore which create average loads of 32,300 lb per wheel; however, little or no rail shelling has occurred. This study was initiated in an attempt to determine why no rail shelling problem exists.

The mechanical properties and weights of rails are given as well as information on the manufacturers who produced the rails. The maintenance schedule regarding the replacement of rails because of curve wear, battered ends, worn fishing areas at joints, and head wear is discussed. Wear profiles of the rail in territories having over 400 million gross tons of traffic indicate that no excessive rail wear or damage exists. It is concluded that the 32,300-lb loads on the 33-in. wheels have not resulted in significant damage to the rail or track structures.

Association of American Railroads Research Department, Engineering Research Division, A.A.R. Research Center, Chicago, Ill., Report No. R-55, March 1965, 17 pp, figs., tables, photographs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0455

ONE OF THE CAUSES OF CONTACT FATIGUE FRACTURE OF RAILS

Investigations were conducted to determine the causes of contact fatigue fracture of rails. It was found that the principal causes are the inadequate strength of metal over the whole rail or in individual zones, and the large or unfavorable combination and orientation of stresses which arise, not only as a result of high wheel pressures, but also owing to the complex system of normal and tangential forces acting on the rails. Laboratory tests have shown that the average value of lateral force acting from the rolling stock on the rail for locomotives is about 1.6 tons at a speed of 70 km/hr.

The initial irregularities on the lateral edges of the rail head arise during rolling of the rails. The author states that these irregularities can be greatly reduced by cold-straightening of the rails in the plane of minimum stiffness ("lateral" straightening), but not on plunger-type presses, and also continuously in roller-straightening machines. When producing hardened rails, such a straightening operation must be carried out with particular care in the unhardened states, irrespective of subsequent straightening after quenching.

Luk'yanov, A. V., Stal [in English], No. 4, April 1970, pp 292-294, 2 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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0456

AN INVESTIGATION OF CROPPING RAIL BY WET AND DRY ABRASIVE WHEEL METHODS

The AAR Research Center conducted an investigation of rail cropping with wet and dry abrasive wheels. In the wet-abrasive cutting study, a general-purpose wet wheel cut-off machine was used to crop 80-lb rail. Photomicrographs of the cut sections revealed that no metallurgical deformation resulted from the cutting process, and it was concluded that wet-abrasive cropping is acceptable for rail. The dry-abrasive method was used to cut 131-lb RE rail in track. The first cut was made through the work-hardened surface and head of the rail and was finished with a full-diameter wheel. Photomicrographs revealed no thermal deformation of the structure, however, a very light layer of martensite was present in some of the cut specimens which was believed to be caused by the easing of pressure in the full-diameter wheel cut through the base. Although this martensitic structure is undesirable, it has not proven harmful. It was concluded that considerable improvement has been achieved in the dry-abrasive method for rail cropping.

Association of American Railroads Research Department, Engineering Research Division, A.A.R. Research Center, Chicago, Ill., Report No. ER-42, February 1964, 11 pp, 14 figs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0457

CHEMICAL METHODS OF IMPROVING RAIL ADHESION

An investigation of chemical methods for improving rail adhesion was conducted. The tests, which involved studying the effects of a wide range of chemical substances on rails in clean, wet, and oily conditions, were conducted in the laboratory and in service at various locations on the British Railways. On the basis of the test results, the author concludes that the adhesion of locomotive driving wheels may be reduced by the boundary-lubrication effect of fluids, usually water or oil, trapped between the contacting surfaces of the tire and the rail, or by unfavorable secondary conditioning of the rail surface. Any application of chemicals intended to increase adhesion should, therefore, reduce the boundary lubrication by mixing with or replacing either water or oil on the rail surface, and should also be capable of improving unfavorable secondary conditioning.

Of the many substances investigated, promising results were obtained from a 2 percent solution of sodium metasilicate in water, from certain esters, and from ... Syton fluids, although each of these substances has certain limitations.

Andrews, H. I. (Research Department, British Railways Board, London), Convention of the Railway Engineering Group, Proceedings of the Institution of Mechanical Engineers (London), November 1963, Paper No. 11, Part 3E, Vol 178, 1963-1964, pp 172-184, 11 figs., 3 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0458

NEW HIGH-PRODUCTIVITY ROLLING MILLS

Modern rolling-mill plants in the Soviet Union and their past histories with details of capacities, applications, and manufacturers are described. A layout sketch of the 900/700/500 continuous billet mill is shown. It is noted that rail mills which have been reconstructed in the post-war period and two new mills fully meet the demand for rail. A special mill is being planned to meet demands for heavy beams, particularly wide-flange beams up to 1000 mm.

Korolev, A. A., Stal [in English], No. 10, October 1967, pp 857-863, 9 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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0459

PROGRESS REPORT OF THE SPECIAL COMMITTEE TO REPORT ON STRESSES IN RAILROAD TRACK

This progress report on a study dealing with the general behavior of rails under load and the action of track as an elastic structure was prepared by a Special Committee composed of members of the Committees of the American Society of Civil Engineers and of the American Railway Engineering Association. A number of steel companies contributed to the funding of this effort, and railway companies cooperated by furnishing facilities for the tests. The University of Illinois provided shop, laboratory, and office facilities as well as the services of a number of its staff who contributed to the design and development of a number of instruments used in the tests and to the methods of testing.

The test results relate principally to stresses in rail and to the depression of track as a whole. Data are presented for depression of track under one- and two-axle loads, and locomotive loading under static conditions along with data on stresses in rail for these loadings and for moving-load tests with locomotives. A general discussion is provided on the effect of speed, influence of rail section, effect of wheel spacing, condition of track, etc. The action of the tie, transmission of pressure through ballast and roadway, and other related matters are not considered in this report.

Procedures for preparation of the test track and the methods employed for conducting the tests are presented, and illustrations and descriptions of the test equipment are provided. A discussion of the reduction of the test data obtained and the accuracy of the test instrumentation is also given. The test results are discussed in detail and summarized in tables, graphs, and diagrams.

Talbot, A. N. (University of Illinois, Chairman, Special Committee to Report on Stresses in Railroad Track), Transactions of the American Society of Civil Engineers, Paper No. 1420, Volume LXXXII, 1918, pp 1193-1383, 198 figs., 13 tables.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0460

STRUCTURAL-TEST APPLICATIONS UTILIZING LARGE CONTINUOUS PHOTOELASTIC COATINGS: PART 2--CALIBRATION, MEASUREMENT, AND DATA-REDUCTION TECHNIQUES

The recommended procedures for preparing the test specimen to be used in the process of photoelastic testing are described. The mould and contoured sheet are illustrated for a typical structural test assembly. Step-by-step procedures such as the calibration of the photoelastic coating, measurements, first, second, third, and subsequant loading cycles, and principal-stress data reduction are presented. The accuracy of the photoelastic-coating technique is compared with strain-gage analysis for certain applications such as missile-guidance structures. Sample calibration and test-data sheets are included.

McIver, R. W. (Douglas Aircraft Co., Inc., Missile & Space Systems Div., Santa Monica, Cal.), Experimental Mechanics, Vol 5, No. 2, February 1965, pp 19A-26A, 16 figs., 1 table, 2 appendixes.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0461

THE PHOTOSTRESS METHOD AS APPLIED TO THE ANALYSIS OF DYNAMIC STATES OF STRESS [IN GERMAN]

A graphical method is presented for directly determining the partial derivatives of displacements, and, in cases of small-strain fields, the components of strains. The linear differential moire method applied with a series of reference gratings of different linear disparities yielded the isocentatics of the normal components of strains. The angular disparity method, where a reference grating of the same line frequency as the specimen grating was angularly displaced by different positive or negative angles, yielded the two cross derivatives of the displacement from which, by addition only, the shear strain distribution is deduced all over the field. Thus, the strain tensor may be completely defined at every point in the strain field without necessitating the differentiation of the displacement fields obtained by the moire patterns.

Schwieger, H. (Consultant to Budd Instrument Div., Phoenixville, Pa., and Vishay Instruments, Inc., Malvern, Pa.), Materialprufung, Vol 7, No. 7, July 1965, pp 251-260, 12 figs., 20 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0462

COMPUTATION OF FINITE STRAINS FROM MOIRE DISPLACEMENT PATTERNS

A new and accurate method is described for deriving finite strains from moire displacement patterns. The components of the displacements at the mesh points of a Lagrangian coordinate network are estimated from the moire fringes. In the neighborhood of a point, where the strains are to be calculated, two algebraic functions are determined, approximating as closely as possible to the two sets of estimated displacement values. The strains are then calculated from the partial derivatives of these two functions. The procedure is repeated for all points at which the strains are required.

When this procedure is applied to a great number of points the use of a computer becomes a practical necessity. Once the formulae have been programmed, the operator has only to estimate the displacement values at the mesh points of the coordinate network and to feed this set of numbers to the computer. This new method thus allows a considerable gain in time and brings about an improvement in accuracy compared with other methods.

Boessaert, W., Dechaene, R. and Vinckier, A. (University of Ghent, Belgium), Journal of Strain Analysis, Vol 3, No. 1, January 1968, 6 figs., 4 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0463

RAIL CORRUGATION--CAN IT BE PREVENTED?

Rail corrugation resulting from high-speed trains is a complex problem for which no solution has been found. The author directed his investigation toward establishing a relation between natural frequencies of rail vibration and wavelength of the corrugation. He does state, however, that the computation which he performed needs to be verified experimentally. Should it prove correct, he believes that corrugation could be eliminated by axle redesign as well as by changes in rail profile and tie spacings.

Spaderna, C. H., Proceedings of the 55th Annual Convention of the AREA, Vol 57, 1956, pp 307-312, 3 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0464

FATIGUE LIFE OF RAIL WEBS IN SERVICE

Rail failures occurring in the early 1940's on the Pennsylvania Railroad as a result of head and web separation (commonly referred to as a split web) are reviewed. Examples of typical split-web failures are shown with typical stress patterns provided by a stresscoat test. Field measurements of compression stresses on rails subjected to loads by seven classes of locomotives were made and the data are presented. Similar measurements were made for tenders, freight cars, and passenger cars showing the estimated number of annual cycles of stress. Experimental work associated with the study of corrosion fatigue was conducted in the laboratory and the data obtained are plotted. The data were related to operations on the Panhandle and Middle Divisions of the Pennsylvania Railroad thus enabling the authors to arrive at the corrosion fatigue life of rail web steel on various curves in the systems.

Code, C. J., and Billstein, A.E.F. (Pennsylvania Railroad, Altoona, Pa.), Proceedings of the Society for Experimental Stress Analysis, Vol 7, No. 1, 1949, pp 103-116, 22 figs., 3 tables.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0465

EVOLVING A LOW ALLOY STEEL FOR HEAVY RAILS AND ITS ADOPTION AFTER SUITABILITY TRIALS

The author indicates that rails of steel containing 0.63 to 0.75%C and 0.5 to 1.0%Cr have, without a strengthening heat treatment, a service life 1.5 times that of rails of carbon steel of standard composition. Their use on sections under heavy traffic, in particular on small-radius curves, is very effective. The step-by-step procedures for manufacturing rail steel in 1965 are presented and data are included for impact-strength tests for both carbon- and chromium-alloy steel, as well as photomicrographs of cross sections of both types of rail steel. Graphical data are shown for tonnage traffic carried as a function of the number of defects in rails for control-test rails and those rails that were experimental.

Kazarnovskii, D. S., Gershgorn, M. A., Sviridenko, F. F., Kravtsova, K. P., and Shneyerman, L. Ya. (Ukrainian Research Institute of Metals and the Azovstal' Works, U.S.S.R.), Stal [in English], No. 4, April 1965, pp 311-313, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0466

INVESTIGATION OF WELDING TECHNIQUES FOR REPAIR BY WELDING OF HEAT TREATED AND FLAME HARDENED RAIL IN BOLTED RAIL CROSSINGS

This report covers an investigation conducted by the Association of American Railroads (AAR) of heat-treated rail and flame-hardened rail in crossing frogs on service installations. Laboratory studies of welding techniques for use in field repair of worn and battered rails were performed by the AAR Research Center and the University of Illinois. The history of all rail specimens consisting of information on heat treatment, manufacturing procedures, controlled cooling, and water and oil quenching is given. The installation conditions of the field service experiment are described in detail. To determine the most promising welding techniques for the test units, an extensive plan was developed, and four different makes of equipment were used. Tabulated data of hardness and end-batter measurements show that each welding technique can be used depending on the type of rail, its chemical composition, and the nature of heat treatment and hardening. Photographs of the installations and sections of the rails after testing are shown.

Association of American Railroads Research Department (Engineering Research Division, AAR Research Center, Chicago, Ill.), Report No. ER-51, November 1964, 17 pp, 65 figs., 5 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0467

PRODUCING HIGH STRENGTH R-65 CHROMIUM STEEL RAILS

The mass production of chromium steel rails (0.5 to 0.9% Cr) of the R-65 type which is known for high strength and long service life is described. Cost information is given for producing the chromium alloy rails and the total tonnage of rails rolled at the Kuznetsk Metallurgical Combine (U.S.S.R.). It has been established that chromium steel rails have a service life longer by a factor of between 1.3 and 1.5 than that of carbon steel rails.

Nikulin, N. G., Yudin, N. S., Darushin, R. I., Gorelkina, A. E., Plakhov, K. G., Kritinin, I. A., Bovin, M. I., Lymar', A. I., and Kocheto, G. S. (Kuznetsk Metallurgical Combine, U.S.S.R.) Stal [in English], No. 2, February 1967, pp 135-136, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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0468

RAILS ROLLED FROM CONTINUOUSLY CAST SLABS

Experimental rolling on an industrial scale of 175 x 700-mm cast slabs and 175 x 650-mm rolled slabs into Type R-50 and R-65 rails carried out on the Asovstal' Rail and Girder Mill (U.S.S.R.) is described. Preliminary trials at the Mill indicate that the mechanical properties of the rails produced from cast slabs are equal to those of conventionally rolled slabs. Detailed information is provided on the combined roll-pass design of the rolls for girders and rails. Tests for mechanical properties on rail steel specimens cut from the heads and webs are described. Graphic data are provided which show the relation between low temperatures and impact strength of longitudinal- and transverse-cut specimens.

Chishkhov, Yu. M., Minaev, A. F., Kondrashin, S. E., Petrovskii, A. A., Rudel'shii, M. L., Sviridenko, F. F., Stefanov, V. E., and Fradina, M. G., (Asovstal' Rail and Girder Mill, U.S.S.R.), Stal [in English], No. 3, March 1967, pp 228-231, 7 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0469

EFFECT OF A TENSILE MEAN STRESS ON THE ALTERNATING STRESS REQUIRED TO PROPAGATE AN EDGE-CRACK IN VARIOUS MATERIALS

The conditions governing growth or dormancy of edge-cracks in plate specimens of 12 materials subjected to general tensile loading cycle are investigated. The chemical composition and mechanical properties of the materials - heat treatment, tensile strength, elongation, and fatigue strength - are given. Details of the edge-notch plate specimen and the crack front profiles are shown. The data are plotted for each of the metals.

Frost, N. E., and Greenan, A. F. (National Engineering Laboratory, East Kilbride, Glasgow, Scotland), Journal of Mechanical Engineering Science, Vol 12, No. 3, pp 159-168, 1970, 6 figs., 6 tables, 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0470

STRAINING OF THE RAILWAY PERMANENT WAY BY HIGH AXLE LOADS [IN GERMAN]

The effects of high axle loads on railway rails was studied with respect to the various factors which result in damage to the rails and their beds. The results are applied to the special conditions existing in the permanent way.

Eisenmann, J., Stahl und Eisen, Vol 89, No. 7, April 3, 1969, pp 373-375, 3 figs., 1 table, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0471

THE FRACTURE TOUGHNESS OF CARBON-STEEL, ALLOY-STEEL AND HEAT-TREATED RAILWAY RAILS

The static and dynamic fracture toughness of standard carbon steel rail was determined using precracked Charpy bars. Since rails are subjected to dynamic loading conditions, dynamic fracture toughness tests were conducted on specimens from alloy-steel and heat-treated rails in order to compare fracture properties. In addition, the standard British rail steel and two heat-treated grades of British rail steel were evaluated.

It was found that carbon levels above 0.55 percent did not affect fracture toughness while increasing silicon decreased fracture toughness in both high- and low-carbon rails. In line with earlier work, it was found that decreasing pearlite spacing increased fracture toughness. In addition, the effects of manganese, chromium, and molybdenum are discussed.

Stone, D. H. (Manager-Metallurgy, AAR Technical Center, Chicago, Ill.), Report No. R-163, September 1974, 23 pp, 7 figs., 3 tables, 11 refs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: AAR Technical Center (repr., PC).

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0472

THE EFFECTS OF MICROSTRUCTURAL VARIATIONS ON THE STRENGTH AND TOUGHNESS OF RAIL STEELS

An experimental program was conducted on fully pearlitic rail steel to determine the effects of microstructural variations on tensile and impact properties. A heat-treating schedule was developed to isolate the effects of prior austenitic grain size, pearlite interlamellar spacing and, to a minor extent, pearlite colony size. Grain size was varied by a factor of ten, and

pearlite spacing by a factor of two. Room-temperature yield strength increased monotonically with decreasing interlamellar spacing, with the latter controlled by the transformation temperature and prior austenitic grain size. Charpy impact tests were performed to obtain an evaluation of toughness, and showed that toughness increased with decreasing grain size, and was largely independent of pearlite spacing. Dynamic fracture toughness values obtained from instrumented impact testing of precracked Charpy bars, were compared with the standard Charpy results and yielded similar findings. Thus, it was found that strength and toughness are controlled by different microstructural parameters, and can be varied independent of each other to optimize service performance.

Hyzak, J. M., and Bernstein, I. M. (Processing Research Institute, Carnegie-Mellon University, Pittsburgh, Pa.), and Stone, D. H. (AAR Technical Center, Chicago, Ill.), Report No. R-168, April 1975. for the Association of American Railroads, 33 pp, 10 figs., 3 tables, 16 refs., 2 appendixes.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: AAR Technical Center (repr., PC).

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0473

DIRECT TRACING OF ISOCLINATICS BY MOIRE PATTERNS

A graphical method is presented for directly determining the partial derivatives of displacements, and, in cases of small-strain fields, the components of strains. The linear differential moire method applied with a series of reference gratings of different linear disparities yielded the isoclinatics of the normal components of strains. The angular disparity method, where a reference grating of the same line frequency as the specimen grating was angularly displaced by different positive or negative angles, yielded the two cross-derivatives of the displacement from which, by addition only, the shear strain distribution is deduced all over the field. Thus, the strain tensor may be completely defined at every point in the strain field without necessitating the differentiation of the displacement fields obtained by the moire patterns.

Theocaris, P. S. (Laboratory for Testing Materials, Athens National Technical University, Greece), Materialprufung, Vol 10, No. 5, May 1968, pp 155-158, 4 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag GmbH (repr., PC).

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0474

THE MOIRÉ GRID-ANALYZER METHOD FOR STRAIN ANALYSIS

The state of strain throughout an extended field is determined from a single photograph by the moiré grid-analyzer method. This is accomplished by two families of moiré fringes that appear simultaneously on the specimen and rigid analyzer screens, thus providing displacements in the "x" and "y" directions throughout the field. Interweaving of moiré fringes so as to disguise the identity of each family is prevented by use of an initial pattern. A rigorous derivation is presented for interpretation of such patterns in terms of strains. Errors in computed shear strains caused by the analyzer misalignment are automatically canceled. The effects of rigid-body rotation of elements within the specimen are routinely eliminated in strain computations. The moiré grid-analyzer method not only makes possible analysis of problems that are considered difficult, but it also offers a simplification for extended-field moiré analyses.

Post, D. (Consultant, Vishay Instruments, Inc., Malvern, Pa., and Adjunct Prof. Rensselaer Polytechnic Institute, Troy, N.Y.), Experimental Mechanics, Vol 5, No. 11, November 1965, pp 368-377, 8 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0475

RAILS PRODUCED WITH FULL HEAT TREATMENT

The increased weights carried by rolling stock and the higher speeds result in shorter rail life. Since heat treatment is one of the principal means of lengthening rail life, the Nizhne-Tagil Combine (U.S.S.R.) established an experimental industrial heat-treating facility for the treatment of rails 12.5 m long by the through-hardening method. Research conducted using this facility enabled the principal parameters of the technology to be studied, and assisted in the determination of the requirements which must be met by the equipment for the mass heat treatment of rail 25 m long. Because of the difficulty of keeping the rails straight in the through-hardening process, the necessity for straightening equipment capable of straightening the rail in two planes is emphasized. Hardness, drop, and impact-strength tests were conducted, and the microstructure of the rail was examined. Data obtained for tensile strength, yield strength, elongation, and reduction of area are presented. The tests confirmed that rails satisfying the requirements in the Standards can only be produced if equipment ensuring an absolutely consistent technology is available. On the basis of this study, it is recommended that rails containing 0.67 to 0.72 percent carbon should be heated to 860 to 880 C; rails with 0.73 to 0.77 percent carbon should be heated to 840 to 860 C; the heating time should be 45 to 60 min; the temperature of the oil should be 50 to 90 C, and the rails must remain in it for not less than 5 min. The rails should be tempered for 2 hr at 450 ± 15 C. The length decided upon for Type R-50 rails to be heat treated was 24,970 mm, but this dimension would have to be adjusted.

Makaev, S. V., Vinokurov, I. Ya., Rabinovich, B. M., and Makarikhin, M. F. (Nizhne-Tagil Combine, U.S.S.R.), Stal [in English], No. 5, May 1967, pp 398-401, 8 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0476

WEB CRIPPLING TESTS ON HYBRID BEAMS

This investigation was undertaken to explore web crippling in hybrid beams for highway bridges and other applications. Although transverse loads (loads in the plane of the web and perpendicular to the longitudinal axis) are usually applied to the compression flange, they are sometimes applied to the tension flange; for example, near an interior support in a continuous-beam bridge, wheel loads are applied through the slab onto the tension flange. A test was performed with a transverse compressive load applied to the tension flange, and a second test was performed with a transverse compressive load applied to the compression flange. In both tests, a bending moment sufficient to cause web yielding was maintained in the beam while the transverse load was applied, and the effect of the transverse load on the behavior of the beam was observed. The tests showed that crippling loads equal to or greater than the nominal yield load, i.e., the yield point of the web steel times the bearing length of the load times the web thickness, can be applied to either the tension or compression flange of a hybrid beam, even when the longitudinal stress of the flange is close to the yield strength of the flange. The experimental crippling stresses were at least 10 times the maximum stress of about 3.8 ksi that would be expected in highway-bridge applications. The tests also showed that the moment capacity of a hybrid beam, i.e., the maximum moment that can be sustained without exceeding the yield strength of the flanges, is slightly reduced when a crippling load is applied to either flange, but that the reduction is small enough to be disregarded in design.

Schilling, C. G. (U.S. Steel Corporation, Monroeville, Pa.), Proceedings of the American Society of Civil Engineers, Journal of the Structural Division, Vol 93, No. ST 1, February 1967, pp 59-70, 10 figs., 9 refs.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0477

THE MOIRÉ-FRINGE METHOD OF DISPLACEMENT MEASUREMENT APPLIED TO INDIRECT STRUCTURAL-MODEL ANALYSIS

This paper describes the application of the moiré-fringe method of displacement measurement to indirect structural-model analysis. The indirect method of model analysis of structures entails the determination of the influence line of a force or moment at a section in the structure from accurate observations of the displacements of the model which occur when a chosen deformation is applied at the particular section under consideration. The basic concept of displacement measurement using moiré fringes is briefly described, and the preparation of the models to be used for demonstration purposes, line screens, testing procedures, displacement application and recording, and the interpretation of fringe patterns are discussed.

Shepherd, R. (University of Canterbury, Christchurch, New Zealand), and Wensley, L. McD. (Moir, Mew & Jenkins, Consulting Engrs., Invercargill, New Zealand), Experimental Mechanics, Vol 5, No. 6, June 1965, pp 167-176, 12 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0478

BASIC OPTICAL LAW IN THE INTERPRETATION OF MOIRÉ PATTERNS APPLIED TO THE ANALYSIS OF STRAINS—PART 1

The objective of this paper is to generalise the optical law that relates the displacement field to the fringes of moiré patterns. Displacements that are equal to an integral number of times the master grid pitch or half the master grid pitch are related to the points of maximum and minimum light intensity, respectively. The generalised optical law gives a continuous relationship between displacements and light intensities. By applying this law it is possible to increase the precision of moiré far beyond the actual limits.

Sciammarella, C. A. (University of Florida, Gainesville, Fla.), Experimental Mechanics, Vol 5, No. 5, May 1965, pp 154-160, 5 figs., 4 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0479

BASIC OPTICAL LAW IN THE INTERPRETATION OF MOIRÉ PATTERNS APPLIED TO THE ANALYSIS OF STRAINS—PART 2

The object of Part 2 of this paper is to show applications of the displacement-light-intensity law derived in Part 1. A photoreading device is described which, combined with the new theory, yields an accuracy beyond the limits so far obtained by the usual method of handling moiré data. Three tests are presented: one test is used as an illustration of the applied procedures, the other two for comparison with theoretical results. These tests show that the theory is useful and that strains can be obtained with an accuracy impossible to achieve by the discrete point method of analysis. Relatively coarse grids (300 lines/in.) are used for these tests.

The equipment used in demonstrating the method of applying the photoelastic test processes is described and shown.

Ross, B. E., Sciammarella, C. A., and Sturgeon, D. (University of Florida, Gainesville, Fla.), Experimental Mechanics, Vol 5, No. 6, June 1965, pp 161-166, 8 figs., 8 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0480

UNCONVENTIONAL TRACKS: LABORATORY AND SITE MEASUREMENTS OF STIFFNESS AND DAMPING OF SELECTIVE TYPES OF DIRECT FIXING FOR TRACKS WITHOUT BALLAST

In the study of vibration and noise with slab-base track, the program envisaged three stages of investigation: track tests at Radcliffe-on-Trent, laboratory tests to establish mechanical properties of fastenings and, finally, a study of their correlation.

This report explains the techniques used in laboratory tests by BR and gives data on stiffness and damping, particularly in the frequency range up to 30 Hz, but provides some results of some experiments under higher frequencies using a resonating system. The results of the study are intended for use in predicting the dynamic interaction between the wheel and the rail. (Carried as RRIS Accession No. 052534).

Jenkins (Chairman, Committee D 87), Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. D 87/RP 8/E, April 1973, 31 pp, 36 figs., 9 tables, 3 appendixes.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0481

OPTIMUM ADAPTATION OF THE CONVENTIONAL TRACK TO FUTURE TRAFFIC: DESCRIPTION OF THE RESEARCH METHODS; DEFINITIONS

This report is devoted essentially to the definition of a plan of work enabling the optimum adaptation of conventional track to future traffic (heavy axle loads and high speeds) to be obtained.

Having described the general concepts and the definitions useful for the pursuit of the study, the plan of work which follows two principal research paths is evolved: tests with predetermined loads and field tests under actual traffic loads; associated work, such as the determination of the rheological properties of the track and the study of ballast performance in the laboratory, is also envisaged and explained. Test areas and certain methods of measurement are described in the appendices.

Janin (Chairman, Committee D 117), Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. D 117/RP 1/E, October 1971, 53 pp. 9 figs., 1 table, 8 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0482

ACOUSTIC EMISSION MONITORING OF SHOP AND FIELD WELDS OF RAIL

A brief program was conducted utilizing state-of-the-art acoustic emission instrumentation to monitor both thermite cast welding and electric flash-butt welding of rail. The primary objective of the program was to investigate the applicability of acoustic-emission techniques for determining the quality of the weld.

Welds on continuous rail strings were monitored during electric flash-butt welding, weld cool-down and weld anneal. The specimen welds were fabricated to represent a variety of good and poor conditions. Piped rail sections, for example, were joined to good rail and electrode burns were purposely made, as were good welds. The acoustic-emission data, both location and number have been correlated with mechanical properties established by physical tests of the welds. Fractographs of the rail sections are shown. The acoustic-emission data gathered during the weld-anneal cycle show a tentative relationship to the strength of the weld. Acoustic-emission data were obtained for a total of seven welds. Thermite

cast welding, as used in the field joining of rail, was also monitored with the same acoustic-emission instruments.

Stone, D. H. (Manager-Metallurgy, AAR Technical Center, Chicago, Ill.), Report No. 162, September 1974, 71 pp, 44 figs., 9 refs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: AAR Technical Center (repr., PC).

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0483

SUMMARY OF PERFORMANCE OF STANDARD-CARBON AND VARIOUS WEAR-RESISTANT RAILS IN TEST CURVES OF THE CHESSIE SYSTEM - SECOND REPORT

This report summarizes the findings of the second annual inspection of a service test installation of fully heat-treated, induction head-hardened, intermediate-manganese and standard control-cooled rail on the Chessie System.

The field inspection is part of the cooperative effort on rail research of the American Railway Engineering Association, the American Iron and Steel Institute, and the Association of American Railroads to observe and analyse those rails in curved track that display some potential for improvement in wear resistance and retarding the onset of shelling.

Measurements were made and recorded of curvature, superelevation, and gage of four service test curves located near Oakland, Maryland. General track conditions were observed also. Rail head cross-section contours were taken and recorded of the 80 test rails contained in these curves. Rail wear has been calculated for the second year of service for the various types of rail in test.

Schoonenberg, K. W. (Research and Test Department, Association of American Railroads, Chicago, Ill.), Report No. 171, April 1975, 25 figs., 1 table.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: AAR Technical Center (repr., PC).

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0484

THE TRACK-GEOMETRY CAR: NEWEST TOOL OF M/W POLICY

The third "roundtable" discussion held by Railway Track and Structures was devoted to a discussion of the track measuring car. Participants in the roundtable were representatives from U. S. railroads that own such cars, and the discussion dealt with all aspects of the subject believed to be of interest to engineers on other railroads. Opinions obtained from the Canadian Pacific as well as from the Quebec, North Shore and Labrador, are presented. The second part of this article was to be presented in the April 1974 issue of this journal.

Railway Track and Structures, Vol 70, No. 3, March 1974, pp 26-30, 92, and 94, 2 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0485

USE OF THREE-DIMENSIONAL PHOTOELASTICITY IN FRACTURE MECHANICS

The philosophy of fracture mechanics is reviewed and utilized to formulate a simplified approach to the determination of the stress-intensity factor photoelastically for three-dimensional problems. The method involves a Taylor Series correction (TSCM) for the maximum in-plane shear stress and does not involve stress separation. The results are illustrated by applying the TSCM to surface flaws in bending fields. Other three-dimensional problems solved by the TSCM are cited.

Smith, W. C. (Virginia Polytechnic Institute and State University, Blacksburg, Va.), Experimental Mechanics, Vol 13, No. 12, December 1973, pp 539-544, 10 figs., 23 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0486

A CALCULATION OF THE LATERAL HUNTING MOTION OF A TRACKED VEHICLE

The lateral hunting motion of a train not only affects riding comfort, but may also cause derailment. The initial step in the design of a safe high-speed train is a theoretical and experimental investigation of this motion and the determination of a practical method for preventing it.

The author's analysis approach to the problem is the "transfer-matrix" technique, whereby once the transfer matrices of each component (car) are derived, it is only necessary to perform successive matrix multiplications to fit the entire system. The technique may also be used to analyze the stability problem associated with the lateral hunting motion, and the forced vibrations caused by lateral distortions and irregularities in the rails.

Iguchi, M. (Massachusetts Institute of Technology, Cambridge, Mass.), Report No. DSR 76109-5, November 1, 1966, for the U.S. Dept. of Commerce, Contract No. C-85-65, 23 pp, 12 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 173 652.

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0487

STUDY OF NEW TRACK STRUCTURE DESIGNS

The effect of an abrupt change of elastic foundation properties upon the motion of a high speed vehicle is investigated in detail in this study. Limiting allowable accelerations are chosen as the criteria for riding quality. The study indicates that there is a likelihood of encountering a variety of elastic soil combinations which can seriously deteriorate the riding qualities of a rail vehicle on conventional track.

As remedial measures, two alternatives are considered to improve the quality of ride; one by improving the rigidity of the track structure by utilizing narrow vertical walls embedded in the subsoil, and the other by carefully compacting the foundation soil to minimize local variations. The relative economics of the alternatives are also investigated.

Bhatia, G. S., Romualdi, J. P., and Thiers, G. R. (Carnegie-Mellon University, Transportation Research Institute, Pittsburgh, Pa.), for DOT/Office of High Speed Ground Transportation, Contract No. C-222-66 (neg), 98 pp, 29 figs., 7 tables, 20 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 179 401.

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0488

NOISE DURING THE USE OF AN ULTRASONIC ECHO-PULSE FLAW DETECTOR

The results of studies of acoustic interference in the ultrasonic high-speed testing of rails are discussed. The statistical behavior of the amplitude and length distributions of the noise pulses are determined. A method for estimating the freedom from interference of ultrasonic detectors is provided, and the apparatus, consisting of the flaw detector, the amplitude calibrator, and an oscillograph with camera for analyzing the amplitude distribution of the acoustic noise pulses is described.

Lomchak, V. A. (All-Union Scientific-Research Institute of Nondestructive Testing, Kishinev, U.S.S.R.), Defectoscopy: The Soviet Journal of Non-destructive Testing (Translation by Scientific Consultants Ltd., London), No. 5, 1969, pp 529-534, 4 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0489

MOIRÉ METHOD OF STRAIN ANALYSIS—CHAPTER VI

This chapter, the sixth in a series of seven, is reprinted from SESA's (Society for Experimental Stress Analysis) Manual on Experimental Stress Analysis. It describes the optical phenomenon designated the "moiré effect" which involves two closely spaced, superimposed arrays of lines that are viewed with either transmitted or reflected light. If the two arrays consist of opaque parallel lines which are not identical in either spacing (pitch) or orientation, then interference occurs between the two arrays, and moiré fringes are produced. The applications of the moiré method of strain analysis are briefly reviewed with regard to the mechanism of fringe formation. The interpretation of moiré fringe patterns is discussed by relating them to the displacement field. The author states that the method has a great deal of potential, in theory, since it provides whole-field data similar to that of photoelasticity. The major problems associated with the application of the method lie in the availability of suitable line arrays with sufficiently high pitches. Illustrations are provided which show formation of the pattern and some examples are given for a special tensile-strength specimen.

Riley, W. F. (Iowa State University, Ames, Iowa), Experimental Mechanics, Vol 7, No. 2, February 1967, pp 19A-24A, 6 figs., 12 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0490

IMPROVING THE QUALITY AND SERVICE LIFE OF RAILWAY RAILS

Background information concerning the trends and developing interests in solving railroad quality and improvement problems is presented. The creation of a Soviet Interdepartmental Commission for Improving the Quality and Service Life of Railway Rails spurred the efforts of all organizations active in the rails area to coordinate their research. Rail steel metallurgy and rolling practices at the various sections of the Kuznetsk Iron and Steel Combine, the Azovstal' Plant, and the Ukrainian Metals Research Institute are discussed. The rail heat treatment activities of the Nizhne-Tagil' Iron and Steel Combine are described. Brinell hardness, tensile-strength, elongation, area-reduction, and impact-strength data for rail steels having different heat treatments are given.

Kazarnovskii, D. Z., and Naumov, A. N. (Ukrainian Metals Research Institute and the General Directorate of Railway Trackwork and Structures, U.S.S.R.), Stal [in English], No. 3, March 1966, pp 225-228, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0491

NON-METALLIC INCLUSIONS IN RAIL STEEL DEOXIDIZED BY VARIOUS METHODS

This investigation was conducted to study the influence the method of deoxidation of rail steel has on the nature of the nonmetallic inclusions with the aim of ensuring a more uniform distribution in the finished rolled product. Conventional metal and the steel from seven trial heats deoxidized by various methods were subjected to metallographic

examination. It was found that when calcium silicide only was used for deoxidation in the ladle (at the rate of 3.5 kg/ton) or calcium silicide with additions of inoculants (ferrotitanium or ferrovanadium at the rate of 1.0 kg/ton each), the inclusions were of a more favorable nature and were more uniformly distributed in the metal than when the normal deoxidation practice was used (i.e., by means of aluminum at the rate of 0.3 kg/ton and 45 percent ferrosilicon).

Klemeshov, G. A., Borokhov, V. I., Derfel', A. G., Pyatikop, V. Ya., and Tarasova, L. P. (Ukrainian Scientific Research Institute for Metals and the Azovstal' Plant, U.S.S.R.), Steel in the U.S.S.R., Vol 1, No. 4, April 1971, pp 287-290, 1 fig., 2 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0492

PHOTOELASTIC RESEARCH ON DYNAMIC STRESSES

The general concepts associated with the photoelastic techniques for stress and strain analysis are briefly described and the application of such techniques to studies of dynamic stresses is discussed. Dynamic stress phenomena which may be analyzed by photoelastic means are grouped in three classes: (1) processes with quasi-static states of stress, (2) vibrations, and (3) stress waves. Various types of photoelastic techniques which have been developed during the past decade (e.g., the Cranz-Schardin system and the Tuzi, rotating-tube, and Photostress method) are described, and the equations which are used in analyzing the results obtained are presented.

Kuske, A. (Technische Hochschule Stuttgart, West Germany), Experimental Mechanics, Vol 6, No. 2, February 1966, pp 105-112, 6 figs., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0493

THE MOIRE METHOD FOR MEASURING LARGE PLANE DEFORMATIONS: GENERAL THEORY AND APPLICATION TO HOMOGENEOUS DEFORMATION

In this article the moire theory for a plane large deformation field is developed using a generalization of the method of indicial representation of figures which was developed earlier by other researchers in this area. The moire equations are developed for arbitrary specimen and master grid pitches and orientations. The choice of master grid is made to represent the coordinate system best suited to the geometry of the undeformed or deformed state of the plane region, and it can be changed arbitrarily during the course of an experiment to obtain more easily measurable patterns. The deformation and strain tensor components determined correspond to the modern theoretical definitions, which simplifies the stress tensor reduction through ready application of existing field theories. Furthermore, either material or spatial reference frames can be used. The results are specifically verified for the measurement of a large simple shear deformation.

Martin, L. P., and Ju, F. D. (University of New Mexico, Albuquerque, N.M.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 36, No. 3, September 1969, pp 385-391, 8 figs., 1 table, 14 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0494

FRA TRACK SAFETY STANDARDS: MODIFICATIONS ARE NOW OFFICIAL

The amendments to FRA Track Safety Standards are: 213.61 Curve data for classes 4 through 6 track; 213.9 Classes of track: Operating speed limits; 213.13 Measuring track not under load; 213.109 Cross ties; 213.113 Defective rails; 213.133 Turnouts and track crossings generally; 213.233 Track inspections; 213.237 Inspection of rail; 213.241 Inspection records. A listing of all types of rail

defects, their lengths, percent of railhead cross-sectional area weakened by the defect, and the remedial action prescribed is included. (Carried as RRIS Accession No. 050415).

Railway Track and Structures, Vol 69, No. 2, February 1973, pp 25-26, 2 figs., 5 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0495

FATIGUE RESISTANCE OF RAIL STEEL [IN FRENCH]

The stress distribution in the longitudinal symmetry plane of the rail was determined for the purpose of obtaining a precise description of the "oval-spot" defect. The yield point and fatigue strength of rail steels may be improved either by work-hardening or by work-hardening followed by an aging period. This article is a summary of a science doctorate thesis submitted by the author.

Stremsdoerfer, M. J., Revue de Metallurgie, Vol 67, No. 12, December 1970, pp 1085-1086, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Revue de la Metallurgie (repr., PC).

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0496

UNCONVENTIONAL TRACKS: NOISE AND VIBRATION FROM UNCONVENTIONAL TRACKS (EXPERIMENTS AT RADCLIFFE-ON-TRENT 1969 AND 1970)

This report presents results of noise and vibration measurements taken on various types of track at Radcliffe-on-Trent. Critical comparisons are attempted to show the effects of varying the types of rail fixing, pad stiffness and spacing, changes in speed, time, and weather. The objective of the research was to establish the fundamental principles and constructional recommendations for unconventional tracks, including those without ballast. Methods were sought for designing for minimum noise emission and ground vibration consistent with adequate mechanical strength. All but one of the railroad sections examined in the experiments had a continuous or quasi-continuous concrete slab as a basic supporting structure. The remaining section consisted of BR standard ballasted track with concrete sleepers. Two sets of experiments were conducted approximately one year apart. During the year between experiments, the test track was traversed by 3 to 5 million tons at speeds between 40 and 96 km/hr. (Carried as RRIS Accession No. 052518.)

Jenkins (Chairman, Committee D 87), et al., Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. D 87/RP 6/E, Report No. 6, April 1973, 91 pp, 51 figs., 13 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (repr., PC).

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0497

TESTS ON THE TRACK ON THE RIDING STABILITY AND THE CURVING QUALITY OF VEHICLES BY MEANS OF A SPECIAL VEHICLE: RESULTS OF THE FIRST TRACK TESTS

This report presents the results of tests made with the experimental bogie track inspection vehicle described in a previous report. The first part of the report contains data relating to four series of tests in which the various parameters of the bogie (lateral play between axle box and axle, axle load) and also the riding speed were successively varied. The second part of this report supplies data relating to

the tests during which the wheelbase of the test bogie was varied. The data obtained have permitted the establishment of some conclusions relating to the wavelength of the hunting movement, the transverse displacement of the bogie frame, the maximum angle of rotation of the bogie, and the transverse forces. The third part of the report contains an account of the results obtained during the tests.

Mauzin (Chairman, Committee B 52), et al., Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Question B 52, Interim Report No. 2, June 1963, 74 pp, 35 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0498

TESTS ON THE TRACK ON THE RIDING STABILITY AND THE GUIDING QUALITY OF VEHICLES BY MEANS OF A SPECIAL VEHICLE: CHARACTERISTICS OF THE EXPERIMENTAL VEHICLE

The objective of this investigation was to study experimentally the riding stability and the hunting movements of vehicles through the use of a track inspection vehicle of simple design (a two-axle isolated bogie). This design was selected so that each of the parameters entering into the dynamic phenomenon involved with the operation of the bogie could be separately varied and measured. The experimental bogie was placed under the middle section of the body of an ordinary bogie coach. The bogie and the experimental coach are described in detail along with the methods adopted for measuring transverse forces, transverse displacement, track gauge, and angle of rotation of the bogie frame. The experimental procedure for the determination of the radii of gyration of the bogie is also given.

Mauzin (Chairman, Committee B 52), et al., Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Question B 52, Interim Report No. 1, June 1963, 50 pp, 31 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0499

FORMATION OF FATIGUE CRACKS IN RAIL [IN GERMAN]

The rates of unlimited fatigue strength resisting flexion, traction-compression, and shearing, are, in the case of a perfect steel, linear functions of the resistance to fracture caused by traction, in the author's view. He provides diagrams showing these rates, as well as their variation in relation to the rail surface. He makes brief reference to the distribution of pressures in the rail, and explains the manner in which the rates of unlimited fatigue strength can be exceeded when the rail contains inclusions of slag, segregations, or concentrations of ferrite. He explains, in detail, the mechanism of the propagation of the oval flaw and concludes with a number of observations concerning the means of improving the resistance of rails.

Beres, L. (Technical University of Miskolc, Hungary), Eisenbahntechnische Rundschau, No. 3, March 1973, pp 98-103, 17 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0500

GENERAL ASPECTS OF THE LATERAL DYNAMICS OF RAILWAY VEHICLES

Recent developments in research into the lateral dynamics of railway vehicles are reviewed with particular reference to dynamic stability, dynamic response, and curving. Two engineering aspects of this work are stressed: the advantages of applying linear theory to a comprehensive study of vehicle dynamics, and the choice of basic assumptions required to make such studies realistic for design purposes. Deviations from a pure rolling motion are described in terms of longitudinal creepage, lateral creepage, and spin. These quantities give rise to corresponding creep forces and a couple. Graphs are presented that describe the lateral dynamics of a two-axle vehicle in terms of longitudinal suspension stiffness and vehicle speed as well as lateral stiffness and vehicle speed.

Wickens, A. H. (British Railways Research Department, Derby, England), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 91, No. 3, August 1969, pp 869-878, 12 figs., 34 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0501

INVESTIGATION OF FAILURES IN CONTROL-COOLED RAILROAD RAILS

This study, sponsored by the subcommittee on "Conditions Affecting Service Life of Rail, Causes of Rail Failures and Defects" (Assignment 2), is reported on as Appendix 2-a.

Reports on the failure of 49 control-cooled rails are presented for use by railroad engineers, rail manufacturers, and the American Association of Railroads. These include transverse fissures from shatter cracks and from hot torn steel, compound fissures from inclusions, fractures from shelling and engine burns, rail-end batter, surface defects, and web failure. Each of the failures is discussed and detailed data are presented in tabulations. Trends are shown for service and detected failures in the United States and Canada for the years 1910 through 1950. Statistical data for accumulated failures of all types of failures by railroad in the period between 1943 and 1963 are included.

Cramer, R. E. (University of Illinois, Urbana, Ill.), Proceedings of the 54th Annual Convention of the AREA, Vol 56, 1955, pp 895-929, 12 figs., 23 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0502

CONTRIBUTION TO THE DETERMINATION OF SMALL PLASTIC DEFORMATIONS BY MEANS OF A MAGNETIC MEASURING METHOD [IN GERMAN]

The author discusses the effect of plastic deformation on the magnetic characteristics of materials.

Stress-strain and stress-induction diagrams are plotted and a statistical evaluation of the results is given. By application of the relationship which exists between the maximum induction-stress value and the permanent set value, and using undeformed steel as a basis for comparison, the degree of plastic deformation in steel can be determined. The test equipment used for studying the magnetic characteristics of steel undergoing plastic deformation is shown.

Cornut, A. (Laboratorium der Lehrstuhls Festigkeitslehre der Technische Hochschule, Timisoara, Rumania), Materialprufung, Vol 9, No. 10, October 1967, pp 381-383, 6 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0503

RAILS MADE OF BASIC CONVERTER STEEL TOP BLOWN WITH OXYGEN

The process for producing a trial batch of R-50 type railway rails, rolled and heat treated at the Dzerzhinskii plant is described. After the process was completed, and following rolling and quenching, the mechanical properties of the rails were examined and the yield-point, tensile-strength, elongation, impact-strength, and reduction-of-area values, are presented in tabular form. The results of metallographic studies to determine the amount of nonmetallic inclusions present and the grain size of the rails, are also presented. The inclusions revealed by the examinations were oxides and sulphides. Comparisons were drawn between chemical compositions of the Bessemer and OH steels, as well as between their Brinell hardness values.

Sorokin, A. A., Kutsenko, A. D., Karpunin, A. M., Rekhlis, G. M., Shcherbina, P. A., and Orgiyan, V. S. (Dzerzhinskii Steel Works, U.S.S.R.), Stal [in English], No. 5, May 1964, pp 359-360, 1 fig., 2 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0504

THE EFFECT OF THE PLASTIC DEFORMATION IN AN AUSTENITIC STATE ON THE TEMPER BRITTLENESS OF RAIL STEEL

Billets of R-65 rail steel of the standard chemical composition (0.70% C, 0.80% Mn, 0.18% Si) were heated to 950°C in an electric furnace, deformed 30% at 850°C in a two-high rolling mill, and immediately afterward quenched in water. The quenched billets were tempered at from 200 to 600°C. Specimens cut from these billets were then subjected to impact tests. Findings: compared with undeformed specimens, which were subjected to similar high-temperature thermomechanical treatment and, following their tempering, cooled in the furnace at 40°C/hr and in water, the specimens with 30% deformation and with quenching in water display a higher impact strength and a somewhat greater (by 1 to 2 units) Rockwell hardness and their curve of impact strength as a function of tempering temperature lacks a minimum in the 250 to 300°C range, while in the 500 to 550°C range its value is close to the level of impact strength for specimens cooled in water. Thus, combining deformation with quenching under conditions precluding the recrystallization of work-hardened austenite suppresses both irreversible (250 to 300°C) and reversible (500 to 550°C) temper brittleness.

Drushinin, V. V., Tarasko, D. I., Grdina, Yu. V., Izvestiya Vysshikh Uchebnykh Zavedeniy-Chernaya Metallurgiya (News of Institutions of Higher Learning--Ferrous Metallurgy), Edited Translation by Translation Division FTD, Report No. FTD-HT-23-1465-67, December 1966, 2 pp, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Defense Documentation Center (repr., PC, microfiche), AD 678406.

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0505

INFLUENCE OF DEOXIDATION AND ALLOY ADDITIONS ON THE PROPERTIES OF RAIL STEEL

The combined investigation is described of the content of inclusions, mechanical properties, and life of batches of rails during testing in a circular experiment track and in actual service track. The rails were produced at three plants using standard practice and also 18 different trial deoxidation variants. Calcium silicide is recommended as deoxidant for reduction of inclusions. The best service properties (tonnage carried

by the rail before the onset of defects due to contact fatigue) were observed in rails of steel deoxidized with calcium silicide and alloyed with vanadium.

Lempitskii, V. V., Derfel', A. G., Kravtsova, I. P., Kazarnovskii, D. S., Kotin, A. G., and Shnaperman, L. Ya. (USSR Ministry of Ferrous Metallurgy and the Ukrainian Research Institute for Metals), Stal [in English], No. 4, April 1970, pp 341-345, 6 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0506

UNIVERSAL HEAVY-TYPE RAIL-PASS DESIGN

An attempt to introduce two new sections at the Nizhnii-Tagil Combine on the rail and structural mills is described, viz., heavy R-75 rails and OR-75 ramp rails in small roll-change batches between the normal R-65 rails. Due to the universal nature of the T-shaped passes in the roughing stands it was found possible to do so to a large extent using the same rolls as used for the R-65 rails. A formula was deduced for calculating the width of the finishing pass which allows for the deformation of the section during subsequent cold straightening in the roller straightening machines. Roll-pass designs, reduction sequences, and methods of mounting the passes in the rolls are presented for rolling these R-75 and OR-75 rails.

Feigin, G. D., and German, I. M. (Nizhnii-Tagil Combine, U.S.S.R.), Steel in the USSR, Vol 4, No. 6, June 1974, pp 484-486, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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0507

ANALYSIS OF THE THERMAL CONDITIONS FOR THE FORMATION OF MARTENSITE BY FRICTION [IN GERMAN]

A mathematical model based on electrical-circuit equivalence and used to calculate the minimum heat-flux density required for the formation of martensite at the surface of railroad rail steel by friction is described. With this model, it is also possible to determine the thickness of the friction-martensite layers. Conclusions drawn from the results are applicable to the formation of the brittle martensite on rails and the wheels of railroad rolling stock, such as freight cars, by braking and engine burns. Other applications are briefly discussed.

Wolfstieg, U., (Institut fur Werkstoffkunde, Universitat Karlsruhe, West Germany), Haerterei--Technische Mitteilungen, Vol 29, No. 4, December 1974, pp 263-269, 17 figs., 1 table, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC and microfilm).

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0508

EFFECT OF THE CURVATURE OF RAILWAY RAILS BEFORE COLD STRAIGHTENING AND OF THE STRAIGHTENING VELOCITY ON THE RECTILINEARITY OF THE FINAL PRODUCT

Factors affecting the straightness of railway rails after cold straightening are considered. The amplitude and frequency of vibrations caused by the straightening machine depend on the degree of initial curvature, the velocity of the rolls, and the physicomechanical properties of the rails. Recommendations for eliminating the problem, involving the use of an automatic control

system to adjust the parameters of the straightening machine, are discussed.

Gavrilyuk, A. N., Kachanenko, A. K., Orgiyan, V. S., Avdeev, M. G., and Sergun, A. I. (All-Union Research Institute of Ferrous Metallurgy and the Dzerzhinskii Works, U.S.S.R.), Steel in the USSR, Vol 1, No. 11, November, 1971, pp 1017-1020, 4 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0509

INVESTIGATIONS ON THE FORM STABILITY OF RAILS AND CONCLUSIONS FOR THE PRACTICE [IN GERMAN]

Investigations into the effects of tensile strength and steel qualities on the form stability of rails when they are subjected to flexural or bending stress are discussed. The role played by the surface condition of the rail is also considered. The testing procedures and test equipment used in providing rolling load action are described. The data obtained during the investigation are analyzed and presented graphically. The results show the hazard of fatigue failure with the S49 rail on main lines, which led to recommendations that the UIC 60 standards be used. (Carried as RRIS Acc. No. 057462)

Eisenmann, J., Oberweiler, G., Schweitzer, R., Heller, W (Technische Universitat Muenchen, and Fried. Krupp Huttenwerke AG, West Germany), Eisenbahntechnische Rundschau, Vol 23, No. 3, March 1974, pp 122-126, 8 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratory.

PURCHASE FROM: Hestra-Verlag (repr. PC).

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0510

NONMETALLIC INCLUSIONS IN RAIL STEEL DEOXIDIZED BY VARIOUS METHODS

See 0491

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0511

CAUSES OF THE OCCURRENCE OF CONTACTLESS DEFORMATION OF RAILS IN ROLLING AND MEASURES TO PREVENT IT

The causes of contactless deformation, observed when rolling rails after discharging from the finishing pass, and attempts made to prevent this are described. These conditions usually appear during the rolling process when a downward deflection of the rail head becomes evident and are due primarily to the difference in peripheral speed on the pass. Forces generated in this phase are unequally distributed over the width of the pass and are directed to the individual parts at different sides. Also considered are moments of these forces acting on the small section of the web, which give rise to the deformation and cause impairment to the quality of track joints. An active influence on the magnitude and direction of the contactless deformation of the rails can be exerted by changing the position of the neutral line of the pass over the height; the influence of upward and downward displacement of this line is examined.

Sharapov, I. A. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 11, November 1970, pp 1010-1012, 1 fig., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0512

STRENGTHENING OF RAIL HEADS IN R-50 RAILS DURING ROLLING

A new method of strengthening railway rails during the process of rolling in which the rail head is heavily worked in a universal stand and then quenched on the running surface with an air-water mixture at the Kuznetsk Works has been investigated. Tests on the qualities, chemical composition, and mechanical properties at the Siberian Metallurgical Institute showed that the method improves the structure and strength of the rails. Microphotographs of steel samples, which reveal the microstructure of the rail heads cooled with an air-water mixture are presented. Comparisons are drawn between the results obtained with the described process and similar results obtained when the rails were oil quenched.

Nekrasov, S. G., Chelyshev, N. A., and Voroshishchev, V. I. (Siberian Metallurgical Institute and the Kuznetsk Works, U.S.S.R.), Steel in the USSR, Vol 2, No. 4, April 1972, pp 307-309, 3 figs. 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0513

AN INTRODUCTION TO THE FRACTURE MECHANICS OF RAILROAD MATERIALS

This report is intended to serve as a primer for railway personnel on the subject of fracture mechanics.

Most structural materials contain flaws or cracks that are introduced during fabrication or service. Under various combinations of static and alternating loads and reactive environments, these flaws begin to grow slowly and stably. Unstable fracture leading to complete structural failure occurs when a flaw has developed to a critical size. The critical flaw size is a function of both the applied and/ or residual stresses acting on the structure, and the toughness of the materials. The principles of linear elastic fracture mechanics can be used to describe the functional relationships for unstable (brittle, rapid) fracture that occurs even though nominal stresses are below the general yield strength (i.e., before full plasticity has occurred in the structure).

The effects of temperature, composition, strain rate and microstructure are discussed using data gathered from railway materials. (Carried as RRIS Acc. No. 080 369)

Tetelman, A. S. (University of California, Los Angeles, Cal.), and Stone, D. H. (AAR Technical Center, Chicago, Ill.), Report No. R-157, May 1974, 27 pp, 11 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: AAR Technical Center (repr., PC).

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0514

INVESTIGATION OF THE NATURE AND DISTRIBUTION OF NON-METALLIC INCLUSIONS IN A 10-TON INGOT OF RAIL STEEL

A study was made of the nature and distribution of non-metallic inclusions in a 10-ton ingot of rail steel containing C 0.78, Mn 0.80, Si 0.18, S 0.029, P 0.020, and As 0.122%. The content of oxide inclusions along the height and cross section of the ingot varied in the range 0.0071-0.0149% except in the central portion where oxide aggregates (up to 0.03%) were found. Non-metallic inclusions were located mainly in the interaxial space and along primary grain boundaries. Sulphide aggregates were found in the top portion of the ingot.

Dorokhov, V. I., Klemeshov, G. A., Ryabinin, B. G., Glazov, V. I., and Malashenko, R. B. (Ukrainian Institute of Metals, U.S.S.R.), Stal [in English], No. 11, November 1970, pp. 1035-1037, 2 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0515

DEVELOPMENT, PRODUCTION AND PROPERTIES OF SELF-HARDENED WEAR-RESISTANT RAILS [IN GERMAN]

Self-hardened alloy steel and special heat-treated steel were studied. The chemical compositions and the related mechanical properties of the steels were determined and are presented. The formation of fissures and their prevention are discussed. The superiority of continuous welded rail over rail connected with joint bars is noted. Illustrations showing rail defects, microstructures, of the steels, and the critical areas of the railhead are included.

Janiche, W., and von Hye, H. (Rheinhausen, West Germany), Stahl und Eisen, Vol 81, No. 19, September 14, 1961, pp 1253-1263, 26 figs., 2 tables, 21 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0516

INFLUENCE OF STRUCTURE ON THE GROWTH RATE OF A FATIGUE CRACK IN RAIL STEEL

A study and laboratory experiment concerning the propagation of fatigue cracks is described. The related theory and processes involving crack formation and the growth rates are briefly reviewed. To study the rate of fatigue crack growth a special experimental apparatus was constructed so that the time of the crack formation could be established accurately and its subsequent growth could be observed continuously until the specimen failed. Flat rail steel specimens simulating the rail head were used for the tests. Heat treatment and quenching of the specimens are discussed. Curves are plotted which show the length of the cracks which developed as a function of cyclic stress.

Stakanova, A. A. and Sokolov, P. S. (All-Union Research Institute of Railway Transport, Ural Dept., U.S.S.R.), The Physics of Metals and Metallography, Vol 26, No. 6, June 1968, pp 153-155, 3 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau Ltd. (repr., PC).

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0517

RAIL QUALITIES FOR SPECIAL STRESSES IN RAIL TRACK AND SWITCH CONSTRUCTION [IN GERMAN]

See 0174

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0518

THE INVESTIGATION OF RESIDUAL STRESSES IN RAILS WELDED BY ALUMINOTHERMIC PROCESS [IN GERMAN]

Residual stresses were ascertained experimentally in nonwelded and in aluminothermic-welded rails with and without weld reinforcement. Strain gauges were used to measure the deformation caused by stress relaxation as components were sectioned. In nonwelded rails tensile stresses were found to be present in the head and the foot in a direction parallel with the rail axis, and compressive stresses were present in the rail web. In welded rails the pattern was reversed, with tensile stresses in the web and compressive stresses in the head and foot. The stress pattern in the welded rails is advantageous because it increases the capacity of the rail to withstand tensile stresses imposed by the load.

Dhose, R. (Elektro-Thermit, GmbH, Essen, West Germany), Schweissen und Schneiden, Vol 19, No. 10, October 1967, pp 471-476, 8 figs., 9 refs.

ACKNOWLEDGMENT: Battelle-Frankfurt Laboratories.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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0519

EXAMINATIONS OF BASIC BESSEMER RAIL STEEL [IN GERMAN]

Basic Bessemer rail steels were studied to determine the causes of black spots (inclusions) and vertical shatter cracks in rails. The authors found that they are related to the presence of oxygen and therefore to the inclusion content of the steel which is a result of the melting and pouring practices employed. Solutions to the problems are suggested. Other investigations in this study included: the role of hydrogen in rail failures, internal/residual stresses, and surface defects. The results obtained with ultrasonic testing are critically evaluated.

Schmedders, H., Hammer, R., and Schrape, U. (Werkstoffausschusses des Vereins Deutscher Eisenhuttenleute), Archiv fur das Eisenhuttenwesen, Vol 37, No. 7, July 1966, pp 551-560, 19 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0520

REPRODUCTION OF TRANSVERSE FATIGUE FAILURES OF RAILS IN LABORATORY CONDITIONS

Transverse fatigue failure of rails, was investigated by inducing, under laboratory conditions, failure of rail steel specimens mounted in a special holder simulating a rail crosstie and plate with eight supports. The tests were carried out by applying alternate reversing stresses (tensile and compressive) to the upper edge of the specimen by means of a four-roller machine. A schematic diagram showing the rolling load concept, resembling the Winkler model, is given. Equations are provided for calculation of compressive and tensile stresses. The test data are analysed, and the authors conclude that transverse cracks in the specimens or in rail can occur only as a result of alternate reversing stresses: considerable tensile stress in the upper layer alternating with compressive stress.

Kislik, V. A., and Karmazin, A. I. (Rail Transport Engineering Institute, Rostov-on-Don, U.S.S.R.), Industrial Laboratory, (Zavodskaya Laboratoriya), Vol 31, No. 3, March 1965, pp 424-426, 2 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau Ltd. (repr., PC).

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0521

ECONOMIC VALUE OF VARIOUS SIZES OF RAIL

This report presents the results of a study of test sections of 112-and 131-lb rails of the Illinois Central Railroad with regard to the average 10-year maintenance costs. Data are provided which compare costs, labor and materials requirements and maintenance charges per mile for the 112- and 131-lb rail. The results of the study indicated that the 131-lb rail performed better than the 112-lb rail with respect to wear, straightness, and joint condition, and there was considerable savings in cost of cross-ties used with the 131-lb rail. The 112-lb rails suffered bolt-hole failures and damage by engine burns.

Shillander, A. A. (Chairman, Subcommittee), et al., Proceedings of the 54th Annual Convention of the American Railway Engineering Association, Vol 56, 1955, pp 927-929, 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0522

STRESS MEASUREMENTS IN THE WEB OF RAIL ON THE DENVER & RIO GRANDE WESTERN

This is a progress report on vertical web stress measurements made on tangent track of the Denver & Rio Grande Western Railroad two miles east of Price, Utah, which was laid with the newly designed D.&R.G.W. 115-lb rail. A brief discussion of the track and track support conditions is given and the test apparatus used for the principal stress measurements is described. Measurements of vertical web stresses were made under the wheels of regular freight and passenger trains with gages placed vertically on the rail web at both inner and outer web faces. The results of the tests are discussed and tabulations and graphical illustrations of the data are presented. Additional information is

provided on similar tests of 112- and 131-lb rails on 6-deg curves which were performed at Farnham, Utah, and Shoshone, Colorado, respectively.

Magee, G. M., and Cress, E. E. (AAR Technical Research Center, Chicago, Ill.), Proceedings of the AREA, Vol 44, 1943, pp M5-M18, 6 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0523

IMPROVEMENT OF STRENGTH AND ABRASION RESISTANCE OF CURVED RAILS

The service life and durability of rails of different composition and given different heat treatment are discussed. The natural hardness of rail surface was increased by higher carbon content, and induction heat treatment and air cooling reportedly ultimately increase the strength and wear resistance of worked areas of the rails. Quenching of the rails was investigated to determine at which point after rolling it should be done. Laboratory tests on cross-sectioned rail specimens to determine the hardness variation from the rail-head surface to a middle location of the head were conducted and the test results are given. A thorough study of the microstructure of the rail was made, and photomicrographs showing the grain structures are included in this paper.

Vondrosek, V. (VSB, Ostrova), Singel, J., Telechy, J., and Kacmarczyk, E. (Zelezarny VRSR, Trinec, Czechoslovakia), Hutnicke Listy, Vol 22, No. 11, November 1967, pp 764-770, 6 figs., 7 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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0524

WEAR-RESISTANT RAILS FROM VACUUM-TREATED STEEL [IN CZECHOSLOVAKIAN]

The processes and the advantages of vacuum degassing of molten rail steel are discussed in relation to the production of rails of high strength and resistance to wear. One of the major advantages of the vacuum processing of rail steel is the elimination of rail flaking. In industrial tests conducted with melts of approximately 1200 tons of metal processed through vacuum degassing and subsequently rolled into rails, the rails were reportedly free of flaking. The metallurgical processes of handling the finished rails, additions of alloying materials, and the control of carbon content and mill temperature conditions are discussed in respect to the production of high-strength railway rails. Data are presented which show variations in chemical contents of the degassed and conventional rail steels. Illustrations are provided that show etched sections of the rail head which have flaws and the method used in the storage of newly produced rails.

Coupette, W. (Standard-Messo, Duisburg, Czechoslovakia), Hutnicke Listy, Vol 20, No. 9, 1965, pp 621-625, 7 figs., 3 tables, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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0525

PROPERTIES OF RAILS FROM VACUUMED STEEL [IN CZECHOSLOVAKIAN]

The properties of 21 melts of vacuum-degassed rail steel containing 0.67-0.80% C and 0.70-1.00% Mn were investigated and compared with properties of conventional rail steel. Rolling-mill practices using vacuum-degassed steel, which simplifies the manufacturing process because neither isothermal annealing nor controlled cooling is necessary, are described. By eliminating the annealing and

cooling production steps, capital and operating costs are reduced. The vacuum-degassed rail steel is made in a 50-ton open-hearth furnace and the degassing is carried out under a vacuum pressure of between 5 to 6 mm Hg during the transfer of metal from ladle to ladle. Data are presented which show that vacuum degassing of rail steel increases impact strength, eliminates flaking, and provides twice the wear resistance as compared with that of rails made in the conventional manner.

Motloch, Z., and Horejs, S. (Vyzkumny Ustav Metalurgicky, Ostrava, Czechoslovakia), Hutnicke Listy, Vol 20, No. 8, 1965, pp 558-562, 6 figs., 5 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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0526

VARIATIONS IN PROPERTIES OF RAIL STEEL UNDER SERVICE CONDITIONS

Reviewed herein are the effects of long-acting cyclic stresses on the physicochemical properties of steel rails, as known by many authors who have studied the problems associated with rail cyclic stresses and have published their works. Concern is shown for steel rails under conditions of prolonged cyclic loading because of significant development of brittleness and the reduction of plasticity. For this reason, rails were selected of the R-50 type martensite carbon steel (commonly used in the Moscow metropolitan railroad network) that had been subjected to approximately one half billion loadings. Both used and unused rails were studied initially to determine their chemical compositions. The mechanical properties of both rail lots were determined and the tabulated data are presented. Impact-strength tests were conducted and graphs plotted from the data are presented. Fatigue-strength tests and the resulting relations between load cyclings and the strengths are discussed.

Oding, I. A., Nikonov, A. G., and Mar'yanovskaya, T. S., Russian Metallurgy and Mining (Translation by Scientific Information Consultants Ltd, London), No. 5, 1964, pp 59-69, 6 figs., 4 tables, 20 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Scientific Information Consultants Ltd. (repr., PC).

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0527

A STUDY OF STRESSES AND DEFORMATIONS UNDER DYNAMIC AND STATIC LOAD SYSTEMS IN TRACK STRUCTURE AND SUPPORT

This is a progress report associated with a program that covers 5 years of study on the stresses and deformations in railroad-track structures and their supports. This portion of study covers the geotechnical properties of different ballast materials and the construction of a full-scale laboratory model test. Vibration characteristics, strength, stress-strain characteristics, density, and disintegration of the ballast are the main soil properties being studied. A more complete study of soil-layer interaction when placed in the form of a track support is also being undertaken. An initial test was performed in which 60 kips (two wheel loads of 30 kips each) was repeatedly applied to the rails above the central tie of 20 feet of 132 lb standard railroad track with a 20-in. center-to-center tie spacing. These tests are to be repeated using a 90-kip load, subject to satisfactory equipment performance.

Raymond, G. P., Gaskin, P. N., Van Dalen, K. and Davies, J. R., (Canadian Institute of Guided Ground Transport, Kingston, Ontario), CIGGT Annual Report, Part 1: Research Progress Report 1973-1974, Report No. 73-11, June 1974, pp 49-85, 15 figs., 10 tables.

ACKNOWLEDGMENT: Canadian Institute of Guided Ground Transport.

PURCHASE FROM: Canadian Institute of Guided Ground Transport (repr., PC).

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0528

THE VERTICAL PATH OF A WHEEL MOVING ALONG A RAILWAY TRACK

This mathematical investigation was carried out in conjunction with full-scale experiments to study the manner in which the running of a pair of wheels and axle along a straight railway track is affected by characteristics such as the elastic yielding of the ballast, the stiffness of the rail, the lack of continuity at a rail joint, wheel loads, and speed. Calculations and graphs show the vertical movement of the wheel as it proceeds along the track. To study the dynamic effects, the path of the wheel for each quality of ballast and each type of rail joint has been computed for four different speeds: 0, 30, 60, and 90 mph. A discussion of this paper by a panel of attendees is included.

Inglis, C. E. (King's College, Cambridge, England), Journal of the Institution of Civil Engineers, Vol 11, 1938-1939, pp 262-288, 15 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC).

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0529

STUDY OF THE OPTIMUM DAMPING REQUIRED BY THE SUSPENSION SYSTEMS OF WAGONS SO AS TO ENABLE THEIR RUNNING, UNDER ANY LOADING CONDITIONS, AT A SPEED OF 80 KM/H ON TRACKS IN AN AVERAGE STATE OF REPAIR

This study examined measures which could be taken to improve the riding quality (stability) of wagons in particular, a certain series of existing wagons, in ordinary service, running at a speed of 80 km/hr. Both construction modifications and adaptation of damping systems were considered.

The study showed that, with respect to two-axle wagons, the ratio between wheelbase and length of the wagon body and, more exactly, between the wheelbase and the radius of gyration in relation to the vertical axis of the center of gravity, is quite important. It is stated that increasing the wheelbase has been shown to be one of the most efficacious means of improving the stability of wagons. In the case of bogie wagons, damping systems based on friction afford improvement in the stability of those vehicles which are fitted with helical spring suspension systems.

Tests of these modifications/adaptations on various rail lines are proposed.

Mr. Moron, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. ORE/B56, Enquiry Report, July 1962, 73 pp, 4 figs., 3 tables, 4 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0530

EFFECT OF WEIGHT REDISTRIBUTION ON THE MAGNITUDE OF LATERAL FORCES EXERTED BY A LOCOMOTIVE

An investigation was conducted to determine the extent to which the lateral forces exerted by a moving Mikado locomotive [Class 1200-1499 (2-8-2)] on the rails of curved track are affected by the transfer of weight from the driving wheels to the leading and trailing wheels. The redistribution of weight had been made to lower bridge stresses. The lateral forces exerted on the rails of 4- and 10-deg curves by a Mikado-type locomotive with original weight distribution were compared with those exerted by a locomotive with some of its weight transferred from the driving wheels to the leading and trailing wheels. The test locomotives and track characteristics are described as well as the electrical strain-measuring apparatus. An analysis of the test data is given in the form of

lateral force diagrams for the various wheel positions and speeds around the curved sections of the track. Test data indicated that no substantial change in the magnitude of the lateral forces was effected by the weight redistribution.

Cartwright, K. (Chairman, AAR Subcommittee, New York, New Haven & Hartford Railroad, New Haven, Conn.), et al., Proceedings of the 47th Annual Convention of the AREA, Vol 49, 1948, pp 735-746, 10 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0531

DETERMINATION OF LATERAL OUTWARD FORCES ON EACH RAIL OF A TURNOUT

This investigation was conducted to determine the lateral outward forces exerted by heavy locomotives (4-6-4 and 4-8-4) on the rails of a turnout at the Chicago & North Western Railway in the approach to the passenger terminal at Chicago where several spikes had been sheared off along the outside of the inner rail. The electrical wire strain gages used for the stress measurements and the recording apparatus are described, and the test-track characteristics and conditions are discussed and illustrated by means of schematics and photographs. The oscillograms showed that the greatest lateral forces on the rails occurred at the location of the driving wheels. Data are presented in force diagrams which are superimposed on the track layouts.

Ferguson, R., Smuchor, M. F., Burham, H. E., Cantley, W. I., and Hagee, G. M. (AAR Research Center, Chicago, Ill.), Proceedings of the 43th Annual Convention of the AREA, Vol 47, 1946, pp 671-695, 17 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0532

COMPARISON OF TWO METHODS FOR ASSESSING RESIDUAL STRESSES IN RAILS

This article reports on a study which was conducted to assess the possibility of determining the maximum residual stress on the rolling surface of the rail head, in the web, and in the central portion of the base from data obtained by examining the contraction of a longitudinal gap-cut in a rail web. The results obtained by measuring stress parameters in 119 specimens that were heat treated and straightened using different techniques were statistically processed to determine the residual stresses by gap-cut and strain-gage methods. Schematic diagrams are provided which show the machining of the specimens and the location of sensors. Scatter-field and regression-line curves are used to plot the data for residual stress in rail profile elements and gap widenings.

Kozyukhov, A. D., Reikhart, V. A., and Kaportsev, V. N. (All-Union Scientific Research Institute of Rail Transport, Moscow, U.S.S.R.), (translation by Scientific Consultants Ltd., London), Zavodskaya Laboratoriya, Vol 39, No. 1, 1973, pp 117-119, 3 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0533

EFFECTS OF LATERAL FORCES WHEN PROPELLING ROUND SHARP CURVES

The electrification of express passenger trains on one of the British Railways main lines led to this study to determine whether reduction in speed would be required on sharp curves. The curvature of the track on which the tests were conducted is nominally 395 ft for a distance of approximately 350 ft; the average radius of the curve is about 478 ft; and the cant is 1-3/8 in., which gives an equilibrium speed of about 12 mph. The test equipment, instrumentation, and test-track condition are described. The test train was

composed of 12 coaches of multiple-unit stock (weight, 450 tons) with tractive force provided by two electro-diesel locomotives that weighed 150 tons and developed a total of 3200 hp. Data from test runs under conditions when the train was hauled, propelled, and coasting are plotted showing the lateral forces on the baseplates and axleboxes as function of speed and acceleration.

Pocklington, A. R. (Engineering Research Division, British Railways Board), The Railway Gazette, Vol 121, No. 23, December 3, 1965, pp 942-945, 4 figs., 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Press Ltd. (repr., PC).

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0534

INTERNAL STRESSES IN RAILWAY MATERIALS

Eighteen examples of the occurrence of internal stresses in rail materials are described. A variety of rails from various countries are discussed in relation to their internal or residual stresses and based on the processing techniques used in their manufacture. Stresses induced by the impact or pounding of locomotives are examined and this condition was simulated in the laboratory to show the development of peening or corrugation. Stress-measurement values for peened piston rings, shot-blasted spring plates, boiler rivets, and expanded boiler tubes are tabulated. The effect of service straining on stress removal is discussed. Fatigue cracking in axle press-fits is outlined and the shrink fits of wheels and tires are considered in relation to thermal effects of braking and welding.

O'Neill, H. (University College, Swansea, England), Symposium on Internal Stresses in Metals and Alloys, London, October 15-16, 1947, pp 337-349, 9 figs., 5 tables, 41 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Institute of Metals (repr., PC).

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0535

PREVENTION OF DERAILMENT OF GOODS WAGONS ON DISTORTED TRACKS

The purpose of this study was to examine the permissible wheel-load deviations and the resultant characteristics of goods wagons (freight cars) in order to determine means for preventing derailments on twisted track. A statistical analysis was conducted which deals principally with the continuous measurement of existing track twists, related to a basis of 5.00 m (wheelbase of the recording coach), and a length of 1,820 km of track on the DB, 1,805 km on the SNCF, and 1,955 km on the PKP. This report analyzes the results of these measurements.

Three possible means of reducing derailments were considered: (1) stricter control of accidental twists of dangerous magnitude, (2) extension of the maintenance regulations for Track Category 2 to the lower categories of track, and (3) improving the adaptation possibilities of the vehicles to track twists. On the basis of the analysis it was concluded that: (1) no appreciable reduction in risk could be expected from stricter control of track twists, (2) the slight gain in safety (reduction of risk) which could be realized from extension of maintenance regulations in force for tracks of higher category to those of lower category was disproportionate to the additional cost which would be involved, (3) the design measure with regard to the rolling stock would much more effectively reduce the risk than the measures relating to track maintenance.

Dr. Sperling (Chairman, Committee B 55), et al. (Office for Research and Experiments of the International Union of Railways), Utrecht, Netherlands, Report No. ORE B55/RP2, Interim Report No. 2, June 1965, 60 pp, 20 figs., 11 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0536

METHOD OF EVALUATING THE CONTACT STRENGTH OF RAIL STEEL

A method using laboratory equipment for the simulation of the main types of contact damage experienced during rail usage is described. The author states that the use of the method provides data which show the actual relation of contact damage in rails to the carbon content and surface hardness of the steel. The conditions that lead to contact or surface damage of rails are defined in terms of fatigue fracture, variable stresses, types of damage, and fractures caused by rolling and rocking. A description is given of the four-roller machine that is used for contact-fatigue testing and of the various changes that take place within the rail specimen as it is subjected to actions of each roller. Data are included for tests on R50 rails which show extent of rail damage as a function of carbon content of the steel.

Kislik, V. A., and Karmazin, A. I. (Railroad Transportation Engineers Institute, U.S.S.R.), Industrial Laboratory (Zavodskaya Laboratoriya), Vol 30, No. 12, December 974, pp 1866-1868, 3 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Ltd. (repr., PC).

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0537

RAIL FAILURE STATISTICS COVERING (a) ALL FAILURES, (b) TRANSVERSE FISSURES, (c) PERFORMANCE OF CONTROL-COOLED RAIL

Statistics on rail failures (service and detected) reported to December 31, 1953 by 62 railroads on all of their main track mileage, constituting approximately 90 percent of the main track of Class I railroads in the U.S. and Canada, are presented in the forms of tabulations, charts, and graphs. Specific data on the following types of failures are included: transverse fissure, web (in joint and other), bolt hole, welded engine burns, vertical and horizontal split head, compound fissure, detail fracture, and broken base. Data for the various rail fabrication mills are also given that show the types of failures occurring on various railroads as related to the mill producing the rail. Some failure data for Canadian National are included.

Code, C. J. (Chairman, Subcommittee), et al., Proceedings of the Fifty-Fourth Convention of the AREA, Vol 56, 1955, pp 904-926, 4 figs., 9 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0538

METHODS OF FURTHER IMPROVING THE QUALITY OF RAILWAY RAILS

A discussion is presented on the research conducted in the Soviet Union for the 15 to 20 years prior to 1967 on improving the quality and lengthening the life of rails. This has involved investigation of the control-cooling process for high-carbon steel rail production, the production of heavy rails for reducing occurrences of cracks resulting from increased loads and speeds, the teeming of steel into wide-and-up ingot moulds, development of methods of quenching the ends of rails, and the production of 25-m-long rails at the Azovstal' Works and the Nizhne-Tagil Combine. The chemical composition and tensile strength of the Soviets' heavy types of rails are given. Statistics for rail defects observed during maintenance and rail inspections show various problems that are occurring because of nonmetallic inclusions, wheel burns, transverse cracks, and fatigue cracks. Cutting/cropping, rail straightening, heat-treatment procedures, and their importance to improvement of rails are discussed. Comparisons are drawn for rail wear of carbon and chromium steel

rails which show that vertical wear has been reduced approximately 50 percent for rails made from chromium steel.

Lempitskii, V. V., Trishevskii, I. S., and Kazarnovskii, D. S. (U.S.S.R. Ministry of Ferrous Metallurgy and the Ukraine Research Institute for Metals), Stal [in English], No. 11, November 1967, pp 929-933, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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0539

TRAIN TRACK DYNAMICS--GUIDELINES FOR: TRAIN HANDLING, TRAIN MAKEUP, TRACK & STRUCTURE, AND ENGINEER EDUCATION

The Track Train Dynamics Program is a major planning effort initiated in July 1971 by the Southern Pacific Transportation Company under contract to the AAR and carried out with AAR staff support. This program encompasses studies of the dynamic interaction of a train consist with track as affected by operating practices, terrain, and climatic conditions. Section 4 of this report concerning the track and structures provides a brief discussion on dynamic forces on rails, prescribes limitations of equipment usage on track curves on the basis of vehicle parameters, superelevation, reverse curves, turnouts and crossovers, grades, graduated speeds, and harmonic rolls. (Carried as RRIS Accession No. 00341).

Association of American Railroads, Report No. R-153, 1973, 83 pp, 29 figs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0540

THE CAUSE OF WHITE ETCHING MATERIAL OUTLINING SHELL-TYPE CRACKS IN RAIL HEADS

The cause of white-etching regions outlining certain subsurface cracks in rail heads was investigated. These cracks, known as shells, can propagate into "shelly spots". This defect generally originates as a horizontal crack or separation and sometimes also develops as a crack component transverse to the length of the rail. Investigations conducted in the laboratory on rail steels prepared by induction of local strains through scratching on the surface of samples are described. Comparisons are drawn between samples containing shelly regions and others with scribed scratches as shown by results from metallographic examinations. On the basis of this study, it was concluded that the mechanism of formation of the white-etching areas outlining some shell-type cracks that develop in certain rail heads under the action of rolling contact is likely to be local plastic deformation.

Neary, R. J. (Homer Research Laboratories, Bethlehem Steel Corp., Bethlehem, Pa.), Journal of Basic Engineering, Trans. of the ASME, Series D, Vol 91, No. 3, September 1969, pp 549-551, 3 figs., 20 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0541

BUCKLING OF BEAMS SUPPORTED BY PASTERNAK FOUNDATION

In this paper, the buckling of infinitely long beams supported by a Pasternak foundation is examined. Assumptions are made that the induced compressive force is axial and uniform throughout the beam. Various foundation models are proposed to approximate the real

foundation behavior. Several examples, such as the various models of Winkler and the modified Pasternak approach, and the elastic continuum, are discussed. Findings of a brief survey of such works as those by Biot, Fillippov, Gorbunov-Posadov, Csonka and others are discussed. Mathematical expressions are presented and modified to expand the models of Pasternak's beams on two- and three-dimensional foundations.

Murthy, G.K.N. (Dept. of Health, City of New York, N.Y.), Journal of the Engineering Mechanics Division, Vol 99, No. EM-3, June 1973, pp 565-579, 7 figs., 22 refs.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0542

RAIL TRACKS FOR JAPAN'S 130-MPH TRAINS

Standards in design and in precision of track alignment set for the Japanese Tokaido Line are described. Features include prestressed concrete ties whose greater weight than wood ties helps to maintain track alignment, also, ballast under the center of each tie is omitted, but extends 20 in. beyond the ends. New switches and rail expansion joints were designed. An automatic track-inspection car that measures and records 16 types of data for computer analysis is described. Inspection parameters include wheel weight, lateral thrust, acceleration, cross level gage, line level, evenness, and distance along the line. Schematics of the track structure, rails, inspection data chart, rail fastening, cross ties, and expansion joints are presented. Tabulations are provided which show line maintenance standard, properties of rail fasteners, prestressed concrete ties, tolerance limits of track maintenance, and chemical composition of the rails.

Matsubara, K. (Railway Technical Research Institute, JNR, Japan), Civil Engineering—ASCE, Vol 39, No. 12, December 1969, pp 32-37, 7 figs., 7 tables.

ACKNOWLEDGMENT: American Society of Civil Engineers.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0543

METHOD OF DETERMINING "FATIGUE LIFE"

The authors describe an ultrasonic method which they have developed to assist in determining "fatigue life" of rail components, particularly rails. The method, using surface waves, is used to determine the time at which the fatigue cracks initiate. By this means it is possible to detect cracks when testing polished samples having no scratches. No attempt is made to monitor crack propagation continuously, since rail fatigue life may be determined accurately by taking two points of the kinetic curve for crack propagation: the instant at which a crack of certain size is formed and the instant at which brittle fracture occurs as the crack reaches a critical size.

The detection system comprises three 18-mm-diameter barium titanate piezo-electric crystals which are attached to the rail head to detect transverse cracks formed during full-scale testing of rails without scratches. One of the crystals, located in the rail axis, emits ultrasonic surface vibrations, the other two crystals, located on the flat sides of the head, act as receivers. An ultrasonic vibration frequency of 0.8 Mc is used, and all measurements are performed while the rail is under load. The apparatus and its operation are described and the results obtained with its use to determine fatigue life of a number of rails are given.

Shur, E. A., and Kolotushkin, S. A. (All-Union Scientific and Research Institute for Railroad Transport), Industrial Laboratory (Zavodskaya Laboratoriya), Vol 35, No. 6, June 1969, pp 871-873, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultant's Bureau, Ltd. (repr., PC).

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0544

THE EFFECT OF PENNY-SHAPED CRACK ON THE DISTRIBUTION OF STRESS IN A SEMI-INFINITE SOLID

The paper contains an analysis of the distribution of stress in a semi-infinite elastic solid when it is deformed by the application of pressure to the inner surface of a penny-shaped crack situated parallel to the free boundary. Two problems are discussed. In

the first problem it is assumed that the free end is stress free and in the second it is assumed to be rigidly clamped. By using the Hankel transforms and the theory of dual integral equations, each problem is reduced to the solution of a pair of simultaneous Fredholm integral equation of the second kind. Expressions for various quantities of physical interest are derived for small values of the ratio of the radius of the crack to that of its distance from the free boundary by finding iterative solutions of these equations. For values of this ratio near unity, simultaneous Fredholm integral equations have been solved numerically.

Srivastava, K. N., and Singh, K. (Maulana Azad College of Technology, Bhopal, India), International Journal of Engineering Sciences, Vol 7, No. 5, May 1969, pp 469-490, 7 figs., 7 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0545

THE DISTRIBUTION OF THERMAL STRESS IN A SEMI-INFINITE ELASTIC SOLID CONTAINING A PENNY-SHAPED CRACK

Thermoelastic equilibrium of a semi-infinite solid containing a penny-shaped crack situated parallel to the free boundary is investigated. It is assumed that the thermal conditions on the upper surface of the crack are identical with those on the lower surface and the free boundary of the solid is kept at zero temperature. Two problems are discussed. In the first problem it is assumed that the free boundary is stress free and in the second it is assumed to be rigidly clamped. By using Hankel transforms and the theory of dual integral equations each problem is reduced to that of solving a set of Fredholm integral equations of second kind. Expressions for various quantities of physical interest are derived for small values of the ratio of the radius of crack to that of its distance from the free boundary by finding iterative solutions of these equations. For values of this ratio near unity, Fredholm integral equations have been solved numerically.

Srivastava, K. N., and Palaiya, R. M. (Maulana Azad College of Technology, Bhopal, India), International Journal of Engineering Science, Vol 7, No. 7, July 1969, pp 641-666, 8 figs., 1 table, 12 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0546

INTERACTION OF ELASTIC WAVES WITH A GRIFFITH CRACK

The problem of the diffraction of normally incident longitudinal and antiplane shear waves on a Griffith crack located in an infinite, isotropic elastic medium is considered. A Fredholm integral equation of the second kind is derived in each case for the determination of diffracted field. From the integral equation an asymptotic development of the solution is obtained which is valid for wavelength long compared with the crack length. For wavelengths comparable with the size of the crack the integral equation is solved numerically. The stress and the displacement fields in the vicinity of the crack as well as the radiation field at points far away from the crack are computed for a range of values of the frequency.

Mal, A. K. (University of California, Los Angeles, Cal.), International Journal of Engineering Sciences, Vol 8, No. 9, September 1970, pp 763-776, 6 figs., 11 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0547

THE STRESSES PRODUCED IN A SEMI-INFINITE SOLID BY A MOVING SURFACE FORCE

The problem considered here is that of a semi-infinite homogeneous isotropic elastic solid to the surface of which are applied forces moving with uniform velocity. The forces are assumed to act for all time, so that the problem is quasi-static. The cases of applied normal force and applied shear force are both considered. The types of applied load considered are those of a point force and of a force which is distributed over either a circular or a rectangular area. The basic equations are solved by means of integral transforms, and the resulting multiple integrals are reduced to single finite integrals which may be evaluated numerically when the velocity of the applied force is below that of Rayleigh waves for the solid. Numerical results are presented in graphical form for the displacement and stress components at points below the point of application of the point force and for the stress components at points below the centre of the loaded area for distributed loading.

Eason, G. (Royal College of Science and Technology, Glasgow, Scotland), International Journal of Engineering Science, Vol 2, No. 6, June 1965, pp 581-609, 13 figs., 12 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press Ltd. (repr., PC).

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0548

ON THE OSCILLATIONS OF STATICALLY INDETERMINATE BEAMS

The problem of determining the natural frequencies and modes of a statically indeterminant, Timoshenko beam is considered. By lumping the beam properties of linear and rotary inertia at discrete points along the length of the beam and by employing the complementary, variational principle, an approximate solution is obtained by simple matrix iteration. Problems in which the beam is required to carry point mass or rotary inertia elements and cases in which these elements occur at the end of a beam section are considered.

Karnopp, B. H., and Nagendra, B. (Michigan University, Ann Arbor, Mich., and Toronto, Canada), Acta Mechanica, No. 9, 1970, pp 121-129, 2 figs., 2 refs.

ACKNOWLEDGMENT: Acta Mechanica.

PURCHASE FROM: Springer Verlag (repr., PC).

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0549

A STUDY OF A NEW FOUNDATION MODEL

The characteristics of a foundation model, consisting of two spring layers interconnected by a shear layer, are studied. The study is conducted on the classical problem of a foundation subjected to a rigid stamp. In order to reduce the number of foundation constants to an absolutely necessary minimum, special attention is given to a possible dependence of the constants of the upper and lower spring layer, particularly to the spring constant ratio three which is suggested by Reissner's foundation model. A comparison of the obtained pressure distributions with relevant experimental data seems to support the adoption of this value, thus reducing the number of foundation constants to two. Advantages of the presented model over other foundation models are pointed out.

Kerr, A. D. (Visiting Professor, Princeton Univ., Princeton, N.J.), Acta Mechanica, Vol 1, 1965, pp 135-147, 8 figs., 11 refs.

ACKNOWLEDGMENT: Acta Mechanica.

PURCHASE FROM: Springer Verlag (repr., PC).

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0550

ELASTIC CIRCULAR INCLUSION IN AN INFINITE PLANE CONTAINING TWO CRACKS

The elastic fields in an elastic circular inclusion and surrounding infinite matrix containing two cracks symmetrically situated are determined when the matrix is subjected to loads at infinity. In this problem, the elastic properties of inclusion could differ from those of the matrix. The Muskhelishvili's technique is used. The solution depends upon two sets of suitable complex potentials for matrix and inclusion respectively, which solves the problem.

Bhargava, R. D. and Bhargava, R. R. (Indian Institute of Technology, Bombay, India), International Journal of Engineering Sciences, Vol 11, No. 4, April 1973, pp 437-449, 5 figs., 9 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0551

THE DISTRIBUTION OF AXISYMMETRIC THERMAL STRESS IN AN INFINITE ELASTIC MEDIUM CONTAINING A PENNY-SHAPED CRACK

The problem of determining the thermal stress in an infinite elastic medium containing a penny-shaped crack deformed by the application of a given pressure (in addition to the given temperature field) was treated by Olesiak and Sneddon. In this paper further consideration is given to this problem. It will be seen that, apart from a multiplicative constant, the effect of the temperature field on the values of both normal and shearing stresses are independent of the temperature field. In Olesiak and Sneddon's paper, this striking result was found only for the normal stress.

Deutsch, E. (Polytechnic Institute of Brooklyn, New York), International Journal of Engineering Sciences, Vol 3, No. 5, May 1965, pp 485-490, 1 table, 4 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0552

THE STRESS INTENSITY FACTOR DUE TO A NORMAL IMPACT LOADING OF THE FACES OF A CRACK

The plane strain problem of a half-plane crack in an unbounded elastic solid is considered. The faces of the crack are subjected to suddenly applied, equal but opposite concentrated normal forces which tend to separate the crack faces. The elastic wave propagation problem, which contains a characteristic length, is solved exactly by linear superposition over a fundamental solution arising from a particular problem in the dynamic theory of elastic dislocations. Attention is focused on the time-dependent stress intensity factor. For an applied load with step function time dependence, the stress intensity factor is negative from the time the first wave arrives at the crack tip until the arrival of the Rayleigh wave. At that instant, it takes on its appropriate static value, which is thereafter maintained. Generalizations are discussed for spatially distributed and/or time-varying normal impact loads.

Freund, L. B. (Brown University, Providence, Rhode Island), International Journal of Engineering Sciences, Vol 12, No. 2, February 1974, 4 figs., 7 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0553

CORROSION-FATIGUE CRACK PROPAGATION BELOW K_{Iscc}

Information on corrosion-fatigue crack growth in engineering structures is necessary for the prediction of service lives of structures subjected to both fatigue loading and an aggressive environment. Thus, as

part of a long-range program aimed at establishing the necessary relations for predicting the corrosion-fatigue behavior of structural steels, the effects of cyclic-stress frequency at various stress-intensity ranges below K_{Iscc} on rates of crack growth were investigated in 12Ni-5Cr-3Mo maraging steel in a room-temperature 3 percent solution of sodium chloride. The results were analyzed by using linear-elastic fracture-mechanics concepts and were compared with fatigue-crack-propagation data obtained in a room-temperature air environment.

The results showed that the primary factor affecting fatigue-crack-growth rates in the environment-material system investigated is the applied-energy release rate. Because energy release can be related to the stress-intensity factor and to the crack-opening displacement, corrosion-fatigue crack-propagation rates can also be expressed in terms of stress intensity factor or crack opening displacement. Furthermore, the data indicate that corrosion-fatigue crack growth in the environment tested can be represented mathematical expressions that are given.

Barsom, J. M. (U.S. Steel Corp., Applied Research Lab., Monroeville, Pa.), Engineering Fracture Mechanics, Vol 3, No. 1, January 1971, pp 15-25, 11 figs., 2 tables, 22 refs.

ACKNOWLEDGMENT: Engineering Fracture Mechanics.

PURCHASE FROM: Pergamon Press (repr., PC).

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0554

DISCRIMINATION ABILITY OF A SUPERPOSED DETECTING SYSTEM FOR SURFACE CRACKS IN INDUCTIVE TESTING OF STEEL COMPONENTS. I. ANALYSIS OF PHYSICAL PRINCIPLES OF TESTING AND AN INVESTIGATION METHOD

Difficulties associated with spurious signals generated when inductive defectoscopes are used to scan regions of the steel part affected by decarburization and cold working in addition to actual surface cracks are discussed. This occurs because the magnetic field normal to the surface of the components and to the plane of the coils of the detector element reacts equally well qualitatively both to cracks and to area of local decarburization. The solution of the problem, suggested by the author, is to employ an inductive defectoscope with a superposed detecting element that reacts to the component of the eddy-current field of the defect which is tangential to the surface of the part being tested. The detection element used in the laboratory to perform experiments on calibrated bars is described in detail. Graphs plotted from laboratory data are used to depict the active and reactive components of electromotive forces induced in the detecting elements under investigation.

Vlasov, V. V., and Komarov, V. A. (Institute of Physics of Metals, Academy of Sciences, U.S.S.R.), Defektoskopiya (Defectoscopy), Translated by Consultants Bureau, Ltd., No. 1, January-February 1970, pp 95-101, 6 figs., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Ltd. (repr., PC).

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0555

ROLL PASS DESIGN FOR ROLLING RAILWAY RAILS [IN CZECHOSLOVAKIAN]

The mill-rolling practice at the K. Gotwald Works for the production of railway rails is described. The old pass arrangement is described from the standpoint that it consisted of two stands with a roll body length of 2300 mm and 7 passes. Prior to discussions on the new 9-pass roll design, comparisons are made with the flat side reduction, vertical, and transverse passes. Examinations of the old 7-pass approach revealed that the metal grains in the base of the rails were parallel to the web and this feature was related to ruptures

occurring between the web and the base fillet. Rolling schedules of both the 7- and 9-pass methods are shown schematically.

Vojtovsky, J. (K. Gotwald Works, Ostrava, Czechoslovakia), Hutnik, Vol 14, No. 7, 1964, pp 340-341, 7 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL--Publisher of Technical Literature (repr., PC).

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0556

COMPARISON OF THE EFFICIENCY OF RAIL DEFECTOSCOPES

The efficiency of a new form of magnetic rail defectoscope is discussed in relation to that of existing models as used on the Odessa-Kishinev railway. Comparisons are made between the effectiveness of rail-inspection units and their costs. Data are tabulated showing the types of inspection units, costs for inspection per mile of jointed and welded rails, and the number of rail defects per thousand kilometers in 1969.

Siruk, N. N., and Rikel'man, I. L. (All-Union Scientific-Research Institute of Nondestructive Testing, U.S.S.R), Defektoskopiya (Defectoscopy), (Translated by the Consultants Bureau, Ltd.), No. 2, 1973, pp 137-138, 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Ltd. (repr., PC).

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0557

SUSCEPTIBILITY OF RAIL STEEL TO FLAKE FORMATION [IN CZECHOSLOVAKIAN]

The effect of processing techniques on the susceptibility of rail steel to flake formation is investigated using statistical analysis methods; 184 melts from fifty 130-ton open-hearth furnaces were examined. The chemical compositions of the rail steel, containing variations in carbon, manganese, silicon, phosphorus, and sulphur, are discussed. The common or parallel occurrence of flaking in high strength rail steel occurs regardless of the content of carbon, manganese, and phosphorus. However, a pronounced susceptibility to flake formation in coke-carbonized melts was observed. It was concluded that existing technology cannot produce high-strength rail steel without flaking at a tensile strength greater than 75 kg/mm^2.

Cechura, F. (Zelezarny VRSR, Trinec, Czechoslovakia), Hutnik, Vol 15, No. 4, 1965, pp 167-174, 4 figs., 6 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL--Publisher of Technical Literature.

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0558

STUDY OF RAIL QUALITY IN THE USSR AND MEANS OF LENGTHENING THEIR WORKING LIFE [IN POLISH]

Rails of the USSR types R50, R60, and R75 are considered equal to those manufactured in Western Europe and the USA, regardless of the belief that they do not satisfy fatigue-strength requirements of the Soviet railway system. The method for obtaining rails with increased wear resistance and with acceptable fatigue strengths through the use of alloying and heat treatment is discussed. Vacuum degassing and control of steel impurities are suggested as means of improving the quality of the rails. The effects of nickel, chromium, manganese, and silicon additions to steel are described. Comparisons are made between the

various methods of controlled cooling, and the use of induction heating for heat treatments before or after mill rolling.

Grobicki, W., Hutnik, Vol 31, Nos. 7-8, 1964, pp 274-276, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Wydawnictwo Lask (repr., PC).

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0559

THE EFFECT OF THE RATIO OF WHEEL DIAMETER TO WHEEL LOAD ON EXTENT OF RAIL DAMAGE

Results are reported of tests using flangeless 33- and 50-in.-diameter wheels, with various loads, on rails with artificial defects in the form of drilled holes in the heads. Also included are the results of tests using shatter-cracked rails from a hydrogen-treated ingot. For both types of tests, an attempt is made to obtain a comparison of the number of cycles for failure of the rail with each wheel. The rails with imposed defects developed horizontal split heads at some unknown number of cycles. The shatter-cracked rails developed transverse fissures at a definite number of cycles; however, it was judged that the cycles for failure in each case could be determined by the depth of the particular crack from which the fissure developed. A third type of test was conducted in which the rail was rolled for a given number of cycles under a given load, then cut up and a hardness survey taken over the rail head. Some indications of piping were noted. Data are tabulated showing wheel-size effects in terms of vertical wear, number of cycles, and loading. Graphs are presented to show the results of the hardness survey.

Allemen, N. J. (University of Illinois, Urbana, Ill.), Proceedings of the 45th Annual Convention of the AREA, Vol 47, 1946, pp 725-741, 11 figs., 5 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0560

A METHOD FOR THE ESTIMATION OF THE STRENGTH OF RAIL STEEL [IN RUSSIAN]

The criteria for assessment and the methods of measurement of the strength of rail steel are analyzed. The complexity of the properties from which the strength and load-bearing capacity of the rails can be judged is discussed.

Rauzin, Ya. R., Vestnik Vses. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta (Moscow), No. 1, 1970, pp 8-12, 4 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kanbin Bookstore, (repr., PC).

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0561

ACOUSTIC EMISSION--1, INTRODUCTION

This paper, the first in a series of three papers on the subject of acoustic emission, its causes and detection, discusses what is common to most acoustic-emission systems and how the emissions are variously treated to give useful information. The complications introduced by the pathway of the emission and its conversion into a signal are emphasized. The various practical systems employed to extract useful information from complex data are also discussed.

Swindlehurst, W. (University of Sussex, Brighton, Sussex, England), Non-Destructive Testing, Vol 6, No. 3, June 1973, pp 152-158, 13 figs., 19 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0562

ACOUSTIC EMISSION--2, ACOUSTIC EMISSION AMPLITUDES

In this paper, the second in a series of three papers on the subject of acoustic emission, the author discusses the significance of the amplitude of acoustic emission and its usefulness as a source of information. A spring-mass model is used to provide an analogue of the acoustic-emission event to describe the theory and application of amplitude sorting. Some experimental results are given for discrete crack movements in UXW steel which show that the emission amplitude is proportional to the mechanical-energy release. The author concludes that the method has a significant future role as part of a more complete characterisation of emission signals.

Pollock, A. A., Non-Destructive Testing, Vol 6, No. 5, October 1973, pp 264-269, 7 figs., 4 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0563

ACOUSTIC EMISSION--3, THE USE OF RING-DOWN COUNTING

In this paper, the third in a series of three papers on the subject of acoustic emission, the authors describe the ring-down counting of signals and discuss its advantages and limitations. The experimental factors which influence the ring-down count and the methods used for their investigations are considered. The dependence of ring-down count on signal-peak height was experimentally determined and the information was used with the peak-height distribution to obtain the dependence of total ring-down count on system gain for a particular test situation. The application of ring-down counting to obtain the metallurgical variables affecting the acoustic-emission activity of steels is described, as well as its application to the determination of the plastic zone size and hence the size of defects in the case of plastic deformation.

Brindley, B. J., Holt, J., and Palmer, I. G. (Central Electricity Research Laboratories, Surrey, UK), Non-Destructive Testing, Vol 6, No. 6, December 1973, pp 299-306, 16 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0564

FLAW DETECTION OF RAILS DURING HIGH SPEEDS OF MOVEMENT [IN RUSSIAN]

(No English Abstract Available)

Dovnar, B. P. (Uralskoye Otdel.), Vestnik Vses. Nauch-Issled. Inst Zheleznodorozhnogo Transporta (Moscow), Vol 72, No. 5, 1972, pp 44-47, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore, (repr., PC).

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0565

COMPARISON OF WEB STRESSES IN 131-LB. RE AND 140 PS—(PENNSYLVANIA) SECTIONS (APPENDIX 12-B)

This Appendix describes a field measurement of web stresses in 115RE, 132RE and 133RE rail sections resulting from evidence which indicated an excess of split web (head and web separations) failures might require a radical change in the design of the head and web. The 140 PS rail section was then designed to give the lowest possible upper fillet stress, under conditions of eccentric loading, consistent with reasonable weight of the section, without sacrificing girder strength of the rail as compared with the 131RE, and without sacrificing the ability to use head-contact joint bars. A

comparison is drawn between the two types of rails and the results of a laboratory study which was undertaken to determine web stresses under controlled static loading are given. Field measurements of service stresses, made on location at the Panhandle Division, west of Carnegie, Pennsylvania, are discussed. Data for stresses measured on rail curves at speeds between 15 and 30 mph are tabulated and graphical illustrations showing curves of web stresses as a function of distances from the ends of the rail are given.

Code, C. J. (Chairman, AAR Subcommittee), Proceedings of the 48th Annual Convention and the 50th Anniversary Year of the AREA, Vol 50, 1949, pp 557-566, 7 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0566

MEASUREMENT OF DYNAMIC FORCES ON TRACK

Design and development of a baseplate for measuring vertical loads and lateral forces between rails and ties are described. The baseplates are designed to withstand combined loads of 15 tons applied vertically and 10 tons applied laterally which is believed to be in excess of the values likely to be encountered. The general mechanical arrangement of the load-recording baseplate, circuitry for connections and installation of the strain-gage bridges, and some typical calibration curves obtained under load conditions are presented. Graphs are included that show a record of vertical and lateral loads and forces, and the total forces between the loading wheel and outer rail when a 118-ton locomotive passed around a curve at 52 miles per hour.

Brown, T. P., and Leech, J. B. (Engineering Research Division, British Railways Board, England), The Railway Gazette, Vol 120, No. 22, November 20, 1964, pp 938-940, 5 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0567

MEASUREMENTS OF STRESSES IN 132 RE RAIL ON TANGENT TRACK--SANTE FE RAILWAY (APPENDIX 11-A)

The purpose of this study was to obtain stress measurements developed under regular traffic on the 132 RE section of the Santa Fe Railway's installation 100 miles west of Chicago. Specifically, the installation offered an opportunity to determine the extent of service stresses in the upper web and rail fillets, the range of stress for correlation with the fatigue-strength tests being carried out in the laboratory, and to obtain information on the effect of bolt-hole spacing. The experimental design of the tests covering the locations of strain gages is discussed, and schematic drawings are included which show the percentage of stress distributions in relation to their proximity on the rail. The data are also plotted to show the rail stresses as a function of rolling-load speeds. Fatigue strength of the rail web for various ranges of stress and frequency of occurrence of dynamic stresses in the upper part of the rail web of rail joints are given.

Code, C. J. (Chairman, AAR Subcommittee), Proceedings of the 49th Annual Convention of the AREA, Vol 51, 1950, pp 626-640, 11 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0568

STUDIES OF THE PRESSURE AS AFFECTED BY THE AREA OF CONTACT BETWEEN WHEEL AND RAIL

The introduction of larger power units designed to haul trains at higher speeds is emphasized as a problem because of the structural weakness of rail steel over which these large units operate. It is pointed out that rails fail due to flow of metal and where the wheel steel is overloaded the same distortion of the metal leads to shelling and wear. The relation between the load and the area of contact which is affected by the diameter of the wheel and the shape of the rail head is studied to fix economical limits in the design of both. In addition, the unit pressures in the different locations of the area of contact, various hardnesses of wheel and rail steels, and the wear on wheels and rails as between tangents and curves with various super-elevations are studied. The experiments designed to consuct laboratory tests on rails which principally consist of rolling load tests are described. The results of test for shatter-cracked rails are presented in terms of Brinnell hardness, wear, and cycles-to-failure.

Alleman, N. J. (University of Illinois, Urbana, Ill.), Proceedings of the 44th Annual Convention of the AREA, Vol 45, 1944, pp 1-8, 3 figs., 1 table.

ACKNOWLEDGMENT: American Association of Railway Engineering.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0569

STRESS MEASUREMENTS ON FOUR 112-115-LB. TEST RAILS IN TANGENT TRACK AND IN A 4-DEG. CURVE UNDER REGULAR TRAIN TRAFFIC--LATHROP TESTS OF 1944 (APPENDIX 12-B)

The purpose of this experimental work was to develop information with regard to the range of stress variation in the rail web under service conditions and to provide information on the effectiveness of the changes in the various rail sections in reducing the stresses produced in service. Tests which were performed in a main line track on four 112-115-lb test rails are described. Details covering the test site and equipment are given. Stresses were measured in the lower portion of the rail web, lower web fillets, rail base and in the bottom of the tie plates. The ranges of these stresses are presented in tabulations and on graphs so that the direct relationship between the stress values and the positions on the rails where the observations were made can be studied. Frequency of measured stresses is also shown on graphs.

Bronson, C. B. (Chairman, Subcommittee), Proceedings of the AREA, Vol 46, 1945, pp 692-73., 46 figs., 6 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0570

SUMMARY REPORT ON FILLET AND WEB MEASUREMENTS ON 90-LB. ASCE AND 112-LB. RE RAIL ON 18-DEG. CURVES--DETROIT, TOLEDO & IRONTON RAILROAD--JUNE 1946 (APPENDIX 12-B)

This investigation was prompted by the development in the past few years of fillet cracks in the upper web on the gage side and the lower web fillet on the outside of 90-lb ASCE inner rails of a sharp curve. The question to be resolved was whether a different propulsion

vehicle should be used or whether the heavier 112-lb rail could reduce the occurrence of fillet cracks. Track conditions for the tests and test equipment used for the study are described. In a schedule of four tests, 13 runs were recorded using engines of the 400 class with nominal weight of 25,000 lb on the front truck and 223,000 lb on the 62-in. drivers. Additional runs were performed with engines of class 700 and 811. The data are presented graphically showing the extent of measured fillet and web stresses in rails of both weights as well as the frequency of their occurrence.

Code, C. J. (Chairman, Area Subcommittee), Proceedings of the 46th Annual Convention of the AREA, Vol 48, 1947, pp 794-804, 6 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0571

SHEARING STRESSES IN RAIL (APPENDIX 12-C)

The purpose of this experimental and analytical investigation was to study the distribution of shearing stresses in a modern rail section under wheel loads applied centrally on the rail head and with various amounts of eccentricity. Data collected by the Engineering Division research staff of AAR were combined with rail tests performed by Northwestern University in their rail test laboratory to permit a study of shearing-stress distribution. The techniques used in the measurement of strains that involve the separation of torsional and flexural shearing stresses through the use of properly placed strain gages are discussed. The data obtained from the experimental work were analyzed and are presented in graphs and discussed in the text.

Maney, G. A. (Northwestern Technological Institute, Evanston, Ill.), Proceedings of the AREA, Vol 46, 1945, pp 733-743, 13 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0572

A METHOD OF CALCULATING THE MAXIMUM STRESS IN THE WEB OF RAIL DUE TO AN ECCENTRIC VERTICAL LOAD

A method principally empirical, is given for calculating a web stress in a vertical plane, in railroad rails due to a vertical eccentric load. The method is based on a series of tests conducted at the Altoona laboratories of the Pennsylvania Railroad using Stresscoat to determine the location of maximum stress, and wire-resistance strain gages to determine the magnitude of the stress. The stress referred to is described as actually the measured strain multipled by the modulus of elasticity. The method of calculation gives the stress resulting from a 20,000-lb load applied parallel with the vertical axis of the rail at a point 3/4 in. from the longitudinal center line of the rail. Four curves are presented, two for use in calculating bending stress and two for calculating direct stress.

Code, C. J. (Pennsylvania Railroad, Altoona, Pa.), Proceedings of the 46th Annual Convention of the AREA, Vol 48, 1947, pp 987-991, 4 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0573

TRANSFORMATION CHARACTERISTICS OF RAIL STEELS AND CONSEQUENCES FOR WELDING AND FLAME CUTTING [IN GERMAN]

Investigations were conducted on the conditions during flame cutting and welding of rails as specified in UIC 860. Rails from normal quality and from A, B or C qualities, according to UIC Technical Code No. 860, were used in the investigations. Of major interest were the mechanical properties and chemical compositions of the steels prior to and after the cutting, cropping, and welding process. The effect on the structure of flame cutting and welding and the consequences of preheating and cooling conditions, with particular reference to the metal's transformation behavior (austenitized steel at 840°C for 15 minutes or 1300°C for one minute) are discussed. This paper includes discussions on measurements of microstresses in welded rails, segregation processes during gas welding, effect of aluminum content on the properties of welded rails, and the hydrogen pick-up of steel during thermite welding.

Heller, W., and Beck, G. (Versuchsanstalt der Friedr. Krupp Huttenwerke AG, Werk Rheinhausen, West Germany), Archiv fur das Eisenhuttenwesen, Vol 39, No. 5, May 1968, pp 375-386, 15 figs., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0574

LATERAL FORCES EXERTED BY LOCOMOTIVES ON CURVED TRACK

This report section describes tests made with a 4-8-4 Northern passenger-type steam locomotive with various amounts and combinations of front and lateral resistances on a sharp curve to determine the arrangement which will give the most favorable lateral-force distribution on the curve. Measurements were also made of the lateral and vertical forces produced by three other classes of locomotives covering a wide range of truck resistances. A description is given of the locomotives, test equipment, and the test track which was located on a 10-deg curve near Cajon, California. The data are presented in bar-chart form for ranges of measured vertical-web and lower-outer-fillet stresses. Included in the measurements are the lateral forces applied to the ties. Similar lateral-force measurements were taken on the web and fillet portions of the rail under various conditions of locomotive acceleration and the results are given.

Jackson, J. R., and Magee, C. M. (AAR Technical Center, Chicago, Ill.), Proceedings of the 50th Annual Convention of the AREA, Vol 52, 1951, pp 93-109, 59 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0575

STATIC STRESS MEASUREMENTS ON FIVE TEST RAILS IN SPECIAL TANGENT TRACK UNDER CONTROLLED LOADING CONDITIONS--PROVISO TESTS OF 1943 (APPENDIX 12-A)

The purpose of this study was to obtain information which would permit determination as to the extent the stress range as found in present rail sections can be lowered by revisions or modifications of the web or other elements of the rail cross section. Five types of rail were tested: three modified designs of 112-lb rail, a modified 115-lb rail, and a 131-lb RE rail. Track and loading conditions in the tests were so controlled as to permit direct comparisons of stresses obtained with the various rail sections. This required that the rail sections to be compared should be subjected to identical loading and support and the stresses accurately measured. The test equipment is described and a layout of the test track for stress measurements of the five rails under controlled loading conditions is given. Data plots show the measured stresses in relation to the location of strain

gages on the web and base of the test rail. Data are also tabulated for wheel loadings and measured stresses for vertical and longitudinal forces.

Bronson, C. B. (Chairman, Subcommittee), Proceedings of the AREA, Vol 46, 1945, pp 660-692, 19 figs., 2 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0576

STEADY-STATE RESPONSE OF A FINITE BEAM ON A PASTERNAK-TYPE FOUNDATION

A uniform Bernoulli-Euler beam of finite length, supported by a Pasternak-type foundation and subjected to a harmonic force concentrated at the midpoint, is investigated. The influence of the shear layer is observed when the model is compared with a beam supported by a Winkler-type foundation. At the first resonant frequency, unbounded values occur for the bending moment, which are not expected according to Winkler's hypothesis. Observations are made on the influence of damping and inertia of the foundation. Analytical expressions as well as frequency-response curves are presented for the beam deflections and the bending moments.

Radeș, M. (Polytechnic Institute, Bucharest, Romania), International Journal of Solids and Structures, Vol 6, No. 6, June 1970, pp 739-756, 6 figs., 2 tables, 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0577

PHOTOELASTIC SOLUTION OF STRESSES IN THE ELASTIC-FOUNDATION SUPPORTING A PLATE

This paper describes an experimental solution of the problem dealing with the three-dimensional stress distribution in a foundation. The stress distribution in a continuous linear elastic foundation supporting a centrally loaded circular plate was analyzed using the photoelastic freezing method. The axial displacements and the radius of contact surface at the interface between the plate and foundation were also determined. Comparisons were made between laboratory test results and theoretical solutions. The particular combination of epoxies used in this analysis makes the photoelastic method easily applicable to the solution of many foundation problems.

Durelli, A. J., Parks, V. J. (The Catholic University of America, Civil and Mechanical Engineering Dept., Washington, D.C.), and Morgard, J. S. (Technical University of Denmark, Lyngby, Denmark), International Journal of Solids and Structures, Vol 9, No. 2, February 1973, pp 193-202, 9 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0578

CONVERGENT INTERNAL STRESSES AND STEADY CYCLIC STATES OF STRESS

The works of various individuals who specialize on the subject of structure under repeated loading are reviewed in regard to definitions of the cyclic state of stress that leads to the theorem of "shakedown". A theorem which is more general than the shakedown theorem is proven in this paper. The theorem is concerned with two bodies which differ only in their initial patterns of internal stress but which will develop identical patterns of internal stress in regions of creep or plasticity when they are subjected to the

same variations of temperature and load. The theorem is proved for simple isotropic multiaxial creep and plasticity laws depending only on the second invariant of stress. Thermal effects, i.e., thermal strains and changes in yield and creep behavior with temperature are included in the analysis.

Frederick, C. O., and Armstrong, P. J. (Central Electricity Generating Board, Berkeley Nuclear Laboratories, Berkeley, England), Journal of Strain Analysis, Vol 1, No. 2, January 1966, pp 154-159, 1 fig., 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0579

ON THE NATURE OF MOVING CRACKS

Dynamic elastic-wave equations that express relations associated with the tip of a moving crack are integrated and an approximation to the solution of these equations is given. From examination of the dynamic stress field, the increase in fracture toughness and surface roughness relative to crack velocity is explained. It is also postulated that fracture paths, asymmetrical to the applied loading, can be stable providing their velocity of crack propagation is great enough.

Cotterell, B. (University of Sydney, Sydney, New South Wales, Australia), Journal of Applied Mechanics, Trans. of the ASME, Series E, Vol 31, No. 1, March 1964, pp 12-16, 6 figs., 15 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0580

THE INTERACTION BETWEEN A CRACK AND AN INCLUSION

A numerical method used to obtain the stress intensity factor for a crack near an inclusion, which is part of many crack and dislocation problems, is discussed. The method used to set up the problem in terms of dislocations and the resulting integral equation is resolved by two methods. The first method consists of reducing the integral equation to a Fredholm equation and the second approach uses an expansion in terms of Tschebyscheff polynomials. Results of the problem solutions involving cracks and inclusions are given in this paper and compared with some results in the literature. Results for the variation of the stress intensity factor with the distance of the crack tip from the inclusion are shown graphically.

Atkinson, C. (Dept. of the Theory of Materials, The University of Sheffield, England), International Journal of Engineering Sciences, Vol 10, No. 2, February 1972, pp 127-136, 7 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0581

THE DISTRIBUTION OF STRESS NEAR THE TIP OF A RADIAL CRACK AT THE EDGE OF A CIRCULAR HOLE

The problem of determining the distribution of stress near the tip of a crack which originates at the edge of a circular hole in an infinite elastic solid is examined. A Mellin transform technique is used to find an integral equation which is related to the stress intensity factor and the formation energy of a crack at the edge of

the circular hole. The biaxial loading case is considered in detail and numerical results are given.

Tweed, J. (The University of Glasgow, Glasgow, Scotland) and Rooke, D. P. (The Royal Aircraft Establishment, Farnborough, Hants, England), International Journal of Engineering Sciences, Vol 11, No. 11, November 1973, pp 1185-1195, 2 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: International Journal of Engineering Sciences.

PURCHASE FROM: Pergamon Press (repr., PC).

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0582

SETTING OF SENSITIVITY OF ULTRASONIC EQUIPMENT FOR WELD INSPECTION

The disadvantages of current methods of setting sensitivity of ultrasonic equipment for weld inspection and the work put forth by the author in connection with overcoming these disadvantages are discussed. The approach utilizes commonly used ultrasonic equipment and a variety of grease-coupled probes. The author's work leads to putting forward a general formula for sensitivity in terms of the amplitude from a reference hole on a IIW block and the attenuation. Working examples and practical advice to the operators is given. The application of Krautkramer Types USK5 and USM2 test equipment is described in this article.

Pinondel, M. J. (Welding Institute, Paris, France), Non-Destructive Testing, Vol 6, No. 2, April 1973, pp 86-91, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC-America, Inc. (repr., PC).

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0583

APPLICATION OF NON-DESTRUCTIVE METHOD TO THE INSPECTION OF STRESS-CORROSION CRACK AFFECTED WELDED STRUCTURES

This paper reports on investigations conducted with a view to solving industrial problems involving the detection of stress-corrosion cracking. The relative effectiveness of dye penetrant, magnetic particle, radiography and ultrasonic tests in the examination of butt welds, inside fillet welds, and lap welds is compared. The development of a method combining ultrasonic and magnetic particle tests is discussed.

Le Fenven, Y. (French Institute of Welding, Paris), Non-Destructive Testing, Vol 5, No. 1, 1972, pp 22-27, 6 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0584

HAVE DIGITAL COMPUTERS A PLACE IN NDT?

The basic and fundamental "black box" approach to conducting nondestructive testing in regards to the essential processes is briefly reviewed prior to establishing the concept associated with automation of the process. This paper points out that because of the computer's inflexibility once it is programmed, a large amount of the current NDT is still better performed by human operators. The computer's unique advantages of speed, reliability, and impartiality make it invaluable, however, for routine data logging requirements and the particular needs of metrology, for which application detailed examples are given.

Cotterell, K. (The Nondestructive Testing Centre, Atomic Energy Research Establishment, Harwell, Didcot, Berkshire, UK), Non-Destructive Testing, Vol 2, No. 4, November 1969, pp 269-273, 7 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0585

MEASUREMENTS OF STRESSES IN 115 RE AND 132 RE RAIL IN CURVED TRACK, OUTSIDE JOINT BAR LIMITS (APPENDIX 10-A)

High localized stresses found in the upper web fillets and in the upper portion of the rail web of 112 RE sections led to modifications of 115 RE and 132 RE rail sections in which the upper part of the web was thickened and combined within longer fillet radii. In addition, the tops of the rails were further rounded to relieve the gage corner from excessive bearing pressures and to bring the centroid of bearing between wheel and rail more nearly to the middle of the rail head.

Laboratory tests indicated that these modifications would effect a stress reduction of 25 percent. Field testing of the 115 RE rail on 6- and 4-deg curves and of the 132 RE rail on 6- and 4-1/2-deg curves was undertaken and the results are discussed. The measured vertical web and fillet stresses under the locomotive and car wheels at four locations on the inner and outer rails of the test track are tabulated, and the frequency of the measured stresses for each weight of rail is given.

It is concluded from the field tests that the redesign of the rails did effect a significant reduction in stresses.

Magee, G. M., Smucker, M. F., and Cross, L. E. (AAR Technical Center, Chicago, Ill.), Proceedings of the 51st Annual Convention of the AREA, Vol 53, 1952, pp 921-940, 12 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0586

EFFECT OF FLAT WHEELS ON TRACK AND EQUIPMENT

Until recent years it was not possible to measure accurately the rapid stress changes in rail and equipment resulting from the impact of flat wheels. In 1942 tests conducted on the New York, New Haven & Hartford Railroad established the characteristics required for reliable instrumentation. Suitable stress-measuring instruments were obtained and a comprehensive test program to determine the effects of flat spots on both the track and equipment was conducted on the Chicago & North Western Railway in 1947.

A special test train was used consisting of a locomotive, a passenger car carrying the measuring and recording instruments for the measurements on the test car, and a flat test car having a flat wheel and loaded with rails. A similar set of instruments was located in a test house along the track for the measurements on the rails. Tests with the flat car were made with wheel loads of 7600, 16,400, and 25,300 lb. Test runs were made at various speeds up to 90 mph on track laid with 100 RA-A rail and 131 RE rail. Tests were run first with round wheels to provide a basis for comparison; then successively with a 2-1/2-, 3-1/2-, and 4-1/2-in. flat spot on one wheel. A 4-1/2-in. spot was then made on the opposite wheel of the axle and, finally, both of these spots were rounded off at the ends to provide flat spots of 8-1/2-in. length but no greater depth.

Impact effects on the track were evaluated principally from measurements of flexural stress in the rail base, and vertical web stresses were measured directly beneath the rail head to aid in determining the impact forces on the rail. Impact effects on the car were evaluated from stress measurements on the wheel plate, axle, truck frame, and one coil spring, and

from acceleration measurements on both the sprung and unsprung weights.

A complete description of the test procedure and a detailed presentation of the results are given.

Joint Committee on Relation Between Track and Equipment of the Mechanical and Engineering Divisions, AAR, Proceedings of the 51st Annual Convention of the AREA, Vol 53, 1952, pp 423-448, 15 figs., 9 refs., 1 appendix.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0587

MEASUREMENT OF STRESSES IN 115 RE RAIL ON TANGENT TRACK--NORTH WESTERN RAILWAY (APPENDIX 11-B)

Test sections for the new 115-lb RE rail were installed on the westbound track of the Chicago & North Western Railway near Sterling, Illinois, for the purpose of testing various joint-bar designs. Each test section had 100 joints and was approximately 2000 ft long. The installation offered an opportunity to obtain measurements of stresses developed in the new 115 RE rail section under regular traffic and by means of the measurements to determine the extent to which service stresses in the upper web and upper rail fillets were reduced with the new design. Additionally, the test indicated the effect of the number of bolt holes and their spacing on the range of web stresses developed in service.

The data from the tests provide percentage of stresses occurring within a given stress range for diesel and steam locomotives and for freight and passenger cars. In addition to the data presented for stress frequencies, the dynamic stresses for each run and the stresses obtained for joints of different drillings are compared. It was concluded that the rail stresses were reduced as a result of the redesign of the rail and that the stresses associated with the bolt-hole regions were within tolerance.

Magee, G. M., Smucker, M. F., and Froseth, O. (AAR Technical Center, Chicago, Ill.) Proceedings of the 50th Annual Convention of the AREA, Vol 52, 1951, pp 690-704, 11 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0588

STRAINS PRODUCED ON END OF OUTER RAIL HEAD OF 6 DEG. CURVE

To measure the stresses produced on the ends of outer rail heads, strain gages (SR-4-1/4-in. long) were attached to one end of a new 131-lb RE rail, and it was placed in the outer rail of a 6-deg curve of the Norfolk & Western Railway. The rail was not end hardened. The first portion of the testing involved measurements of residual static strains that developed after the passage of a locomotive over the test section. Subsequent measurements yielded data on horizontal and vertical residual stresses in various positions of the inner rail-head surfaces. Similar tests were conducted on used rails, and it was noted that none of the gages recorded high residual stresses. The final experiment involved measurements of dynamic stresses under the wheels at the ends of the used rail and oscillograph traces were taken. From the test results it was concluded that: high residual stresses are developed within the rail head at points where the actual dynamic stresses during wheel passage are well below the yield point of the steel; the repetition or reversal of dynamic stresses accompanying wheel passage in the area where shelling develops is not sufficiently high to indicate fatigue failure; accumulated residual strains are quite high in the area where shelling develops; shelling may be the result of exhausted ductility due to excessive

plastic flow and high residual strains rather than fatigue of the metal from repeated or reversed stresses.

Hewes, F. S. (Chairman, AREA Subcommittee), Proceedings of the 45th Annual Convention of AREA, Vol 47, 1946, pp 438-443, 3 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0589

BEHAVIOUR OF THE METAL OF RAILS AND SMALL DIAMETER WHEELS (QUESTION C53) AND TESTS CONCERNING SMALL WHEELS (QUESTIONS C9, C53, B98)

The first report ["Behaviour of the Metal of Rails and Small Diameter Wheels" (Question C53)] deals with an inquiry made by the Office of Research and Experiments (ORE) with regard to the increasing use of small-diameter wheels for existing or planned rolling stock such as coaches, wagons, and various railcars. Concern is shown over the geometric problems and the problems of stresses developed in the contact zone of the rail and wheel. It is noted that a questionnaire on small-diameter wheels was sent to the European Member-Administration of ORE in January 1965. The minimum wheel diameter in Europe is discussed and comparisons are drawn between European and American rails.

The second report ["Tests Concerning Small Wheels" (Questions C9, C53, B98)] deals with a study of the use of small diameter wheels for rolling stock approved for international traffic, with particular reference to piggy-back traffic and double-deck car carriers. This study was performed by UIC for the Italian State Railways. Three problems relating to small-diameter wheel use were studied: derailment, permissible load, and braking. It was concluded that the results obtained from this investigation are inconclusive and that additional tests are required.

Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Questions C53, C9, and B98, ORE Publication No. 25, July 1967, 4 pp 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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0590

INVESTIGATION OF THE IMPACT OF FLAT WHEELS-PRELIMINARY REPORT

This report describes some tests conducted to study the effects on the track and equipment of wheels with flat spots and of irregularities and conditions in equipment passing over tracks at varying speeds. Such experiments were conducted previously; however, they raised considerable question as to whether the electromagnetic type of strain-gage equipment used had a frequency response high enough to give satisfactory accuracy of measurement. A description of the test track, located on the New Haven Railroad between Endicott and Islington, Massachusetts, is given along with information concerning the modulus of elasticity of the track support (1500 to 2000 psi). Photographs of the test equipment and their emplacement are shown. A description of the flat wheel and the means for alignment of the defect with the gage location is presented. The data are presented graphically and numerical values of the stresses caused by heavy load transportation by cars with flat spots on their wheels are discussed.

Magee, G. M., and Cress, E. E. (AAR Technical Center), Proceedings of the 44th Annual Convention of the AREA, Vol 45, 1944, pp 9-23, 11 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0591

STRESSES IN RAILROAD TRACK

The purpose of this paper was to examine the problem of stresses created in rails by moving loads which has become of greater significance with the current trend in railroad practice to increase the axle loading and speed of locomotives. A study conducted by Westinghouse Electric and Manufacturing Co., principally in connection with the study of tracking characteristics of electric locomotives, resulted in the development of a method of experimental determination of the vertical and lateral forces produced on the rails by a moving locomotive. It is shown that these lateral forces produce very high stresses in rails. The authors briefly discuss the theory which was used as a guide in the experimental research and describe some recent experiments in the laboratory and in the field. Instrumentation used in this study consisted of strain gages and photoelastic test equipment, and the procedures for and descriptions of their applications are shown.

Timoshenko, S. (University of Michigan, Ann Arbor, Mich.) and Langer, B. F. (Westinghouse Research Laboratories, East Pittsburgh, Pa.), Transactions of the ASME, Vol 54, APM-54-26, 1932, pp 277-302, 40 figs., 1 table, 64 refs. and footnotes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0592

SUMMARY OF PROGRESS ON INVESTIGATION OF STRESS RELAXATION IN RAIL STEEL (APPENDIX 9-B)

This study was initiated to investigate the possibility that residual stresses and or fatigue damage (preceding cracking) induced in the rail by rolling loads might be relieved by heating the rail steel to subcritical temperatures. The report describes work in progress and provides data obtained on the study of stress relaxation in small bar specimens as a function of time and temperature and rolling-load fatigue tests being conducted on small specimens. Photographs of the laboratory test equipment being used for rolling fatigue-testing are included.

Jenkins, D. R., and Grover, H. J. (Battelle Memorial Institute), Proceedings of the 51st Annual Convention of the AREA, Vol 53, 1952, pp 916-920, 5 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0593

EFFECT OF BOLT SPACING ON RAIL WEB STRESSES WITHIN THE RAIL JOINT (APPENDIX 12-A)

Tests conducted in the laboratory at the University of Illinois to study the effects of bolt-tension, applied wheel loads, and bolt-hole spacing upon rail web stresses are described. The rail used was the new 115-lb RE section of 36-in. headfree joint bars with 1-in.-diameter bolts. Similar tests were conducted on two 131-lb RE rail joints in tangent track during the passage of regular trains. It was concluded that high tensile stress in a vertical direction is produced at the bolt holes and in the upper and lower fillets at the rail end when the track bolts are tightened; the stress decreases when the distance from the rail end to the first bolt is increased. A significant range in stress was noted as a result of the passing wheel loads which could result in fatigue failure. The difference in the amount of rail-end batter or joint deflection with variations in bolt hole spacings was considered insignificant.

Code, C. J. (Chairman, Subcommittee), et al., Proceedings of the 47th Annual Convention of AREA, Vol 49, 1948, pp 464, 17 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0594

RAIL DESIGN STUDY AND TESTS ON MODIFIED RAIL SECTIONS-1945

This portion of the report deals with extensive stress measurements made in straight and curved track as they relate to prior shelly rail studies. The rails used in this study consisted of the 112-, 113-, 114-, 131-, and 132-lb designs. Sections of the rails being tested are shown along with a modified design of the 131-lb RE-rail. Technical details concerning the insertion of the test rails into the track system and the strain-gage instrumentation are discussed. The data are presented graphically in a manner such that the stress measurements can be correlated with a designated position within the rail geometry. Tabulated data are presented which provide the maximum stresses in the upper web fillets and portions of the rail webs with vertical loads of 40,000 lb applied to each of the rail test specimens. A similar presentation is given for the lower fillets and rail webs.

Magee, C. M. (AAR Technical Center, Chicago, Ill.), Proceedings of the 45th Annual Convention of the AREA, Vol 47, 1946, pp 449-463, 9 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0595

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE: RESIDUAL STRESSES IN THE RAIL (CONTINUED); STUDY OF THE WORK HARDENED ZONE

This is a continuation of ORE Report C 53/RP 4 which dealt with methods for determining the residual stresses in the rail and covered the first measurements of these stresses taken by the SNCF and the Mechanics of Solids Laboratory of the Paris Polytechnic, using a new rail. This present report contains the results of additional measurements taken with a new rail and also with a twin rail from the same manufacturing batch which had been placed in the track and then withdrawn after having carried about 50 million tons in a line used chiefly by goods trains (main circle line, Paris). All the measurements were taken in order to study the work-hardening caused by traffic, and more especially the changes in the residual stresses in the rails near the running tread which constitute an important factor in the study of rail fatigue phenomena. About 5 mm below the surface the work-hardening is very large, and the rail is the center of a hydrostatic pressure zone extending down to a depth of approximately 10 mm, this then changing into a tensile one with a maximum at about 15 mm. This may explain why the fatigue cracks (of the kidney-shaped flaw type) tend to originate at a depth of 10 to 20 mm but do not develop in the upper highly compressed zone. Furthermore, the residual-stress fields vary from one section of the rail to another, probably as a result of the oscillations of the wheel-loads due to short-wave rail corrugations.

Prud'homme (Chairman, C-53 Committee), Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands), Report No. C-53/RP-6, October 1970, 22 pp, 36 figs.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0596

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE: COMPOSITION OF THE DIFFERENT STRESS CONDITIONS IN THE WHEEL/RAIL CONTACT ZONE; DEVELOPMENT OF A NEW FATIGUE CRITERION

The first part of this report contains some additional results concerning the residual stresses in the rail. The second part, which constitutes the more essential part of the study, deals with calculations on the composition of the residual stresses induced in the rail during the passage of a wheel, for different wheel-loads and diameters, transverse curvature radii of wheel tires, rail inertia, and track moduli. Some qualitative conclusions on the influence of

these various parameters have been given in using an original fatigue criterion, the principles of which are also outlined in this report. This criterion should permit a quantitative analysis of the fatigue phenomena to be made when the results of the fatigue tests in progress are known.

Prud'homme (Chairman, 53-Committee, Office of Research and Experiment, International Union of Railways, Utrecht, Netherlands), Report No. C-53/RP-7, April 1972, 68 pp, 42 figs.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0597

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE: TENTATIVE STUDY OF STRESSES IN A RAIL BY PHOTO-ELASTIC AND EXTENSOMETER MEASUREMENT

Photoelastic measurements through the use of synthetic material as a simplified model were made to determine the stresses developed in a vertical cross section of the rail, along the contour of the section and at the generatrix of the rail in its plane of symmetry. The measurements were performed by photoelastic and strain gauge methods. Reasons are given for using the simplified models made from synthetic materials, rail steel, and the actual rail. The test results are described and the methods used in the laboratory are subjected to critical consideration.

Prud'homme (Chairman, 53-Committee, Office of Research and Experiment, International Union of Railways, Utrecht, Netherlands), Report No. C-53/RP-5, October 1969, 30 pp, 21 figs.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0598

BEHAVIOR OF THE METAL OF THE RAILS UNDER THE REPEATED ACTION OF THE WHEELS: RESIDUAL STRESSES IN THE RAIL (PART 1)

This report deals with the methods for the determination of the residual stresses in the rail; it is part of a more general study on research into the mechanical causes of deep faults in the rail heads and wheel defects. The problem of residual stresses is a subject which is complete in itself, and its study is essential to the analysis of the mechanical behavior of the rail in the track. For this reason it was considered desirable to deal with it separately in this report. The objective of this report is to establish a method for the determination of residual stresses and to provide results obtained by applying such a method in some special case. The residual stresses are described as being due to heat effects during controlled cooling after the rail leaves the rolling mill, trimming after rolling in both directions, and the cold rolling of the top surface of the rail by the passage of loads.

Prud'homme (Chairman, C-53 Committee, Office of Research and Experiment, International Union of Railways, Utrecht, Netherlands), Report No. C-53/RP-4/E, Interim Report No. 4, October 1966, 25 pp, 28 figs., 8 refs., 4 appendixes.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0599

BEHAVIOR OF THE METAL OF THE RAILS AND WHEELS IN THE CONTACT ZONE: INQUIRY INTO THE PROBLEM OF SMALL DIAMETER WHEELS

This report involves an inquiry into the effect that a reduction in the diameter of the wheels would have on the behavior of rails and wheels in service. The

inquiry was conducted by questioning the Member-Administrations of the ORE as well as by making a study of the literature. The report summarizes the information collected on the subject of load per wheel/wheel diameter ratios and includes an analysis of tests carried out by the U.S.A., U.S.S.R., D.B., B.R., and the S.N.C.F. Very different values of the ratio were found, depending on the railway and the type of steel in the rails, and thus it was not possible to develop a justifiable theory. The past practices of the European railways indicate a theme of caution; however, a trend toward exceeding the stipulated ratios is beginning to appear.

Prud'homme (Chairman, Committee C53, Office of Research and Experiment, International Union of Railways, Utrecht, Netherlands), Report No. C-53/RP-3/E, Interim Report--Doc. No. 3, October 1966, 21 pp., 5 figs., 3 appendixes.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC).

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0600

RUNNING THROUGH CURVES

This paper deals with simple methods for the determination of wheel flange forces and wear, as well as how they affect the track structure. The works of Professors H. Heumann and Vogel, and others, are reviewed in relation to their development of the minimum and vehicle-position diagrams associated with their names. Mathematical treatment pertinent to calculations of the angle of attack of the wheel flange, rail directing forces, lateral forces, safety against derailment, and tractive resistance factors is covered in the text as well as by data plotted on curves. Investigations conducted in the United Kingdom, France, Germany, Sweden, and Switzerland are briefly mentioned when they are related to this study.

Koffman, J. L. (Traction & Rolling-Stock Development Engineer, British Railway Board, England), The Railway Gazette, Vol 123, No. 9, April 21, 1967, pp 307-311, 7 figs., 1 table, 27 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0601

ON THE SOLUTION OF BEAM-ON-ELASTIC-FOUNDATION PROBLEMS BY MEANS OF A MECHANICAL ANALOGUE

The conception of a loaded beam resting on an elastic foundation whose reaction at any point is proportional to the deflection of the beam at that point, as usually ascribed to Winkler, in 1867, is reviewed. An analysis of bending stresses, such as might occur in railway track resting upon soil, was given by Zimmerman in 1888. The mathematical expressions on which these analyses depend can be solved by means of the differential analyser, but only straightforwardly when the four boundary conditions are specified at one point. When the equation is associated with beams on elastic foundations, the boundary conditions are more often specified at two points, and a quicker method of solution is desirable. In the analogue, direct use is made of the beam in the form of an elastic wire, supported at regular intervals in T-shaped cradles from the arms of which weights are suspended. The wire takes up a transversely deflected form which may be measured, and boundary conditions are imposed where required. A specific problem is examined and results are shown to be in reasonable agreement with the solution by calculation.

Wells, A. A. (British Welding Research Association, England), Proceedings of the Institution of Mechanical Engineers, Vol 163, 1950, pp 307-310, 6 figs., 3 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0602

FLEXURAL STRESSES IN CURVED BEAMS OF I- AND BOX-SECTION

A mathematical and experimental investigation is made of the stresses resulting from the flexure of curved beams of I- and box-section. It is shown that the flanges, if unsupported, distort under the influence of radial stress-components, and are less effective in carrying the circumferential bending stresses than would appear from ordinary methods of calculation. The distortion is accompanied by transverse bending stresses which, in certain circumstances, may be of greater magnitude than the circumferential stresses, and which at the inner radius combine with the circumferential stresses to introduce critical stress conditions. The distortion effects may be limited by using thick, narrow flanges, by ample fillets between the flanges and the webs. Formulae and charts for the estimation of stresses are presented in convenient form for design purposes.

Anderson, C. G. (Coal Production Branch, State Electricity Commission, Victoria, Australia), Proceedings of the Institution of Mechanical Engineers, Vol 163, 1950, pp 295-306, 17 figs., 5 tables, 23 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr. PC).

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0603

MEASUREMENT OF FORCE OF IMPACT FRACTURE ON NOTCHED SECTION OF RAIL [IN FRENCH]

The apparatus used in laboratory measurements of impact fracture on notched rail sections is discussed. The test equipment and methods developed by the Societe des Hautes Fourneaux de la Chiers, France, is described as well as a photographic technique employed by the French railroads. Details of a photoelastic method being used for stress and strain investigations are described and some test results and conclusions are given.

Perrey, M. M., Revue de Metallurgie, Vol 43, November-December 1946, pp 236-246, 10 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM. Revue de Metallurgie (repr., PC).

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0604

RAIL--THE FOUNDATION OF RAILWAY PROGRESS

This paper contains a series of articles that are presented by the Railway Engineering and Maintenance journal to commemorate the 75th anniversary of the rolling of the first steel rail in the United States. Included are articles on: the importance of rail in transportation; how rail sections were developed; metallurgical and manufacturing progress in rail production; the importance of rail fastenings; the care that is given in laying and maintenance to conserve the life of rail; and some predictions regarding composition, shape, size, weight, and length of rail in the future.

Railway Engineering and Maintenance, Vol 36, No. 9, September 1940, pp 558-573, 1 fig., 1 table, 17 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Out of print.

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0605

IMPACT STRESSES IN A FREELY SUPPORTED BEAM

This paper reviews various theories used in estimating impact effects on a freely supported beam, and points out the error which may be introduced if it is assumed that elastic forms are similar under dynamic and static loading. An apparatus is described in which a railway rail is subjected to

central impacts, strain measurements being made along the flange by means of small scratch extensometers. An analysis of the results indicates instantaneous bending moment distribution occurring at time intervals of 1/100 second during impact. Bending stresses are shown to be approximately 20% greater than those calculated by assuming statical equivalence. Diagrams of results obtained by calculation from an equation derived by Timoshenko show agreement in form with the load variations recorded by the extensometers. Results obtained by measurement from the area of the ellipse of contact are also given, and loads - obtained by four independent methods - are drawn to a base of impact velocity for various weights. Mention is made of the practical significance of the results.

Arnold, R. N. (Dept. of Civil and Mechanical Engineering, Royal Technical College, Glasgow, Scotland), Proc. of the Institution of Mechanical Engineers, Vol 137, November-December 1937, pp 217-281, 39 figs., 4 tables, 8 refs., discussion, and 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0606

DETERMINING COUNTERBALANCING EFFECTS BY RAIL-STRESS MEASUREMENTS

Higher speeds in rail transport have resulted in increased rail stresses to the point where they may exceed the elastic limit of the rail steel. This paper investigates the possibility that the primary problem lies in the imperfect balancing of the engines and summarizes extensive studies conducted by the Association of American Railroads involving a series of rail-stress measurements performed on a site selected by the C. & N.W. Railway System. The results obtained indicated that the rebalancing of certain 2-8-2 steam locomotives has so reduced rail stresses in 100-lb rails that the maximum permissible speed, previously limited to 50 mph is now restricted only by the capabilities of the traction vehicle. The principal objective of the investigation was to compare the stresses produced in the rails over a considerable range of speed using a variety of locomotives, including some that have been suspected of causing considerable rail damage at speeds up to 80 mph. Considerable information is given concerning the physical characteristics of the locomotives for use in summation of the rail loading parameters. A description of the test track is provided and the rail histories from manufacturing to current use are discussed. Data taken by means of strain-gage instruments were analyzed. Information is provided on rail depression/deflection, working stresses, and the modulus of elasticity for the rail supports as a result of this investigation.

Engineering, Vol 154, Nos. 4005, 4007, 4011, October-November 1942, pp 301-304, 341-344, and 421, 15 figs., 13 figs., 2 footnotes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Canadian Technical Publications, Ltd., (repr., PC).

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0607

CALCULATION OF STRESSES IN RAILS DUE TO STATIC VERTICAL LOADS

A survey of the literature on the calculation of the deflections and bending moments in rails showed that there is a broad division between solutions involving a continuous elastic support and solutions involving equally spaced elastic point supports. This article is concerned with briefly reviewing these various methods and comparing their merits. Data are plotted that show the variation in the maximum bending moment due to a changing foundation modulus for B.H. rail as well as rail deflection for different bending moments and distances from the supports. A table is presented

which compares three methods (three moment, continuous bed, and relaxation) for solving a typical problem with three equally spaced 10-ton loads.

Storey, C., Engineering, Vol 185, No. 4800, March 7, 1958, pp 311-312, 3 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0608

STRESS MEASUREMENTS ON 131-LB. RE RAIL IN TANGENT AND IN A 6-DEG. CURVE UNDER REGULAR TRAFFIC—NORFOLK & WESTERN RAILWAY—1945 (APPENDIX 12-A)

Stress measurements obtained in the upper and lower web fillets, in the upper portion of the web, and along the top outer edges of the base of 131-lb RE rail in tangent track and in a 6-deg curve of the Norfolk & Western Railway which is subjected to regular traffic are given. Data for stress measurements made on supporting tie plates are also given. The measurements were made under the wheels of 186 regular freight and passenger locomotives and tenders and under a portion of the heaviest cars. Stresses under some 2000 loaded coal cars were also recorded. All measurements were made with SR-4 type electrical wire resistance strain gages with an effective length of 1/4 in. The gages were placed at positions on the rail cross section where it was known that the most significant stresses would be found and could be determined under the variety of loading conditions in track.

On the basis of the tests, it was concluded that: the range of stress measured in the 131-lb RE rail in tangent track and in the outer rail of the 6-deg curve under regular traffic on the N&W did not exceed the endurance limit of rail steel at any of the gage positions; on the inner rail of the 6-deg curve at the upper web fillet and upper portion of the web on the gage side, occasional localized compressive stresses are considerably above the limit of rail steel; on the inner rail of the 6-deg curve at the lower outer web fillet and along the top of the outer edge of the base of rail directly over the bearing on new rolled crown tie plates, the ranges of measured stress are considerably above the endurance limit of rail steel, and their frequency of occurrence is high under locomotive and tender wheels; at the same rail positions directly over the wider bearing on worn rolled crown tie plates, the range of stress is well within the endurance limit.

Code, C. J. (Chairman, Subcommittee), et al., Transactions of the 46th Annual Convention of the AREA, Vol 46, 1945, pp 768-794, 11 figs., 6 tables.

ACKNOWLEDGMENT: American Railway Engineering Association

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0609

STEEL RAILS, THEIR HISTORY, PROPERTIES, STRENGTH AND MANUFACTURE WITH NOTES ON THE PRINCIPLES OF ROLLING STOCK AND TRACK DESIGN: CHAPTER IV. STRESSES IN THE RAIL

This chapter presents information relative to stresses at the point of contact of the wheel with the rail, solutions of the bending stress in rails and tests to determine them, calculation of the bending and shearing stress in the rail, and the effects of rail joints on stresses. Illustrations are given which show details of equipment used for bending stress tests, and data for worn rails subjected to bending tests are included. Experimental data obtained during studies which were conducted to observe the depression of rails under loading conditions are discussed.

Hollaw, W. H. (Michigan Central Railroad), Steel Rails, D. Van Nostrand Company, New York, 1913, pp 193-269, 43 figs., 21 tables, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: D. Van Nostrand Company (repr., PC).

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0610

STRESS MEASUREMENTS IN 115 RE AND 132 RE RAIL ON CURVED TRACK

As a result of some difficulties with web cracking which were experienced by one railroad with 112- and 131-lb RE rail section, the need for accurate measurement of the stresses developed in the upper web and fillet area under actual service conditions was recognized. Such measurements were made on the 112 RE section in 4-deg curved track and on the 131 RE in 6-deg curved track using SR-4 strain gages. It was found that stresses in the web were quite high (in many cases as high as 80,000-psi compression). In an attempt to reduce these stresses, it was then recommended that 115 RE and 132 RE rail be redesigned to increase the thickness somewhat in the upper part of the rail web and to increase the length of the fillet radius. This was done and the rails were tested on curved track. Measurements showed that, in general, the upper range of stress for the redesigned 115 RE section on 6-deg curve was reduced to approximately 40,000-psi compression. The stress range for the redesigned 132 RE was found to be quite similar.

Data and charts for both the old and redesigned rail are presented which show the extent of the stresses on both sides of the web and base, as well as in certain portions of the baseplate. The results of fatigue tests are given in the form of Goodman diagrams, and other graphical illustrations using the conventional S-N diagram are included.

Magee, C. M. (AAR Technical Center), Proceedings of the 51st Convention of the AREA, Vol 53, 1952, pp 1140-1150, 10 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0611

VISUALIZATION OF PULSED ULTRASOUND USING STROBOSCOPIC PHOTOELASTICITY

This paper describes the use of stroboscopic photoelasticity for visualization in solids, compares the method with its schlieren counterpart, and discusses possible applications relevant to nondestructive testing. The optical and electrical arrangements of the experimental system are described, and an explanation of the functional modes is given. Photographs of visualized ultrasonic pulses are presented which show optical polarizers that give maximum sensitivity for longitudinal shear waves. Suggestions as to the uses of the technique for ultrasonic nondestructive tests are offered.

Wyatt, R. C. (Central Electricity Generation Board, Scientific Services Department, Portishead, England), The British Journal of Non-Destructive Testing, Vol 5, No. 6, December 1972, pp 354-358, 7 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC.).

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0612

DIRECT ULTRASONIC VISUALIZATION: A NEW INSPECTION METHOD

Direct ultrasonic visualization of defects, considered to be a new method for imaging discontinuities in materials, is described in this paper. This method, which makes mechanical scanning and lasers unnecessary, provides instantaneous imaging. The method operates by focusing ultrasonic reflections, using a focusing system with properties that permit a continuous image to be presented, viewed transversely to the ultrasonic illumination, and preserving the spatial relationship of the originating discontinuities. Applications are

presented which demonstrate the value of the method to engineering inspection problems.

Hanstead, P. D. (Central Electricity Generating Board, Scientific Services Laboratories, Portishead, England), The British Journal of Non-Destructive Testing, Vol 16, No. 2, March 1974, pp 34-44, 22 figs., 22 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0613

THE USE OF EDGE-OF-BEAM METHODS FOR THE ASSESSMENT OF DEFECT SIZE

This article is devoted to a description of the edge-of-beam method (20 db or 6 db drop) and a discussion of the errors that can arise in the plotting and use of the systems in the vertical plane when shear-wave probes are used. The major factors affecting the estimation of defect size are discussed, namely, selection of probe, suitability of surface and couplant, calibration of time base, plotting of the effective beam profile in the vertical plane, construction of the beam profile, and the use of the beam profile to assess the defect size.

Jackson, B. (West Bromwich College of Commerce and Technology, Wednesbury, England), The British Journal of Non-Destructive Testing, Vol 16, No. 4, July 1974, pp 114-116, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc., (repr., PC).

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0614

EDDY CURRENT TESTING - THE PRESENT SITUATION, RESULTS, NEW DEVELOPMENTS

This paper gives a brief review of nondestructive testing techniques being used as an integral part of the production process for the automatic inspection of semifinished products. The classical theories of Forster and the newly established theories by Burrows, Dodd, et al., relating to eddy-current flaw detection with encircling coils are discussed, together with up-to-date methods for the recovery, assessment, and analysis of measured values, and, finally, the kind of action on the inspected product and the process. New coil configurations are discussed and considered in relation to their industrial application. Statistical assessments of the stored results are discussed, and some recommendations are made regarding their inadequacies. Examples of routine exploitation of eddy-current testing are also presented.

Stumm, W. (Institut Dr. Forster, Reutlingen, West Germany), The British Journal of Non-Destructive Testing, Vol 15, No. 5, September 1973, pp 134-142 and 151, 14 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0615

ULTRASONIC TESTING OF AUSTENITIC STEEL CASTINGS AND WELDS

This paper discusses angle probes that are built to emit short-pulse, focused longitudinal waves and the experimental and theoretical basis of using them for the testing of austenitic castings and welds. Special probes designed to operate with Krautkramer USM2 equipment modified to shift the bandwidth to lower frequencies are described.

The performance of these probes is compared with that of standard commercially available probes, and the data obtained from tests designed to show these comparisons are given.

Pelseneer, J. P., and Louis, G. (Association Vincotte, Brussels, Belgium), The British Journal of Non-Destructive Testing, Vol 16, No. 4, July 1974, pp 107-113, 8 figs., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0616

DELTA TECHNIQUE EXTENDS THE CAPABILITIES OF WELD QUALITY ASSURANCE

This paper presents a brief review of the delta technique and phenomena which involve a basic configuration for a multisearch unit used in inspections based on sensing redirected sound energy that originates when a scanning sound beam strikes internal discontinuities. Structures containing various weld configurations were evaluated by means of the Delta technique. Defect character, inspection technique, and data recovery are reviewed and compared with other nondestructive testing techniques and metallurgical sections. Unique recording techniques developed to provide flaw depth and size information are also discussed.

Cross, B. T., Hannah, K. J., Tooley, W. H., and Birks, A. S., The British Journal of Non-Destructive Testing, Vol 11, No. 4, December 1969, pp 62-77, 26 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0617

DYNAMICS OF RAILWAY TRACK SYSTEMS AND THEIR ECONOMIC CONSEQUENCES

A summary of a paper presented by the Chief Civil Engineer of the British Railways Board that deals with the circumstances and practices on British Railways (BR) is covered in this paper. He explained that the BR had divided track into four categories which were based on differences in speed, and track lives and manpower allowances were decided on these differences. This categorization is now regarded as lacking in definition and new categories have been introduced which take into account that higher speed necessitates track perfection while heavy traffic destroys it. Statistics are provided on the incidence of broken rails on the BR for a five-year period and on the relative effects of higher speeds, static axleloads, and unsprung masses on a dipped rail joint. Maintenance schedules for 90 mph plain jointed track and for continuous-welded rail plain track as well as the annual costs of replacements for both are given. The problem of obtaining meaningful data on rail stresses is discussed in connection with decisions to be made on rail renewal.

Paterson, R. A. (British Railway Board, England), Railway Gazette, Vol 126, No. 1, January 2, 1970, pp 19-24, 5 figs., 7 tables, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0618

MEAN STRESS EFFECTS ON FATIGUE CRACK GROWTH AND FAILURE IN A RAIL STEEL

Over a limited range, the effect of mean stress was studied on fatigue-crack propagation and on the critical fatigue-crack size associated with sudden fast fracture in center-notched plate specimens of a rail steel under pulsating loading. The results are presented

in terms of the stress-intensity factor range, K, and the ratio, R, of the minimum to maximum stress. Increasing R was found to both accelerate cracking and reduce the critical crack size at instability. The data have been correlated with three crack-growth equations currently used in the literature and it was found that the equation of Forman, et al., relating crack-growth rate to K and R gave the best fit. This equation was used to predict life in the finite range of the S-N curve. Fractographic examination revealed that the fracture surfaces were complex and a number of fracture modes contributed to cracking. (Carried as RRIS Accession No. 071782.)

Evans, P. R., Owen, N. B., and McCartney, L. N. (Division of Materials Applications, National Physical Laboratory, Teddington, Middlesex, England), Engineering Fracture Mechanics, Vol 6, No. 1, March 1974, pp 183-193, 8 figs., 2 tables, 8 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0619

STEADY-STATE MOTION OF RAILWAY VEHICLES ON CURVED TRACK

In this paper, a linear analysis is developed to describe the approximate behavior of a bogie vehicle on curved track; the two-axled vehicle is treated as a reduction of the general case. The analysis is simplified by disregarding small effects such as wheelset roll, gravitational stiffness, and spin creepage. The approach used is based on providing guidance by creep forces in conjunction with wheel conicity so that flange contact is normally avoided. The bounds of linear theory are defined by the onset of wheel slip. Representative experimental results for a two-axled vehicle are presented; tests are being performed both on a laboratory roller-rig and on the track.

Boocock, D. (British Railway Board, The Railway Technical Center, Derby, England), Journal of Mechanical Engineering Science, Vol 11, No. 6, 1969, pp 556-566, 10 figs., 12 refs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0620

DIFFICULTIES IN THE ULTRASONIC EVALUATION OF DEFECT SIZE

This paper points out the intricacy of assessments of defect size in solid bodies and welded fabrications detected by ultrasonics. Knowledge of a number of characteristics peculiar to the defects is necessary, and these are difficult to determine. The author warns users of ultrasonic equipment of the danger of making over-hasty interpretations which can lead to serious errors. AVG-diagrams which permit direct comparison between probes of differing diameters and frequencies are shown. The limitations of the Krautkramer method for detecting defects are discussed. Test data which bear out the author's belief that changes in the shape of the defect can produce considerable variations in reflective properties are also presented.

Bastien, P. (President of CCRS, Institute of France), Non-Destructive Testing, Vol 1, No. 3, February 1968, pp 147-151, 6 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC, Inc., Science and Technology Press, Ltd. (repr., PC).

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0621

AN EXPERIMENTAL STUDY OF THE FORCED VIBRATION OF BEAM UNDER MOVING LOAD

The author attempts to solve the problem of a simple beam under a concentrated rolling load by experimental means since it is beyond the reach of pure mathematics. Zimmermann and Timoschenko published papers on this subject, however, Zimmermann disregarded the mass of the beam in his study, and Timoschenko ignored the load. The author's experimental study is concerned with "Zimmermann's Effect" where a heavier load rolls over a flexible

beam; the deflection at the middle point of the beam under the rolling load was determined by means of proper apparatus. As a result of about 1200 measurements with nine different combinations of beam length and the weight of the load selected for the purpose and related to different velocities, an empirical formula was obtained. Further experiments are being conducted on the effect of a series of loads on the "Timoschenko Effect" which is caused by lighter loads rolling over a rigid beam.

Shibata, H. (Research Office, Japanese Government Railways, Japan), Proceedings of the World Engineering Congress, Tokyo, 1929, Vol III, Engineering Science, Part I, pp 395-415, 12 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kogakkai, Japan (repr., PC).

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0622

A METHOD OF MEASURING FATIGUE DEGREE AND ITS RECOVERY

This paper deals with a study and experimental work associated with metal subjected to repeated stress or impact conducted for the purpose of investigating fatigue and recovery from fatigue. The progress or degree of fatigue was measured by the changes in magnetic properties in a test piece and by the changes in Charpy and Izod number after different periods of repeated impacts. The data obtained from the experimental work are analysed and plotted to show the relationship between degree of fatigue and fatigue recovery as functions of carbon content, temperature, and magnetising current.

Asahara, Y. (Research Institute for Iron, Steel and Other Metals, Tohoku Imperial University, Sendai, Japan), Proceedings of the World Engineering Congress, Tokyo, 1929, Vol III, Engineering Science, Part I, pp 63-72, 11 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kogakkai, Japan (repr., PC).

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0623

COMPUTER REVEALS TRACK QUALITY INSTANTLY

A high-speed, data-processing system, the Tamper Valuator, has been developed by Tamper, Inc., and mounted in one of its Matisa Trackfax Cars. It is capable of measuring such parameters as gauge, twist, superelevation, surface and line of right and left rails. When the Valuator is used on the Trackfax car it provides a computer and print-out mechanism in addition to the strip chart. The basic procedures for operation within the ranges stipulated by railway standards are discussed. A typical print-out of the Valuator system is included to show the high-priority deviations as well as roadside references. The Valuator is being used on the Trackfax track inspection car on the Chicago & North Western Railroad.

Railway Track and Structure, Vol 67, No. 10, October 1971, pp 28-30, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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0624

NEW METHODS OF ULTRASONIC INSPECTION OF MATERIALS FOR FLAWS AT THE RESEARCH FACILITY OF THE S.N.C.F. [IN FRENCH]

New methods and devices, in particular the "Sonirail" and "Metallorada SNCF" test apparatus, for ultrasonic testing of rails for flaws are discussed. Problems experienced with these devices have prompted a laboratory investigation concerned with the study of influence on absorption of ultrasonic waves of

such factors as structure of steel, various heat treatments, and cold working, residual stresses. Types of rail flaws such as fissures, splitting, shelling, and bolt-hole cracks are discussed and illustrations are given to show their appearance. A discussion is provided to explain the functioning of the ultrasonic probes and how the angular positioning affects their operation. Information on crystallography of rail steel is also presented.

Palme, M. (S.N.C.F. Research Laboratory, France), Revue de Metallurgie, Vol 54, No. 11, November 1957, pp 879-888, 26 figs., 1 table, discussion.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Revue de Metallurgie (repr., PC).

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0625

HIGHER SPEEDS THROUGH CURVES

The ability of locomotives to run at high speed around curves which depends on their stability against overturning, safety against derailment, the loads and stresses imposed on the track, and rail and wheel wear, is discussed. Mathematical expressions are provided which aid in the study of stability against overturning, permissible track cant, and acceleration around curves. A model for calculating the lateral and angular displacement of a locomotive body subject to centrifugal force on a curved track is given. The requirements specified on the Soviet Railways concerning the periodic stress relief on jointed or continuously welded rails are briefly mentioned. A curve showing the relation between the lateral forces imposed on the track by the French SNCF Bo-Bo locomotive as a function of speed is included.

Koffman, J. L. (Traction & Rolling Stock Engineer, British Railways Board, England), Railway Gazette, Vol 126, No. 2, January 16, 1970, 4 figs., 1 table, 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0626

DETECTION OF INTERNAL RAIL DEFECTS BY THE SONIRAIL FLAW DETECTOR [IN FRENCH]

The use of the "Sonirail" flaw detector in detecting internal rail defects is described. The instrument is capable detecting defects on the basis of both sonic frequency and intensity of the signal. The author states that this device permits accurate detection of all defects in the rail. Photographs are included which show rails that have failed as a result of to bolt-hole cracks, head splitting, transverse fissures, cracked webs, and railhead surface defects.

Palme, J., Revue de Metallurgie, Vol 52, No. 9, September 1955, pp 711-716, 12 figs., discussion.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Revue de Metallurgie (repr., PC).

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0627

METHODS OF APPLICATION OF THE ULTRASONOSCOPE FOR SOUNDING OF RAILS [IN FRENCH]

The methods for testing and inspection of rail heads developed at the French Metallurgical Research Institute are discussed. Examples of tests that make it possible to detect defects in the rails because of fatigue and other flaws that exist are given. A brief description is presented of the operation of the Siemens ultrasonic flaw detector and the positioning of the probe and oscilloscope signal traces are shown. Tests associated with rolling loads on rail specimens are described and data are plotted.

Beaujard, L., and Husarek, V. (French Metallurgical Research Institute, France), Revue de Metallurgie, Vol 51, No. 8, August 1954, pp 558-568, 30 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Revue de Metallurgie (repr., PC).

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0628

A SHAKEDOWN LIMIT IN ROLLING CONTACT

The two-dimensional (plane deformation) shakedown problem of a rigid cylinder rolling on an elastic, perfectly plastic semi-infinite solid is studied. It is found that, under repeated rolling, the combined system of residual and contact stresses will shake down to an elastic state provided that the maximum Hertzian pressure is less than 4.0 k (k = yield stress in simple shear). At loads in excess of this limit the system will not shake down and plastic flow will occur during each traversal of the rolling cylinder.

Johnson, K. L. (Brown University), Proceedings of the Fourth U.S. National Congress of Applied Mechanics, ASME, New York, Vol 2, 1962, pp 971-975, 3 figs., 7 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0629

A THREE-DIMENSIONAL PHOTOELASTIC STUDY OF INTERIOR STRESSES IN THE HEAD OF A RAILROAD RAIL IN THE REGION UNDER A WHEEL

This paper deals with the problem of measuring stress distributions in the transverse plane under the center of a wheel on a rail, i.e., transverse to the plane of symmetry. The author has published an earlier report on a three-dimensional photoelastic study of contact stresses in the head of a railroad rail. This paper continues the discussion of that study and, in addition, includes determinations of stress distributions along interior lines parallel with the axis of the rail in the region of contact with the wheel. Rectangular stress components and the principal stresses are determined by the shear-difference method in combination with frozen stresses. The results of the investigation are shown in proximity to the region of shelly failures and planes subjected to large alternating stresses and shears. These stresses may well be the causes of the failures found in the rails.

Frocht, M. M. (Illinois Institute of Technology, Chicago, Ill.), and Wang, B. S. (Arpex Computer Products Co., Chicago, Ill.), Proceedings of the Fourth U.S. National Congress of Applied Mechanics, ASME, New York, N.Y., 1962, Vol 1, pp 603-609, 11 figs., 10 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0630

DETERMINATION OF THE NATURAL FREQUENCIES OF CONTINUOUS BEAMS ON FLEXIBLE SUPPORTS

The purpose of this paper is to present a method for calculating the undamped natural frequencies of flexural vibration of continuous beams on flexible supports. The supports are represented by a set of mutually independent, linearly elastic, deflectional and rotational springs. The effects of concentrated masses, attached either directly to the beam or through a spring, are also considered.

Veletsos, A. S., and Newmark, N. M. (University of Illinois, Urbana, Ill.), Proceedings of the Second U.S. National Congress of Applied Mechanics, ASME, New York, 1955, pp 147-155, 6 figs., 2 tables, 10 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0631

THE DYNAMIC STABILITY OF RAILWAY VEHICLE WHEELSETS AND BOGIES HAVING PROFILED WHEELS

The dynamic instability of railway vehicle bogies and wheelsets is caused by the combined action of the conicity of the wheels and the creep forces acting between the wheels and rails. The instability is investigated in the important case where the wheels are profiled rather than purely conical. Equations of motion are formulated and stability criteria obtained which indicate the effect of varying the various parameters of the system. The nature of the motion at the critical speed is investigated and the mode of energy conversion between the forward motion of the vehicle and the lateral motion of the bogie or wheelset is explained. (Carried as RRIS Accession No. 040123.)

Wickens, A. H. (British Railway Board, Derby, England), International Journal of Solids and Structures, Vol 1, No. 3, July 1965, pp 319-341, 8 figs., 25 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press, Inc., (repr., PC).

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0632

GAS-SHIELDED ARC WELDING OF HIGH-MANGANESE STEEL RAILS

In the present study the aim was to realize automation of the welding of manganese crossings which has been conventionally executed by manual arc welding process, thereby sharply raising the welding efficiency and obtaining sound welds with good mechanical properties and free from welding defects. As a basic step to automatic welding of manganese crossings, the case of automatic welding of cast high-manganese steel rails is treated here. The mechanical properties and chemical composition of the high-manganese rail steel and welding electrode wire are given. Numerical test data showing the effects of shielding gas on the mechanical properties of the steel, such as tensile strength, elongation, and impact values are presented and discussed. The procedures used in conducting bend tests are described and the results from the tests are shown. (Carried as RRIS Accession No. 033147.)

Ando, S., Uchida, A., and Kimata, N. (Japanese National Railways), Railway Technical Research Institute Quarterly Report, Vol 8, No. 1, March 1967, pp 11-17, 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0633

LOADS BORNE ON ELASTIC SUPPORTS

The problem considered here is concerned with loads carried upon a number of elastic supports. Owing to the number of supports, the proportion of the load carried by each cannot be determined by statics alone but depends, in large part, on the elastic properties of the supports. The author describes an exact method suitable for application to such problems as occur in connection with the wheel loading of railway rolling stock and locomotives, motor vehicles, etc., and, in particular, directed to the question of the adjustment of the springs necessary to produce a desired distribution of the loads upon them. It is shown that if the initial loading on the springs, i.e., before adjustment, is known by direct measurement, the equations which give the amounts of the adjustments to be made in terms of the desired increments of the load take a conveniently simple form, and the adjustments can be calculated and made once for all without any necessity for trial-and-error methods. A few simple examples are given in the paper, and an appendix contains a short account of an extension of Castigliano's second theorem from which the equations in the paper may be

derived, and an example showing the application of the method to the adjustment of the wheel loading of a locomotive.

Lamb, E. H. (Dept. of Civil and Mechanical Engineering, Queen Mary College, University of London, England), Proceedings of the Institution of Mechanical Engineers, Vol 151, 1944, pp 265-273, 5 figs., 1 table, 5 footnotes, 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0634

IMPULSIVE LOADING OF RIGID-PLASTIC CURVED BEAMS

Dynamic analysis of a rigid-plastic curved beam with axial constraints under impulsive loading is presented. The governing equations for the dynamic equilibrium of the moving hinges for various phases of motion have been formulated. The nonlinear differential equations are then solved by a numerical integration process for a curved beam consisting of two straight elements for different initial rises and initial velocities. The results are compared with the case of a rigid-plastic straight beam treated by Symonds and Neal.

Hsu, P. T., and Pian, T.H.H. (Massachusetts Institute of Technology, Cambridge, Mass.), and Chen, N. N. (Boston University, Boston, Mass.), Proceedings of the Fourth U.S. National Congress of Applied Mechanics, ASME, New York, 1962, Vol 2, pp 1039-1045, 11 figs., 5 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0635

DYNAMIC RESPONSE OF A BEAM SUBJECTED TO A MOVING FORCING SYSTEM

A procedure is presented for obtaining exact solutions of the fundamental differential equations governing the dynamic response of a simply supported prismatic flexural member loaded by a damped sprung-mass system moving with constant velocity across the span. Effects of inertia, gravity, and damping of both the flexural member and forcing systems are considered. Expressions are derived for displacements and accelerations of the beam and the spring-borne mass for any position of the moving load. The procedure is general and can be extended to more complex systems with arbitrary initial and boundary conditions.

Licari, J. S., and Wilson, E. N. (New York University, N.Y.), Proceedings of the Fourth U.S. National Congress of Applied Mechanics, Vol 1, ASME, New York, 1962, pp 419-425, 3 figs., 22 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0636

MOVING MASS ON AN INFINITE BEAM

This paper contains an analysis of the problem of a mass moving with constant velocity across a uniform, flexible beam of infinite extent. The analysis takes into account both the inertia of the moving mass and the inertia of the beam, neglecting, however, the effects of rotatory inertia and shear in the beam. A fundamental solution to the beam equation is found, and with it an integration method for an infinite beam is developed. The application of the technique to the moving mass problem yields an integrodifferential equation of the convolution type with the deflection under the mass as the

unknown function. This equation is solved by means of the Laplace transformation and the final result is expressed in terms of certain infinite integrals.

Tseng, C. (University of Illinois, Urbana, Ill.), Proceedings of the Fourth U.S. National Congress of Applied Mechanics, Vol 1, ASME, New York, 1962, pp 411-418, 10 figs., 6 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0637

TIMOSHENKO'S SHEAR COEFFICIENT FOR FLEXURAL VIBRATIONS OF BEAMS

It is pointed out that Timoshenko's shear coefficient, in his equations of flexural vibrations of beams, depends on both the shape of the cross-section and the mode of motion. It is shown how the latter may be taken into account by matching solutions, of Timoshenko's equations and the three-dimensional equations, for simple thickness-shear motions of infinite beams of various cross-sectional shapes.

Mindlin, R. D., and Deresiewicz, H. (Columbia University, New York, N.Y.), Proceedings of the Second U.S. National Congress on Applied Mechanics, ASME, New York, 1955, pp 175-178, 2 figs., 2 tables, 11 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0638

CREEP BUCKLING OF CURVED BEAM UNDER LATERAL LOAD

Variational theorem for creep is applied to the problem of creep deflection of a curved beam under lateral loading. The ends of the beam are restrained from sliding motion, hence under a static load it is possible to buckle suddenly from one equilibrium condition to another. It is shown that this abrupt buckling may also occur under the action of creep deformation. Both viscoelastic and nonlinear creep properties are included in the analysis.

Pian, T.H.H. (Massachusetts Institute of Technology, Cambridge, Mass.), Proceedings of the Third U.S. National Congress of Applied Mechanics, ASME, New York, 1958, pp 649-654, 6 figs., 9 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0639

THE INFINITE BEAM ON EQUIDISTANT SUPPORTS AND RELATED PROBLEMS

A method of systematic reduction is used in replacing the effect of continuity on the loaded span by two adjoining spans of proper flexural stiffness. The problems analyzed in this manner include: (a) the infinite beam on equidistant supports, (b) an infinite sequence of open continuous frames, and (c) an infinite sequence of closed frames supported at equal intervals. The procedure is analytical, and the results are "exact" within the limitations of the usual flexural theory of beams.

Hetenyi, M. (Northwestern University, Evanston, Ill.), Proceedings of the Third U.S. National Congress of Applied Mechanics, ASME, New York, Vol 1, 1958, pp 369-374, 5 figs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0640

BUCKLING OF LATERALLY OR TORSIONALLY RESTRAINED BEAMS

In this paper, the author applies the finite-element approach, first proposed by Barsoum and Gallagher, to the problem of lateral buckling of simply supported beams provided with a central, elastic restraint possessing either lateral or torsional stiffness. The approach

employed differs from that used by others in that the beam is modelled as an elastic line, thus precluding considerations of a change in cross-sectional shape on buckling. Three types of loading, as well as flange loading are considered. Good agreement is shown between the theoretical results obtained here and experimental results previously obtained by the author in tests performed on 6 x 3-in., 15-ft-long, cold-formed channel sections.

Nethercot, D. A. (Dept. of Civil and Structural Engineering, University of Sheffield, England), Proceedings of the American Society of Civil Engineering, Journal of the Engineering Mechanics Division, Vol 99, No. EM 4, August 1973, pp 773-791, 15 figs., 10 tables, 16 refs., 2 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society of Civil Engineers (repr., PC).

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0641

THE PREVENTION OF FLAKES BY HOLDING RAILROAD RAILS AT VARIOUS CONSTANT TEMPERATURES

The work of a number of authors concerning the causes of flaking and shatter cracks and their effect on the life and service of rail is reviewed, and the authors describe their own investigations. The objective of their investigations was to determine the lengths of time at which 131-lb rails should be held at 1100, 900, 700, and 500 F (595, 480, 370, and 260 C) to prevent the formation of flakes or shatter cracks. The chemical composition of the four heats of open-hearth rail steel used in the studies is given. Prior to testing all ingots from which the rails were rolled were treated with hydrogen to insure that the steel would have a strong tendency to develop flakes.

On the basis of the test data, the authors conclude that flake formation may be prevented by holding the specimen 3 hr at 1100 F (595 C), 4 hr at 900 and 700 F (480 and 370 C), and 5 hr at 500 F (260 C).

Cramer, R. E., and Best, E. C. (University of Illinois, Urbana, Ill.), Blast Furnace and Steel Plant, Vol 27, No. 11, November 1939, pp 1174-1176 and 1182-1183, 1 fig., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0642

CORRUGATION AND PITTING OF THE ROLLING SURFACES--ARE THEY CONTINGENT UPON ULTRASONICS?

This article is an abridgement of Essay No. 28/1973 held in the Archiv fur Eisenbahntechnik. Rail corrugations, which were a familiar phenomenon in the 1890's, and similar periodic forms of wear occur in other rolling-contact combinations. An attempt is made in this paper to explain these manifestations. The author concludes that troublesome corrugations and perhaps damaging pitting might be avoided if, in addition to the attenuation of low-frequency oscillations, a means could be found to prevent the agitation and propagation of intensive ultrasonic fields within the area of the running surfaces.

Werner, K. (Bundesbahn-Zentralamt Minden, Weserglacis, West Germany), Wear, Vol 32, No. 2, April 1975, pp 233-248, 10 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0643

HIGH LATERAL FORCES ON SHARP CURVES WITH PROPELLED TRAINS

In an effort to explain why the outward forces on the trucks of propelled trains are greater than can be explained by the angle present between center lines of the vehicles, British Railways conducted a test on curved track to determine vertical loads and lateral forces. Six special baseplates were installed on adjacent sleepers on the test curve to record vertical loads and lateral forces between rail and sleeper. It was found that lateral forces toward the outer rail when propelled are considerably greater than when hauled. A more severe speed restriction on a particular curve

is of little assistance because speed, and hence centrifugal force, is low anyway. The increase of lateral force toward the outer rail when the train is propelled is accompanied, at the leading outer wheel of a bogie, by increased vertical load so that the possibility of flange-climbing derailment is not altered appreciably. Propulsion on a sharp curve produces an overturning movement on the train. For severe locations its magnitude should be restricted by a limitation on tractive effort. (Carried as RRIS Accession No. 40099.)

Pocklington, A. R. (Engineering Research Division, British Railways Board, Derby, England), The Railway Gazette, Vol 121, No. 12, December 1965, pp 993-996, 4 figs., 2 photos.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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0644

PROPULSION OF TRAINS ON SHARP CURVES

A model to simulate the forces resulting in overturning and flange-climbing with propelled trains on sharp curves led to a series of tests arranged on a sharp curve at Dover. An axlebox lateral-force gear was used to measure the elements of the flange force present at the axleboxes, and load-measuring baseplates were fixed between the outer rail and the sleepers to measure the vertical loads imposed by the wheels as well as the lateral loads. The latter are equal to the flange forces, less the lateral tread friction at the outer rail. The results of these tests showed that the increased lateral force when propelling exceeded considerably the value attributable to the propulsive effort and the angle between the coaches. (Carried as RRIS Accession No. 40096.)

Pocklington, A. R. (Engineering Research Division, British Railways Board, Derby, England), Railway Gazette, Vol 121, No. 11, November 1965, pp 909-912, 7 figs., 1 photo, 2 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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0645

ON THE STABILITY OF THE RAILROAD TRACK IN THE VERTICAL PLANE

The paper reviews and discusses various aspects of railroad track buckling in the vertical plane. Buckling tests of straight tracks are reviewed first. A review of the published analyses on vertical track buckling reveals that they may be grouped into two main categories. In one category, the author assumes that the track is an elastic beam which is continuously supported by a Winkler base, before as well as during buckling. In the other group, the author assumes that the track is a beam of uniform weight, which rests on a "rigid" base and that the buckling load is reached when part of the track lifts itself off the base. To clarify the validity of some of the assumptions made, two simple models which represent the assumptions made are studied first. This is followed by a review of the literature. It is shown that the assumption of continuous elastic support during buckling is not admissible. It is also shown that for buckling with lift-off, the use of linearized analyses may lead to erroneous results.

Kerr, A. D. (Visiting Prof., Dept. of Civil and Geological Engineering, Princeton Univ., Princeton, N.J.), Rail International, Vol 5, No. 2, February 1974, pp 131-142, 18 figs., 1 table, 47 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Railway Congress Association (repr., PC).

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0646

TEST FOR WHEEL BURNS OF RAILS BY D-TYPE AC LOCOMOTIVES

This test was intended to analyze the process of wheel burn formation. In the gradient traction test of an ED 75 AC locomotive, on the Kagoshima line, wheel slip was forced to occur by various operating conditions, and the wheel burns of rails were examined. It is the object of this test to find an optimum operation method for heavy trains and to improve the practical adhesive capacity as a preventive measure of wheel slip, by the analysis of adhesion on various

rail conditions. (Carried as RRIS Accession No. 33150.)

Shiba, S., Kimura, S., Ito, A., and Ueda, T. (Japanese National Railways, Tokyo, Japan), Railway Technical Research Institute, JNR, Quarterly Reports, March 1967, pp 48-50, 6 figs., 1 ref.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0647

EXPERIMENTAL RESULTS OBTAINED ON THE LATERAL PROBLEMS OF THE LONG WELDED RAIL CONTINUOUSLY LAID ON SEVERAL SPANS OF THE BRIDGE WITHOUT BALLAST

To show the lateral stability of continuously welded rail on a bridge, and the character of the lateral load on the bridge caused by such rail, a test was conducted by the Japanese National Railways on an actual bridge. The data resulting from this test show that even though there were no problems resulting from unballasted rail on the bridge, the lateral forces between rail and sleepers vary and may reach a value ten times that of the calculated value. This phenomenon occurs as a result of the high lateral elastic coefficient of the supporting system for the continuous rail. (Carried as RRIS Accession No. 39440.).

Sato, Y., and Nagata, M. (Japanese National Railways, Tokyo, Japan), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 10, No. 1, March 1969, pp 8-10, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0648

NONLINEAR WHEELSET DYNAMIC RESPONSE TO RANDOM LATERAL RAIL IRREGULARITIES

The nonlinear equations of motion for a railway vehicle wheelset having profiled wheels and contact of the wheel flange with flexible rails are presented. Spin creep and gyroscopic effects are considered. The rails are assumed to have random lateral irregularities which are described by prescribed power spectra. The equations of motion are integrated numerically and the effects on the dynamic response of quantities such as speed, track roughness, wheel wear, flange clearance, and lateral stiffness of the rails are investigated.

Law, E. H., (Dept. of Engineering Mechanics, Clemson University, Clemson, S.C.), Journal of Engineering for Industry, Trans. ASME, Series B, Vol 96, No. 4, November 1974, pp 1168-1176, 9 figs., 20 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0649

THE EFFECT OF TECHNOLOGICAL FACTORS ON THE PROPERTIES OF HEAT TREATED RAILS [IN RUSSIAN]

A study was made of the effects of the initial structure and quench temperature (820 to 880 C), and of rolling temperature (820 to 840, 880 to 900, 980 to 1000 C), and cooling regime after rolling, on the properties of a rail steel containing 0.73% carbon and 0.87% manganese. The optimum quench temperature for this steel is 860 C which markedly increases the strength properties and the hardness without loss of ductility. Using this quench temperature there is no lose of properties if the end of rolling temperature is raised to 1000 C. There is a noticeable increase in ductility and brittle-ductile transition temperature with a relatively small reduction in strength if the steel is transformed to a globular pearlite structure before quenching.

Loshkina, N. A., and Rauzin, Ya. R. (Institute of Railroad Engineering, U.S.S.R.), Trudy Vsesoyuznyi Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 136-139, 3 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kanklin Bookstore (repr., PC).

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0650

HEATING OF RAILS DUE TO CONTACT RESISTANCE [IN RUSSIAN]

Formulae are derived for the thermal balance of component rails, for the stationary temperature field of any two current-carrying contiguous rails, and for the heat at the junction of the rails, generated due to contact resistance. The theoretical predictions are verified experimentally within an accuracy of 11 percent, using model sections of copper rails with relatively large contacting surfaces of different cross-sections. Ambient air cooling only was employed in the experiments.

Ushakov, V. G., and Kharlamova, S. P., Izvestiya Vysshikh Uchebnykh Zavedenii Elektromekhanika, No. 5, May 1970, pp 598-600, 1 fig., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0651

NEUMANN TYRE PROFILE TESTS ON BRITISH RAILWAYS

A new tire profile, based on the studies of Professor Neumann, was designed and is illustrated. This tire profile should assist in ensuring good riding qualities and increase the resistance to derailment which, in turn, should reduce tire and rail wear and ensure a favorable wear pattern. This can be accomplished by ensuring one-point contact running and a gradual transition of the throat profile. The results of trials carried out with standard 32-ton British Railways coaches running on B4-type bogies with 3-ft wheels, positive axle guides, 19-1/2-in. effectively long swing-links and helical springs throughout are shown. Ride index values during acceleration and wear patterns for the tires are given. The tests have shown beneficial results, although further tests are needed. (Carried as RRIS Accession No. 037861.)

Koffman, J. L. (British Railways Board, Derby, England), The Railway Gazette, Vol 121, April 1965, pp 279-283, 9 figs., 7 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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0652

THE VARIABILITY OF ULTRASONIC TRANSDUCERS

A statistical analysis of the variation in some of the important properties of ultrasonic probes is described. The probes evaluated by the NDT Centre's probe-beam plotter have been used as a sample. An attempt has been made to define acceptable limits to the variations in probe parameters, although these may not be of wide application since every application of ultrasonic testing defines slightly different limits of acceptability. It appears that 45% of low-frequency probes and 81% of high-frequency probes may lie outside these limits. The subject of beam-sensitivity classification of the probes studied is discussed briefly.

Lidington, B. H., and Silk, M. G. (Non-destructive Testing Center, Materials Physics Division, UKAEA Research Group, AERE, Harwell, England), The British Journal of Non-Destructive Testing, Vol 14, No. 6, November 1972, pp 173-184, 18 figs., 5 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0653

INVESTIGATION OF JOINTS IN CONTINUOUS RAILS PRODUCED BY THE SECHERON WELDING PROCESS [IN GERMAN]

This paper presents the results of tests performed on welded rail joints produced by the Secheron process. Five types of steel were used for this investigation, ranging from regular quality to special Ti- and Mo-alloy wear-resistant grades, and paired in different combinations. Results based on tests for mechanical

properties and the examination of the microstructure of the tested specimens are given. Comparisons of specimens welded using the Secheron process and others with Thermit and flash butt welds are discussed.

Heller, W., and Simon, W. (Technical University of Munich, West Germany), Schweizer Archiv, Vol 33, No. 8, August 1967, pp 239-242, 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0654

RESIDUAL LONGITUDINAL STRESSES IN THE RAIL

The residual stresses result from heat effects during the cooling of the rail after it leaves the rolling mill; from trimming after rolling in the vertical and horizontal directions; and from the plastic deformation of the top surface of the rail by the passage of loads. Several existing methods for determining the residual longitudinal stresses are compared. A test was made by the SNCF on four rails which were removed after 11 years of service (tonnage 11 million tons). The vertical deflections before laying and after removal were measured. It is apparent that the longitudinal compressive residual stresses produced by cold rolling at the level of the contact surface give rise to a curvature. (Carried as RRIS Accession No. 039538.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), ORE Publication No. 25, July 1967, pp 19-20.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0655

PROBLEMS OF INTERACTION OF VEHICLES AND TRACK---WORN PROFILES OF RAIL HEADS AND WHEEL TYRES

As a result of a large number of tests it has been proved that service wear on wheel tires and rail heads leads to definite profiles. These worn profiles are to a large degree independent of the initial profiles of tires and rail heads. In the worn condition the profiles maintain their form and are not subject to any further change. The worn profiles are characterized by good mutual conformity and thus by little increase in wear. The worn profile of tires results in a shortening of the wavelength of the periodical wheel set motions (hunting) in the track clearance. It was concluded that to wear, new profiles of rail heads and tires should be adapted as much as possible to the worn profile. The use of special wheel tire profiles promises no lasting influence on the riding quality of vehicles. Therefore, other design measures on the vehicles should be preferred to control the hunting motion. (Carried as RRIS Accession No. 040418.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C9/RP6, October 1962, 2 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0656

LATERAL STABILITY OF RAILS, ESPECIALLY OF LONG WELDED RAILS

This report discusses the results of a questionnaire to determine the state of the art of welded rail. It includes discussion of the history of the uses of long welded rail, and of tests to determine the characteristics of such rail under varying climatic conditions. The report also covers

track buckling tests at Karlsruhe and London in the late 1950's and includes a chapter on the characteristics of track incorporating long-welded rail. Various theories on the stability of long welded rail are covered briefly, and an extensive bibliography is included. (Carried as RRIS Accession No. 033211.)

Loach, J. C., and Klaren, J. W. (British Railways Board, Derby, England), International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D14/RP 1, April 1965, 82 pp, refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0657

MODERN NON-DESTRUCTIVE METHODS FOR MATERIALS TESTING--DOCUMENTARY REPORT

This report deals chiefly with flaw detection which is a small part of the wider science of nondestructive examination of metals. The Committee has kept strictly to its main objective which is to produce a balanced account of applications of nondestructive testing to railway problems. The directly practical part of the Committee's account is to be a catalogue of procedure charts describing and illustrating the methods actually used in the workshops of the various Administrations, and drawing attention to those which merit special recommendation. This catalogue will constitute Part 2 of the Committee's report (ORE report E 29/RP 2). The present documentary report is a single guide to the principles on which nondestructive testing is based and does not take the reader beyond the minimum of information required for a proper understanding of Part 2. Its production has nevertheless entailed a search among recent publications in several countries. It applies to cast, forged, and rolled products, but does not include rails. The techniques of liquid-penetrant, magnetic-flux, ultrasonic, X-ray, gamma ray, and eddy-current testing are covered. (Carried as RRIS Accession No. 033209.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. E29/RP 1, 89 pp, 137 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0658

MODERN NON-DESTRUCTIVE METHODS FOR MATERIAL TESTING--CATALOGUE

The purpose of this report is to give an overall view of the results obtained so far and the development of nondestructive test methods by the railway Administrations. The Committee collected data on the application of nondestructive tests, of which the catalogue leaflets represent a concise summary. The leaflets of this catalogue refer to a selection of important components which are at present examined by nondestructive methods on those Administrations included in the inquiry. The descriptions relate to components whose design, or behavior in service, must be of immediate interest to all who already have experience of them and to those about to adopt similar designs. The sketches provoke thought not only in regard to service performance, but also to the necessity of repairing or of tolerating the presence of certain defects until such time as repairs can be carried out. Documentary report E 29/RP 1 is of considerable assistance for a sound understanding of the Catalogue. The report covers the detection of flaws in axle shafts, wheels, locomotive rod drives, plates, sheets and welded seams, diesel engine parts, and bearings

by liquid-penetrant, magnetic-flux, ultrasonic, X-ray, and gamma-ray inspection. (Carried as RRIS Accession No. 033210.)

International Union of Railways, (Office for Research and Experiments, Utrecht, Netherlands), Report No. E29/RP 2, July 1962, Final Report.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0659

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT

The revisions of the album of sample sulfur prints appended to UIC leaflet No. 860 for the supply of rails are summarized. Results of the correlation between performance of Thomas steel rails with test results are reported. The object was to develop a single test or group of tests to project performance during the initial acceptance of the rails. These tests show that with Thomas steel rails, there is a specific relationship between the results of the transverse tensile test, the compression test, the turning-by-stages test, the magnetic-powder test, the dye-penetration test, deep etching, and the microscopic determination of silicate inclusions and the liability of the rails to "shelling" (dark patches), horizontal longitudinal cracks, and transverse cracks. (Carried as RRIS Accession No. 037638.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), ORE Publication No. 24 (Question D45), January 1967, pp 19-23, 2 figs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0660

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT--CONDITIONS OF USE FOR TECHNICAL SPECIFICATION UIC 860-1

The conditions of application of UIC Specification No. 860-1 were investigated relative to dimensional tolerance, falling-weight test, tensile test piece, and detection of piping. Initially, rail tolerance measurements indicated that the majority of mill-produced rails were not acceptable, but it was felt that if specified tolerances were strictly adhered to, the price of rail would increase greatly. Since users were reasonably satisfied with currently produced rail, the tolerances applicable to web thickness, inclination, and openings of the fishing angles were relaxed. When UIC Specification No. 860-1 was initiated in 1954, it constituted the first step towards the standardization of the falling-weight test. The Committee now offers a choice between two methods of carrying out the falling-weight test; one involves two successive blows applied to the test pieces rolled from a certain number of ingots, and the other involves one blow and is applied to test pieces rolled from every ingot. Because of the nature of the steel used for wear-resisting rails, the corresponding UIC Specification 860-2 has been drafted to include a tensile test piece 10 mm in diameter. The Committee decided to propose the standardization of the 10-mm-diameter test piece. One result of this decision is that the minimum elongation will have to be raised from 12 to 14% in the case of ordinary rails. This test has been found to be not very accurate and of limited interest, since in reality it only permitted the revelation of piping in the rail without offering the possibility of its true appreciation. The Committee therefore sought another test for inspection purposes which would reveal piping in an indisputable manner. After considerable research, they have decided on a test which consists of the examination of the polished slice of rail intended

for the macrographic (sulfur print) test. (Carried as RRIS Accession No. 040414.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D45/RP 2, March 1962, 3 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0661

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT

This report represents a collection of documentary leaflets covering principal rail defects. A leaflet on starcracking in fishbolt holes discusses causes, propagation, detection, and remedies. Photographic evidence of defects is presented. A second document covers progressive transverse cracking in rail heads and includes origin of cracks, detection, and remedies. Numerous photographs illustrate this defect. A final section deals with transverse fractures at longitudinal fissures at the foot of rails. Again, specific fractures are illustrated photographically. (Carried as RRIS Accession No. 033213.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Interim Report No. D45/RP 3, March 1952, 96 pp, photos, 12 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0662

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT--FALLING WEIGHT TESTS AND DEFINITION TESTS

The main object of these tests was to define and to standardize the conditions of use of the falling-weight tests, laid down in UIC Leaflets 860-1-O and 860-2-O, for the acceptance of rails of current quality and rails of nontreated steel of a quality resistant to wear. It was concluded that results of a falling-weight test, irrespective of its type, are not representative of the fatigue behavior of rails in the track, but it was considered advisable to retain, for the time being, such a test on complete pieces of rail to make it possible to detect and eliminate brittle rails with a large degree of probable success and to maintain each rail production within a truly characteristic and correct scatter range. (Carried as RRIS Accession No. 040413.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D45/RP 4, April 1963, 2 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0663

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT. TESTS WITH APPARATUS FOR THE CONTINUOUS EXAMINATION OF RAILS IN THE TRACK

Report discusses the use of high-speed rail-inspection equipment, and the ways in which joint operation of such vehicles would be practical. The amount of track to be inspected, the frequency of inspection and geographic considerations are

determinants of the practicality of joint ownership and operation. Also, a comparison of the performance of Teledetector, the Spema, and the DB ultrasonic rail fault coach is made over identical track. A discussion of rail flaws and their classification is included. (Carried as RRIS Accession No. 33214.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D45/RP 6, October 1963, 20 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0664

QUALITY OF RAILS AND MEANS OF GUARANTEEING IT; EXAMINATION OF THOMAS STEEL RAILS OF THE THIRD SERIES OF TESTS BY MEANS OF RALUS ULTRASONIC PROCEDURE; DOCUMENTARY REPORTS OF THE IRSID AND BAM

The investigation of the quality of steel rails and the means of guaranteeing it has been entrusted to the D 45 Specialists Committee at the request of the 7th UIC Commission. Two series of tests have already been made within the scope of this work. A third series of tests was then carried out on rails having shown "good" or and "bad" performances in the track, these performances being defined beforehand according to some accurate criteria. The definition tests and the special tests on the Thomas steel rails of this series have been dealt with in Interim Report No. 9. As many as possible of the Thomas steel rail samples of the third series of test have been examined by means of the RALUS ultrasonic equipment, developed by IRSID and designed for the automatic industrial ultrasonic inspection of the rail head. The results of this examination have been dealt with in this report (RP 10), which also contains a documentary report by IRSID on the RALUS method and one by BAM on the investigation of rails for nonmetallic inclusions. (Carried as RRIS Accession No. 033215.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D45/RP 10, November 1967, 18 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0665

BEHAVIOR OF THE METAL OF RAILS UNDER THE REPEATED ACTION OF WHEELS. STUDY OF THE FIELD OF STRESSES IN THE ELASTO-PLASTIC ZONE, PRELIMINARY CALCULATIONS

This report contains the results of the various calculations effected so far. These can be considered as preliminary calculations carried out before proceeding to the complete calculation of the stresses in a railhead. The report likewise contains several analytical studies, both for gaining a better insight of the stresses (the methods and the formulae are, as a rule, well known, though, generally speaking, the numerical results are not published) and for rendering possible a comparison of the results obtained by means of the numerical method with those obtained by means of exact calculations. (Carried as RRIS Accession No. 033207.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C53/RP 1/E, March 1964, 102 pp.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0666

BEHAVIOR OF THE STEEL AT THE POINT OF RAIL-WHEEL CONTACT--INTRODUCTORY STUDY ON THE CAUSES OF SHELLING CRACKS IN RAILS

This report reviews pertinent literature on the subject of shelling cracks in rail head. From the research conducted at the University of Illinois it is concluded that shelling cracks in rail heads are primarily due to fatigue under repeated rolling action. Obvious methods of reducing the development of shelling cracks would be to reduce wheel loads on the rails, to use larger diameter wheels, or to use stronger rail steels. Future research should be directed towards the closing of the gap between standard fatigue data and the fatigue phenomenon as it occurs under contact stresses due to rolling action. At the moment, the prime difficulty in correlating tensile or torsion and rolling-contact fatigue data stems from insufficient knowledge of stress distributions modified with respect to elastic theory by plastic deformation. (Carried as RRIS Accession No. 040417.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. C53/RP 1/E, October 1961, 10 pp., 9 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0667

STRESS DISTRIBUTION IN THE RAILS DUE TO TRAFFIC LOADS

Tests were conducted to determine stresses in rail which result from vehicle wheels. These stresses were measured on the surface of a rail section, in the track, and in the inner zone. Tests to determine the relationship between actual and theoretical stresses of ballast and blanket were also conducted. The conclusions were that the force between rail and sleepers was proportional to the force exerted. Stress within ballast was determined to be related to the method of packing. Hand packing resulted in more stress concentration than did machine packing. (Carried as RRIS Accession No. 039408.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), ORE Publication No. 24, 29, Report No. 6701-6907, (Question D71), 18 pp., 24 figs., 2 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0668

DYNAMICS OF RAIL FAILURES IN THE TRACK

The propagation conditions of the following defects were studied: transverse cracks in the head; horizontal cracks in the head; and starcracking at fishbolt holes. The main object was to attempt to determine the length of time after the appearance of detection of the failures during which the rails could be left in the track before dangerous failure became imminent. Laboratory tests failed to determine this time factor. Field-test results from the Paris suburban railway are briefly described for the three types of defects. Laboratory measurement of transverse defects showed that the electric method gave more accurate results than

the ultrasonic method using pulse echoes. (Carried as RRIS Accession No. 04G122.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), ORE Publication No. 25 (Question D88), July 1967, pp 33-35.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0669

STUDY OF RAIL FAILURES IN THE TRACK-STANDARD: RAIL FAILURE STATISTICS

The main object was to define the type and form of presentation of rail-failure information to be supplied by various ORE Member Administrations so as to permit the better use of such information--and to draw some concrete conclusions. Committee D 88 found great difficulty in identifying a suitable denominator to which the rail failures could be related for purposes of comparison between Administrations. In the absence of a more reliable denominator, rail failures were related to the kilometers of track concerned with the type of failure being compared. This should enable Administrations to decide whether their present policies in regard to choice of rail section, steel quality, rail welding, joint design, track maintenance policy, and rail renewal frequency (only to quote the main factors) require any alteration. (Carried as RRIS Accession No. 040061.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D88/RP 1, April 1965, 22 pp., 9 appendixes.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0670

STUDY OF RAIL FAILURES IN THE TRACK--STUDY ON THE DYNAMICS OF RAIL DEFECTS

The following rail defects were investigated: starcracking at holes within fishplate limits; horizontal cracks in the head; and transverse cracks (kidney-shaped fatigue crack) starting within the head. The report also formulates some observations on the dynamics of each of the defects, namely, irregular development of starcracks; checking or "stagnation" of horizontal cracks in the head; propagation of transverse cracks, according to an exponential law. The report concluded that the irregular development of starcracks depended on a large number of factors, of which the condition of the railjoint and the maintenance conditions appeared to be the most important. The same was true in the case of horizontal cracks in the head at the railend. (Carried as RRIS Accession No. 040177).

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D88/RP 2, October 1965, 14 pp., 1 appendix.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0671

THE PRINCIPAL RAIL DEFECTS, INTERIM REPORT NO. 3 (CHAPTERS I-IV)

A listing of principal rail defects which includes the description, causes, consequences, and remedies for each is presented. Those included are: vertical longitudinal splitting, laps, shelling of heat-treated rails, gauge corner shelling, starcracking of fishbolt holes, progressive transverse cracking in rail heads, horizontal cracking of rail head, and transverse fractures at longitudinal fissures. Included at the end of each unit are a number of photographs of each flaw. (Carried as RRIS Accession No. 033212.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Report No. D88/RP 3, March 1962, 57 pp., photos.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0672

STUDY OF RAIL FAULTS IN THE TRACK - STANDARD RAIL FAILURE STATISTICS; 1965 RAIL FRACTURES CAUSING DERAILMENTS

This report provides an account of rail failures for 1965 compiled by nineteen Administrations. The report also includes a study on broken rails having caused derailments. A primary distribution of the failures based on their location is: failures at rail ends, failures away from rail ends, and butt-weld failures. The principal rail defects classified according to their cause are: failures attributable to manufacturing defects, failures attributable to service, failures which may be attributed either to manufacturing defects or to service, and failures due to butt welding or thermit welding and rebuilding of surfaces. (Carried as RRIS Accession No. 040179.)

International Union of Railways (Office for Research and Experiments, Utrecht, Netherlands), Final Report No. 5 (Question D88), April 1968, 27 pp., 8 figs., 5 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: International Union of Railways (Available Only at DOT-Library) (repr., PC).

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0673

HIGH-SPEED LIGHTWEIGHT TRAINS

This paper outlines the changes which have occurred during the last 5 years in high-speed passenger train cars and in motive power for hauling them and the economic factors which have brought about these changes. The new designs for passenger cars and the materials used in their construction are discussed. A detailed comparison of steam locomotive and diesel-electric locomotive characteristics as they affect the operation of these new high-speed trains is presented. Test data are included to indicate the importance of comparative stress in track produced by the two types of power. Reference is made to the steady improvement which has been made in steam locomotive design, but it is shown that there is a need for some rather extensive experimentation to make this type of power more suitable for this particular class of service. The author presents his views on the general results which have been secured from the operation of these new trains and the probable trend in their future development.

Ripley, C. T. (Chairman, A.S.M.E. Railroad Division), Proc. of the Institution of Mechanical Engineers, Vol 142, 1939, pp 97-111, 3 figs., 7 tables, 41 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0674

BR COMMISSIONS AN ULTRASONIC RAIL-TESTING TRAIN

The ultrasonic rail-testing train introduced in 1971 on the British Railway System is described. The equipment for ultrasonic inspection was designed and supplied by Wells-Krautkramer, Ltd., for installation aboard a two-car diesel train. The cost of converting the train is given. The speed rate of track inspection and staff size and their mode of operation are discussed. Techniques used for handling and processing of data accumulated during a 100-mile run involve the use of photographic recorders and means for developing films. A brief discussion concerning the inspection car's evaluation is presented.

Railway Gazette International, Vol 127, No. 5, May 1971, pp 181-188, 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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0675

TRACK MAINTENANCE TO ACCOMMODATE FAST, HIGH AND HEAVY LOADS

Problems attendant to the advent of cars with major increases in capacity, length, height, and wheel loading, and high speed operation are discussed. Definitions are presented for each of the principal parameters and terms associated with the trends for high speeds and heavy rail loadings. The effects of modern transportation equipment in connection with derailments, quality of car movement on tracks with irregularities, and rail flaw developments are reviewed. Rail shelling and shell formations, rail stresses, and rail wear are emphasized as areas of major concern. Track maintenance requirements and the ways to reduce maintenance are discussed in general terms.

May, W. W. (Professor, Railway Civil Engineering, University of Illinois, Urbana, Ill.), Railway Track and Structures, Vol 63, No. 10, October 1967, pp 36-39.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Co. (repr., PC).

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0676

LATERAL FORCES ACTING ON WHEEL, WHEEL LOAD, COEFFICIENT OF DERAILMENT AND BENDING STRESS OF WHEEL-AXLE OF THE CAR ON THE NEW TOKAIDO TRUCK LINE

This paper discusses a study of the lateral force acting on the wheel and wheel axle of the car on the new Tokaido Truck line. The coefficient of derailment, lateral acceleration of the carbody, and the bending stress of the wheel axle were measured for the purpose of establishing practices associated with track maintenance and running safety. This paper provides an examination of data obtained from August 1964 to December 1965. The measurement method and arrangement of data are described. (Carried as RRIS Accession No. 037208.).

Nakamura, N., and Tanaka, S. (Car Structure Laboratory, Japan National Railways, Tokyo, Japan), Railway Technical Research Institute, Quarterly Report, Vol 8, No. 2, June 1967, pp 103-106, 10 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0677

RAIL STEEL AND RAIL WEAR

Steels produced by different methods are discussed in relation to their use for rails for the purpose of reducing the misunderstandings that occasionally arise regarding the advisability of using a steel made by one or another process. The differences between the processes and end results for the Bessemer acid and the Siemens Martin technique are described. Chemical analyses for each of three processes used for making rail steel are given. Mechanical properties of rail steels produced by the open-hearth and Bessemer acid processes are also given. Information is provided on the subject of rail wear as a function of rail weights.

Sanderson, L., Metallurgia, Vol 13, No. 76, February 1936, pp 113-114, 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Associacao Brasileira de Metalis (repr., PC).

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0678

SOME SOLUTIONS OF THE TIMOSHENKO BEAM EQUATIONS

Solutions are obtained by the method of Laplace transformation for four types of loadings applied to a semi-infinite beam. Numerical results are presented for two of these, both for suddenly applied and gradually varying loads. The effects of shear deformations and rotatory inertia are taken into account according to Timoshenko's beam model. A brief comparison with the corresponding results of the Bernoulli-Euler theory is presented.

Boley, B. A., and Chao, C. C. (Institute of Air Flight Structures, Columbia University, New York, N.Y.), Journal of Applied Mechanics, Trans. ASME, Vol 77, 1955, pp 579-586, 10 figs., 3 tables, 9 refs., 1 appendix.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0679

AN APPROXIMATE THEORY OF LATERAL IMPACT ON BEAMS

The approximate theory derived in this paper describes, by means of a "traveling-wave" approach, the behavior of beams under transverse impact. Lateral impact is considered in detail, namely, that in which a section of the beam undergoes a sudden change in velocity or shear force. The theory considers the effects of shear deformations and of rotatory inertia according to Timoshenko's model, and that of lateral contraction as suggested by Love. The governing equations and the boundary conditions are developed with the aid of an energy-variation technique. Numerical examples are given in which the behavior of the boundary layer near the point of impact is examined. For one of these the exact solution is available and is in agreement with the present approximate results. Some general considerations concerning the velocity of propagation also are discussed.

Boley, B. A. (Associate Professor of Civil Engineering, Columbia University, New York, N.Y.), Journal of Applied Mechanics, Trans. of the ASME, Vol 77, 1955, pp 69-76, 5 figs., 2 tables, 1 appendix.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0680

COMPUTERIZED DATA PROCESSING OF TRACK GEOMETRY RECORDING

The computerized data processing of information accumulated by the track inspection car used on the British Railways (Matisa Track Recording Trolley) is described. The North Eastern Electronic Peak Tracing Unit and Numerical Evaluator (NEPTUNE) used with the Matisa provides the means for measuring numerically and automatically the amplitude of the deviations about the mean curve where the datum varies because of track geometry. The recording speeds of the track inspection car are given with explanations as to the range of values and modes of operation. A sample graph recording with manual and automatically registered notations is included.

Coombe, D. H. (Permanent Way Engineer, British Railways Board, Derby, England), The Railway Gazette, Vol 122, No. 14, July 15, 1966, pp 560-562, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0681

ULTRASONIC TESTING OF MATERIALS

Portions of this book which are pertinent to rail technology have been selected for abstracting. A brief description of the operational modes and principles of the "Audigage Rail Flaw Detector" manufactured by Branson is given. One section is devoted to applied ultrasonic testing of rails. At the outset, the section reviews the various types of defects that occur in rail during the manufacturing process and subsequent service use. Such rail defects as shatter and transverse cracks, and others associated with the rail head are mentioned. The ultrasonic inspection car used by the German Federal Railways is shown along with the general location of the probes. Data obtained through the use of the rail inspection cars are discussed and some typical examples of outputs are shown.

Krautkramer, J., and Krautkramer, H. (Wells-Krautkramer Company, West Germany), translation of the Second Revised German Edition, Springer-Verlag, New York, Inc., 1969, pp 222-223 and 298-325, 33 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Springer-Verlag (repr., PC).

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0682

FEATURES OF THE INITIATION AND DEVELOPMENT OF INTERNAL FATIGUE CRACKS CONSIDERED ON THE EXAMPLES OF RAIL FAILURE

This paper describes an attempt to study the problem of internal fatigue-crack development in a railroad rail by using a model in which the cyclic load, combined with other types of action, causes a fatigue fracture to initiate inside the metal. Previously conducted studies are reviewed that show that the initiation of cracks inside the specimen is usually observed in the presence of a strain-hardened (by rolling, surface heat treatment, thermico-thermal treatment, etc.) surface layer. Such cracks usually initiate just below the strain-hardened layer. Typical examples of transverse and longitudinal cracks are shown. The experimental work performed in this study involved subjecting rail specimens to static and cyclic loading and impact compression. Experimental results show that the white zone interlayers consist of martensite and austenite and that their structures and properties are similar to those of the white zone found in the deep layers of railhead metal.

The author concludes that: (1) the formation of internal fatigue cracks conforms to the general laws of the fatigue process and the formation of internal cracks, like the formation of cracks initiated on the external specimen surface, takes place in the presence of a free surface; (2) during complex loading, the formation of the internal, slightly constrained surface is facilitated by the changes in the condition and structure of the metal due to the application of the load components and to their interaction; (3) under correct loading conditions a fatigue crack can act as a free surface for other fatigue cracks.

Ravitskaya, T. M. (All-Union Scientific-Research Institute of Metallurgy and Machine Construction, Slavyanski, U.S.S.R.), Strength of Materials, Vol 6, No 11, November 1974, pp 1374-1379, 4 figs., 23 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Plenum Publishing Corp. (repr., PC).

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0683

LATEST RESEARCHES ON METALLIC MATERIALS' RESILIENCE MADE IN THE RAILWAY EXPERIMENTAL INSTITUTE OF THE COMMUNICATIONS (ITALIAN STATE RAILWAYS)

This report discusses the considerations, tests, and results on which the Experimental Institute of Communication (Italian State Railways) based its suggestions for the introduction into the rules on the compulsory test for brittleness of rot bars, the measurement of resilience as an integrating test of traction. The practical necessities of the brittleness measurement of resilience

tests, the discordance, concordance, and controllability of the results, the "attendability" [sic] of the results, and the function of the knowledge of resilience gained in the improvement of metallurgical work. Results of tests of 10 x 10 x 55-mm steel bars using a Charpy Amsler 30 kg/cm^2 and other hardness testing machines are given.

Forcella, F. (Experimental Institute, Italian State Railways, Rome, Italy), Proceedings of the World Engineering Congress, Vol III, Engineering Science, Part I, Paper No. 520, 1929, pp 553-582, 4 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kogakkai, Japan, (repr., PC).

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0684

IMPROVING THE SERVICE LIFE AND RELIABILITY OF RAILROAD RAILS

The microstructure of the rails in the zone influenced by contact stresses is considered in this paper. Current metallurgical practices associated with the production of high-tensile-strength rail steels are reviewed. These include rails with high carbon (0.69 to 0.82%) and manganese (0.70 to 1.05%) contents and tensile strengths averaging between 97 and 100 kg/mm^2 and wear resistance of between 0.4 to 0.5 mm per million tons of gross traffic. Practical tests on experimentally hardened rails laid in sections of high-density traffic with an outside rail curvature showed no tear-out or pitting after 120 to 140 million gross tons of traffic. It was concluded that the endurance of rails is influenced not only by the strength and other mechanical properties but also by the microstructure, and, in fact, this may often be decisive.

Lempitskiy, V. V., and Kazarnovskiy, D. S. (Moscow, Khar'kov, U.S.S.R.), Russian Metallurgy, No. 1, 1973, pp 111-117, 6 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Scientific Information Consultants, Ltd. (repr., PC).

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0685

STUDIES OF RAIL MATERIALS AND PROBLEMS IN THE FIELD [IN GERMAN]

Production statistics and causes of rail failures are reviewed. Correlations of experimental fatigue failure data of rails with actual service failures are attempted. Other characteristics of the finished rails such as cold work hardening and its measurement, rail steel toughness, and welding repairs are discussed. The effects of copper additions on corrosion resistance of rails are also noted.

Janiche, W. (Vereins Deutscher Eisenhuttenleute, Rheinhausen, West Germany), Stahl und Eisen, Vol 70, No. 5, March 2, 1950, pp 174-186, 24 figs., 6 tables, 31 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0686

METALLURGICAL ACHIEVEMENTS AND PROBLEMS OF RAILS [IN GERMAN]

This paper provides a general discussion on the subject of rail stresses and the required properties of rail steels. The metallurgical processes that contribute to improving rail wear and fracture resistance are discussed. The acceptance tests for rails and their basic requirements are reviewed.

Schulz, E. H., Stahl und Eisen, Vol 58, No. 37, September 15, 1939, pp 996-998, 1 fig., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0687

INFLUENCE OF CASTING AND ROLLING CONDITIONS ON FRACTURES IN RAILBASE S 49 [IN GERMAN]

An investigation of rails made from cast steel ingots containing 0.5% carbon, 0.25% silicon, 0.7% manganese, 0.06% phosphorus, and 0.035% sulphur that were rolled according to the Thyssen process on 2- and 3-high mills is described. Magnetic techniques were employed to detect surface flaws, and static bend tests were conducted to compare the performance of the specimens with that of others rolled by conventional processes.

Janiche, W. (Vereins Deutscher Eisenhuttenleute, Rheinhausen, West Germany), Stahl und Eisen, Vol 66/67, Nos. 17-18, August 14, 1947, 14 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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0688

ARTIFICIAL REPRODUCTION OF ROLLING CONTACT FATIGUE DEFECT IN SPECIMENS CUT FROM RAIL HEADS [IN RUSSIAN]

A testing machine is described which not only tests rolling-contact strength, but also reproduces rolling-contact-fatigue defect No. 82 on rail specimens. Specimens cut from R-65 rail heads were tested on this machine, and defect No. 82 was reproduced after 70 hours of simulated use.

Grdina, Yu. V., and Kotov, A. V. (Siberian Institute of Metallurgy, U.S.S.R.), Izv. VUZ Chernaya Met., No. 6, 1965, pp 148-150, 3 figs., 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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0689

AUSROLLING RAIL STEEL CONTAINING HIGHER AMOUNTS OF MANGANESE AND SILICON [IN RUSSIAN]

Standard rail steel has low austenite stability and poor hardenability. These properties can be improved by alloying. The effects of Mn, Si, and Cr on the mechanical properties (tensile strength, yield point, elongation, reduction in area, impact strength, hardness) of rail steel during high-temperature thermomechanical treatment were studied. The following method of rail production is recommended: heating ingots in furnaces from 1100 to 1150 C; reducing 15-20%; cutting into lengths so that after rolling in the finish pass with 15-20% reduction, the specified lengths of rails are obtained; air cooling from 680 to 650 C; isothermal holding in furnaces to prevent flaking; heating from 880 to 900 C and holding to equalize temperature across the rail cross section; reducing rail heads in the finishing pass by 15-20% in one pass; slow cooling of rails in oil or by water spray; tempering from 350 to 400 C; and final finishing. Optimum alloying quantities are 1.5-1.7% Mn and 0.5-1.5% Si. Hardenability is good even at low carbon content (0.48-0.64%). Optimum deformation temperature is 850 to 900 C.

Tarasko, D. I., Grdina, Yu. V., and Drushinin, V. V. (Siberian Institute of Metallurgy, U.S.S.R.), Izv. VUZ Chernaya Met., No. 6, June 1967, pp 131-135, 3 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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0690

AUSROLLING RAIL STEEL

Two grades of steel were produced, one designated A, composed of 0.038% P, 0.04% S; the other designated Yu, was composed of 0.73% C, 0.70% Mn, 0.12% Si, 1.0% Cr, 0.07% Ti, 0.002% B, 0.025% P, 0.03% S. The steel was induction

melted, and then annealed. Steel A was ausrolled by three different variants; heated to 950 C, rolled at 820 C, reduced 0-50%, cooled in water, tempered at 350 C; heated to 950 C, rolled at 680 C, other treatment as above; heated to 1000 C, rolled at 900 C, other treatment as above. Steel Yu was heated to 1000 C, rolled at 750 C reduced 0-35%, oil quenched and tempered at 200 C. Specimens were then tensile and impact tested. Tensile strength, yield strength, elongation, reduction of area, impact strength and hardness were determined in relation to degree of plastic strain and ausrolling conditions. Effective strengthening during ausrolling of rail steel is obtained by reducing 15-25% in the finishing pass at 850 to 900 C.

Druzhinin, V. V., Tarasko, D. I., and Grdina, Yu. V., (Siberian Metallurgical Institute, U.S.S.R.), Izv. VUZ Chernaya Met., No. 12, December 1966, pp 116-119 (English Translation by the Joint Publications Research Service), 3 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0691

INFLUENCE OF ADDITIONS OF RARE EARTH ELEMENTS ON PROPERTIES OF RAILS MADE FROM CONVERTER STEEL [IN RUSSIAN]

Mischmetal, in the form of grooved blocks, was added to steel during casting into intermediate ladles in a ratio of 0.5-2.5 kg/ton of steel. Rails made from the steel were tested to determine effect of mischmetal addition on hardenability, wear resistance, hardness, impact strength, yield point, tensile strength, elongation, reduction of area, and microstructure. Metallographic analyses of nonmetallic inclusions and impurities are discussed.

Baptizmanskii, V. I., Vikhlyaev, V. B., Karpunin, A. M., and Orgiyan, V. S., Izv. VUZ Chernaya Met., No. 3, 1965, pp 64-69, 4 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0692

EFFECT OF THE ADDITION OF RARE EARTH ELEMENTS ON THE COLD BRITTLENESS AND TEMPER BRITTLENESS SUSCEPTIBILITY OF ACID CONVERTER RAIL STEEL [IN RUSSIAN]

Rail steel was produced, adding 0.7 and 2.5 kg/ton mischmetal during pouring, into the intermediate ladle. Samples without mischmetal were also produced. The ingots were heated and rolled into type R-43 railroad rails. Rail heads were hardened so as to insure a rolling surface hardness of 363-388 Bhn. Study samples were taken from rail heads. Grain size, contamination by nonmetallic inclusions, and impact strength, in relation to mischmetal content, were determined. Critical brittleness temperature and susceptibility to temper brittleness were also measured. Degree of embrittlement was determined from average temperature shift.

Orgiyan, V. S., Izv. VUZ Chernaya Met., No. 4, April 1967, pp 124-127, 3 figs., 3 tables, 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0693

RAILROAD RAILS WITH HIGH RESISTANCE TO TRANSVERSE FRACTURE [IN RUSSIAN]

The production of rail steel with a high resistance to transverse fracture is investigated. A test steel composed of 0.26-0.36% C, 0.5-0.9% Mn, 0.15-0.28% Si, 2.0-3.0% Cr, 0.040% S and 0.050% P is melted in tilting open-hearth furnaces. Rails are rolled from heading and bottom portions of 15 ingots weighing 9.75 tons each and one ingot weighing 6.5 tons. Eight specimens are selected for mechanical testing. Tensile strength, yield strength, elongation, and reduction in area values are shown for both normal size and outsize specimens. Impact strength of standard notched specimens after

rolling at 20 C is about 1.5 kg/cm^2. Test specimens are fatigue tested in static bending tests to determine susceptibility to stress concentration. Specimens of the test steel and control specimens (carbon steel) in rail form are use-tested on a railroad line. In a specified period, five rails made of the carbon steel are replaced due to transverse fracture, in comparison to none of the test alloyed-steel rails. It is concluded that the high resistance of the test rails to transverse fracture is due to the high ductility of the steel, low area of deformation, and higher resistance of the steel to cracking and crack propagation.

Kazarnovskii, D. S., Shnaperman, L. Ya., Kravtsova, I. P., and Klimov, K. N., Izv. VUZ Chernaya Met., No. 8, 1965, pp 118-122, 4 figs., 1 table.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0694

EXAMINATION OF FOUR RAIL SAMPLES WITH WEB CRACKS IN THE JOINT BAR LIMITS--CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC RAILROAD

This report section discusses the results of tests made on four rail samples to determine the cause of web cracks in the joint bar limits. Photographs are presented which show views of the rail cracks and fissures at the joint bar limits and bolt holes resulting from close examination of the failed specimens. The conclusions from the examination indicated fatigue development and stress-corrosion cracking. Possibilities that failures resulted from residual stresses caused by welding and end hardening are mentioned.

Wisnowski, H. J. (AAR Technical Research Center, Chicago, Ill.), AREA Bulletin 636, Proceedings Vol 73, January-February 1972, pp 295-311, 19 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0695

CAUSES OF SHELLY SPOTS AND HEAD CHECKS IN RAIL; METHODS FOR THEIR PREVENTION

The purpose of this investigation is to determine whether rails made from vacuum-degassed steel and air cooled are comparable in properties with rail steel produced by currently common practices. Presently, rails are manufactured in 39-ft lengths. The desire to obtain longer lengths of rail has been expressed by many railroads because of savings anticipated from a reduction in the number of welded joints required in continuous welded rail strings. One factor inhibiting the production of rails longer than 39 ft is the practice of control cooling in covered containers. Control cooling is employed to prevent the development of internal flakes or shatter cracks that have been causally related to the level of hydrogen absorbed in the steel. With the use of vacuum degassing, hydrogen content is controlled by a different technique; therefore, it is believed that rails made of vacuum-degassed steel can be air cooled without shatter cracks developing.

Parvin, C. F., et al. (Chairman, Subcommittee on Assignment 8, AREA, Chicago, Ill.), AREA Bulletin 636, Proceedings Vol 73, January-February 1972, pp 338-387, 42 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0696

RAIL FAILURE STATISTICS, COVERING (A) ALL FAILURES, (B) TRANSVERSE FISSURES, (C) PERFORMANCE OF CONTROL-COOLED RAIL

This report is a compilation of data on rail failures reported to December 31, 1969, by railroads that are responsible for approximately 90% of the main track mileage of Class I roads. The reports are furnished on a voluntary basis by railroads. However, given the fact that most failures are reported by a small number of railroads, it is evident that there is little uniformity in reporting failure data. Therefore it is not feasible to draw definitive

conclusions, except on the assumption that each railroad has been consistent in its reporting practice. In that case, trends can be examined. However, absolute comparisons and total failure rates cannot be derived from the data.

Bush, R. F., et al. (Chairman, Subcommittee, Assignment 3, AREA, Chicago, Ill.), AREA Bulletin 631, Proceedings Vol 72, January-February 1971, pp 372-391, 4 figs., 10 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0697

INVESTIGATION OF RAILS MADE BY THE AUSTRALIAN IRON AND STEEL COMPANY

At the request of the Southern Pacific Transportation Company, an investigation was conducted to determine whether the quality of rails rolled in Port Kembla, Australia, by the Australian Iron and Steel Company, a division of Broken Hill Properties, is comparable to that manufactured in the United States. To make this comparison, three 7-ft lengths of 132-lb RE rail sections were submitted to the Association of American Railroads Research Center for an evaluation. This evaluation was based on the results obtained from a rolling-load test, slow bend test, drop test, chemical analysis, physical-property determination, impact properties, hardness survey, and a metallurgical macroscopic and microscopic examination.

Wisnowski, M. J. (AAR Research Center, Chicago, Ill.), AREA Bulletin No. 631, Proceedings Vol 72, January-February 1971, pp 310-333, 18 figs., 8 tables.

ACKNOWLEDGMENT: American Association of Railroads.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0698

MEASUREMENT OF VERTICAL FORCES ACTING FROM THE WHEELS OF A MOVING TRAIN ON THE RAILS [IN RUSSIAN]

A method for continuous registration of vertical dynamic forces exerted on rails by rolling stock wheels is described. Methods for selecting the distance between strain gages glued to the rail web were developed, as were methods of connecting groups of strain gages to form a bridge circuit. Illustrations are provided which show the arrangement of strain gages on the rail web of a R65 rail and the electrical connections as they relate to recording devices. Data produced by the arrangement of vertical-force-measurement equipment are plotted in relation to the positions of the rolling loads and the locations of the strain gages on the rail web.

Kudryavtsev, N. N., Malentyev, L. P., and Granovskiy, A. N. (Institute of Railroad Engineering, Moscow, U.S.S.R.), Herald of the All-Union Scientific-Research Institute of Railroad Transport, No. 6, 1973, pp 31-33, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kankin Bookstore (repr., PC).

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0699

ERRORS OF MEASUREMENTS OF VERTICAL FORCES ACTING ON RAIL SUPPORTS [IN RUSSIAN]

The reasons for a possible methodological error that can occur when using dynamometers to measure forces acting on the subrail support are examined. Illustrations are provided which tend to show what happens when rigid clamps are used to attach the dynamometer to the rail support. Various dynamometer-mounting techniques are used to draw comparisons among methods and how the error of measurements can be computed when rigid clamps are used. The author concludes that, when dynamometer backings with rigid clamps are used, significant error is possible in registering forces acting on rail supports

because of forces exerted by fully tightened bolts with rigid clamps. It is suggested that, to avoid error, tests should be conducted with loose clamps, or one should use plate clamps or rod clamps, which are yielding.

Baroboshin, V. F. (Institute of Railroad Engineering, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovateskogo Instituta, No. 7, 1973, pp 22-23, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0700

WHAT KIND OF RAILS TO PUT ON PARTS WITH HIGH DENSITY OF FREIGHT TRAFFIC [IN RUSSIAN]

The problems of rail failures occurring because of heavy-freight-traffic densities that exceed 50 million ton-kilometers per kilometer are emphasized. Numerous data on failures of R50, R65, and R75 rails under various conditions of traffic density and amount of freight are given. The author contends that the trend for traffic-density increase has exceeded the rate at which heavy-duty rails are being laid in place of the lighter rails. The major criticism is that rails are placed under significantly more severe operating conditions than they were designed for. Recommendations are made that track structures with freight-traffic density of more than 50 million ton-kilometers/kilometer per year be divided into 3 categories, 50-80, 80-100, and over 100. Sections in this last category should be equipped only with normally hardened type R75 rails.

Shvarov, Yu. F., and Golovanchikov, A. M., Put I Putevoye Khozyaystvo (Track and Track Management), No. 11, 1973, pp 27-28.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0701

ON THE QUESTION ABOUT CALCULATIONS OF LONG RAILS [IN RUSSIAN]

The effect of joints on the stability of a section-type track is examined. A general method of calculating permissible longitudinal compressive force on the rail ends is developed. Data from calculations which show the effect of track rigidity in the joint zone on the value of the critical longitudinal force are graphically presented. Mathematical expressions used to assess the relation of size of end-face angle of a rail to longitudinal forces are given.

Morozov, S. I. (Arkhangelskiy Lesotekhnicheskiy Inst. U.S.S.R), Izvestiya Vysshikh Uchebnykh Zavedeniy (News of Higher Education Institutions), Lumber Journal, No. 1, 1972, pp 43-47, 3 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0702

THE EFFECT OF THE FORM OF THE HEAT TREATMENT ON THE STRUCTURE AND PROPERTIES OF HIGH STRENGTH ALLOYED RAIL STEEL [IN RUSSIAN]

Results are given of a study of the mechanical properties of five types of alloy rail steels [(1) 0.5-0.6% C plus Cr-Mn-Si-Mo, (2) 0.5-0.6% C plus Mn-Si-B, (3) 0.55-0.65% C plus Cr-Mn-Ni, (4) 0.55-0.65% C, 2% Mn plus Cr, and (5) 0.55-0.65% C, 2% Cr plus Mn] after volume quenching to martensite and tempering and isothermal and interrupted quenching followed by tempering. Comparison of the properties resulting from the various types of quenching, showed the lower bainite temper to be more satisfactory than troostite temper with regard to ductility and impact toughness at elevated temperature. After the various forms of heat treatment, the endurance limits of steels (1), (2), and (3) were similar. The difference

in properties of the troostite and lower bainite is related to smaller grain sizes after the isothermal quench.

Zonov, P. N., Shur, E. V., Velikanov, A. V., Kiseleva, T. N., and Bychova, N. Ya., Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 176-181, 3 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0703

EFFECT OF VARICUS PRODUCTION PARAMETERS ON FIRST-GRADE RAIL YIELD [IN RUSSIAN]

The results are given on the study of character and degree of effects of various metallurgical production parameters on rail quality. The study was made by correlation analysis with computer processing of data for 400 melts. Expressions are given for calculation of effects of the parameters on the yields of first-grade rails. The furnace type, contents of carbon, manganese, sulfur, phosphorus, and arsenic in steel, pure boil duration, temperature of ingots during charging to the soaking pit, duration of malleabilizing, and rail type are the principal parameters having the greatest effect (of 30 investigated) on the quality of the rails.

Sudarev, V. P., Pliskanovskii, S. T., Sviridenko, F. F., Kaminskii, G. P., Vistorovskii, N. T., and Grishchuk, N. M., Sbornik Nauchnykh Trudov Zhdanovskogo Metallurgicheskogo, Instituta (Moscow), Vol 71, No. 2, 1971, pp 140-145, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0704

CURRENT DEVELOPMENTS IN THE CONSTRUCTION OF RAILROADS [IN RUSSIAN]

The importance of railroads is stressed. At the present time 1 km of road in the U.S.S.R. is used 6 times more intensively than in the U.S.A. Therefore, railway superstructures must be built heavier and more durable. The average weight of rails went up 8% during the eighth five-year plan. Rails have recently been studied on a broad scale. The most effective method of heat treating rails has been thermal volumetric hardening of the rails in oil. Resistance of rails to damage has been raised 1.5 to 2 times during the current five-year plan. Rail fastenings are examined. Work is being done on the creation of a boltless fastening with an elastic attaching element. Ties are also studied, and concrete ties are reviewed.

Klinov, S. I. and Lonchakov, E. T., (Candidates for degree of Technology/ Technical Sciences, U.S.S.R.), Transportnoye Stroitel'stvo, No. 11, 1973, pp 8-11, 7 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0705

IMPROVING THE WORKING-LIFE OF VOLUME-QUENCHED RAILS BY ADJUSTMENT OF STEEL COMPOSITION AND HEAT TREATMENT [IN RUSSIAN]

Methods are described for increasing the hardness and strength of quenched rail steels by small adjustments of the chemical composition, e.g., by raising the C and Si content and modifying with V, while retaining, and in some cases improving, the impact strength. Rail steels in the composition ranges C 0.73-0.81, Mn 0.86-0.97, Si 0.20-0.38, S 0.022-0.032, P 0.013-0.027, Cu 0.09-0.22,

V 0.0-0.08% were oil-quenched and tempered for 2 hr at 300-450°C. Alloying with ≤0.08% V and raising the Si content ≤0.38% had a beneficial effect on the brittle strength of full-profile rails. Small increases in C content did not increase brittleness. There was ~15% increase in the fatigue strength of the hardened rails (with high C and Si) compared with standard production rails. Both the temperature and duration of austenitizing influenced the mechanical properties and thus can be used to give some increase in hardness without affecting other properties.

Loshkina, N. A., Velikanov, A. V., and Rabinovich, D. M., Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 129-134, 4 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0706

USE OF HARMONIC ANALYSIS FOR THE NON-DESTRUCTIVE TESTING OF THE EFFICIENCY OF HEAT TREATMENT [IN RUSSIAN]

A nondestructive method of testing the efficiency of heat treatment applied to C and alloy steel parts is described. The method is based on the use of a transformer-type defectoscope sensor; the secondary emf arising in the windings of this transformer on application to the test samples is subjected to harmonic analysis. The relative proportions of the fundamental and higher harmonics may then be correlated with the parameters of the original heat treatment (temperature, time, etc.).

Luchevsky, B. A., Izvestiya Akademii Nauk Belorusskoi S.S.R., Seriya Fizika-Technicheskikh, No. 2, 1971, pp 73-78, 6 figs., 7 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0707

FATIGUE FAILURES IN RAILWAY RAILS [IN HUNGARIAN]

Fatigue failures in rails are related to the stress distribution, mechanical properties, and development of fatigue failures. Suggestions are made regarding the means for reducing the probability of fatigue failure through the use of homogeneous structure (pearlite) for rails made of alloyed steel or rails of larger cross-sectional area.

Beres, L., Vizy, G., and Somvari, P., Banyaszati es Kohaszati Lapok, Kohaszat, Vol 106, No. 8, August 1973, pp 359-363, 9 figs., 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0708

STRENGTHENING OF THE HEADS OF R-65 RAILS DURING ROLLING [IN RUSSIAN]

The influence of a combined thermo-mechanical treatment, without a martensite transformation, on the rolling of R-65 rail-heads was investigated on a pilot-scale mill. This process led to a marked increase in the ductility of a standard-composition rail steel, with a moderate increase in strength compared with normal rolling techniques.

Nekrasov, S. G., Chelyshev, N. A., Kobyzev, V. K., and Kachurin, D. S., Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya, No. 12, 1968, pp 97-101, 5 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0709

MELTING RAIL STEELS FROM HIGH-PHOSPHORUS HOT-METAL IN THE CONVERTER [IN RUSSIAN]

A technique was developed in an experimental 8-ton converter for producing steel containing C 0.7-0.8% from hot metal with 1.8-2.2 P and 2.0% Mn. O was supplied at 10-15 atm and fine CaO was injected. The best conditions for dephosphorization were found in terms of slag composition, blowing temperature, and blowing rate in both stages of the blow. The best time for slagging-off maximum rate of C removal, and optimum blowing procedure were established.

Shumov, M. M., Kvitko, M. P., and Afanas'ev, S. G., Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya, No. 3, 1968, pp 46-50, 4 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0710

PERFECTING THE SCHEDULE FOR THE ISOTHERMAL HOLDING OF TYPE R-65 WITH RAILS [IN RUSSIAN]

The treatment used at a metallurgical combine for preventing flake formation in types R-43 and R-50 rails, which involves isothermal holding and cooling to 350-550°C, followed by holding in the furnace at 600± 20°C, has been modified to reduce the incidence of flaking. The method of treatment and monitoring are described.

Grdina, Ya. V., Rabinovich, D. M., Krepysheva, I. A., Shmonin, I. A. and Slobtsova, N. A. (Siberian Research Institute of Metallurgy, U.S.S.R.), Izvestiya Vysshikh Uchebnykh Zavedenii, Chernaya Metallurgiya, No. 12, 1968, pp 131-135, 5 tables, 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0711

OPTIMUM CHEMICAL COMPOSITION OF ALLOY STEEL RAILS [IN RUSSIAN]

The results of some special research into the optimum chemical composition of rail steel are presented. The main purpose of the research was to increase the mechanical strength of the rails while still retaining the ordinary cooling rates for which provision is made on existing equipment. A new and very efficient type of steel having a considerable Mn content but containing only small quantities of Cr and V is proposed. The properties of this steel in the as-supplied state and after special heat-treatment are indicated.

Grdina, Yu. V. (Siberian Research Institute of Metallurgy, U.S.S.R.), Izvestiya Vysshikh Uchebnykh, Chernaya Metallurgiya, No. 4, 1968, pp 118-119, 3 tables.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0712

INFLUENCE OF HOLDING TIME BETWEEN THE END OF DEFORMATION AND QUENCHING IN AUSFORMING ON THE MECHANICAL PROPERTIES OF RAIL STEEL [IN RUSSIAN]

Experimental data are presented on the influence of holding time between the end of deformation and quenching in high-temperature thermomechanical treatments on the mechanical properties of rail and experimental steels. A gap of more than 30 sec between working and heat-treatment leads to the complete elimination of the strengthening effect of the treatment.

Drushinin, V. V., Tarasko, D. I., and Grdina, Yu. V. (Siberian Institute of Metallurgy, U.S.S.R), Izvestiya Vysshikh Uchebnykh, Chernaya Metallurgiya, No. 2, 1969, pp 113-114, 2 figs., 1 table.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0713

SOME PROPERTIES OF HIGH-STRENGTH ALLOY STEELS [IN RUSSIAN]

The properties of some high-strength rail steels of various compositions [C 0.3-0.6, Cr ≤ 2, Mn ≤ 2, with some containing Ni, Si, or V] were analyzed. Steels containing C 0.5-0.6% and alloyed mainly with Si, Mn, and Cr heat-treated and given a troostite temper to HRC 45 had no detectable advantages in properties over the ordinary oil-quenched rail steel [C 0.75 and Mn 0.8-1.1%]. Thus, the selection of steel compositions for high-strength rails, that are to be subjected to oil-quenching, will become a complex problem.

Velikanov, A. V., Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 169-175, 2 figs., 2 tables, 16 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0714

SINGULARITIES OF ROLLING RAIL STEEL INGOTS AT THE KUZNETSK BLOOMING MILL [IN RUSSIAN]

Ingots of rail steel (0.70% C, 0.71% Mn, 0.14% Si, 0.016% P, 0.030% S), are rolled in a blooming mill according to two programs: an 11-pass program and a 13-pass program. Metal pressure on rollers is measured simultaneously by gages placed under clamping screws of the mill and a tensometer fastened on the forward back brace which is equipped with wire resistance gages. A comparison shows that in the 11-pass program the reduction is considerably greater but in the 13-pass program the ingots are reduced more uniformly. The 13-pass program insures production of higher quality metal, increased productivity of acceptable rails, a lower load on the mill with this rhythm of rolling, and increased mill productivity. Productivity can be further increased by acceleration and by increasing the grip rate. Detailed parameters for each pass design are tabulated.

Chelyshev, N. A., Permyakov, V. M., Kaftanov, M. P., Zaykov, M. A., et al., (Kuznetsk Steel Combine, U.S.S.R.), Izv. VUZ, Chernaya Met., No. 8, 1965, pp 94-101, 3 figs, 2 tables, 8 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0715

ACHIEVEMENTS IN THE HEAT TREATMENT OF RAILS [IN RUSSIAN]

Modern methods of heat-treating steel rails (bulk oil quenching, surface treatment with hot water, treating the surface with high-frequency heating, etc.) are described and discussed. The rival merits of these and other forms of treatment used in hardening the rolling surface of railway rails are considered. An important aspect in addition to the normal one of mechanical strength and long life is the economic question, and some recent advances in reducing the overall cost of producing hardened rails are indicated.

Grdina, Yu. V. (Siberian Research Institute of Metallurgy, U.S.S.R.), Izv. VUZ, Chernaya Metallurgiya, No. 10, 1967, pp 132-139, 3 figs, 2 tables, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0716

DISTRIBUTION OF TORQUE BETWEEN THE BLOOMING MACHINE ROLLS [IN RUSSIAN]

An oscillographic device is used for analysis of the distribution of torque between rolls during rolling of rimming steel and rail steel and between flat and grooved rolls of the blooming mill. The relationship is shown between torque and deformation degree and rotation of the rolls. It is

determined that the torque moments are more evenly distributed with increasing deformation.

Peretyat'ko, V. N., Chelyshev, N. A., Permyakov, V. M., Kobyzev, V. K., and Osokin, E. A., Izv. VUZ, Chernaya Met., No. 12, 1965, pp 64-67, 5 figs, 5 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0717

EFFECT OF PLASTIC DEFORMATION IN AUSTENITIC STATE ON TEMPER BRITTLENESS OF RAIL STEEL [IN RUSSIAN]

Rectangular billets were cut from the head of an R-65 rail (0.70% C, 0.80% Mn, 0.18% Si) and heated in an electric furnace to 950 C, with subsequent deformation at 850 C, on a two-high rolling mill (rolling rate 4.4 m/sec). Specimens were water cooled after 30% reduction in one pass. Interval between rolling and quenching did not exceed 2-3 seconds. Quenched billets were tempered at 200 to 600 C (at 50 C intervals) and furnace cooled. Unstrained billets, cooled after tempering in the furnace at 40 C/hr and in water, were similarly treated. Impact-test specimens were cut from all the billets. Impact strength in the strained specimen was higher than that in the unstrained specimens. Combined straining and quenching under conditions which exclude recrystallization of the work-hardened austenite results in a suppression of irreversible (250 to 300 C) and reversible (500 to 550 C) temper brittleness.

Drushinin, V. V., Tarasko, D. I., and Grdina, Yu. V. (Siberian Research Institute of Metallurgy, U.S.S.R.), Izv. VUZ, Chernaya Met., No. 12, December 1966, pp 120-121, 1 fig.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0718

FORMATION OF A WHITE LAYER IN RAILROAD RAIL HEADS [IN RUSSIAN]

The characteristics of structural changes in rails, affected by internal transverse-fatigue cracks, and artificially produced white portions of the structure, were studied. The cracks are located at a depth of 5 to 7 mm from the rolling surface of the rail and appear to be the continuation of one of the longitudinal cracks present at this depth. A portion of white layer is seen along the cracks. The width of the white layer, found on one side of the cracks, is 2.5 to 35 microns. A similar white layer was produced in a laboratory experiment. U8 steel specimens were subjected to multiple static compression on a 200-ton press until cracks appeared. A portion of the specimens was artificially weakened. In all cases, white portions were observed only close to the cracks. The data obtained suggested that the mechanism of the formation of a white layer and the accompanying fatigue cracking in rails and specimens is the same. The microstructure of the white layer consists of a finely dispersed mixture of cementite and martensite crystals with high internal stresses. Microhardness was between 1100 and 1200 kg/mm^2.

Stafeeva, A. D., Tuminskaya, K. I., and Tuminskii, L. I., Izv. VUZ, Chernaya Met., No. 10, October 1966, pp 124-127, 3 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0719

PROPERTIES OF RAILS WITH INCREASED SILICON CONTENT [IN RUSSIAN]

A study was made of the mechanical properties and microstructure of rails containing 0.72% C, 0.82% Mn, and 0.54% Si. The tensile and fatigue strengths, bending deflection, hardness, and microstructure of the steels with increased Si content were about the same as

those of standard rail steels. Over 1000 tons of rails with the Si content increased to 0.50-0.64% were inserted into railroad tracks in various parts of the U.S.S.R. An examination after 4 years' service showed that the performance of the higher-Si rails was about the same as that of rails made of standard rail steel: no advantage is gained by increasing the Si content.

Grdina, Yu. V., Govorov, A. A., Nesterov, N. A., and Grigorkin, V. I. (Siberian Research Institute of Metallurgy, U.S.S.R.), Izv. VUZ, Chernaya Met., No. 10, October 1966, pp 150-151, 1 fig., 3 tables.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0720

USE OF NITRIDED FERROCHROMIUM IN RAIL PRODUCTION [IN RUSSIAN]

The effect of nitrogen on the tensile strength, impact strength at 20 to -60 C, yield strength, elongation, reduction in area, and hardness of rail converter steel was investigated. Test heats were made, alloying converter melts with nitrided ferrochromium (75% Cr, 1.4% N). Two heats contained the nitrided ferrochromium, and the third contained ordinary ferrochromium (60% Cr, 0.05% N). Ingots of test heats were rolled into rails which were variously heat treated: normalized at 830 to 850 C, quenched at 860 to 830 C. High values of plasticity and impact strength are noted in steels alloyed with nitrided ferrochromium. Alloying with nitrided ferrochromium also increased hardenability.

Prosvirin, K. S., Orgiyan, V. S., Kutsenko, A. D., Karpunin, A. M., et al. (Siberian Research Institute of Metallurgy, U.S.S.R), Izv. VUZ, Chernaya Met. No. 11, November 1966, pp 30-34, 1 fig., 3 tables, 9 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0721

STRENGTHENING OF HIGH-MANGANESE STEEL BY COMBINED THERMOMECHANICAL TREATMENT

This paper describes combined ausrolling of manganese steel (13% Mn), including rolling at 1150 C with 45% reduction with subsequent holding of steel in a lead bath at 370 C and secondary rolling with 10% reduction and water cooling. The effect of this treatment on mechanical properties (tensile, yield, elongation, reduction in area, and hardness) of steel is discussed. Applicability of the above method for increased wear resistance of railroad frogs is discussed.

Tushinskiy, L. I., Tushinskaya, K. I., Stepin, S. I., and Tikhomirov, L. B., Izv. VUZ, Chernaya Met. (Translation by Joint Publications Research Service), No. 12, 1965, pp 114-115, 2 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Joint Publications Research Service (JPRS 46592, October 3, 1968, repr., PC).

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0722

WEAR AND FATIGUE OF RAILS [IN FRENCH]

The results of tests conducted on rail specimens of 22 different compositions and given various heat treatments are given. The investigations, conducted at the Swiss Federal Materials Testing Laboratory, comprised a number of tests including chemical analysis, examinations of microstructure, measurements of Brinell hardness, resistance to deformation, fatigue analysis, evaluation of tensile strength properties, and observation

of wear resistance. Data are presented in graphical illustrations, photographs of rail-head ruptures, and photomicrographs that show the crystal structure of the rail-head surface regions.

Ros, M., and Wichser, O. (Geleisen der Gotthardlinie der Schweizerischen Bundesbahnen, Zurich, Switzerland), Revue de Metallurgie, Vol 50, No. 6, June 1953, pp 389-409, 60 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Revue de Metallurgie (repr., PC).

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0723

AN EVALUATION OF THE STATE OF BOTTOMS OF RAILS DAMAGED BY CORROSION [IN RUSSIAN]

The inaccessibility of locations where corrosion frequently occurs in rails, such as the underside of the tie plate, is a major limitation to means for detecting it. This is particularly a problem where ties of pressed wood are in use. The authors of this brief paper propose a method for corrosion detection which involves the use of an ultrasonic defectoscope which indicates the depth of the corrosion present by the strength of the signal emitted. The progression of corrosion from cavity to fracture is documented, and descriptions of their experiments with the defectoscope comprise the bulk of the article.

Put i Putevoye Khozyaystov (U.S.S.R), No. 12, 1973, pp 40-41, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0724

LABORATORY EVALUATION OF RAILS PRODUCED IN SOME FOREIGN COUNTRIES [IN RUSSIAN]

Analyses of data and observations from laboratory investigations of rails produced in foreign countries are presented. The chemical compositions, mechanical properties, and illustrations of the microstructures of seven rail-steel specimens melted in different ways in various furnaces are given. It was concluded that the rails produced from steel obtained through the O-converter process were inferior to those manufactured by using the basic open-hearth furnaces.

Komolova, E. F., Konyukhov, A. D., Vlasov, V. I., and Inshakov, N. N., Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 182-201, 9 figs., 11 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0725

PECULIARITIES OF THE ORIGINATION AND DEVELOPMENT OF CONTACT FATIGUE DAMAGE OF RAILS IN SERVICE [IN RUSSIAN]

The authors review some studies which they and others have conducted on detected and undetected light-colored longitudinal-slanted fatigue cracks on microsections of rail. Photographs that are presented showed various views of these fatigue cracks. Conclusions offered are: (1) to eliminate mass damage to standard and thermally treated rails by contact-fatigue defects, production technology must assure a finely dispersed state and uniform distribution in the steel of the nonmetallic phase, and the absence in the rails of local accumulations of nonmetallic inclusions stretched out along the rolling line in the shape of small strips; (2) a white layer of high-hardness metal with a changed structure on the surface of fatigue

cracks in rail heads is not a cause, but a result of the development of such cracks.

Baulin, I. S., and Uskova, O. N. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 95-101, 6 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0726

QUALITY OF SURFACE-HARDENED RAILS FROM BESSEMER STEEL [IN RUSSIAN]

This paper describes studies of the mechanical properties of the surface-hardened layer of rails which were produced in 1968 at the Dzerzhinskiy Metallurgical Plant, and compares them with hardened rails produced between 1959-1962. Tests and analyses were performed to provide data on the mechanical and chemical properties of batches of rails. Distribution of Vickers hardness measurements taken along the depth of the hardened layer of the rail heads of selected rail batches is shown graphically. It was concluded that the mechanical properties of the hardened rails produced in 1968 changed insignificantly in comparison with hardened rails produced in the 1959-1962 period. One of the major problems encountered with thermally processed rails -- inhomogeneity of structure and hardness along the depth of the hardened layer of the head -- has not been eliminated, and this contributes to insufficient fatigue strength of the rails.

Velikanov, A. V. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 202-204, 1 fig., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0727

CHANGE OF RESIDUAL STRESSED STATE OF RAILS IN PRODUCTION PROCESS [IN RUSSIAN]

The author discusses methods of measuring residual stresses and examines the specific stressed state created when various methods of rail hardening are used. The methods discussed include surface hardening of rail heads following volume furnace heating, surface hardening of rails heads following high-frequency induction heating, and volume hardening in oil. Measurement of residual stresses in rails produced by the Nizhne-Tagil Metallurgical Combine which were not heat treated and volume hardened were made on the Central Scientific Research Institute's experimental track which carries loads of between 20 and 750 million tons. The data showed that initial residual stresses in the rail heads change much more slowly in hardened rails than in rails of standard manufacture. Cases of brittle fracture of rails in areas along the web (several meters long) are discussed and these have been attributed to high residual stresses in the bolt-hole region.

Konyukhov, A. D. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuz Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 102-117, 9 figs., 2 tables, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0728

INVESTIGATING THE FEATURES OF EFFECT OF TRAIN LOAD ON A ROAD BED UNDER ISOLATED GEOMETRIC IRREGULARITIES OF THE RAILS [IN RUSSIAN]

This paper discusses the effect of isolated irregularities on the stresses of the road-bed support in straight and curved sections of track, and an evaluation of additional stresses in the rail support caused by the presence of track irregularities. Oscillograms show the road-bed support stresses as they relate to speed, and types of

supports (wooden ties). Similar presentations are given for studies of stresses under the inner and outer rail as a function of speed. The procedure for measurement of road-bed support stresses along the length of isolated irregularities in the track at speeds up to 90 km/hr during passage of a wheel is discussed for the case where concrete ties are used. Comparisons are drawn between calculated and experimental stresses on the track support.

Konshin, G. G. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuz Nauchno-Issledovatatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 460, pp 95-118, 13 figs., 6 tables, 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0729

ULTRASONIC METHOD OF DETECTING ZONES OF STRUCTURAL INHOMOGENEITY IN RAILS [IN RUSSIAN]

The authors present a reverberation method of monitoring metal which is based on the use of ultrasonics for measuring the level of echoes. The reflection effect of ultrasonic oscillations from structural elements in the monitored layer and subsequent multiple interference is discussed. Illustrations are given which show reverberation signals, distribution of ultrasonic energy, relationships of the size of received signal to the distance between radiators and the change in ultrasonic structural indicators with variations in the structural state of the rail metal. Numerical information that describes the conditions of constant frequency of ultrasonic vibrations and constancy of their wavelength is included. The necessity for equipping flaw detectors with units that correct automatically for the structural type of metal to precisely determine the dimensions of defects in rails is discussed.

Yushkevitch, I. N. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 150-162, 9 figs., 2 tables, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0730

RELATION OF IMPACT STRENGTH OF RAIL STEEL TO FINISH ROLLING TEMPERATURE [IN RUSSIAN]

In investigating a rail steel of standard chemical composition (0.72% C, 0.80% Mn, 0.21% Si, 0.019% P, and 0.029% S), it is established that when the finish rolling temperature is increased, the grain size increases, particularly rapidly at temperatures over 900 to 1000 C. Such grain-size growth should lead to decreased impact strength, and a statistical analysis is made to confirm this. The mean values of impact strength of rails with finish rolling temperatures of 1040 to 1060 C and 850 to 860 C are compared. The distribution of these values at both temperatures and its agreement with the normal mechanism is examined. It is determined that in rail steel, the value of impact strength is connected to a functional relationship with grain size and also with finish rolling temperature. At a finish rolling temperature of 900 to 1000 C, the impact strength of rail steel is decreased.

Grdina, Yu. V., and Gordin, O. V. (Siberian Scientific Research Institute for Metallurgy, U.S.S.R.), Izv. VUZ, Chernaya Met., No. 8, 1965, pp 114-117, 2 figs., 3 tables, 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0731

REDUCTION AND ROLLING OF CONTINUOUSLY CAST METAL [IN RUSSIAN]

This book contains 17 chapters associated with the reduction and rolling of continuously cast metal into railroad rails and pipes. The early chapters deal with state of reduction as it applies to deformation stress, the end scab, power conditions, strip stability, and roller calibration. Subsequent chapters deal with the requirements for obtaining high-quality rolled products, the infuence of deformation on the properties of the metal, packing of the metal in the process of reduction, quality of the surface of the cast metal, the industrial practice of reducing and rolling of cast slabs, and the rolling of products.

Chizhikov, Yu. M., Metallurgiya, 1974, 384 pp, 8 figs., 16 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0732

A STUDY OF THE LAWS OF FATIGUE FAILURE IN STEEL SAMPLES BY ELECTROMAGNETIC TESTING METHODS

A study of fatigue processes in C, Mn, and Cr-Ni steel based on variations in their magnetic permeability and other magnetic properties, as determined by electromagnetic nondestructive testing methods is presented. The close relationship between the magnetic and mechanical characteristics of such materials is confirmed. By observing the changes in magnetic permeability using these testing methods, the progress of mechanical fatigue may be accurately followed. Fatigue and magnetic curves illustrating this possibility are presented.

Shagaev, Yu. P. (Dept. of the Physics of NDT, Academy of Sciences of the Belorussian SSR), Defektoskopiya, (Translation by the Consultants Bureau, Ltd.), No. 5, 1970, pp 115-119, 4 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Ltd. (repr., PC).

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0733

EFFECT OF TEMPERING ON THE CRITICAL TEMPERATURE OF BRITTLENESS OF CARBON STEEL SUBJECTED TO LOAD CYCLING

A study was made of the tempering effect on rails from carbon steel containing 0.65% C and 0.77% Mn which had been subjected to loads of 100×10^6, 300×10^6, 400×10^6 and 500×10^6 tons for varying lengths of time. The prepared billets were tempered at 650 C for 3 hr. The critical temperature of brittleness was determined from data on impact tests of specimens cut from the top section of the rail heads in a temperature range from -60 to +20 C. The upper temperature boundary of the zone of spread was taken as the critical temperature of brittleness. After tempering at 650 C all rails had the same critical temperature at brittleness, which, for tempered rails in service remained above that of rails not in service. Some but not all of the fatigue damage accumulated in the metal of the rails during service was healed by tempering at 650 C with a resulting critical temperature brittleness higher than in rails not subjected to load cycling.

Oding, I. A., Nikonov, A. G., and Mar'yanovskaya, T. S. (A. A. Bailkov Institute of Metallurgy), Doklady Akad. Nauk SSSR, Vol 161, No. 3, March 1965, pp 577-579, 2 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: American Institute of Physics (repr., PC).

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0734

LABORATORY TESTING OF DEVICES OF PRIMARY PROCESSING AND AUTOMATIC INPUT OF DATA INTO AN ELECTRONIC DIGITAL COMPUTER FOR TESTING THE STRESS IN RAILS [IN RUSSIAN]

Laboratory tests were conducted on: (1) a device for processing cyclic stresses in rails, (2) a time-quantizing processor (analog-digital converter), and (3) a device for amplitude-time processing. A diagram showing the processing by time quantizing is given. The purpose of the tests was to investigate the efficiency of the entire system and its separate components. The accuracy of execution of the basic operations of primary processing and computer input codes are discussed.

Skalov, A. D. (All-Union Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuznogo Nauch.-Issledo. Instituta Zheleznodorozhnogo Transporta, No. 38, 1972, pp 46-48, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0735

NEW METHOD OF DETERMINING CARRYING CAPACITY OF RAIL AND TRAVELLING WHEEL [IN YUGOSLOVIAN]

A method for calculating the carrying capacity of rail and travelling wheels is presented. Taken into consideration are such events as error in the wheel position due to rail deformation, deformation of the rail foundations, residual stresses caused by overburdening, internal tension of surface-hardened material, and shocks (impacts) of operating groups (trucks). The method includes coefficients associated with many of possible rail applications under various operating conditions.

Kos, M., Strojniski Vestnik, Vol 21, Nos. 3-4, March-April 1975, pp 71-81, 14 figs., 7 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0736

EFFECT OF STRUCTURE PARAMETERS ON THE FATIGUE LIFE OF RAIL STEEL [IN RUSSIAN]

An investigation to determine the effect of size of austenite grain and pearlite dispersion (interlamellar distance) on the propagation of fatigue cracks and mechanical properties of rail steels is described. The chemical composition of the rail steels tested is given. Different dimensions of austenite grains were observed while changing the austenitization temperature from 800 to 1250°C, as well as dispersion of pearlite as a function of cooling rates. The modes of heat treatment given to the various test specimens are described. The data obtained show the decisive effect of interphase-boundary density on rail-steel viability. The test equipment used for determining rail-steel viability, means for recording data, and the relation between pearlite properties and the effect of interlamellar spacing are shown.

Kiseleva, T. N. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuznogo Nauch.-Issled. Instituta Zheleznodorozhnogo Transporta, Series No. 509, 1974, pp 125-129, 4 figs., 2 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0737

CONSIDERING THE EFFECT OF OPERATIONAL FACTORS ON THE SERVICE LIFE OF USED RAILS [IN RUSSIAN]

Relationships of isolated failures of worn R50 and R65 rails to past tonnage utilization are presented. The investigation of these relationships was based on statistical data obtained from 11 railroads during the period of 1965-1968. Analysis of the data showed that initial operating conditions have a decisive effect on the reuse of the rails. Isolated failures reported during the period indicated that failures of the R50 and R65 rails were 38 and 29% higher.

respectively, on sections with downgrades steeper than 4 percent, and 16 percent and 18 percent higher, respectively on up-grades steeper than 4 percent. Thus, there was an increase of 1.8 to 3.8 times the failures of used rails over new rails. Graphs are presented which show failures according to profiles when the rails' loads comprised diesel locomotives, electric propulsion, and freight traffic. Comparisons are made between the R50 and R60 rails.

Videneyev, V. P. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauch.-Issled. Utelskogo Inst. Zheleznodorozhnogo Transporta, Series No. 464, 1972, pp 49-55, 4 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0738

LONG LIFE FOR REFURBISHED RAILS [IN RUSSIAN]

The authors present information on the types of defects which develop in R65 rails, and on a procedure for inspecting worn rails for defects, repair, and reuse. Statistical data are given for rails produced at the Asovstal' plant which were repaired after 500 to 560 million tons of freight had passed over them. These rails were repaired and relaid to a less active section where they carried 70 million tons of freight. The distribution of defects, by type, in the rails before and after repair is discussed. Other information is provided on the detectability of defect type 21 by different flaw-detection equipment expressed as percentages of the area of the detector-head cross section.

Kolotushkin, S. A., and Poroshin, V. L., Put I Putevoye Khozyaystvo (Track and Track Management), No. 2, 1972, pp 21-22, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0739

OCCURRENCES, TESTING, CAUSE, AND ELIMINATION OF RAIL FLANGE CRACKS [IN GERMAN]

A special committee was selected to study the origin and effect of rail flange cracking which leads to rail breakage. Statistics were compiled which show distribution of the rail flange cracks and breakages according to rail class, rail supplier, and year of delivery. Old and new rails were tested in different locations for flange cracks by subjecting them to static and dynamic transverse-bending tests, magnetic-particle tests, and structural fracture evaluation. The flange surface of the rails is interspersed at irregular intervals over the length of the track with numerous crystallization flaws which lead only to fracture; however, other circumstances, such as straightening, may cause crack initiation. Blowholes below the surface are of particular significance in breakage. The results of some of the various test methods are compared, but it is not possible to compare the results obtained with the rail flange transverse-bending tests with those obtained by another method. In general, a higher breakage load during the flange transverse-bending test results in a greater degree of bending. Rails made from Thomas and Siemens-Martin steel show no significant differences.

Kuhnel, R. (Reichsbahndirektor, Zurich, Switzerland), Stahl und Eisen, Vol 64, No. 11-12, March 1944, pp 169-175 and 187-194, 30 figs., 3 tables, 24 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0740

APPARATUS FOR INVESTIGATING THE KINETICS OF THE DEVELOPMENT OF FATIGUE CRACKS IN RAIL HEADS OF A TRACK [IN RUSSIAN]

This article presents descriptions of devices developed and manufactured by the Planning-Design Bureau of the Central Scientific Research Institute of the Ministry of Railroads in conjunction with the Institute's pilot plant. These devices permit observation of the speed of crack development in the absence of train traffic. One flaw-detection device which is discussed is a manually operated, portable, transistorized, ultrasonic instrument. Schematic diagrams are provided which show the details of the device and how it is applied to locate cracks and to measure the occurrence of internal longitudinal fissures. Another device which determines the area of transverse and longitudinal fatigue cracks in rail heads is also discussed. An automatic system for recording the rate of growth of a transverse fatigue crack of a rail in a track is described.

Kolotushkin, S. A., Dyakonov, V. N., and Kashnitskiy, Yu. V. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 140-149, 8 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0741

RESEARCH ON NONMETALLIC INCLUSIONS AND GASES IN EXPERIMENTAL RAILS DURING VARIOUS METHODS OF SMELTING AND KILLING OF STEEL [IN RUSSIAN]

In an effort to produce high-purity steel which would be free from "stitch-shaped" inclusions of aluminum oxide and silicates, a number of experimental melts were produced. Experimental bars were rolled into rails and nonmetallic inclusions were studied using metallographic, petrographic, and chemical methods. The investigation centered on studies of specimens cut from the rail-head section where the greatest contact stresses occur. The data are tabulated to provide complete information on the rail-manufacturing and metallurgical processes from the nature of smelting to the measurements of oxide contents. Photographs of the inclusions are given. It was concluded that the use of silico-calcium as a killing agent removes large chains of aluminum oxides from the rail steel; however, silicate inclusions are introduced. Complex killing by means of silico-calcium with ferro-vanadium was found to provide marked improvement in terms of stitch-inclusion reduction.

Kleshcheva, I. T., Orlova, G. M., and Saveleva, R. A. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1972, pp 45-55, 6 figs., 2 tables, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0742

INFLUENCE OF DYNAMICS OF A TRACTION DRIVE MECHANISM OF A LOCOMOTIVE ON UNDULATING WEAR OF RAILS [IN RUSSIAN]

The authors studied the effect of drive dynamics on the undulatory wear of rails as one of the important factors contributing to a great extent to this type of rail damage. Three conclusions were arrived at on the basis of the study results: (1) intensity of undulatory rail wear depends principally on the size of the non-spring-mounted mass of the wheel pair and on the amplitude of the dynamic torque produced by vibration of the wheel pair; (2) the use of an elastic gear wheel in the traction transmission of a support-axle drive allows an almost threefold reduction in the wave formations; and (3) the most effective means of reducing wave formation is the use of a support frame traction drive of modern design which assures the least non-spring-mounted weight of a wheel pair and uniform transmission of moment from the armature of the electric motor. Mathematical expressions are given. An oscillogram

of the vertical accelerations associated with the axle box and dynamic torque in the armature shaft shank during motion of a diesel locomotive along a section of track affected by wear is shown.

Ivanov, V. N., and Belyayev, A. I. (Moscow Institute of Railroad Transport Engineering), Trudy Moskovskogo Instituta Inzhenerov Zheleznodorozhnogo Transporta, No. 1, 1973, pp 3-11, 1 fig., 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0743

DEVELOPING A METHOD OF THERMAL REINFORCEMENT OF HIGH STRENGTH RAILS

This paper reviews methods of thermal strengthening steel rails which permit selections of an optimum microstructure at a given level of hardness (BH 450-480). The methods discussed involve normal volume hardening with tempering, stepwise volume hardening with tempering, isothermic hardening with and without tempering, high-temperature thermomechanical treatment, and high-temperature thermo-mechanical treatment with bainite transformation with and without tempering. Tabulated information is presented on types of steels tested, their chemical compositions, and their mechanical properties when strengthened. Graphs which are presented show the effect of hardness on the contact strength; head, web, and base hardness; brittle-fracture values for three different steels; and the occurrence of failure during low-temperature impact tests. It was concluded that none of the methods of rail hardening provided high contact strength and the necessary reliability needed. Additional tempering of the web and base increased rail viability.

Rauzin, Ya. R., Shur, Ye., A., Zonov, P. N., and Velikanov, A. V. (All-Union Scientific Research Institute of Railroad Transport), Vestnik Vsesoyuz Nauch-Issled Inst. Zheleznodorozhnogo Transporta (Moscow), No. 3, 1974, pp 45-50, 2 figs., 4 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0744

RAILS ROLLED FROM ELECTROSLAG-REMELTED INGOTS AND FROM STEEL DEOXIDIZED BY DIFFERENT PROCESSES [IN RUSSIAN]

The authors presents results of laboratory tests of experimental batches of rails and provide comparisons of the various batches. The chemical compositions and mechanical properties of the experimental rails prior to their subjection to tensile stresses are given. Tests conducted on rails samples obtained from the head portion comprised impact and bend, rolling load, and dynamic bending. The results are presented in curves and tabulations. Examinations of the steel cross sections revealed that the use of special complex metallurgical methods affects the nature and quantity of nonmetallic inclusions. Electroslag remelting of rail steel produces a reduction in the stable nonmetallic inclusions. The damageability of rails associated with longitudinal-slanted fatigue cracks is related to steel purity and the quantity and dimensions of nonmetallic inclusions.

In'shakov, N. N., Vlasov, V. I., and Komolova, E. P. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauch-Issled. Inst. Zheleznodorozhnogo Transporta, No. 434, 1971, pp 37-44, 3 figs., 6 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0745

INCREASING THE CONTACT STRENGTH OF RAIL STEEL [IN RUSSIAN]

This article describes a comprehensive study of the dynamic, cyclic, and static contact strength of rail steel which was done to find ways to improve the rail without affecting other strength properties. The effects of hardness and structure, carbon content, mode of heating or tempering during hardening processes, and residual stresses were studied. Data are tabulated which show the effect of hardness and structure on contact hardness and the results of residual stress tests. Graphs are presented that show the effects of interphase surface on contact-fatigue strength and the carbon content. The relation between external concentration of stresses and the contact-fatigue strength of the rail-steel samples is presented. It was concluded that contact-fatigue strength of rail steel is primarily determined through studies of their structures. An explanation is given for a marked increase in the limit of hardness of contact strength that occurs with increased carbon content.

Moskov, M. M., and Rauzin, Ya. R. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauch-Issled. Inst. Zheleznodorozhnogo Transporta, No. 434, 1971, pp 70-79, 6 figs., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0746

THE INFLUENCE OF PHOSPHORUS ON THE STATE OF GRAIN BOUNDARIES IN STEEL FOR RAILS [IN RUSSIAN]

A study on the effect of phosphorus on the state of grain boundaries through experimentation with rails having various known contents is discussed. All samples drawn were pickled in an ether-aqueous solution of picric acid which is sensitive to phosphorus content. Tests showed that the grain boundaries of Bessemer and open-hearth steels are saturated with phosphorus, the level of which depends on the total phosphorus content in the steel. It is shown that at a phosphorus content greater than or nearly equal to 0.03%, during hardening or tempering of the rail from the austenite region, a high etchability of the grain boundaries can be recorded. Photomicrographs of three rails steels are included.

Polyakov, S. N., Glikman, Ye. E., Karpunin, A. M., Orgiyan, V. S., and Levoshich, N. V., Metallurgicheskaya i Gornorudnaya Promyshlennost (Metallurgy and Mining), No. 2, 1972, pp 37-38, 3 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0747

PERMANENT WAY IN AN AGE OF HIGH SPEED

The essential factors for the maintenance of the permanent way for high-speed lines are discussed. These include rails of adequate weight, rigid fastenings, and good ballast as well as programmed mechanized maintenance procedures. Concern is shown for the maintenance of track structures which will enable such railway systems as the Japanese National Railways, German Federal Railway, and French National Railways to continue transporting passengers at speeds of 200 km/hr. The author comments on the contributions of IUC/ORE to advances in the European railway systems. Brief comments and descriptions of work conducted by Professors Birmann and Eisenmann on variations in the railhead shearing stresses, and the reduction in the cost and frequency of maintenance, are also included. A breakdown in the percentage of investment for the permanent way is presented.

Jaudeau, M.D.R. (Chief Engineer, Dept. of Fixed Installations, RENFE), Railway Gazette, Vol 126, No. 15, August 1970, pp 588-590, 1 fig., 4 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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0748

METHODS AND PARAMETERS OF EVALUATING VIABILITY OF RAILS [IN RUSSIAN]

The author defines rail viability as the capacity of the rail for performing its function in a damaged condition. Three batches of rails were tested for viability on the basis of their endurance and mechanical properties. The data from the investigation were plotted and the curve trends showed rail survival; the kinetic function of damage; damage incurred by rails from each batch as a function of load; and the relation between the average rate of crack development and loading. Mathematical expressions based on the curves for endurance, viability and durability, and kinetic damage function are included.

Sokolov, P. S. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 80-87, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0749

MECHANISM OF SURFACE MARTENSITE FORMATION [IN RUSSIAN]

The author investigated the mechanism by which surface martensite is formed on unstable iron alloys during polishing. Two stages in formation of surface martensite were examined: the first is associated with the plastic deformation of austenite, and the second with electron changes in the lattice of deformed austenite. The latter changes result in transformation of the face-centered lattice to a body-centered lattice of martensite. Regularities of the occurrence and type of surface martensite are analyzed. Illustrations are provided which show: atom shifts during the emergence of a particle of surface martensite and the formation of a needle of surface martensite; formations of surface-martensite blocks; types of surface martensite; surface-martensite relief; and occurrence of massive martensite.

Masin, A. (Railroad Research Institute, Prague, Czechslovakia), Kovove Materialy, Vol 11, No. 6, 1973, pp 671-683, 6 figs., 39 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0750

PARAMETERS OF STRUCTURAL STRENGTH OF RAIL STEEL [IN RUSSIAN]

In this paper the author investigates the strength characteristics of steel rails in an effort to determine their design strength. The strength characteristics of interest are: static load-carrying capacity, long-term cyclic load-carrying capacity, endurance under bending load, and operational reliability. Graphs are presented which show the change in the limit of contact endurance of a rail as a function of hardness, and the relation of elasticity limits under contact loading to the hardness of volume-hardened rail steel. Photographs are included that show rail fractures and surface pitting.

Rauzin, Ya. R. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Zheleznodorozhnogo Transporta, No. 434, 1971, pp 56-59, 5 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0751

EFFECTS OF ALUMINUM AND NITROGEN ON MECHANICAL AND PLASTIC PROPERTIES OF ROLLED AND AGED STEEL RAILS [IN POLISH]

Investigations were carried out on batches of steel made in 150- and 50-ton fixed open-hearth furnaces, with nitrogen (as $CaCN_2$) and aluminum added to the ladle just before casting. For each batch of steel, with different nitrogen and aluminum contents, four specimens were machined for tensile tests 16 hr after rolling, and eight specimens for Charpy tests 16 days after rolling. The results were subjected to statistical analysis, and the principal conclusions were: the effects of the concentration of nitrogen normally found in open-hearth basic steel - up to 0.0090% - are of no significance of its mechanical or plastic properties. Above this amount there is an appreciable effect on these properties evidenced by an increase in tensile strength and a decrease in impact resistance. Aluminum in any amount affects tensile strength and impact resistance of rolled and aged steel but has no effect on plastic properties.

Mazanek, T. (Polytechnical Institute Slaska-Katowice, Poland), Hansel, W., and Dojka, B. (Huta Pokoy-Ruda Slaska, Poland), Hutnik (Katowice), Vol 37, No. 7/8, July-August 1970, pp 335-342, 1 fig., 7 tables, 20 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kubon & Sagner, West Germany (repr., PC).

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0752

PHYSICAL TEST RESULTS OF OXY-ACETYLENE PRESSURE BUTT WELDS OF HEAT TREATED RAILS

This report covers an investigation performed at the request of the Norfolk and Western Railway to develop data in regard to continuous-welded rail rolling load; flexure, drop, and slow bend tests were performed on oxy-acetylene pressure-butt-welded fully heat-treated rails. The fully heat-treated rails, 132-lb RE section, were supplied by Bethlehem Steel Corporation. A description of the rail test specimens and specific details of the tests performed are given. The data obtained from the tests indicate that even though the benefit from the heat treatment has been eliminated in that part of the rail heated above the critical temperature during the welding process, fully heat treated rail welded by this process will perform as well as standard control-cooled rail in the weld zone. The failures reported in the tests are considered no different from those that have been experienced in laboratory tests and field service in welds made by this process with standard control-cooled rail.

Kannowski, K. (Engineering Research Division, AAR Research Center, Chicago, Ill.), Report No. ER-8, February 1961, 3 pp, 2 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0753

AN INVESTIGATION OF VARIOUS WELDING TECHNIQUES FOR BUILDING UP BATTERED RAIL ENDS

The building up of battered rail ends by means of different welding procedures and the evaluation of welding rods and electrodes used in these procedures is described. The program followed during this investigation is discussed. The Pennsylvania Railroad supplied 50 matched battered rail ends of 131-lb RE section that had at least 0.040-in. batter when they were removed from the track. The testing program involved in this investigation covers the oxy-acetylene and electric-arc welding methods and variations of both procedures. The data obtained from this study are tabulated and presented in this report along with detailed discussions of the processes and inspection results. Rolling-load tests were conducted on the repaired rail sections.

The data from this investigation indicated that the joints welded by the oxyacetylene method perform better than those welded by the electric-arc method. Failures of electric-arc welds are often caused by improper deposition of the weld metal by the human welder; however, this problem is gradually being eliminated by improvements in the automatic feed and wire electrode welding process.

Magee, G. H., and Kannowski, F. (Engineering Research Division, AAR Research Center, Chicago, Ill.), Report No. ER-32, March 1963, 20 pp, 25 figs., 2 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0754

PERFORMANCE DATA FOR ULTRASONIC EQUIPMENT

The quality of specifications relating to ultrasonic flaw detection equipment and questions arising in regard to their suitability in covering meaningful technical information are discussed. The major concern is for drift caused by internal heating, battery discharge, voltage fluctuations, and changes in ambient temperatures. Concern is also shown for time base limitations, frequency range, sensitivity, attenuation accuracy, zone of influence, vertical linearity, suppression, and readability of trace. A detailed discussion of each of these areas of concern is provided and supplemented with numerical information. A general description of the Krautkramer Model MTA 375 ultrasonic flaw detection device is also given.

Wells, C. D. (Wells-Krautkramer Ltd., Letchworth, England), The British Journal of Non-Destructive Testing, Vol 13, No. 3, May 1971, pp 78-84, 10 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America Ltd. (repr., PC).

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0755

THE STATE OF ULTRASONIC TESTING IN GERMANY AND THE APPLICATION OF THIS METHOD BY THE GERMAN FEDERAL RAILWAYS

The status of ultrasonic testing in West Germany is described with special attention to its use by the German Federal Railways for the inspection of axles on rolling stock and also rails. Detection of horizontal, oblique, and vertical flaws in rolled products of long length is given as a typical example of the use of ultrasonic methods. A brief review of angle-beam testing is given and some illustrations are used to show recordings of incipient cracks in bolt-hole areas of rails. The method for automatic detection of flaws in rails in the track is described along with some results of its application to the detection of fishplate and web cracks.

Martin, E. (Minden, Westf., West Germany), Nondestructive Testing, Vol 14, No. 3, July-August 1956, pp 26-31, 15 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Testing Materials (repr., PC).

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0756

NONDESTRUCTIVE TESTING ON THE DENVER AND RIO GRANDE WESTERN RAILROAD

The activities of the Department of Standards and Research of the Denver & Rio Grande Western Railroad, which is the nondestructive testing laboratory, for the Railroad, are described. These activities include the investigation of problems associated with elimination

of hot boxes, increasing the life of rails and ties in the roadbeds, improvement in the service life of all materials, and the development of materials which will withstand the stresses imposed by ever-increasing speeds in modern trains. The various types of nondestructive techniques used to detect flaws by the Laboratory are reviewed. These techniques include Magnaflux, the Audigage, photoelastic analysis, radiography, and activated materials. Each of the methods for nondestructive inspection is briefly discussed.

Penney, C. O. (Denver & Rio Grande Western Railroad, Denver, Colorado), Nondestructive Testing, Vol 13, No. 4, July-August 1955, pp 33-38, 12 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Testing Materials (repr., PC).

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0757

DEOXIDATION OF RAIL STEEL WITH SILICO-MANGANESE [IN ROMANIAN]

A comparative study was made of the effect of deoxidizing rail steel with silico-Mn and ferro-Mn on the mechanical properties, chemical composition, and microstructure of the rails. The tests were carried out on 30 charges deoxidized with silico-Mn and on 25 charges with ferro-Mn. The results show that deoxidation with silico-Mn is more convenient since the Mn reaction takes place at lower temperature, owing to the formation of Fe and Mn silicates with low melting point, and the deoxidizing time is shortened. An increase in quality is also reported. It is concluded that silico-Mn may replace ferro-Mn in the deoxidizing process.

Vacniuc, N., Metalurgia, Vol 24, No. 8, August 1972, pp 535-537, 6 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Associacao Brasileira de Metalis (repr., PC).

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0758

DETERMINATION OF THE ORIGIN OF NONMETALLIC INCLUSIONS IN RAIL STEEL BY A METHOD OF LABELED ATOMS [IN POLISH]

Exogenous inclusions and methods used for investigating these inclusions are discussed. Probable sources of exogenous inclusions in rail steel are determined, and the method used for the distribution of radioactive and nonradioactive La_2O_3 tracers is described. The sampling method for examination of distribution of tracers in steel and in inclusions is also described. The following sources were investigated: slag, tapping hole, runner, and various materials of the casting system. Radiometric measurements are described. Investigations have shown that the source of typical nonmetallic macroinclusions is the brickwork of the casting system, and that of microinclusions is the casting system, the runner lining, and, in very small amounts, the slag.

Dalecki, W., Rewiencka-Kosciuk, B., Michalik, J., and Jurczyk, J., (Inst. Badan Jad., Swierk/Otwocka, Poland), Hutnik, Vol 38, No. 12, 1971, pp 622-628, 7 figs., 5 tables, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner, West Germany (repr., PC).

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0759

EFFECT OF THE CHEMICAL COMPOSITION OF RAIL STEEL ON HARDENABILITY [IN RUSSIAN]

The effects of additions of C, Cr, V, Mn, and V on the hardenability band of rail steel were studied. The introduction of 0.56 to 0.75 percent C into steel when its Mn and V content are kept unchanged increases its hardening capacity with little increase in hardenability. Addition of less than 2 percent Mn has no significant effect on the hardenability of rail steel. Addition of 0.3 percent Cr to steel increases its hardenability 1.5 times. V has a negative

effect on the hardenability of steel because of V carbide formation; this carbide dissolves at very high temperatures.

Karpunin, A. M., Shafran, I. K., Orgiyan, V. S., and Levoshich, N. V. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R), Met. i Gornorudn., Prom. Nauch.-Tekhn., i Proizy. Sbornik, Vol 73, No. 2, 1973, pp 34-35, 4 figs., 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0760

AN INVESTIGATION OF THE PROPERTIES OF A RAIL STEEL REJECTED IN IMPACT TESTS [IN RUSSIAN]

The reasons for a rail steel failing on impact test were investigated. The impact brittleness of failed steels of higher P content is associated with an increased ferrite microhardness at the boundaries of the austenite grains. This leads to a deterioration of the whole complex of mechanical properties, and to a reduction in the resistance of the steel to fracture under dynamic loading.

Polyakov, S. N., Kudlay, A. S., Serdyuk, A. G., Karpunin, A. M., and Orgiyan, V. S. (All-Union Scientific Research Institute of Railroad Transport), Met. i Gornorudn., Prom. Nauch.-Tekhn., i Proizy. Sbornik, No. 5, 1973, pp 29-31, 3 figs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0761

QUALITY OF RAILS MADE FROM CARBON AND CHROMIUM STEELS [IN RUSSIAN]

The origins of two forms of defect characteristically encountered in C and Cr steel railway rails are considered. One form of defect consists of medium-length cracks sited in places of particular stress, while the other consists of structural inhomogeneities, clearly revealed by etching, mainly associated with As and P liquations. These defects may be largely eliminated by modifying the conditions of deoxidation, e.g., halving the relative proportion of Al used for this purpose.

Fradina, M. G., Rakhansky, B. I., Dolinenko, O. V., Chernyakov, V. I., and Kretova, G. V., Metallurg., No. 12, December 1971, pp 27-28, 2 figs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0762

EFFECT OF ALUMINUM ON THE QUALITY OF (STEEL) RAILS [IN RUSSIAN]

The effect of Al content on the structure and properties of steel rails was studied. With increasing Al content, the number of oxide and sulphide inclusions diminished. Increasing the proportion of Al from 0.001 to 0.04% greatly refined the austenite grains and reduced the tendency towards grain growth on heating, as well as improving the ductility of the material and increasing the impact strength, particularly after heat treatment. An optimum Al content of 0.01 to 0.03% is recommended.

Govorov, A. A., et al., Izvest. VUZ, Chernaya Met., No. 4, 1970, pp 158-162, 4 figs., 5 tables, 8 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0763

NON-METALLIC INCLUSIONS IN BESSEMER RAIL STEEL CONTAINING RARE-EARTH ELEMENTS [IN RUSSIAN]

The nature of the non-metallic inclusions in Bessemer rail steel containing traces of rare-earth elements was studied by metallographic, electrochemical, and petrographic

methods. With increasing proportion of rare-earth elements, the shape and character of the inclusions changed substantially. X-ray microanalysis revealed the presence of complex inclusions simultaneously incorporating Ce, S, and Mn, the complexity of the inclusions increasing with increasing rare-earth content. The mechanisms responsible for the formation of these particles are discussed.

Petrichenko, A. G., Lev, I. E., Prosvirin, K. S., and Pasternak, A. S., Izvest. VUZ, Chernaya Met., No. 12, 1970, pp 41-45, 2 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0764

THE EFFECTS OF VACUUM-DEGASSING HIGH-TENSILE (≥ 90 KG/MM2) STEEL FOR RAILS [IN POLISH]

The principles of vacuum degassing and its advantages in the production of high-tensile steel for rails are discussed. A steelworks vacuum degassing plant and its operation are described in detail. The results of trials on 53 batches of steel (C 0.6-0.75, Mn 0.8-1.30, Si <0.50, P<0.05 and S<0.05%) in terms of mechanical properties are included. Vacuum degassing reduced the H content of the steel by 40 to 60% (eliminating the risk of H embrittlement), reduced the O content by ~50%, and considerably improved the ductility of the steel.

Mazanek, T. (Polytechnical Institute of Slaska-Katowice, Poland), and Kliswics, Z. (Institute of Steel Metallurgy, Gliwice, Poland), Hutnik (Katowice), Vol 37, No. 12, December 1970, pp 559-564, 11 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kubon & Sagner, West Germany (repr., PC).

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0765

INVESTIGATIONS IN INDUSTRIAL SERVICE CONDITIONS OF THE EFFECT OF TRACK RAILS ON THE BILLET REHEATING PROCESS IN A CONTINUOUS PUSHER TYPE FURNACE [IN POLISH]

Described are investigations of the reheating process of standard-size billets in a continuous type furnace, in which the disposition of track rails and the stock varied according to the operating conditions of continuous furnaces. Different variants of reheating processes on track rails are discussed. Guidelines are presented for the design of track lines and arrangement of heating zones in the continuous pusher-type furnaces.

Szecowka, L. (Polytechnical Institute of Czestochowska, Poland), Hutnik, Vol 40, No. 7, 1973, pp 323-328, 8 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner, West Germany (repr., PC).

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0766

PREVENTING RAIL FAILURES IN TRACK

This paper presents a discussion of problems of rail failures and the nature of defects that are occurring that eventually lead to derailments. Flaws are classified into two general types: head defects and web defects. The head defects are listed as transverse fissures, compound fissures, detail fractures, and vertical and horizontal split heads; web defects generally consist of cracks in the horizontal plane in the upper fillet between the rail head and the web, or in cracks out of the bolt holes. The historical development of the rail-defect detection vehicle is reviewed and techniques for detecting flaws are discussed. This involves the early Sperry and AAR rail-defect detector cars and those that are currently in development and operation. Techniques used for

rail-flaw detection abroad are discussed and comparisons are made between European and American approaches to solving the problem. The benefits from nondestructive testing for rail defects are described and cost information is given.

Magee, G. M. (Director of Engineering Research, Association of American Railroads, Chicago, Ill.), Materials Evaluation, Vol 23, No. 10, October 1965, pp 508-511, 1 fig., 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Society for Testing and Materials (repr., PC).

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0767

RESEARCH AND DEVELOPMENT OF CONTINUOUS-WELDED RAIL

The author presents a discussion on the introduction of welded rails into railways systems and gives the reasons for the change from the bolted joint-bar technique of joining rails and the advantages gained. The equipment used in welding and grinding rails is described and such activities as performed by a number of railroads are reviewed. The theory of continuous-welded rail is presented, and research investigations conducted by the Association of American Railroads that deal with the problems of expansion and slippage of the continuous rail are summarized. Stresses resulting from temperature changes are discussed and numerical values of tensile forces per degree of temperature are given. Developments in welding techniques are also discussed.

Magee, G. M. (Formerly Director of Engineering Research, AAR, Chicago, Ill.), Welding Journal, Vol 39, No. 9, September 1960, pp 881-889, 12 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Welding Society (repr., PC).

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0768

EFFECT OF MELTING PRACTICE ON THE CONTAMINATION OF RAILS BY OXIDE STRINGER TYPE INCLUSIONS

The effect of melting practice on contamination of rails by oxide stringer-type inclusions is discussed. The correlation of data from three Soviet plants showed that when rail steel is melted in 400-ton open-hearth furnaces, minimum length of oxide stringers is obtained when duration of bottom boil is 50 to 65 min, carbon elimination rate being 0.16 to 0.24%/hr, and when metal temperature at beginning of pure boil is 1515 to 1535 C, not exceeding 1585 C before deoxidation. The slag basicity during bottom boil must not be high.

Derfel', A. G., Kotin, A. G., Kotlyar, V. L., Sviridenko, F. F., Tarasova, L. P., Yudin, N. S., and Nikulin, N. G. (Ukrainian Scientific Research Institute for Metals, Azovstal' Works, and Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 8, August 1968, pp 639-641, 5 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Steel Institute and The Metals Society (repr., PC).

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0769

MODERN MILL LAYOUT AND DESIGN FOR ROLLING STRUCTURAL STEEL

Descriptions of the U.S. Steel Corporation's combination mills for rolling wide-flange beams and rails as well as other structural configurations are given. The descriptions include the rolling schemes and schedules, pass and mill designs, mill sizes and equipment for hot and cold sawing, cooling, straightening, piling, and strapping. The author states that the Carnegie method has been generally adopted in the rolling processes because it offers the most practical method for producing parallel flanges and rails. The

various practices in mill rolling of rails are discussed while emphasis is placed on the advantages in the use of the universal mill.

Reuter, P. H. (Blaw-Knox Foundry & Mill Machinery, Inc., Pittsburgh, Pa.), Iron and Steel Engineer, Vol 47, No. 5, May 1970, pp 73-87, 27 figs., 7 refs.

ACKNOWLEDGMENT: Association of Iron and Steel Engineers.

PURCHASE FROM: Association of Iron and Steel Engineers (repr., PC).

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0770

CONTROL OF RAIL-END HARDENING

Manual methods for flame hardening ends of ordinary carbon steel rail in the field and the state of the art and standardization of such practices are discussed. Progress reports of the AREA Committee on rail-end hardening are reviewed and mention is made regarding the confirmation of the Committee's fundamental conclusions. The two procedures for end-hardening which are in common use and appear to provide satisfactory results are described. These are compressed-air quench and self-quenching. The self-quench method requires closer control than the air-quench method. Equipment and personnel requirements for both methods are discussed. Investigations conducted by the Air Reduction Laboratory on the influence of variable conditions and procedure modifications are summarized.

Grover, L. H. (Welding Engineer, Air Reduction, New York, N.Y.), The Welding Journal, Vol 31, No. 1, January 1952, pp 7-17, 8 figs., 3 tables, bibliography.

ACKNOWLEDGMENT: American Welding Society.

PURCHASE FROM: American Welding Society (repr., PC).

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0771

A HIGH FREQUENCY EDDY-CURRENT, NON-DESTRUCTIVE TESTING APPARATUS WITH AUTOMATIC PROBE POSITIONING SUITABLE FOR SCANNING APPLICATIONS

It is shown that at high frequencies, the reactance reflected into the probe circuit is dependent on the resistivity of the metal object. The reflected reactance is suggested as a means to control the degree of coupling between the probe and the object with the result that the reflected resistance is determined solely by the resistivity of the metal. A prototype instrument is described which makes use of these principles. The instrument can scan over a surface with an irregular topography without making mechanical contact, and the information from the instrument can distinguish between changes in the surface, variations in resistivity, and mechanical defects such as cracks.

Owston, C. N. (Cranfield Institute of Technology, Bedford, England), The British Journal of Non-Destructive Testing, Vol 13, No. 6, November 1971, pp 170-174, 7 figs., 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC America, Inc. (repr., PC).

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0772

TO IMPROVE THE CONTROL OF RAILS [IN RUSSIAN]

A brief critical evaluation of flaw detectors used for locating defects in rails is presented. The principal complaint with regard to the quality of flaw detectors has been the unreasonably long periods of time required for solving operational problems concerning the ultrasonic type units. The Soviet UKD-58 ultrasonic inspection unit is considered to be a high-quality flaw detector, but requires considerable adjustment and some modifications before the unit will operate properly. The author

lists improvements that were made in his shop and criticizes the subcomponents used in the unit's fabrication.

Volkov, V. M., Put i Putevoye Khozyaystvo (Track and Track Management), No. 5, 1972, pp 42-43.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0773

INVESTIGATION BY DIGITAL COMPUTER OF THE FEASIBILITY OF PRODUCING LONG WELDED RAILS [IN RUSSIAN]

Studies on the production of 25-meter long welded rails, made from sections out of which defective parts have been cut, are reported by authors at an Electro-Technical Institute. Specifications associated with the rails are given. Statistical modeling of the process of rail welding was carried out on a digital computer. A simulation algorithm of the process of welded-rail production was constructed on the basis of the studies and subsequent calculations through the use of a URAL-3 computer. As a result of the simulation, relations characterizing the value of the probability of rejects as a function of the volume of distribution were obtained.

Chernyshev, A. N., Dekhtyar, Ye. I., Tkalenko, V. G., and Dubinskiy, R. I. (Instituta Elektrotyazhkhimproyekt, U.S.S.R.), Metallurgicheskaya i Gornorudnaya Promyshlennost', No. 4, 1972, pp 17-18, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0774

RAIL PRODUCTION AT THE NO. 2 LARGE SECTION MILL AT FUKUYAMA WORKS

The role which Nippon Kokan's new heavy rail production facility, Fukuyama No. 2 large section mill, plays in the development of Japan's high-speed railway system is discussed. The production equipment and processes employed by the mill are described. Mention is made that the rolling mill has sufficient space such that rail lengths of 50 and 100 meters are no longer a problem. In order to achieve more efficient production, a study was conducted by the steelmaking, blooming/slabbing, and rolling divisions of the mill to determine the quality of rails which could be produced from 13-ton rather than the 7 to 8-ton ingots which were being used. Areas studied included the degree of segregation, sulfur print, macro-pattern, nonmetallic inclusions, hydrogen content, microscopic detection of the presence of Fe_3C, and the mechanical properties throughout the entire length of the rail. Prototype rails produced from the 13-ton ingots were tested at the Research Center of the Japanese National Railways and found to be acceptable. Bar charts showing the mechanical properties, dimensional accuracy, and quality of the rails are given.

Gino, T., and Gocho, M. (Nippon Kokan K.K., Fukuyama, Japan), Iron and Steel Engineer, Vol 52, No. 6, June 1975, pp 25-31, 10 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute (repr., PC).

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0775

SOIL PRESSURE DISTRIBUTION ALONG FLEXIBLE FOUNDATIONS

The problem of determining soil distribution pressure along a flexible slab transmitting its load to an elastically yielding ground is discussed. Previous work on the subject and the earlier methods of treating the problem

are reviewed. A general mathematical expression for the yield curve is derived for some of the simplest loading conditions, such as a single load applied at the center of the span. An approximate treatment is given which involves a number of loading points and subsequent derivations of expressions that deal with equivalent forces. A numerical example is presented for wide-flange beams embedded in concrete. A model analysis is included which consists of stretched bands and wires held in suspension by weights in an effort to explain the relationship between resiliency and flexibility. Results of a study using the model are given.

Bull, A. (Board of Transportation, City of New York), Journal of the Franklin Institute, Vol 233, June 1942, pp 559-580, 12 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Franklin Institute (repr., PC).

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0776

STRESSES IN SOILS UNDER A FOUNDATION

This paper presents a mathematical analysis for stresses in a semi-infinite substance in which the ratio of modulus of elasticity in compression to modulus of elasticity in shear is greater than that for solids. This ratio then becomes a soil constant which can be evaluated to suit tests and may vary for different soils. In other respects the analysis conforms to the familiar assumptions of the theory of elasticity. It is developed first for problems in two dimensions and later for those in three. Some applications to particular kinds of loadings are indicated. This study concerns itself with concentrated, distributed, and uniformly varying loads.

Weiskopf, W. H. (Weiskopf and Pickworth, Consulting Engineers, New York, N.Y.), Journal of the Franklin Institute, Vol 239, June 1945, pp 445-465, 7 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Franklin Institute (repr., PC).

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0777

THE COMPOSITION OF STEEL FOR HIGH STRENGTH RAILS [IN RUSSIAN]

The authors studied three groups of steels to determine whether rail steel possessing high carbon content and contact-fatigue strength together with sufficient toughness and plasticity could be produced, and whether it is possible to obtain sufficient toughness when carbon content is decreased and contact-fatigue strength is increased by alloying the steel. Illustrations are provided which show the effect of carbon on the limit of endurance during contact loading of carbon steel and complexly alloyed steels. Data are tabulated which provide some indication of toughness failure. Experimental rails of various chemical compositions were fabricated and their hardenability, during the volume hardening in oil was determined. It was concluded that alloying of steel, within the limits studied, when carbon content is reduced cannot increase contact-fatigue strength of rails to the required level. Alloying of steel by using the conventional methods of hardening (volume, stepwise, isothermic) does not compensate for the reduction in cohesive strength and viability of rails which are observed with increases in carbon content, and does not produce the combination of mechanical properties that assure the necessary rail design strength.

Safonova, K. E., Velikanov, A. V., Vinokurov, I. Ya., Rabinovich, D. M., and Rauzin, Ya. R. (All-Union Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1974, pp [illegible], 4 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0778

INELASTIC BEHAVIOR OF DUCTILE MEMBERS UNDER DEAD LOADING

The main body of this bulletin is devoted to the presentation and analysis of test data concerning the load-carrying capacity of ductile beams as influenced by small amounts of inelastic action and by method and schedule of loading. These data were obtained from conventional tests made in screw- or hydraulic-powered testing machines as well as special tests made in a constant or dead-load testing machine. A description is given of a series of tests made on straight and curved beams having various cross-sections and made from two types of materials. Stress-strain diagrams for annealed 0.8 percent carbon (rail) steel are presented. Included are dimensionless moment-deformation, and typical constant load time-deformation diagrams for rail steel. Results of tests were analyzed by comparing the experimental moment-strain and moment-deflection diagrams with those obtained by theoretical considerations.

Clark, M. E., Corten, H. T., and Sidebottom, O. M. (University of Illinois Engineering Experiment Station, Urbana, Ill.), Bulletin No. 426, October 1954, 48 pp, 25 figs., 1 table, 3 appendixes, 53 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: University of Illinois Engineering Experiment Station (repr., PC).

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0779

INFLUENCE CHARTS FOR COMPUTATION OF STRESSES IN ELASTIC FOUNDATIONS

A simple graphical procedure for computing stresses in the interior of an elastic, homogeneous, isotropic solid bounded by a plane horizontal surface and with distributed vertical loads at the surface is described. The stresses are computed from charts, which are given in the article, merely by counting on a chart the number of elements of area, or blocks covered by a plan of the loaded area drawn to proper scale and laid upon the chart. The influence charts included in this bulletin are of a size convenient for practical use in computing vertical stress on horizontal planes, the sum of principal stresses, and horizontal stress on vertical planes, the latter two charts being constructed for a value of Poisson's ratio of 0.5. Influence charts are also given to a smaller scale for computing the components of shearing stress on horizontal and vertical planes, and for computing the corrections to the various stresses when Poisson's ratio is different from 0.50.

Newmark, N. M. (University of Illinois Engineering Experiment Station, Urbana, Ill.), Series No. 338, Vol 37, 1942, pp 25, 8 figs., 3 plates, 2 tables, 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: University of Illinois (repr., PC).

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0780

CORROSION AND PROTECTION OF RAILS IN TUNNELS

Atmospheric corrosion tests were made on specimens in the form of cross-rail templates produced from experimental heats of eight low-alloy steels containing 0.1% copper, 0.18% vanadium, about 2.5% chromium, and 0.9% nickel. Steels hardened and tempered to high hardness are prone to corrosion cracking. In order to protect rails against corrosion due to leakage of traction current in tunnels, rails are fastened with separate "K" type fasteners using rail chairs coated with films of insulating polymers.

Vedenkin, S. G., and Dobrolyubov, V. V. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Protection of Metals, Vol 1, No. 1, 1965, pp 68-71, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Ltd. (repr., PC).

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0781

OCCURRENCE OF PLASTIC DEFORMATION IN THE SURFACE ZONE OF THE ROLLING SURFACE OF RAIL HEADS [IN RUSSIAN]

Studies of the distribution of plastic deformation in the rolling surface zone of R65 rail heads were conducted at the Track-Testing Laboratory of MIIT. Hardness tests were performed on wedge-shaped sections cut from rail heads by using a Rockwell hardness tester adjusted to subject the specimens to a load of 100 kg. Data are presented which give the average axle loads and vertical wear of rails, and the distribution of hardness ranges in head sections of new and used rails. An analysis of the data indicates that deformation distribution depends principally on axle loads, tonnage carried by the rail, and the conditions of wheel-rolling surface contact.

Nikonov, A. M., and Artamonov, V. A. (All-Union Scientific Research Institute of Railroad Transport), Trudy Mosk. Inzhenerov Zheleznodorozhnogo Transporta, No. 354, 1971, pp 104-108, 2 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0782

EFFECT OF STRUCTURE OF RAIL STEEL ON ITS MAGNETIC PROPERTIES [IN RUSSIAN]

Studies of the magnetic properties of rail steel of standard chemical composition and having a lamellar structure are described. Magnetic parameters such as coercive force and maximum, minimum, and initial magnetic permeability of the rail steel are shown in graphical illustrations. Correlations are made between the saturation and residual magnetism of the metal. The relations studied suggest that the coercive force and magnetic permeability are the most sensitive indications of metal structure. This is further shown by plotting the change in coercive force, magnetic permeability, and hardness in relation to tempering temperatures. Experimental studies were performed by using two batches of rails produced at the Kuznetsk Metallurgical Combine and the test results are briefly described. It was found that work-hardening of rail-head metal which occurs on exposure to operating loads causes changes in hardness and the magnetic characteristics, such as coercive force, increase while magnetic permeability decreases.

Zarochentsev, G. V., Kozhevnikov, G. I., and Yushkevich, I. N. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuz Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 508, 1974, pp 43-48, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0783

STRESSES BENEATH A RAILWAY TRACK

Stress testing of railroad bed materials in Great Britain is described. Tested soils included clay and marl. Stresses were determined between ties and ballast and under rails. Pressure cells were used for quasi-static and dynamic testing. Smaller sized pressure cells of series Y and Z are most suitable. Test and theoretical values show close agreement. Mohr's circle representation demonstrates that vertical and horizontal stresses are principal ones. Results obtained have enabled realistic stress levels to be adopted in laboratory tests of repeated stressing of soils.

Heath, D. L. and Cottram, M. (British Railways Research Dept., Derby, England), Railway Gazette, Vol 122, No. 24, December 16, 1966, pp 1001-1007, 13 figs., 4 photos, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0784

LATERAL BALLAST RESISTANCE AND STABILITY OF TRACK IN EARTHQUAKE

The behavior of the railway track in an earthquake was studied through experiment and theoretical analysis. The experiment was performed with real tracks in the RC-box placed on the vibrational table, 5 x 5 m^2 in dimensions. The conclusions are as follows: against the earthquake acceleration with which railway structures are designed, 83% of the ballast resistance is maintained in the track on the Shin Kansen and 78% in the track with PC-ties and crushed stone ballast on the narrow gauge lines. The long weld rail track holds the safety factor at least 1.15 for the buckling due to temperature rise in the earthquake with the same acceleration mentioned above.

Sato, Y. (Track Laboratory, Railway Technical Research Institute (JNR)), Railway Technical Research Institute Quarterly Report, Vol 11, No. 1, 1970, pp 3-6, 4 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0785

CONTACT STRENGTH OF STEELS FOR RAILWAY RAILS

Contact strength of steels for railway rails is discussed. Contact defect types were reproduced on heavy rails R-50 using models. In studying conditions responsible for their formation, it was found that rails of chromium-containing non-heat-treated open-hearth steel should have high resistance to formation of contact defects, whereas resistance of rails of non-heat-treated open-hearth carbon steel and of hardened chromium-containing Bessemer steel will be lower. Results were confirmed by track tests.

Makukhin, S. I., Mavotrotskii, I. V., and Kazarnovskii, D. S. (Ukrainian Research Institute for Metals, U.S.S.R.), Stal, No. 9, September 1962, pp 838-842, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultant's Bureau, Inc. (repr., PC).

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0786

WHY R-50 RAIL SURFACES CHIP AWAY NEAR THE INNER FACE

Why R-50 rail surfaces chip away near the inner face is explained. Rails removed from track because they had chipped away, and rail steel specimens were tested. Second-order stresses of 34-42 kg/sq mm were found to cause crystal lattice distortions under which cracks form in rails. Vanadium improves resistance to cracking, which is the initial cause of metal chipping away.

Kontorshchnikov, P. V. (Urals Branch of TsNII MPS, U.S.S.R.), Stal, No. 5, May 1963, pp 464-466, 5 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Inc. (repr., PC).

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0787

SPECIAL FEATURES OF THE DEFORMATION OF RAILS COLD-STRAIGHTENED ON ROLLER MACHINE

Special features of deformation of rails cold straightened on roller machines are described. Cold straightening of rails on roller straightening machines produces not only longitudinal but also transverse deformations at an angle of 45° to the generatrix of the section. In areas of compression where rail is bent on a straightening machine, longitudinal tensile stresses occur on side surfaces. Rails are actually deformed in

straightening machines not only by the middle part of the rollers but also by their ends.

Plekhanov, P. S., Gladkov, G. A., Rudol'skii, N. L., Valenko, N. S., Mogilenko, A. S., Sivokho, A. F., and Fradina, M. G. (DONNICHERMET and the Azovstal' Works, U.S.S.R.), Stal, No. 2, February 1968, pp 145-148, 3 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Inc. (repr., PC).

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0788

COOLING CONDITIONS WHEN RAILS ARE CASE-HARDENED

The cooling conditions in case hardening of rails are discussed. A method was developed for continuous case-hardening of R65 rail heads with HF current. The rails are quenched with a mixture of water and air, and there is the required steady reduction of hardness in the case-hardened layer. Additional consumption of compressed air is needed and sprayer length is comparatively long. Rails must be bent initially in order to prevent high residual stresses from developing when they are straightened after quenching.

Golovin, G. F., Smirnov, V. I., Suchkousov, V. P., Zammes, A. N., and Bikhanov, L. Ya. (All-Union Research Institute for Rail Transport (VNIIZhT) and the Azovstal' Works, U.S.S.R.), Stal, No. 5, May 1968, pp 427-429, 7 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau, Inc. (repr., PC).

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0789

MOTIVATION BEHIND MANAGEMENTS' USE OF JUMBO-RAIL-CARS

This paper presents an economist's point of view with respect to the reasons why railway management continues to purchase large, heavy, or high-capacity cars in the face of persuasive evidence of the damage being done to the railway system's track structure. The author briefly touches on the effect of such track loading in relation to the high stresses that develop with the rail head. The economical aspects of the trend for heavier cars in regard to the long-run average cost are discussed. The author indicates that the decision on whether or not to use jumbo cars may be independent of whether they cause a disproportionate amount of rail damage. Mention is made of current studies being conducted by the Federal Railroad Administration and the Canadian National Railroad on the variability of maintenance-of way costs.

Selzer, L. J. (Industry Economist) (unpublished), presented at the 12th Railroad Engineering Conference, Pueblo, Colorado, October 21-23, 1975.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: To be published.

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0790

EFFECT OF HEAVY AXLE LOADS ON RAIL AND TIES

This paper, on the subject of the effect of heavy axle loads on rail and ties, is based primarily on experience with the Iron Ore Company of Canada's main line subsidiary, the Quebec North Shore and Labrador Railway and the Carol Lake Mine Automated Railway. A discussion is provided on the tonnage and characteristics of loads hauled annually by these railway systems and the types of wheels and bearing systems used on their hopper cars. The author observes that as a result of these

high-capacity loads corrugation develops quickly on grades and curves, oilers are all important, joint bars must be maintained tight, and rail ends must be built up to reduce the effects of end batter. Most of the wear occurs on curved rails and the use of heat-treated rails, although expensive, has reduced the extent of wear considerably. It is noted that the Sperry Rail Service Car is used for assessing track condition. Schedules for grinding rail heads and installations of continuous welded rail are briefly mentioned.

Monaghan, B. M. (Iron Ore Company of Canada), Paper No. 5 (unpublished), presented at the 12th Railroad Engineering Conference, Pueblo, Colorado, October 21-23, 1975.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: To be published.

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0791

MARTENSITE FORMATION ON THE SURFACE OF CARBON STEELS AS A RESULT OF BRIEF, INTENSIVE SLIDING FRICTION [IN GERMAN]

Martensite formation at the surface of carbon steels as result of brief, strong sliding frictions is discussed. Theoretical considerations of temperatures engendered by friction are followed by a description of the experimental investigation in which carbon steels were tested under conditions resembling rapid travel of wheels over worn rails. Surface temperatures of over 1000 C and cooling rates of over 100,000 degrees per sec were measured. Dependence of martensite formation on rate of friction is described.

Stolte, E. (Versuchsanstalt der Hutten- und Bergwerke, Rheinhausen AG, West Germany), Mitteilungen Krupp (Forschungsberichte), Vol 20, No. 4, 1962, pp 143-151, 16 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen AG (repr., PC).

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0792

STATISTICAL ANALYSIS OF ADHESION PERFORMANCE OF LOCOMOTIVES

A method developed to calculate the expected drawbar pull of a locomotive took account of the probability distribution of the coefficient, μ, of ultimate friction (i.e., coefficient of adhesion) between wheel and rail. For typical μ distributions, calculations were made by this method, and the results revealed the effects of various factors. The calculated results agreed largely with observed results. The method should be helpful in rational design of locomotives and planning for locomotive operation.

Hirotsu, T. (Hitachi Research Laboratory, Hitachi, Ltd., Katsuta, Japan), Journal of the ASME, Paper No. 70-WA/RR-8, presented at the ASME Annual Meeting, November 29-December 3, 1970, New York, N.Y., 8 pp, 7 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0793

AUTOMATIC RAILROAD TRACK INSPECTION

A technical survey of the automated stationary and mobile track test train systems to date is presented. The use and availability of sensors is also reviewed. A method of in-situ excitation in conjunction with a radio interrogation coupled to existing railway communication systems is discussed. The automatic inspection system proposed here is limited to the track bed and the rails. The rails are tested for any fissures and flaws and not for the cross-over error and misalignment, although these are invariably also caused by the settling of the track bed. The major feature of this system is the real-time segment interrogations system. Track spatial deployment to cover maximum optimum segment is, however, also discussed. The need for the railroad industry to expand its efforts in the area of the development

of automatic track and track bed inspection is shown to be highly desirable as well as economical from an operational standpoint.

Hayre, H. S. (University of Houston, Houston, Tex.), IEEE Transactions on Industry Applications, Vol IA-10, No. 3, May/June 1974, pp 380-384, 4 figs., 19 refs.

ACKNOWLEDGMENT: American Institute of Electrical and Electronic Engineers.

PURCHASE FROM: American Institute of Electrical and Electronic Engineers (repr., PC).

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0794

SOLID-BED TRACK LAID FOR TRIAL SERVICE ON NETHERLANDS RAILWAYS

This paper reviews ORE investigations by Committee D 87 which is responsible for the study of ballastless track and the associated construction tests in the laboratories of the University of Munich and British Railways at Derby, England. The investigation includes noise and vibration attenuation studies, the use of high speed lines, and dense traffic in sharp curves. Details of the ballastless construction which consists of the use of concrete structures, cork-elastomers, rail fastenings, and glueing techniques, are discussed. An analysis of longitudinal resistance of ballasted track, which involves calculations of permissible tensile stresses, rolling stresses, and stress due to shrinkage of the rail, is presented. A similar treatment of stress condition is made using a Smith diagram for examining the problem of stresses from a theoretical standpoint.

Eisses, J. A. (Permanent Way Department Headquarters, Netherlands Railways, Netherlands), Rail Engineering International, Vol 5, No. 5, August 1975, pp 186-194, 22 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Geerings of Ashford, Ltd., (repr., PC).

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0795

DETERMINATION OF LOADS ON TRACK

Heavy axle loads now being carried on track have heightened the need for determining the actual loads imposed on the various track components. In this paper some of the progress and problems associated with the determination of loads are discussed. Recent analytical and field-measurement techniques are discussed, as well as actual loads which have been predicted or measured under some of today's problem conditions. Ongoing programs concerning the determination of (1) wheel/rail loads and (2) cross-tie loads are also presented.

Meacham, H. (Battelle's Columbus Laboratories, Columbus, Ohio), Paper No. 1 (unpublished), presented at the 12th Railroad Engineering Conference, Pueblo, Colorado, October 21-23, 1975.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: To be published.

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0796

PLASMA TREATMENT OF RAILWAY RAILS TO IMPROVE TRACTION

Plasma-torch treatments of track rails to improve locomotive wheel traction were investigated as a potential substitute for rail sanding. Rolling friction tests were conducted under simulated rail-wheel load conditions at about 200,000-psi contact stress. Although traction was improved significantly in laboratory tests, total power required to significantly improve the coefficient of friction for a diesel electric operation at low speeds appears excessive. Power required at 80 mph is prohibitive. Moreover, safety maintenance, and mechanical aspects require a

considerable amount of further development before such an application can be considered possible on American railroads.

Gifford, R. E. (General Motors Corporation, Warren, Mich.), and Yosnino, R. T. (GMC, La Grange, Ill.), Journal of Engineering for Industry, Trans. of the ASME, Series B, Vol 93, No. 8, August 1971, pp 867-874, 14 figs., 2 tables, 18 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0797

PROBLEMS OF INTERACTION OF VEHICLES AND TRACK (ESSAYS CONCERNING THE HUNTING PROBLEMS OF RAILWAY VEHICLES)

This report comprises the three prize-winning essays in the competition sponsored by ORE for a solution to the problem of hunting of railway vehicles.

The first essay (by DePossel) gives a formula for the problem of hunting. The forms indicated for the profiles of wear give rise to three functions which are replaced by limited developments with an approximation of 10% for the whole amplitude possible in the numerical application suggested. In the final equations only the linear terms of these developments remain. Stability is studied in the case in which the law of friction is assumed to be linear.

The second essay (by Boutefoy) lays down equations for those cases in which the damping of the suspension and the rail-wheel deflections are disregarded; the friction is assumed to be linear, but the constants are modified so as to make certain allowance for the deflections and for the nonlinear law of friction.

The third essay (by Matoudeira) approaches the problem of hunting in a manner so that the calculations disregard not only the rolling motion but also the perpendicular reactions in the direction of movement due to the obliqueness of the rail-wheel contact. Consequently, the results are valid only for perfectly conical wheels.

DePossel, R., Boutefoy, J., and Matsudeira, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 9/RP 2/E, Part 2, Interim Report No. 2, June 1960.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0798

PROBLEMS OF INTERACTION OF VEHICLES AND TRACK [METHODS OF REDUCING WEAR OF RAILS AND TYRES BY LUBRICATION (STATE OF DEVELOPMENT 1959)]

The merits of rail lubrication as an effective means of reducing rail wear and increasing the mileage of motive power units are discussed. Rails in curves are protected against severe wear by indirect lubrication (flange lubricators). The lateral wear of rails on straight track resulting from the sinuous running of vehicles is decreased. A reduction of wear can also be expected on the flanges of carriages and wagons when the rails are lubricated by the motive power unit. Some concern is expressed with regard to the possibility that greased rails contributed to the problem of shelling.

Specialists Committee C 9, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C9/RP 3/E, Interim Report No. 3, April 1961.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0799

PROBLEMS OF INTERACTION OF VEHICLES AND TRACK (MEASUREMENTS MADE WITH RAIL VEHICLES DURING 1961 TO ASSESS THE CLEARANCE GAUGE ALLOWING FOR ROLLING MOVEMENTS OF THE VEHICLES)

The purpose of this study was to make measurements which would provide information on the behavior of the bogies and their position on the track, and to assess the lateral and rolling motions of the vehicles caused by the forward traveling speed, the curve radii, and the superelevation in the curved track. The data are to be used in setting up a kinematic vehicle gauge. Difficulties were experienced in installing the measurement devices because of the restricted space on the lower section of the vehicles into which they had to be installed and because of the vibration of the various structural components of the traction vehicles.

Specialists Committee C9, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 9/RP 5/E, Interim Report No. 5, October 1962.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0800

PROBLEMS OF INTERACTION OF VEHICLES AND TRACK (PERFORMANCE OF SMALL DIAMETER WHEELS WHEN TRAVERSING A 1 IN 9 CROSSING ON A CURVE OF 450 M)

This report provides a concise account of the results obtained by test-bench studies of the geometry of the contact of small-diameter wheels and the safety against derailment when traversing a 1-in-9 crossing on a curve of 450-m radius (approximately a No. 8 turnout in the U. S.). To determine the problems involved, it was decided that the performance of the small wheels currently in service should be tested in a crossing on a running line. The principal aim of the tests was to confirm that the values measured on the test bench were not exceeded by wagons in current service. Consequently, the maximum values of the angle-of-attack of the wheelsets and the transverse forces on the axleboxes, which were due to the effects of the vehicle on the wheelset and to those of the train formation on the individual vehicle, were measured.

Specialists Committee C 9, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 9/RP 8/E, Interim Report No. 8, June 1967.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0801

INCREASE IN THE PERMISSIBLE LOAD OF S AND SS WAGONS (INFLUENCE OF THE NATURE OF WAGONS, THE SPEED AND THE SUB-RATED WHEEL LOAD ON THE FATIGUE OF THE TRACK)

The objective of these tests, which were carried out by the SNCF in 1969 on a track in an average condition of maintenance, was to examine the possibility of increasing the maximum axle-load of modern wagons in S and SS service, which is at present 18 and 16 tons, respectively.

A large number of strain-gauge measurements were taken on the track to determine the statistical distribution of the dynamic forces exerted on the track by vehicles (on old-type wagon and modern non-bogie wagons) in different load conditions and at different speeds. It appears that the transverse forces are very weak (less than 10^4 N), therefore, only the vertical forces were considered.

Two vehicle-effect indices were considered, based on the standard deviation of the statistical distribution of the forces and

characterizing (a) the damage caused to the track per gross-ton and per kilometer, and (b) the maximum dynamic wheel load.

It was established that the maximum permissible loads should be 19.5 tons for modern nonbogie wagons used in SS service and 20 tons in other cases (S service and modern bogie wagons in SS service) in order to ensure that their effect on the track is not greater than that of the old-type wagons.

Specialists Committee C 113, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 113/RP 1/E, Interim Report No. 1, April 1970.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0802

INCREASE OF THE PERMISSIBLE LOAD OF S AND SS WAGONS (MEASUREMENTS TAKEN ON VEHICLES)

This report contains the results of the measurements taken simultaneously on the vehicles in straight and curved track in order to determine the forces exerted on the track as a result of cant deficiency or excess and the random forces due to the movements of the suspended and nonsuspended masses.

The first part of the report contains a description of the evaluation procedures used in order to determine the various factors. Taking into consideration two criteria defining the detrimental effects of vehicles on the track, it was found that the modern bogie or nonbogie wagons running with an axle load of 20 tons and at a speed of 120 km/hr are no more harmful to the track than the old type, nonbogie wagons running at a speed of 80 km/hr with an axle load of 20 tons.

In the second part of the report the results of the measurements on the constituent components of the wagons are discussed.

Specialists Committee C 113, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 113/RP 2/E, Final Report, October 1970.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0803

PREVENTION OF DERAILMENT OF GOODS WAGONS ON DISTORTED TRACKS (WHEEL LOAD MEASUREMENTS AS A MEANS FOR TESTING TWO-AXLED GOODS WAGONS)

The conditions leading to variations or divergencies of vertical wheel loads, such as tracks with varying twist, are discussed. It is important that wheel-load variations be as small as possible and that they remain within a given permissible value of the maximum variations given in Interim Report No. 3.

When the wagon is subjected to track internally "twisted" both in magnitude and direction, the wheel-load variations are represented by means of a diagram (torsion diagram) the special features of which depend on a certain number of parameters characteristic of the wagon: natural "out-of-planeness" of the assembly, torsional stiffness of the assembly, body hysteresis, and internal friction of the suspension springs. This diagram provides some indication as to the importance of these parameters. It also makes it possible to determine whether a wagon tested in this way is capable of running with adequate safety on a track with a determined "twist". The essential points of the diagram are determined by means of a

measuring installation, the main parts and mode of functioning of which are dealt with in the last chapter of this report.

Specialists Committee B 55, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 55/RP 1/E, Interim Report No. 1, October 1964.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0804

PREVENTION OF DERAILMENT OF GOODS WAGONS ON DISTORTED TRACKS (PERMISSIBLE WHEEL-LOAD VARIATIONS ON TWO-AXLED GOODS WAGONS)

This report contains the theory pertaining to the relations between wheel-load variations, vehicle characteristics, and track twists and also equations and nomograms relative to these relations.

Furthermore, this report contains the results of statistical enquiries regarding the vehicle characteristics affecting ΔQ of the usual goods wagons. In conjunction with theory, these results serve as a basis for the discussion of measures to be effected on goods wagons with high torsional stiffness in order to comply with the principal recommendation made in the report.

Specialists Committee B 55, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 55/RP 3/E, Interim Report No. 3, October 1966.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0805

PREVENTION OF DERAILMENT OF GOODS WAGONS ON DISTORTED TRACKS (TWO-AXLED GOODS WAGONS SUBJECTED TO SIMULTANEOUS STRESSES DUE TO TRACK DISTORTION AND TO TRANSVERSE COMPONENTS OF THE FORCES OF THE AUTOMATIC COUPLER; DYNAMIC EFFECTS OF TRACK DISTORTIONS)

The results are given of recent investigations of the performance of two-axled wagons during quasi-static running on twisted track when exposed simultaneously to components of forces in the transverse direction as they may arise from the longitudinal compressive forces of the automatic coupler. Detailed descriptions of the investigations are provided in three appendixes to the report.

The representation of the results obtained from the quasi-static tests is supplemented by formulas and a nomogram which make it possible to ascertain for a wagon the transverse components of the coupling forces acceptable on track with a given twist, or the track twist safely negotiable under the effect of a given transverse component of the coupling force. Dynamic tests at speeds up to 120 km/hr have shown that the limit value which is valid for quasi-static was exceeded during short periods without resulting in derailment.

These tests and the theoretical investigation have both shown that a certain coincidence of defects (a succession of two defects) may greatly impair the safety against derailment.

Specialists Committee B 55, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 55/RP 4/E, Interim Report No. 4, October 1970.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0806

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND THE GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES (RESULTS OF THE MEASUREMENTS MADE WITH THE LOCOMOTIVES 040 DE 12 OF THE SNCF AND NO. 0621 OF THE WESTPHALIAN PROVINCIAL RAILWAY)

This report describes studies concerning the problem as to whether a locomotive without bogies, but equipped with the Beugniot lever system, might be admitted as a standard locomotive suitable for running at speeds up to 80 km/hr. The measurement procedure and handling of motive-power equipment are described. Several measurements were made after blocking two axles of the locomotive equipped with the Beugniot lever system, thus producing a running-gear arrangement possessing the same characteristics as that of a rigid-frame locomotive. Comparative measurements proved the superiority of the Beugniot lever system over the rigid-frame arrangement. As a result of this study, both types are to be considered to possess approximately equivalent riding qualities. In conducting this investigation, the transverse forces were used as a criterion in order to determine, quantitatively, the running properties of the locomotives under test.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 3/E, Interim Report No. 3, October 1959.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0807

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND THE GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES [COMPARISON OF THREE MEASURING METHODS FOR DETERMINING THE FORCES EXERTED BY THE WHEELS OF A MOTIVE POWER UNIT ON THE RAILS OF 300 M RADIUS (GIORNICO 1957)]

This report compares three methods of measurement for determining forces exerted by the wheels of a motive power unit on the rails of a 300-meter radius curve. To measure the forces exerted in the contact area between the wheel and rail, several measuring methods were applied by various means and several measuring apparatuses were developed for this purpose. A working group of the B 10 Specialists Committee carried out comparative tests between the measuring rail developed by the CFF and the measuring base plates developed by the NS and those developed by the SJ. These tests were conducted on the Gothard line near Giornico in October 1957 and are designated "Giornico Tests of 1957".

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 4/E, Interim Report No. 4, November 1960.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0808

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND THE GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES [MEASUREMENTS OF THE FORCES EXERTED ON THE RAILS BY VARIOUS TYPES OF MOTIVE POWER UNITS (MEASURED IN A CURVE OF 300 M RADIUS AT GIORNICO)]

This interim report covers the continuous experimental study related to measurements of the forces exerted on the rails by various types of motive power

units. Measurements were made on a 300-meter-radius curve at Giornico. Previous work in the area of rail wear on curves caused by the CoCo and BoBo locomotives which subjected the curved track to lateral forces is summarized. It was concluded that the modern bogie locomotives subjected the track to less wear at the same speed than the rigid-frame locomotives of the old types. This report also provides information on tests which were duplicates of those conducted in 1955, except that a larger number of locomotive types were included and a considerable versine error was intentionally arranged in the test track.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 5/E, Interim Report No. 5, November 1960.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC; copy located at AAR Technical Center, Chicago, Ill.).

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0809

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES [RESULTS OF THE MEASUREMENTS MADE ON THE LOCOMOTIVES E 424.065 AND E 646.014 OF THE ITALIAN STATE RAILWAYS (FS)]

The report describes the work program of the B 10 Specialists Committee which included an investigation into the behavior of the FS locomotive series, E 424 and E 646, with regard to their riding stability. These locomotives were chosen for this investigation because of the similarity in the structure of their bogies. Results of measurements made on the locomotives which were part of the Italian State Railways (FS) are discussed.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 7/E, Interim Report No. 7, July 1961.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0810

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND THE GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES [MEASUREMENTS RELATING TO THE LOCOMOTIVES E 424.065 AND E 646.014 OF THE ITALIAN STATE RAILWAYS (FS)]

This report gives a comparison between the transverse forces (H-forces) on the axleboxes on a Bo'Bo' locomotive and on a Bo'Bo'Bo' locomotive of the Italian State Railways and the guiding forces (Y-forces) exerted by the vehicles on a curved track. It is shown in the report that the Y-forces are more suitable than the H-forces for assessment of the riding qualities of the vehicles. Measurement of Y-forces is considered more accurate and they also provide information on the coefficient of friction when the wheels slide in the transverse direction. Thus the wheel loads are simultaneously measured with a sufficient degree of accuracy.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 8 E, Interim Report No. 8, October 1962.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0811

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES (INVESTIGATION OF RIDING STABILITY OF THE ELECTRIC CO'CO' LOCOMOTIVE No. 1010.01 OF THE AUSTRIAN FEDERAL RAILWAYS (OBB)

A brief summary is given in connection with previous measurements made to study the stability and guiding qualities of the Bo'Bo'Bo' locomotive and some four-axled locomotives which justified continued investigations with the Co'Co' locomotives (No. 1010.01) of the Austrian Federal Railways (OBB). Reasons given for the selection were that the Co'Co locomotive had pivotless bogies which provided an interesting linkage system that performs the function of the pivot.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 9/E, Interim Report No. 9, June 1964.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0812

CONSTRUCTIONAL ARRANGEMENTS FOR IMPROVING THE RIDING STABILITY AND THE GUIDING QUALITY OF ELECTRIC AND DIESEL LOCOMOTIVES AND VEHICLES (RIDING STABILITY - TEST AND EVALUATION TECHNIQUES, CRITERIA)

Quantities which are typical of the riding of a vehicle regarding its performance and safety aspects are discussed, methods of measuring them are described, and procedures enabling a reliable and comprehensive evaluation of the results measured are indicated.

The random character of the processes permits representative characteristic values to be obtained only by means of a statistical analysis of values measured on a test track of adequate length. These values enable vehicles of different design and construction and also various designs of parts of the same vehicle to be compared.

Methods which permit a statistical analysis based on different points of view are referred to, and in this connection the method of range mean counting is considered to offer an efficient procedure for analyzing the problems of the riding stability. An analogue representation of the quantities measured should not, however, be dispensed with since a statistical analysis does not generally provide any information on the sequence of the values measured with respect to time.

In addition, terms of importance to questions of the riding stability are simplified and systematically arranged, and reference systems of coordinates which are of general validity are established.

Specialists Committee B 10, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 10/RP 12 E, Interim Report No. 12, April 1969.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0813

TESTS ON THE TRACK ON THE RIDING STABILITY AND THE GUIDING QUALITY OF VEHICLES BY MEANS OF A SPECIAL VEHICLE (DESCRIPTION OF THE NEW BOGIE WITH ELASTIC PRIMARY SUSPENSION BETWEEN AXLES AND FRAME)

This report gives a detailed description of the new bogie and of the devices adopted to enable the elastic connections between bogie frame and wheelsets to be varied. The purpose of this experimental bogie fitted under a measuring coach is to study the

effect of different design parameters on stability: elastic suspension between bogie frame and axles, wheelbase, suspended mass, vertical load carried by the bogie, tire profile. This free bogie installed under the measuring coach is subjected only to slippage originating at the point of contact between wheel and rail.

Specialists Committee B 52, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 52/RP 3/E, Interim Report No. 3, October 1971.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0814

IMPROVEMENT OF THE RIDING STABILITY OF EXISTING RIV WAGONS REQUIRED TO RUN, UNDER ANY LOADING CONDITIONS, AT SPEEDS OF 80 KM/H (CRITERIA FOR ASSESSING THE SUITABILITY OF A TWO-AXLED WAGON TO RUN AT A MAXIMUM SPEED OF 80 KM/H; TEST PROCEDURE BASED ON THIS CRITERION)

This report deals with two fundamental test procedures developed by Specialists Committee B 56 to make possible the assessment, in a uniform manner, of the running characteristics of wagons required to run at 80 km/hr under any loading conditions.

The first part of the report contains a description of the test procedure which is based on safety. It involves the measurement of accelerations at specified distances which are given by the radius of gyration from the center of gravity. This makes it possible to ascertain four forces. The maximum value of the four forces thus obtained during a test run must meet specific conditions, and limit values are laid down with regard to the safety of the track against lateral deformation.

The second part of the report discusses the method of the riding index which has been described in ORE Report B 37. The method consists in recording and evaluating oscillations to which the vehicle has been subjected. The accelerations are always measured on the platform above the trailing axle and at the end of the wagon.

Specialists Committee B 56, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 56/RP 1/E, Interim Report No. 1, February 1965.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0815

IMPROVEMENT OF THE RIDING STABILITY OF EXISTING RIV WAGONS REQUIRED TO RUN, UNDER ANY LOADING CONDITIONS, AT SPEEDS OF 80 KM/H [PART 1: STUDY OF THE EFFECT OF VARIOUS SIMPLE MODIFICATIONS ON THE STABILITY OF OLD-TYPE TWO-AXLED WAGONS (FIRST PROGRESS REPORT): PART 2: ATTEMPT TO DEFINE A GENERAL CRITERION FOR RIDING QUALITY]

Part 1 of this report is an account of the investigations conducted by Specialists Committee B 56 with a view to determining inexpensive modifications which might be made to old-type, two-axled wagons in order to make them suitable for running at 80 km/hr under all loading conditions. The investigations were restricted to four wagons, viz., two SNCB wagons and two SNCF wagons which were considered sufficiently representative. The modifications made to them, and described in this report, did not result in an adequate improvement in riding quality.

Three reports of tests carried out by the DB at their own expense on three types of DP wagons are provided in the appendices. Tests in progress and recent theoretical studies, have given encouraging results.

Part 2 of this report specifies the data which the B 56 Committee wishes to collect for the purpose of defining a single criterion for assessing riding quality.

Specialists Committee B 56, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 56/RP 2/E, Interim Report No. 2, March 1967.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0816

IMPROVEMENT OF THE RIDING STABILITY OF EXISTING RIV WAGONS REQUIRED TO RUN, UNDER ANY LOADING CONDITIONS, AT SPEEDS OF 80 KM/H (SUPPLEMENTARY TESTS AND RECOMMENDATIONS)

Reports B 56/RP 1E and 2/E which contain the results of technical investigations conducted for the purpose of defining a general criterion for assessing the riding quality of old-type, two-axled wagons, and the results of line tests before and after modifications are reviewed. No satisfactory means of modifying the wagons were found in these investigations. Fairly simple and economic modifications which could be made to meet the requirements of UIC-Leaflet 439.0 are recommended. The report surveys the results obtained in previous investigations and describes and gives the results of supplementary tests conducted by the SNCF and the JZ. It gives some indication concerning theoretical and technical investigations which will be covered in detail in the final report, and on some of which the present report is based. The results obtained are collated, and recommendations are formulated which might be useful to railway administrations in assessing the riding quality of their two-axled wagons and in making the necessary modifications to those wagons found unsuitable.

Specialists Committee B 56, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 56/RP 2/E, Interim Report No. 3, October 1968.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0817

IMPROVEMENT OF THE RIDING QUALITY OF EXISTING RIV VEHICLES REQUIRED TO RUN AT 80 KM/H UNDER ALL LOADING CONDITIONS (SUMMARY OF THE WORK OF THE COMMITTEE)

This report provides a comprehensive review of the two criteria used for assessing the suitability of two-axled wagons for running at 80 km/hr. One of these criteria concerns the distortion of the track; the other concerns riding quality. Both criteria are based on the execution of track tests. The results achieved with the various modifications tried and those recommended for the wagons considered as well as the costs involved are discussed. A synoptic table is provided in the appendix to the report which lists all types of two-axled wagons, their possible suitability for running at 80 km/hr, and recommended modifications. A mathematical study carried out by the Railway Research Center of the Yugoslavian

Railways is also mentioned which should be assistance to those encountering special problems in this area.

Specialists Committee B 56, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. B 56/RP 4/E, Final Report, April 1969.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0818

TESTS CONCERNING THE PROBLEMS INVOLVED WITH THE KINEMATIC GAUGE (THEORETICAL INVESTIGATIONS CONCERNING THE POSITION OF VEHICLES IN THE TRACK)

This task was concerned with studying the position of bogies in the track. Tests were carried out on passenger coaches, electric motor-coach trains, electric driving trailers, electric locomotives, and diesel locomotives.

With regard to the position of bogies in the track, it was found that in curves, while braking, while stationary, and upon starting, the leading axles of bogie vehicles were pressed against the guiding surface of the outer rail. The rear axles of the bogie vehicles were displaced toward the inside of the curve and the clearance between outer rail and the wheel varied between 0 and 30 mm. The motor bogies of electric tractive units were an exception. During acceleration, the wheelsets of these sometimes slid, within short distances (10 to 60 m), to press against the inner rail. The question still remained as to whether, for calculating the inner and outer limits, these tests were sufficiently representative to allow the problem of track negotiation as set forth in Technical Unity to be dispensed with and whether some new positions should be indicated more suitable to the permissible widths of vehicles, especially passenger coaches.

Specialists Committee C 102, Office for Research and Experiments of the International Union of Railways, Utrecht, Netherlands, Report No. C 102/RP 1/E, Interim Report No. 1, April 1968.

ACKNOWLEDGMENT: International Union of Railways.

PURCHASE FROM: International Union of Railways (repr., PC); (copy located at AAR Technical Center, Chicago, Ill.).

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0819

RANDOM VIBRATION OF BEAMS

The calculated response of a uniform beam to stationary random excitation depends greatly on the dynamical model postulated, the damping mechanism assumed, and the nature of the random excitation process. To illustrate this, the mean square deflections, slopes, bending moments, and shear forces are compared for four different dynamic models, with three different damping mechanisms, subjected to a distributed transverse loading process which is uncorrelated spacewise and which is either ideally "white" timewise or band-limited with an upper cut-off frequency. The dynamic models used are the Bernoulli-Euler beam, the Timoshenko beam, and two intermediate models - the Rayleigh beam, and a beam which has the shear flexibility of the Timoshenko beam but not the rotatory inertia. The damping mechanisms are transverse viscous damping, rotatory viscous damping, and Voigt viscoelasticity. It was found that many of the mean-square response qualities are finite when the excitation is ideally white (i.e., when the input has infinite mean square); however, some of the responses are unbounded. For the latter cases,

the rate of growth of the response as the cut-off frequency of the excitation is increased is obtained.

Crandall, S. H., and Yildiz, A. (Massachusetts Institute of Technology, Cambridge, Mass.), Journal of Applied Mechanics, Trans. ASME, Series E, Vol 29, No. 2, June 1962, pp 267-275, 3 figs., 3 tables, 12 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0820

SOME ASPECTS OF SERVICE DEVELOPMENTS IN RAIL HEAD METAL

The author discusses his activities and associations with the railway systems in Australia as they apply to ore-transport. A brief discussion is given on the sizes of unit trains, each car's gross weight, and the annual tonnage of ore transported. Problems associated with rail fatigue and corrugation are mentioned. The author reviews and comments on the validity of several papers that have appeared in the AREA proceedings on the subject of fatigue graphs. He concludes that they were not applicable to cases involving heavy unit trains that haul high annual tonnages.

Read, R. G. (Railways, Minenco Pty. Ltd., Melbourne, Australia), American Railway Engineering Association, Bulletin No. 639, Proceedings, Vol 74, September-October 1972, pp 37-38.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0821

JOINING AND HARDFACING OF RAILS, POINTS AND CROSSINGS USING MANUAL METAL-ARC WELDING ON THE SWEDISH RAILWAYS

Two basic tasks associated with development of a suitable technique and filler materials for rail welding by joint efforts of the Swedish Railways Track Office and the ESAB Central Research Laboratories in Goteborg are described. The first task was to reduce maintenance costs for rail materials by the hard surfacing and joining of rail ends and crossings, and, later also, points. The second main task was to further develop a technique and backing material for the joining of rails by means of manual mold welding. Numerical values that cover the requirements of fatigue strength and good resistance to brittle fracture, and hardness are presented. A step-by-step procedure is given for selection of welding electrodes, surfacing of joints, and joining of rails. A schematic drawing is given which shows the shape and positioning of the copper shoes used to establish the minimum length of the mold. Tests that were conducted on the welded joints made it possible to obtain data on the weld-deposit strength, fatigue strength, and notched weld bead.

Ljunggren, J. (Swedish Railways Central Administration, Goteborg, Sweden), and Lundin, S. (ESAB Central Research Laboratories, Goteborg, Sweden), Svetsaren, No. 2, 1974, pp 1-5, and 8-9, 9 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Eyre & Spottiswoode, Ltd. (repr., PC).

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0822

CRACK INITIATION BEHAVIOR OF STRUCTURAL STEELS—TESTS WITH SHARP NOTCH BENDING SPECIMENS [IN GERMAN]

For the evaluation of the safety of welded constructions it is important to know up to which temperature and stress a material may be loaded without an already existent crack becoming unstable and converting into a brittle fracture, which propagates very fast. The transition of a static crack to a high-speed crack is called crack initiation. The behavior of structural steels during the initiation of cracks is studied by sharp-notch-bending tests. The technique for measuring the resistance of the material against crack initiation and the critical temperature is described. The phases of fracture are discussed. The central part of the investigation is concerned with the dependence of crack initiation upon the conditions of loading, i.e., temperature, state of stress, strain rate, and dimensions of specimen. The influence of the

anisotropy of the material and of a deformation at low temperatures is dealt with in detail. The scatter in the results of crack-initiation tests is determined.

Degenkolbe, J., and Musgen, B. (Huttenwork Oberhausen AG, West Germany), Materialprufung, Vol 11, No. 11, November 1969, pp 365-372, 9 figs., 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0823

THE MECHANICAL PROPERTIES OF A PRESTRAINED LOW CARBON STEEL UNDER MULTIAXIAL STRESSES [IN GERMAN]

The static strength and the ductility under multiaxial stresses have been examined as functions of prestrain and mean notch factor which comprises the variation of the form of the notch during plastic deformation. Statistical relations have been established between the increase in tensile strength or yield strength, respectively, and the variation of permanent strain. These relations are independent of prestrain and state of stress in the tested range. The fractographic and microfractographic investigations showed cracks connected with quasi-cleavage zones.

Safta, V. (Timisoara, Rumania), Materialprufung, Vol 13, No. 11, November 1971, pp 376-381, 8 figs., 1 table, 23 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0824

ACOUSTIC EMISSION TECHNIQUES IN MATERIALS RESEARCH

A review of the application of emission analysis to evaluate materials properties and defect structure is presented. Topics discussed include fracture toughness and crack propagation, fatigue, plastic deformation, and creep processes in metals, composites, and rock materials. The status of emission techniques as applied to the evaluation of structural integrity is reported. A complete discussion of experimental techniques and data-acquisition and -processing systems is given. The authors conclude that acoustic emission techniques have wide applicability to experimental studies in materials research and to evaluation analysis of structural integrity. Directions of future developments and applications are discussed.

Liptai, R. G., Harris, D. O., Engle, R. B., and Tatro, C. A. (Lawrence Radiation Lab., Univ. of California, Livermore, Cal.), International Journal of Nondestructive Testing, Vol 3, No. 3, December 1971, pp 215-275, 21 figs., 117 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Gordon and Breach Science Publishers (repr., PC).

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0825

THE DISTRIBUTION OF STRESS AROUND A FLAT PARABOLIC CRACK IN AN ELASTIC SOLID

A simple limiting procedure is revealed whereby the three-dimensional state of stress and deformation around parabolic cracks or flaws embedded in elastic solids may be obtained. Several results are derived from available solutions concerning elliptical cracks or thin-sheet rigid inclusions. In particular, stress-intensity factors used in the Griffith-Irwin theory of fracture are evaluated and shown in curves. The findings of this investigation may also be exploited to determine the stress-strain field in thin sheets containing parabolic holes (and hence semi-infinite cracks) from existing solutions concerning similar bodies with elliptic holes.

Kassir, M. K. (City College of New York, New York, N. Y.) Engineering Fracture Mechanics, Vol 2, No. 4, June 1971, pp 373-385, 3 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0826

ON THE DETERMINATION OF STRESS INTENSITY FACTORS FOR SOME COMMON STRUCTURAL PROBLEMS

This paper presents theoretical analyses of the crack-tip stress-intensity factors for some typical basic models of sheet structures. Two of these models are on cracks approaching the boundary of a change in thickness or rigidity and another is on cracks approaching a hole. In practical structures, the former is considered to correspond to, for example, the case in which the cracks are approaching welded stiffeners and the latter is considered to correspond to the case in which a crack is growing from one rivet hole to another. Therefore, the analyses of these models will give some information on the design of crack arrestors for aircraft, ships, and various machines. The analyses are based on Laurent's expansions of complex stress potentials where the expansion coefficients are determined from the boundary conditions. In numerical calculations, the perturbation technique is employed and the expressions for the crack-tip stress-intensity factors are given in the form of power series of λ, the ratio of the crack length to the plate width, and some other geometrical parameters. The results of numerical calculations for each problem are represented as the correction factors.

Isida, M. (National Aerospace Laboratory, Chofu-shi, Japan), Engineering Fracture Mechanics, Vol 2, No. 1, January 1970, pp 61-79, 6 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0827

STRESS-INTENSITY FACTOR FOR AN ELLIPTICAL CRACK UNDER ARBITRARY NORMAL LOADING

Harmonic stress function and the stress-intensity factor for an elliptical crack embedded in an elastic solid and subjected to an arbitrary internal pressure are derived in this paper. The internal pressure is assumed to be expressible in terms of a polynomial (x and y). Mathematical expressions are presented for the internal pressure. The stress-intensity factor for the elliptical crack subjected to this polynomial loading reduces to the solutions given by Green, Sneddon, Kassir, and Sih when most of the coefficients are zero. The solution is then used to determine the transient stress-intensity factor of an elliptical crack embedded in a thick plate, one side of which is subjected to temperature change. Other possible applications of this solution, such as an elliptical crack in a large beam in pure bending, are also discussed in this paper.

Shah, R. C., and Kobayashi, A. S. (Boeing Company, Seattle, Wash., and University of Washington, Seattle, Wash.), Engineering Fracture Mechanics, Vol 3, No. 2, August 1971, pp 71-96, 7 figs., 3 appendixes, 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0828

DATA AQUISITION FOR AUTOMATED TRACK INSPECTION

The purpose of this paper is to describe the use of a minicomputer in an integrated track-inspection program. The basic elements of such a program include the measuring vehicle, data-reduction process, and presentation of data to the various management levels. The paper describes such a system, which has been in use on the Southern Railway for over 5 years, and points out desirable changes, problems, and economics.

Sullivan, J. H. (Research and Test Laboratory, Southern Railway Company, Alexandria, Va.), IEEE Transactions on Industry Applications, Vol IA-10, No. 6, November/December 1974, pp 770-777, 10 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: American Institute of Electrical and Electronic Engineers.

PURCHASE FROM: American Institute of Electrical and Electronic Engineers (repr., PC).

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0829

EFFECT OF TWO DRILLED HOLES ON THE ELASTIC AND ELASTIC-PLASTIC STRAIN DISTRIBUTION AROUND A CHARPY V-NOTCH

In the present study, three experimental techniques were used to define the effect of two holes on the mechanics of deformation and fracture of notched bars loaded in three- and four-point bending: (1) two-dimensional photoelastic stress analyses were performed on models of both the standard Charpy and drilled geometries; (2) a sensitive dislocation etch-pitting technique was used to observe directly the plastic-strain fields developed in V-notch samples of Fe-3% Si alloy loaded in slow bending; and (3) the Charpy striker was instrumented to record load-time curves during impact bending and thereby determine the dynamic fracture strength of notched and drilled mild-steel samples. It was determined that two holes do not significantly reduce the elastic stress-concentration factor, although they cause considerable redistribution of the local shear stresses around the notch. Consequently, the elastic-plastic state develops quite differently in the presence of two holes, and hole drilling can increase the load-carrying capacity of notched mild-steel bars by more than 100 percent even when bars fail by brittle cleavage prior to general yielding. The implications of these results with respect to other forms of "stress-relieving notches" are discussed.

Rau, Jr., C. A. (Pratt and Whitney Aircraft, Middletown, Conn.) and Tetelman, A. S. (University of California, Los Angeles, Cal.), Experimental Mechanics, Vol 10, No. 9, September 1970, pp 362-369, 14 figs., 17 refs.

ACKNOWLEDGMENT: Society for Experimental Stress Analysis.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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0830

AXIALLY CONSTRAINED BEAMS ON ELASTIC FOUNDATION

The problem of bending in axially constrained beams on a Winkler-type elastic foundation is considered. This nonlinear problem is approached by a differential equation method as well as a finite element method. Numerical results are presented which show that for a low modulus of the foundation the linear solution for deflection (which neglects axial constraint effect) yields deflection values which may be several times higher than the exact solution. The two methods are shown to be in good agreement.

DasGupta, S. (Bell Laboratories, Columbus, Ohio), International Journal of Mechanical Sciences, Vol 16, No. 5, 1974, pp 305-310, 4 figs., 1 appendix, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0831

BENDING OF AXIALLY CONSTRAINED BEAMS ON ELASTIC FOUNDATION

In the analysis of simply supported beams on elastic foundations by Euler-Bernoulli beam theory it is usually assumed that the ends of the beam are free to move along the longitudinal direction, so that there is no stretching of the neutral surface of the beam. In many practical situations, however (e.g., anchored railway tracks), the ends of a simply supported beam are often constrained in such a way that no relative movement of the supports in the longitudinal direction is possible. The beam will undergo some stretching under the application of lateral loads, because of the axial force which comes into play. If the beam is slender and the lateral displacements are other than infinitesimal, the axial force of constraint may become significant and must be taken into consideration in the analysis. The axial force is a function of the lateral displacement, and the resulting problem becomes nonlinear.

Miyogi, A. K. (University of Iowa, Iowa City, Iowa), International Journal of Mechanical Sciences, Vol 15, No. 10, 1973, pp 781-787, 4 figs., 3 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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0832

SOME ASPECTS OF THE INFLUENCE OF THE COMFORT FACTOR ON THE TOLERANCES FOR THE DESIGNING OF RAILROAD CURVES ON HIGH SPEED AREAS [IN ROMANIAN]

This paper is concerned with the aspects of some factors which influence the tolerances in the rail deviations from the ideal position in a curve, horizontal deviations, and height deviations. Because of traffic and high speeds, the rails are subjected to some horizontal, in-plane, and height deformations. These deformations are detected through a series of measurements. In case the deformations exceed the admissible values, the rail is brought back into the correct position, i.e., maintenance expenses. If the admissible tolerances are very close, it means that the maintenance operations have to be done very frequently, which in turn implies, on a national scale, a very expensive and unprofitable operation. On the other hand, if the tolerances are too large, due to some still admissible deformations, traffic safety is endangered. Another factor which influences the tolerances is the graphic processing of the measurement data by the angle diagram method. The method involves, in the case of high speeds, fairly large errors.

Cristescu, N., Taub, M. S., and Posescu, M. N. (Institute for Construction, Bucharest, Romania), Revista De Geodezie, Cadastru si Organizarea Teritoriului, Vol 18, No. 2, 1974, pp 8-21, 2 figs., 5 tables, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0833

ANALYSIS OF THE RECONSTRUCTION OF RAIL GEOMETRY FROM CURVATURE DATA

The reconstruction of rail geometry from measured curvature data is analyzed. The mathematical concept of curvature is developed and utilized in numerical integration of differential equations describing the rail path. Formulas are derived for various chord-displacement methods of measuring curvature and for their measurement response functions. The reconstruction of rail shapes is demonstrated by means of computer simulation, and the effects of measurement response and measurement error are analyzed. Accuracies are compared with those that might be obtained with accelerometer devices used to measure curvature. The techniques and results can be applied to the design of practical rail-measurement systems.

Iverson, W. C. (Kaman Sciences Corporation, Colorado Springs, Colo.), IEEE Transactions on Industry Applications, Vol IA10, No. 3, May/June 1974, pp 368-379, 10 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Institute of Electrical & Electronic Engineers (repr., PC).

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0834

MAUL BLOWS ON WEBS CRACK RAILS AT LOW TEMPERATURES

The fact that the webs of rails can be fractured readily in cold temperatures by heavy spike maul blows has been demonstrated by laboratory tests. These tests, in which rails were chilled to a temperature of 20 deg below zero and then struck on the web with a spike maul while at temperatures ranging from 13 deg below zero to 25 deg above zero, point to the danger of heavy blows on the web of a rail, particularly under low temperatures, at any time during its life. The second series of tests was made for the purpose of determining to what extent, if any, rail design might influence the development of cracks from spike maul blows. Summarizing this second series of tests, it was observed that cracks were produced in one or more specimens of all rail sections included in the tests. Concerning all of the tests, it is of interest to note that cracks were produced irrespective of the branding, stamping, rail position in the ingot, or rail section. "It may be concluded from these tests that it is entirely possible to produce cracks in the rail web by striking the web a heavy blow when at a low temperature." (Carried as RRIS Accession No. 037608.)

Railway Engineering and Maintenance, December 1944, 2 pp, 7 photos, 1 table.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Thomson Publications, Ltd., (repr., PC).

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0835

EFFECTIVENESS OF ALLOYING RAIL STEEL WITH CHROMIUM

Service tests have proved that type R-50 railway rails made of steel containing 0.63 to 0.75% C and 0.7 to 1.0% Mn and alloyed with chromium (0.5 to 1.0%) have an increased (by a mean 25%) resistance to contact-fatigue defects, less wear per 100 million gross tons of freight, and less rippling of the surface after use than carbon steel rails of standard composition. These advantages are obtained if the total C and 1/4 Mn content of the steel is not lower than 0.88%.

Kazarnovskii, D. S., Shnaperman, L. Ya., Kravtsova, L. Y., et al. (Ukraine Research Institute for Metals and the All-Union Research Institute for Rail Transport), Stal, No. 9, 1969, pp 828-830, 6 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0836

THE BAND-AID APPROACH (MAINTENANCE OF WAY, PRESENT AND FUTURE)

This article, Part 2 of a special two-part report, deals with the status of American railroads in regard to the continuing buildup of track-maintenance deferrals and the capabilities of the various industries that supply materials to the railroad maintenance programs. Steel is available for rail production, and the ability of the mills to produce rail appears to depend on other demands for steel, but at present, the rail demand appears to be met satisfactorily. New rail laid in 1974 totalled 708,362 tons. Mention is made of the need for rails as long as 117 ft. Wooden and concrete tie production is discussed in relation to the problems of meeting demands. One problem is the slowness of tie production because of requirement for seasoning and treating which is about one year for hardwoods and six to eight months for soft. Acceptance of concrete ties has been slow as a result of technical problems and lengthy service tests. It is noted that without modern track maintenance machines railroads would be totally bankrupt and out of business. Some statistics are provided on the tonnages of new and used rail for replacements.

Myers, E. D. (Staff Writer), Modern Railroads, Vol 30, No. 11, November 1975, 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Cahners Publishing Co., Inc. (repr., PC).

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0837

A METHOD FOR TESTING THE INFLUENCE OF FRETTING CORROSION ON FATIGUE STRENGTH [IN GERMAN]

The two principal causes of fretting corrosion, i.e., slip amplitude and contact pressure, can be measured with the described test method. The influence of edge pressure is avoided, and the materials in contact, ambient temperature, and humidity are kept constant. The experimental results show the unexpectedly strong and hazardous effect of fretting corrosion on the fatigue strength of steel. It is pointed out that the type of stressing selected (one- or two-step test) can have an important influence on the test results.

Funk, W. (Laboratorium II fur Maschinenelemente der TH, Darmstadt, West Germany), Materialprufung, Vol 11, No. 7, July 1969, pp 221-227, 10 figs., 18 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0838

FIGHTING SHELLY RAIL WITH HIGH-CANT TIE PLATES

Extensive tests with plates having a 1-in-14 cant were carried out at Union Pacific. The results of the tests led to the decision to make them standard for curves of two degrees and over on this heavy-traffic road which has encountered a serious and extensive shelling problem. (Carried as RRIS Accession No. 050389.)

Railway Track and Structures, Vol 67, No. 5, May 1971, pp 20-21, 2 photos.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corporation (repr., PC).

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0839

THE "SECONDARY CONDITIONING" EFFECT OF SURFACES AS OBSERVED ON STEEL RAILS

Measurements of "adhesion" or the limiting friction obtaining between the driving wheels of railway locomotives and the rails usually produce results so spread that they are difficult to analyze. During investigations carried out over a number of years on full-scale railway equipment both in service and in a special laboratory, a study was made of the effects of contaminants upon the rail surface. It was found that, in addition to the normal effect produced by such substances, which could be removed by cleaning, minute traces of certain materials, notably oil, could produce a further effect, described as "secondary conditioning" which could greatly alter the adhesion values, even though the rails were covered with other substances. This secondary effect was later deliberately produced, and was found to be independent of the normal or "primary" effect and strongly resistant to cleaning. Such "secondary conditioning" was apparently the explanation of local reductions of rail adhesion experienced on the track, which are often a severe difficulty in railway operation. Reexamination of the results of many measurements already made on rails in different conditions in relation to the corresponding values of "secondary conditioning" enabled much more definite relationships to be established, and a simple method is suggested for comparing such measurements in future.

Andrews, H. I. (British Transport Commission, Marylebone, London, England), Wear, Vol 6, No. 4, July-August 1963, pp 262-275, 10 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia SA (repr., PC).

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0840

STRENGTH BEHAVIOR OF STEELS UNDER THREE-DIMENSIONAL STATES OF STRESS [IN GERMAN]

From the results of tensile tests with notched specimens, the influence of three-dimensional states of stress on yield stress, tensile strength, true tensile stress, reduction of area, and elongation at rupture were determined at room temperature and 350°C. The materials used were 15 Mn 5 (annealed and artificially aged) and 4-A-X-TRA 70 (heat-treated). The three-dimensional stress state resulting from a notch effects an increase in the load capacity for ductile materials and a decrease for brittle materials compared with uniaxial stressing. Although the plastic deformations at rupture seem to diminish gradually as the notch acuity rises, the local strain at the notch tip actually increases considerably.

Dietmann, H., and Bodenstein, H. (Institut fur Materialprufung, Univ. Stuttgart), Materialprufung, Vol 13, No. 11, November 1971, pp 369-376, 7 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0841

INDUCTION HEAT-TREAT SYSTEM INCREASES RAIL LIFE FOR RAILROADS

Joint research by U. S. Steel and Westinghouse Electric Corporations in regard to increasing the hardness of rail heads for the purpose of reducing excessive rail wear on curved track sections is discussed. An automatic, semicontinuous rail-hardening system was developed through the use of electrical induction by Westinghouse and U. S. Steel, owners of patents covering the system, which enabled U. S. Steel to produce an extended-life rail (Curvemaster). The system contributed to minimum straightening after heat treatment as well as accurate, consistent heating control for reduced scaling and decarburization. The induction-heating process, field tests, and mechanical properties of heat-treated rails are briefly discussed. (Carried as RRIS Accession No. 047896.)

Metal Treating, Vol 24, No. 2, April 1973, pp 10-12, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Temple Publications, Inc. (out of print).

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0842

FRACTURE MECHANICS AND PLAIN STRAIN FRACTURE TOUGHNESS OF CAST STEELS

This paper presents a review of concepts dealing with fracture mechanics and the basic assumptions related to crack-like defects. Under conditions of plane strain, fracture mechanics relates the stress intensity in the vicinity of a crack or crack-like defect to the nominal stress applied on the structure and to the size of the defect that will become unstable, propagate rapidly, and thereby cause brittle fracture. Temperature, mechanical, and metallurgical variables influence the critical stress intensity or plane strain fracture toughness. The definition of the stress-intensity factor is given to explain how it relates to applied load and crack geometry. The applications of fracture mechanics are reviewed and mathematical expressions for the critical stress intensity are presented. Numerical data are provided to illustrate the use of fracture mechanics in practical cases.

Plane strain fracture toughness of cast steels was measured for Type AISI 4335 in the quenched and tempered condition in the 75 to 205 ksi yield-strength range and for Type AISI 9535 in the normalized and tempered condition at yield-strength levels of 89 and 109 ksi. A comparison between data obtained in this investigation and data taken from the literature indicated that the fracture toughness of cast steels compared favorably with the fracture toughness of wrought steels.

Wieser, P. F. (Director, Steel Founders Society of America), Groves, M. T. (TRW, Baldwin Laboratory), and Wallace, J. F. (Case Western Reserve University, Cleveland, O.), American Railway Engineering Association, Bulletin 653, Proceedings, Vol 76 June-July 1975, pp 665-686, 15 figs., 4 tables, 35 refs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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0843

RAIL WEAR AND CORRUGATION PROBLEMS RELATED TO UNIT TRAIN OPERATIONS--CAUSES AND REMEDIAL ACTION

Unit trains are often used to carry large quantities of bulk materials from resource areas to seaports or other major distribution centers. These resource areas are usually found in mountainous terrain, consequently, sharp curves are frequently encountered. In some cases, the existing railway lines were not built to handle the 100-ton heavy vehicles now in service. The combination of curved track, heavy vehicle, and large annual tonnages results in greatly accelerated rail wear in curves. This paper is a case study of rail-wear problems on Canadian National's main line through the Rocky Mountains. Three-rail wear problems occur simultaneously in curves on this line: (1) gauge face wear on the high rail, (2) rail-head flow on the low rail, and (3) corrugations having a wavelength varying from 8 to 30 in. on the low rail. The paper discusses the causes of these three types of rail wear and proposes remedial action based on the best knowledge at this time.

King, P. (Canadian National Railway), Paper No. 15 (unpublished), presented at the 12th Railroad Engineering Conference, Pueblo, Colorado, October 21-23, 1975.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: To be published.

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0844

MATCHING THE TRACK TO THE LOAD

The standard medium-manganese rail on British Railways weighs 113-1/4 lb/yd, and with 0.6 percent carbon and 1-1/4 percent manganese is a good general-purpose rail. For very heavy wear, particularly side cutting, a rolled 13 percent manganese rail is used. The magnesium rail cannot be welded to a normal rail and notch ductility is such that the rails cannot be turned. Trials in producing fracture-tough rails have shown encouraging results. It appears that the new rails will show considerable improvement in toughness without reducing the head-wear properties. Although more expensive, there is every reason to believe that this steel will be particularly suitable for switches and crossings and at insulated joints where rail life is shortest.

Paterson, A. (British Railways, Derby, England), Railway Gazette International, Vol 128, No. 2, February 1972, pp 53-56, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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0845

NEW RAIL STEELS FOR HEAD-HARDENED CROSSINGS OF WELDED CONSTRUCTION

The progress of research on the composition of low-alloy rail steels used in the fabrication of head-hardened crossings of welded construction is described. This involves the technical research project of the Japan National Railways' "Research and Development of Turnouts for High Train Speed in Narrow-Gauge Tracks" during 1968-1971. The chemical compositions of steels used in crossings of welded construction and those used for trial fabrications are given. It was concluded that the fabrication of a wear-resistant crossing of welded construction is very simple when lower bainitic steel with secondary hardening characteristics is used. (Carried as RRIS Accession No. 048002.)

Ito, A. (Japan National Railways, Tokyo, Japan), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 14, No. 1, March 1973, pp 58-59, 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0846

NUMERICAL CALCULATION AND APPROXIMATE FORMULA OF BUCKLING STRENGTH OF TRACK

In 1967 the decision was made to use 60-kg rail in the track of the Sanyo Shin Kansen line. It was believed that the corresponding temperature difference for the buckling strength of the track with this rail would not differ significantly from that of the track with 50 T rail. To confirm this, the authors conducted an investigation of the buckling strength of track and computed this for every rail in Japan including the new 60-kg rail. As a result of this investigation they developed a simple approximate formula to calculate the buckling strength of track. This paper presents the approximate formula and examples of its use. (Carried as RRIS Accession No. 041107.)

Sato, Y., and Kobayashi, S. (Track Laboratory, Railway Technical Research Institute, Tokyo, Japan), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 13, No. 1, January 1972, pp 35-39, 4 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0847

SOME WELDING PROBLEMS OF THE CONTACTLESS RAILWAY TRACK CONSTRUCTION OF THE HUNGARIAN RAILWAYS [IN POLISH]

Results of recent studies in Hungary on the technology of rail joining by welding are presented. The object of the studies was to determine: the fatigue strength of flash-welded railway joints, technological factors influencing the mechanical properties of Thermite-welded joints, and the hardness of the running face in the resistance welded rail joints and rail joints which had been heat-treated on the running face before welding.

Nakonda-Trepka, L., Przeglad Spawalnictwa, Vol 23, No. 7, July 1971, pp 182-189, 20 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner, West Germany (repr., PC).

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0848

ONE METHOD FOR ELIMINATING ECHOES FROM FALSE FLAWS IN ULTRASONIC RAIL INSPECTION

In the present practice of track maintenance, ultrasonic rail inspection for early detection of flaws is making a valuable contribution to train operation safety. In the use of the existing straight beam probe for rail inspection, it sometimes happens that, with no presence of any flaw, an "echo" or "ghost" appears when a rail with worn tread surface is inspected. This presents a problem in the evaluation of rail flaws, because it can be mistaken for an actual head and web separation or a horizontal crack in the web. The cause of such a ghost or echo has been determined and an appropriate countermeasure has been developed. The results of tests conducted to evaluate the effectiveness of this countermeasure are reported in this paper.

Serizawa, M., Nomura, F., and Wada, K. (Automation Laboratory, Railway Technical Research Institute, Japanese National Railways, Tokyo, Japan), Railway Technical Research Institute, JNR, Quarterly Reports, Vol 13, No. 1, January 1972, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0849

ON DETERMINING THE RUPTURE TOUGHNESS PARAMETER K_{Ic} IN FATIGUE TESTS

The determination of the rupture toughness parameter, K_{Ic} (associated with the work of crack generation and propagation of rail steels from the data obtained in fatigue tests based on the repeated to-and-fro bending (either of the rails as such or samples prepared from the same material) is discussed. Comparison is made with the results of tests based on ordinary tensile measurements (static loading) and on the bending of samples already containing fatigue cracks. By analyzing the results of such tests the critical size of fatigue cracks leading to brittle fracture under normal service conditions may be estimated. The values so estimated agree closely with the results of direct measurements.

Bychkova, N. Ya., Kiseleva, T. N., and Shur, E. A. (All-Union Scientific Institute of Railroad Transportation, Moscow, USSR), Problemy Prochnosti, No. 5, May 1973, pp 633-638, 6 figs., 3 tables, 5 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0850

DIRECTIONS IN TRACK STRUCTURE RESEARCH

This paper presents a survey of contemporary problems in track structure technology and the programs of research and development addressing these problems. It reports current and anticipated investigations into aspects of the service environment of railroad track structures, the mechanics of track-structure degradation, the fatigue and fracture of rails the development of rational design and maintenance techniques, the improvement of track components, and the development of nonconventional, low-maintenance track structures for application to high-speed, high-density service. Efforts involved with both the fundamentals of track mechanics and the design of improved structures for urban rapid-transit applications, as well as mainline railroad use are included.

McConnell, D. P. (Transportation Systems Center/DOT, Cambridge, Mass.), Paper No. 74-WA/APM-24, presented at the Winter Annual Meeting of the ASME, November 17-22, 1974, New York, N. Y., 9 pp, 7 figs., 1 table, 47 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: Engineering Science Library (repr., PC, microfilm).

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0851

MEASUREMENT AND ANALYSIS OF WHEEL-RAIL FORCES

This paper describes a method used to continuously measure, record, and analyze the lateral and vertical forces between wheels and rails of several types of railroad freight cars under a variety of car and track conditions. The method, using analog-to-digital conversion and computerized data handling, has produced results relating to a multitude of car and track behavior subject areas. Especially important is the definition, development, and verification of performance "signatures" which are generated in a unique and characteristic manner by each car in negotiating a given curve. The finding of such "signatures" to be completely reproducible and yet sensitive enough to change with relatively minor track or car component variations, i.e., modifications, supports the belief that these techniques can be applied beyond pure experimental scopes into routine (a) trackside inspection of cars in passing trains; (b) mechanized track inspection; and (c) truck design evaluation.

Peterson, L. A. (Bessemer & Lake Erie Railroad Co., Pittsburgh, Pa.), Freeman, W. H. (Quebec Cartier Mining Co. Railroad, Port Cartier, Quebec, Canada), and Wendrinco, J. M. (U. S. Steel Corp., Monroeville, Pa.), Paper No. 71-WA/RT-4, presented at the ASME Winter Annual Meeting, November 28-December 2, 1971, Washington, D.C., 20 pp, 22 figs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0852

THE INFLUENCE OF WHEEL-RAIL CONTACT FORCES ON THE FORMATION OF RAIL SHELLS

This paper describes an analytical and experimental investigation of the problem of rail shelling; in particular, the influence of the stresses resulting from wheel-rail contact forces is studied. These contact forces are due to the weight of the car, and the tracking of the wheel on the rail. An analytical analysis was conducted on the yielding of the rail material, the subsequent development of residual stresses, and plastic flow due to a moving load. Explanations are given for the mechanics of shelling and other associated behavior that is found in rail.

Martin, G. C. (Association of American Railroads, Chicago, Ill.), and Hay, W. W. (University of Illinois, Urbana, Ill.), Paper No. 72WA/RT-8, presented at the ASME Winter Annual Meeting, New York, N. Y., November 26-30, 1972, 13 pp, 17 figs., 19 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: Engineering Societies Library (ESL) (repr., PC, microfilm).

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0853

METHOD OF DETERMINING THE WORK ABSORBED DURING THE RUPTURE OF RAILS

A simple, practical method of estimating the work absorbed during the deformation and rupture of C and alloy steel rails is proposed. The method is based upon the pendulum method of impact testing. A close correlation exists between the amount of work absorbed, the contraction of the base of the rails, and the test temperature. Hence, a calibration curve may easily be constructed to relate these quantities, and in all subsequent tests at a specified temperature the work absorbed may be deduced from the measured degree of contraction of the base. The use of this criterion greatly simplifies standard rail testing.

Vladimirskii, T. A. and Mel'ko, Yu. M. (All-Union Scientific-Research Institute of Railway Transport, Moscow, U.S.S.R.), Industrial Laboratory, Vol 39, No. 10, October 1973, pp 1635-1637, 1 fig., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0854

DYNAMIC VARIATION OF WHEEL LOAD ATTRIBUTED TO VERTICAL DEFORMATION OF RAIL END

Vertical deformation of rail end within the allowable tolerance when supplied from the manufacturer often causes unevenness of the running surface of rail at the weld. The transient vibration caused by this local unevenness at the weld was theoretically discussed for the vehicle-track vibration system. The relationships among train speed, length of unevenness, spring coefficient of rail support, damping coefficient of rail support and dynamic variation of wheel load are discussed.

Kuiroda, S. (Track Materials Laboratory, Railway Technical Research Institute-JNR), Quarterly Reports of the Railway Technical Research Institute, Vol 14, No. 3, September 1973, pp 143-144, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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0855

TECHNOLOGY FOR HEAT TREATING RAILS IMPROVED AT THE DZERZHINSKII WORKS WITH A VIEW TO LENGTHENING THEIR LIVES IN THE TRACK

The processes involved in the quenching of rail heads throughout their entire length as performed at the Dzerzhinskii Works and the improvements that have been instituted in these processes are discussed. The improvements include: raising the temperature of the quenching water (from 15 to 20° C to 35 to 45°C), increasing the quenching time by 2 sec, raising the level of the water jets in the quenching apparatuses so that they cover the rail heads more completely; increasing the length of water jet apparatus (from 670 to 800 mm), modifying the bending machine to eliminate the bending back effect previously found at the ends of rails, dispersing the rails on the racks for cooling so that the head of one rail does not rest against the foot of another and the hardness is, therefore, not reduced in the central regions of the rails. As a result of these improvements/modifications, the properties of the quenched rails were greatly improved; the hardness and thickness of the quenched layer was increased, and there was less warp/deformation in the rails before they were cold straightened to the standard straightness for untreated rails. Chemical compositions and mechanical properties of the rails are given. A study was also conducted on the effects of the improvements on residual and tensile stresses and the data from this study are included.

Besedin, P. T., Sorokin, A. A., Filonov, I. G., et al. (Ukrainian Research Institute of Metals, Dzerzhinskii Metallurgical Combine, U.S.S.R.), Stal [in English], No. 5, May 1964, pp 386-388, 4 refs., tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0856

DEVELOPMENT OF A NEW TECHNIQUE FOR QUENCHING RAILWAY RAILS AFTER HEATING WITH HIGH-FREQUENCY CURRENT

A new technique for increasing the fatigue strength of rail heads is described. The process involves quenching rails after high-frequency induction heating of the rail head over its entire length in an elastically stressed state. The quenching practice ensures martensite-free structure across the quenched layers. In addition to the improved microstructure and hardness, this process also decreases out-of-straightness, residual stresses, and the shortening of the rail after straightening. Production runs were made of rails at a pilot plant, and from this batch, 61 rails were tested on a circular test track. Comparisons are drawn between the prototype rails and the conventional types currently used.

Kazarnovskii, D. S., Pliskanovskii, S. T., Tochilenko, V. S., Zamsa, A. N., and Bikhunov, L. Ya. (Ukraine Scientific Research Institute of Metals and Zhdanov Azovstal' Works, U.S.S.R.), Steel in the USSR, Vol 2, No. 3, March 1972, pp 256-258, 2 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0857

THE CAUSES OF CHIPPING AND TRANSVERSE CRACKS IN RAIL HEADS

This paper deals with a study of chipping and transverse cracks in rail heads which has become a problem in the Soviet Union as a result of the trend toward decreasing radii in curved sections of the track. It was observed that chipping develops at places on the rolling surface where dark longitudinal patches have formed and at places where the metal overflows on the side surfaces of the heads. Later such metal layers break off in individual places forming this chipping. A variety of possible causes for the occurrence of this defect are discussed including: metallurgical surface flaws, wheel slippage, improper rolling-mill practice, and contact stresses which result in internal fatigue cracks. Experiments were conducted which simulated service use of portions of the rail. It was concluded that contact stresses, with the resultant internal fatigue-crack formation, are the principal cause of chipping, and that further hardening of the rail heads to a sufficient depth (not less than 20 to 25 mm) will effect a solution to the problem.

Shkol'nik, L. M., Stal [in English], No. 6, June 1960, pp 442-444, 6 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0858

PROPERTIES AND SPECIAL FEATURES OF THE PRODUCTION OF TYPE R-75 HEAVY RAILS

The concern over the growth of freight traffic, increased axle loads, and higher train speeds and the resultant effects on the track systems in the Soviet Union, has forced them to enter into a program of conversion from the lighter Type R-65 rail to the heavier Type R-75 rail. Production of the R-75 rail at the Azovstal' Works began in 1956. The physical description and chemical composition of the R-75 rail is given as well as a discussion of the metallurgical processes involved in its manufacture. The mechanical properties and results of tests designed to simulate field service are also discussed.

Protasov, M. F., Shuvalov, B. I., Fradina, M. G., Chernova, A. V., and Rakhanskii, B. I. (Azovstal' Metallurgical Combine USSR), Stal [in English], No. 8, August 1963, pp 635-637, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0859

THE PHYSICAL AND MECHANICAL PROPERTIES OF BASIC CONVERTER STEEL FOR RAILS

This article describes studies of some physical and mechanical properties of basic converter steel and compares them with the properties of acid Bessemer steel produced at the Dzerzhinskii Works, and with basic open-hearth steel melted at the Kuznetsk Iron and Steel Combine. The chemical compositions and amounts of nonmetallic inclusions are given for each of the steels. The impact properties of the steels were examined in detail and the data concerning tensile strengths, yield points, elongation, and reduction in area are included. Tensile and hardness properties are presented graphically for each steel type. It is concluded that the oxygen converter rail steel is superior to acid Bessemer rail steel of the same carbon and manganese content and is not inferior to open-hearth steel with regard to mechanical properties.

Glikman, E. E., and Orgyan, V. S. (Dzerzhinskii Metallurgical Combine, USSR), Stal [in English], No. 9, September 1964, pp 737-739, 5 figs., tables, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0860

NON-METALLIC INCLUSIONS IN RAILS WITH VARIOUS METHODS OF DEOXIDATION

The effects of coarse oxide inclusions in rails are discussed along with experimental work performed with the objective of decreasing their presence. It was determined that the oxide inclusions effectively reduce the fatigue strength of rails and that they can be eliminated by deoxidizing the steel in the ladle without using aluminum. Calcium-silicon and ferro-vanadium are used instead. It was recommended that the extent to which steel is contaminated by inclusions be evaluated not only by the average rating according to specification GOST 1778-62 but also according to the length of the strings of inclusions. The data obtained in this study are presented in tables and curves. A nomogram which shows a generalized rating based on the GOST-specification for the length of an inclusion is included.

Visloguzov, G. I., Rabinovich, D. M., Orlova, N. I., Shmonin, I. A., Kampmiets, G. M., Kondrat'ev, S. N., and Loshkina, N. A. (Nizhne-Tagil' Metallurgical Combine, U.S.S.R.), Stal [in English], No. 6, June 1967, pp 490-492, 4 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0861

SERVICE LIFE OF R-65 RAILS ON THE TRACK

An assessment is made of the service life of Type R-65 rails based on the amount of operational maintenance required because of wear, or individual replacement due to various defects. The heavy rails, produced at the Kuznetsk Combine, which carry a considerable weight of traffic on the four sections of the East Siberian Railway (total length of 128 km), were inspected on the track and following removal to establish actual data for their service life. The gross tonnage carried during the average monthly inspection is given, and the vertical wear figures for the R-65 rails in one of the four straight or curved sections of track are presented. Replacements of individual rails per kilometer as a function of tonnage carried are listed. The types of rail defects are listed by group for each of the four track sections. The most common defects were chipping, horizontal cracks on rail heads, and transverse tears.

Kondakov, N. P., Akulov, V. E., and Oparina, N. A. (Novosibirsk Institute of Railway Engineering, U.S.S.R), Stal [in English], No. 1, January 1962, p 61, tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0862

OBSERVATIONS ON THE EFFECT OF HEAVY WHEEL LOADS ON RAIL LIFE

Ore traffic and other mixed traffic is discussed in relation to observations of rail wear and rail life under conditions attributed to the growing trend for using high-capacity hopper cars. Some background information is given concerning this trend on the Bessemer and Lake Erie Railroad (B&LE). By the late 1930's, the B&LE was operating a large fleet (over 6,000) of 90-ton hopper cars. Through the years these cars, first loaded to 90 tons and later to 100 tons of ore and stone traveled on some of the heaviest rail sections made. When loaded to 90 tons they produce a static wheel load of 29,800 lb and, when loaded to 100 tons, 32,300 lb on nominal 33-in. wheels. Statistical information is presented to illustrate the hard wear experienced during 12 years of such traffic. Comparisons are made between the wear values for jointed and for welded rails. Similar experiences associated with rail wear due to high-capacity ore-bearing cars on other railroads are used to compare the extent of wear and maintenance programs.

Reagan, M. (Bessemer and Lake Erie Railroad Company), Paper No. 4 (unpublished), presented at the 12th Railroad Engineering Conference, Pueblo, Colorado, October 21-23, 1975, 14 pp, 8 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: To be published.

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0863

EFFECT OF EXOTHERMIC FILLER COMPOSITION ON THE MACROSTRUCTURE OF RAILS

The absence of regulations in the Soviet railway rail standards for the control of macrostructure quality is briefly discussed in connection with its importance to rail manufacturing. As a result of this lack in macrostructure-quality control, it was found that there is a broad variation in this characteristic from plant to plant. At the Nizhne-Tagil' Combine, they have established graduated scales for rating macrostructure which provided correlations with the results observed in rail drop tests. An experimental study of five ingots which involved rolling the ingots into rails and subsequently examining their macrostructures is reported. The data from this study are presented and an analysis is provided which relates to the use of exothermic fillers.

Freidenzon, E. Z., Kompaniets, G. M., Rabinovich, D. M., Zatulovskaya, E. Z., and Shchetkina, N. A. (Nizhne-Tagil' Metallurgical Combine, U.S.S.R.), Stal [in English], No. 9, September 1965, pp 705-706, 2 figs., tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society

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0864

IMPROVING RAIL PASS DESIGN

The new Soviet standards that cover the dimensions of their R-50 and R-65 rails (GOST 7174-65 and 8161-63), and which differ from the old ones by restrictions in the tolerance ranges, are discussed. The new specifications call for changes in the base tolerance by 42.7 and 16.7%, respectively. The best pass design for complying with the new standards when rolling R-50 and R-65 rails is that with ten-passes and six rail passes. With five rail passes, the introduction of the last asymmetrical ten-pass makes it possible to form the base in the first rail pass (split pass). The processes of rail rolling at the Nizhnii-Tagil' Metallurgical Combine (NTMK) used to conform with the new requirements are described. Illustrations are provided showing the stands, changes in dimensions before and after the correction, the pass profiles, and the finished products.

German, I. M., and Feigin, G. D. (Nizhnii Tagil Metallurgical Combine, U.S.S.R.), Stal [in English], No. 2, 1969, pp 184-187, 4 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0865

STRENGTH, LIFE AND RELIABILITY OF METAL FOR RAIL TRANSPORT

On the basis of many years of research at UKRNIIM (the Ukraine Research Institute for Metals), carried out in collaboration with a number of steelworks and other institutes, decisions have been made regarding the principal ways of improving the strength (static and fatigue) and life of rails. Under production conditions, high-quality rails have been produced, but owing to the continuous increase in freight-traffic density, increase in axle loads, etc., their quality has not been sufficiently improved. The new requirements regarding products for rail transport can be satisfied by improving the technology for the production and use of new grades of steel. There is a correlation between static and fatigue strengths. The best possible combination of mechanical properties for the metal after strengthening treatment, so that life and service reliability are as good as possible, has been established. In the case of high-tensile-strength rails, an important index for calculating fatigue strengths from the results of static tensile tests is the ductility (the reduction in area).

Kazarnovskii, D. S. [Ukraine Research Institute for Metals [UKRNIIM], U.S.S.R.], Stal [in English], No. 8, 1968, pp 682-685, 3 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0866

SWITCH DESIGNS WITH UIC 60 RAILS IN THE GERMAN FEDERAL RAILWAY [IN GERMAN]

A series of new switch designs using UIC 60 rails are being developed to meet the requirements of high speed and high loading. Described here are the more important of the changes, such as the altered switch geometry, longer tongue rails, new check rails with rigid crossings, and crossings with movable tips without check rails. (Carried as RRIS Accession No. 05759.)

Morgenschweis, O. (Bundesbahn-Zentralamt, Munich, West Germany), Eisenbahntechnische Rundschau, Vol 23, No. 3, March 1974, pp 97-104, 9 figs., 1 ref.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Hestra-Verlag Hernichel und Dr. Strauss (repr., PC).

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0867

ADJUSTABLE COOLING OF RAILS IN THE LOWER-TAGIL IRON AND STEEL COMBINE [IN CZECHOSLOVAKIA]

To avoid flaking on rails after rolling and during cooling, a furnace was installed to control cooling with isothermal soaking. Batches of 12.5 or 25-m-long rails are placed in the furnace every 9 min. Each batch is held 2 hr at 600 C to entirely eliminate from the metal the hydrogen which causes flaking. The hearth is 13 by 26.7 m and the furnace is fired with coke-oven 1500-kcal/m^3 gas. Gas consumption is 3000-4000 m^3/hr.

Vinokurov, I. J., Hutnicke Listy, Vol 20, No. 5, 1965, pp 360-361, 2 figs., 2 tables.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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0868

PRODUCTION OF RAILS IN CONTINUOUS MILLS [IN RUSSIAN]

A method is described which is based on the use of a mill consisting of two continuous lines, one of which is interded for the base, the second for rolling the top part with the neck. The rail elements are welded where the neck joins the base under a flux layer, forming a high-strength seam in continuous automatic units. The method proposed for the production of rails has many advantages, compared with existing methods. Rail rolling is carried out by the elements in a continuous high-duty section mill, which considerably reduces the cost of the finished product. The simplicity of passes and their arrangement on the rolls eliminate the causes of increased roll wear as the need for supporting cones and deep flanged passes no longer arises. It appears possible to produce rails with a hard head and ductile base. Rail rolling according to elements reduces the irregularity of metal deformation and improves product quality.

Pavlov, V. L., and Pobegailo, G. C., N-T Inst. Chern. Met. Gos. Kom. po Chern. Tsvet. Met. Pri Gosplan SSSR, Vol 21, 1965, pp 337-341, 2 figs., 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0869

THE EFFECT OF CHROMIUM ON THE MECHANICAL PROPERTIES OF A RAILWAY STEEL [IN RUSSIAN]

The effect of additions of 0.30 to 1.87% Cr on the properties of a steel containing 0.37 C, 0.66 Mn, 0.33 Si, 0.024 S, and 0.027% P in the normalized and thermally strengthened conditions was studied. The upper limit of Cr was determined, an increase in the Cr content being advantageous only up to ~0.7%. Increase in Cr content above this value causes an anomalous reduction in wear resistance and then a general reduction in ductility.

Uzlov, I. G., and Miroshnichenko, N. G., Sbornik Trudy Inst. Chern. Metallurg. Ministerstva Chern. Metallurg. S.S.S.R., No. 30, 1969, pp 128-131, 4 figs., 1 table.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0870

THE EFFECT OF ADDITIONS OF RARE EARTH ELEMENTS ON THE MECHANICAL PROPERTIES AND PHASE COMPOSITION OF A RAIL STEEL AFTER TEMPERING [IN RUSSIAN]

A study was made of the effect of rare-earth metal additions to rail steel on its mechanical properties. Misch-metal (Ce ~50%) was added during pouring in the intermediate steel smelting ladle to give a steel containing C 0.6, Mn 0.87, Si 0.27, S 0.03 to 0.016, P 0.055, N 0.017, and Ce 0.014 to 0.023%. Specimens were oil-quenched from 810-830°C, tempered at 200-650°C, and water-quenched. With small additions of rare-earth metals, no significant difference was found in the nature and value of mechanical properties compared with those of normal rail steels. However, with higher additions of these elements, the range of marked weakening was shifted somewhat toward low temperature.

Syasev, Yu. A., Orgiyan, V. S., and Makarova, I. A., Met. i Gornoryda. Prom. Nauchno-Tekhn. i Proizv. Sb., No. 4, 1968, pp 36-38, 3 figs., 1 table.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kaukin Bookstore (repr., PC).

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0871

HEAVY-RAIL ROLLING SCHEDULES

The heavy-rail rolling schedules for the R-50, R-65, and R-75 rails at the Azovstal' Works are discussed from the standpoint that they are being improved on a continuous basis. The main concern is that in the course of rolling heavy rails, the loads on the structural mill main motors are close to their tolerable limits. The structural mill output has been substantially raised, but the power parameters have grown at the same time, and there arises the risk of overloading the motors and the main components of the rolling mill working trains. In view of this trend, studies were conducted whereby the pressure on the rolls was determined through the use of strain gauges, and torques were measured for each roller shaft. The rolling of R-65 rails is described by listing the reduction schedule. Schematic drawings are provided to show the general configuration of the rolling stands. Drawings are also included that show the groove wear characteristics when R-50 rails are rolled in the 800 train stands.

Gorenshtein, M. M., and Tsilevich, I. Z. (Zhdanov Iron and Steel Institute and the Azovstal' Works, U.S.S.R.), Stal [in English], No. 7, July 1972, pp 535-538, 5 figs., tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0872

PRODUCTION OF LOW-ALLOY CONVERTER RAIL STEEL

A technology is described for the production of increased- and high-strength rails produced from low-alloy converter steel, which was developed by the combined efforts of the Ukrainian Institute of Metals and the Dzerzhinskii Iron and Steel Works. This research was prompted by the severe service conditions under which failures occurred when the heavy types of carbon-steel rails (R-50, R-65, and R-75) were used. These rails became defective or unserviceable because of breakdowns of the head under contact forces, particularly on curves with radii of 1000 meters or less when the traffic is heavy. The rail-steel-manufacturing processes are described in detail. The properties of the experimental rails steels are given, along with an analysis of the composition of nonmetallic inclusions.

Gershgorn, M. A., Kazarnovskii, D. S., Filonov, I. G., Kutsenko, A. D., and Ul'yanov, D. P. (Ukrainian Institute of Metals and the Dzerzhinskii Iron and Steel Works, U.S.S.R.), Stal [in English], No. 5, May 1961, pp 324-328, 5 figs., tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0873

WORKING OF THE SPECIAL RAILWAY TRACKS OF IRON- AND STEELWORKS UNDER HEAVY LOADS

The conditions of service of the railway track along which pig-iron trucks, slag trucks, and ingot-carrying wagons travel are discussed. On tracks carrying hot metal, the rails frequently last only 3 to 4 years, wooden sleepers 2 to 3 years, and point tongues only 3 to 4 months. The rails are not only worn down, but are rapidly flattened, and the rail heads are split. Stresses in R-43 and R-50 rails are given as being between 18 and 33 kg/mm^2. Data are plotted to show the dependency of the greatest initial stresses in the rail base and head on the radii of curves. Recommendations are given as to the rail weights needed to reduce the stress caused by pig-iron trucks. Rail ballast and supports that will withstand the foundation pressures are suggested. Wooden and reinforced-concrete sleepers are compared.

Frishman, M. A., Belykh, K. D., Voloshko, Yu. D., and Levankov, I. S. (Dnepropetrovsk Institute of Railway Engineers, U.S.S.R.), Stal [in English], No. 4, April 1964, pp 327-328, 1 fig., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0874

THE THROUGH HARDENING OF RAILS ON THE EXPERIMENTAL INDUSTRIAL INSTALLATION

The Soviet heavy rail (R-75) is discussed in relation to the problems that occur when rails of this material are used in tracks subjected to modern conditions of increasing contact loads. Mention is made that the R-75 rail without heat treatment does not provide the rail life desired and that to increase the service life, the ultimate tensile strength must be raised to between 100 and 120 kg/mm^2, along with an increase in yield point to over 80 kg/mm^2. The mechanical properties of experimental rails made of carbon and alloyed steels are given. The hardening of rails is described and comparisons are made between rail-head wear for those that were through hardened and others that were not treated. Illustrations are provided which show the fluctuations of hardness according to Brinell indentations. Data are discussed which cover the principal mechanical properties and the results of metallurgical tests.

Makaev, S. V., Gubert, S. V. and Rabinovich, D. M. (Nizhne-Tagil' Metallurgical Combine, U.S.S.R.), Stal [in English], No. 2, February 1961, pp 126-129, 5 figs., tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0875

EFFECT OF STEEL DEOXIDIZING METHODS ON SERVICE OF RAILROAD RAILS [IN RUSSIAN]

To find an efficient method of deoxidizing rail steel, test rails were rolled from a total of 27 test heats. For all variants, a notable decrease in amount of nonmetallic inclusions was observed in the finished rails compared to rails from 27 heats of furnace deoxidized steel. The lowest amount of alumina in the rails was found in cases where Al was not added or where silicocalcium was substituted for Al. Metallographic analysis showed that metal deoxidized by the first and second variants contained sulfides, silicates and sulfosilicates, whereas in ordinary melts and those with Al additive (the third variant) sulfides, oxides and sulfosilicates were present. Less contamination appeared in metal deoxidized with silicocalcium. The chemical composition and mechanical properties (tensile strength, yield strength, elongation, reduction in area, and impact strength at 20 and -40°C) are shown for rails produced with various deoxidizing methods. Fatigue testing of finished rails showed highest fatigue strength and service life for those rails made from metals deoxidized by silicocalcium--lowest, deoxidized by Al in pipes.

Shirokov, N. I., and Kotov, A. V., Izv. VUZ Chernaya Met., No. 2, February 1966, pp 48-50, 2 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0876

USING THE ROLLED-ON GRID METHOD FOR STUDYING CRACK GROWTH IN WORK-HARDENED METAL

The effect of preliminary compression deformation on mechanical characteristics determined during bending was studied in a series of tests on rail steels. Combining compression with bending was based on the consideration that, in actual use conditions, the pressure of the wheels produces deformation in the top layers of the metal of the rail head, and rail fracture occurs as a result of the effect of bending loads. The heterogeneity of distribution of plastic deformation on the side surface of the specimen and the boundary of the work-hardened and nonwork-hardened space were determined using the rolled grid method. An evaluation of changes in crack resistance of metal, work-hardened by compression, and on the work-hardened boundary, was made by tests of prismatic notched specimens for concentrated bending. The specimens were prepared by applying a grid and a control line. A bending diagram was recorded during testing and load was registered when cracks appeared. Crack resistance was evaluated according to the amount of stress required to produce cracks. Results showed that preliminary plastic deformation by compression leads to lower cracking resistance in high-carbon steels.

Mavrotskii, I. V., and Makukhin, (Ukrainian Scientific Research Institute of Metals), Zavodskaya Laboratoriya (Industrial Laboratory), Vol 32, No. 4, April 1966, pp 579-581, 3 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0877

ASSESSMENT OF DESIGN TOOLS AND CRITERIA FOR URBAN RAIL TRACK STRUCTURES, VOLUME I. AT-GRADE TIE-BALLAST TRACK

The development of techniques and criteria for track design is an important part of the Rail Supporting Technology Program that is being managed for the Urban Mass Transportation Administration by the Transportation Systems Center (TSC). This report presents the results of a critical review of the technical factors which govern the design and performance of at-grade tie-ballast track for urban rail systems. The assessment of current design practice is based on a review of the literature and discussions with experienced track design personnel. The evaluation includes design loads and the criteria for selecting rail size, tie size and spacing, ballast depth, and subgrade parameters. The major track problems identified were rail joints, rail wear and noise on curves, rail fasteners, and rail corrugation. Detailed technical evaluations were made to determine those areas where the track design procedures are inadequate. The report includes detailed information for the engineering design of track and recommendations for both short- and long-range program plans for future research pertaining to the improvement of track performance. Volume II of this two volume report, entitled "At-Grade Slab Track", gives similar results for at-grade concrete slab track construction.

Prause, R. H., Meacham, H. C., et al. (Battelle-Columbus Laboratories, Columbus, Ohio), Report No. UMTA-MA-06-0025-74-3, April 1974, for DOT/UMTA/ORD, Contract No. DOT-TSC-563, 233 pp, 63 figs., 20 tables, 5 appendixes, 179 refs., indexed.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 233 016.

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0878

TRIBOLOGY OF WHEEL ON RAIL

The functioning of wheels and rails as a supporting and guiding system depends on a Hertzian contact of 1.2×10^{-4} m^2 (0.2 $in.^2$) area. In addition to its supporting function, this area must withstand tangential forces to enable the functions of traction, braking, and guidance to be fulfilled. Such traction forces are accompanied by a deflection known as "creep" and classical estimates of this quantity are compared with measurements made on the track. Modes of wear of wheel and rail are described and alternative systems which avoid contact are discussed.

Barwell, F. T. (University College of Swansea, Glamorgan, Wales), Tribology International, Vol 7, No. 4, August 1974, pp 146-150, 5 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: IPC Science and Technology Press (repr., PC).

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0879

DYNAMIC LONGITUDINAL FORCES AND THE DISLOCATION OF RAILS OF A RAILROAD TRACK--RAIL CREEP [IN RUSSIAN]

This textbook contains five chapters which deal with the subject of the problem and contemporary state of rail creep and the analysis, hypothesis, and theories associated with it. Equations are given which describe the processes of elastic and residual dynamic shifts of the rails and longitudinal dynamic forces occurring in the rails during the action of vertical loads on the rails. Methods of solving problems for determining the amount of rail creep are discussed. Calculation of rail creep is included, along with an analysis of the effect of different factors that contribute to the extent of creep. An approximate solution to the problem of creep associated with continuous welded track is given.

Men'shikova, V. I. (Scientific Research Institute of Railroad Transport, USSR), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta (Moscow), No. 466, 1972, pp 83-189, 52 figs., 53 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0880

SERVICE FAILURES AND THEIR IMPLICATIONS FOR BRITISH RAILWAYS

A variety of service failures experienced by British Railways are described and measures for their avoidance and early detection are discussed. Failures of rails, wheels, tires, bogies and other components, and of ancillary equipment are included. Emphasis is placed on good design as a means of preventing the occurrence of stress concentrations which may result in premature service failures. Illustrative examples are presented.

Waldron, G.W.J., and Wise, S. (British Railway Board, Derby, England), Metallurgist and Materials Technologist, Vol 5, No. 1, January 1973, pp 15-21, 13 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Naylor the Printer, Ltd. (repr., PC).

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0881

STRAIGHTENING OF RAILS AND ITS INFLUENCE ON THE GEOMETRY OF THE SECTION

Investigations showed that the straightening of rolls in both planes of rigidity in one pass causes considerable changes in the principal dimensions of the section. Complete compensation for these changes is not achieved by corrective pass design. In producing three-dimensionally hardened rails, maintenance of the tolerances provided for in the crude rails leads to a rise in roll consumption, and to increased mill standstill periods owing to roll changes, and it also complicates their adjustment.

Gurfinkel, O. L., Peganov, S. A., German, I. M., and Feigin, G. D. [Nizhnii Tagil Metallurgical Combine (NTMK), USSR], Stal [in English], No. 10, October 1970, pp 801-803, 3 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0882

POSSIBILITIES IN THE DEVELOPMENT OF RAILS FOR A HEAVY DUTY RAPID TRANSIT SYSTEM [IN GERMAN]

A heavy-duty rapid transit system imposes additional requirements on rails. The possibilities of developing air-hardened rail steels are discussed from the materials point of view. The results obtained from tests conducted with company-manufactured rails of pearlitic steels, transformed steels, and low-carbon steels are disclosed.

Heller, W. (Friedrich Krupp Huttenwerke AG, Bochum, West Germany), Technische Mitteilungen Krupp, Werksberichte, Vol 33, No. 2, May 1975, pp 73-77, 6 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0883

INTERNAL STRESSES IN ROLLED BAR WITH SPECIAL REFERENCE TO RAILS [IN GERMAN]

A general discussion of the causes of stresses in rolled bars is presented. In rails, such stresses may be unduly high and may be due to uneven distribution of the material mass. Residual stresses are brought about by uneven shrinkage of the component parts of the rail due to irregular cooling, and they are, in general, greater than those due to the mechanical action of rolling. The stresses are greatest in the cases of rails rolled from material which is not uniformly hot throughout at the beginning of rolling, particularly if the ingot is not completely solidified in the center. The irregular distribution of the sulfur in the rail is characteristic of rails rolled from ingots still liquid internally. This is immediately shown by application of the Baumann test for sulfur to the polished surface of a steel rail.

Bardenheur, P. (Dusseldorf, West Germany), Stahl und Eisen, Vol 45, July 9, 1925, pp 1098-1101, 4 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0884

NON-METALLIC INCLUSIONS IN RAIL STEEL

Maximum contamination by nonmetallic macroinclusions is observed in the portion of the rail ingot beneath the feeder head. These inclusions are complex silicates, alumina, and alumino-silicates and are the products of deoxidation of the steel. Inclusions in the rails corresponding to the bottom of the ingot consist of oxides of iron and particles of refractories.

Tarasova, L. P., Kalashnikov, A. G., Dolinenko, O. V., Nazarenko, E. T., Bul'skii, M. T., and Sviridenko, F. F. (Ukrainian Scientific Research Institute for Metals, Azovstal' Works, and the Kuznetsk Combine, USSR), Stal [in English], No. 8, August 1963, pp 642-643, 3 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0885

EFFECT OF THE MODE OF THERMAL HARDENING ON THE SERVICE LIFE OF RAILS

The service life of C-steel railway rails was studied in relation to the method of heat treatment employed to harden them. The life of the rails was longest in those cases in which the heat treatment created compressive residual surface stresses in the heads of the rails and the microstructure was extremely fine. Tabulated information is presented showing the heats, chemical composition, hardening conditions of the rails, and residual stresses in the head, web, and base of 22 specimens. Fatigue curves are given for thermally hardened rails and the rate of fatigue-crack development in relation to loading.

Vekser, N. A., and Kazarnovskii, D. S. (Ukrainian Scientific-Research Institute of Metals, Khar'kov, U.S.S.R), Problemy Prochnosti (Translation by Scientific Consultants Ltd., London), No. 12, December 1972, pp 1532-1534, 3 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0886

DEVELOPMENT OF ROLLING PRODUCTION TECHNOLOGY AND THE CONSTRUCTION OF ROLLING MILL PLANTS

The development of rolling techniques in the Soviet Union is reviewed and typical examples of the restoration and reconstruction of rolling mill plants and of the planning and erection of new plants and equipment are described with the types of products produced: semi-finished products, heavy rails and beams, rolled sections, rod and strip, plate, sheet, tires and wheels. The rolling mill practice for rails is discussed as it applies to three rail plants. The heat-treatment plant of the Nizhne-Tagil Combine is emphasized as the most modern and largest facility in the world, and the complete layout of all its stages of rail heat treatment is given. The section-rolling plant of the Krivoi Rog Works, which consists of blooming and billet mills, and section, wire rod, and strip mills, is illustrated by schematic layout drawings.

Istomin, A. V., Stal [in English], No. 10, October 1967, pp 850-857, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0887

CONSIDERATIONS FOR ESTABLISHING ULTRASONIC TEST ACCEPTANCE STANDARDS

The principles associated with failure of materials and types of defects are reviewed to establish a basis for physical acceptance criteria. The various types of inclusions, cracks, and elastic properties of metal structures are discussed in terms of their effect on stress concentrations. The radiographic technique is explained and data are presented which show the minimum detectable half-crack depths for tight and wide cracks. The characteristics of ultrasonic testing and the practical considerations associated with it are reviewed. Three separate means for determining acceptance limits for ultrasonic testing are given, two from failure considerations and one from current radiographic practice. Ultrasonic testing acceptance standards used in the U.S. and Germany are compared.

Sinclair, N. (General Dynamics Corporation, Groton, Conn.), Materials Evaluation, Vol 25, No. 5, May 1967, pp 118-125, 8 figs., 2 tables, 10 refs.

ACKNOWLEDGMENT: American Society for Nondestructive Testing.

PURCHASE FROM: American Society for Nondestructive Testing (repr., PC).

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0888

HOW IC (ILLINOIS CENTRAL) INCREASES THE LIFE OF CURVE RAILS

Early experimental research conducted at the AAR Research Center dealing with intermediate manganese steel rails is reviewed. These rails were manufactured in accordance with modern steelmaking practices, followed by controlled cooling, and then laid in track on the Missouri Pacific Railroad. Inspections subsequently made indicated that the rails showed promise for resisting severe abrasive wear on curves. In view of this, IC ordered two heats of the rail and the rail was laid in 1967. After 3 years of service on a track near Cairo, Illinois, an assessment of the wear was made and it was found that the rail with high manganese content had already outlasted the conventional rail. It was concluded that by adding to the manganese content of the rail steel, a life expectancy four times greater than that of conventional rail on curves can be expected. (Carried as RRIS Accession No. 046917.)

Railway Track and Structures, Vol 66, No. 9, September 1970, p 23, 1 fig.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Simmons-Boardman Publishing Corporation (repr., PC).

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0889

OBLIQUE INCIDENCE OBSERVATIONS AS AN AID TO THREE-DIMENSIONAL STRESS SEPARATION

In the most general case the determination of the separate stresses along a selected line in a three-dimensional photoelastic model requires the evaluation of the shear slopes in two mutually perpendicular planes which intersect in the chosen line. The measurement of one normal and two oblique observations at a series of corresponding points in a set of parallel slices provides an alternative method for determining the shear slopes and yields a complete analysis of the stress distribution without further optical measurements. An example of the use of the method is given by analysing the stresses in a model of a loaded rail supported upon a deep welded plate girder.

Allison, I. M. (Dept. of Civil and Municipal Engineering, University College, London, England), Journal of Strain Analysis, Vol 1, No. 4, July 1966, pp 322-330, 9 figs., 1 table, 2 appendixes, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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0890

ANALYSIS OF DESTRUCTIVE MATERIALS TESTING BY MEANS OF NONDESTRUCTIVE ELECTROMAGNETIC METHODS---PURSUING THE CRACK PROPAGATION DURING THE FATIGUE TEST [IN GERMAN]

This report deals with the sensitive detection of fatigue cracks of small depth. The quantitative pursuing of the propagation of a defect as to position and depth gives a C-scanning in form of crack-depth diagrams. These diagrams as well as the records of crack depth of rotating bar specimens will be obtained during the rotation of the specimen. Therefore, the distribution of crack depths on the circumference of the specimen can be recorded continuously and quantitatively from the initial crack up to just before rupture without any contact with the specimen.

A device is described for detecting and pursuing fatigue cracks in flat axially loaded specimens with notch. By means of a rotating eddy-current probe, which is introduced in the bore hole of the specimen, the inner surface of the hole can be represented by horizontal lines on the screen. Cracks in the bore hole appear as vertical peaks proportional to the crack depth. Cracks with a depth of 5 μm are well detectable. By means of a peak writer, the maximum crack depth at the circumference is recorded versus the length of the hole.

Forster, F. (IFR, Reutlingen, West Germany), Materialprufung, Vol 12, No. 5, May 1970, pp 149-156, 10 figs., 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0891

SOME FUNDAMENTAL ASPECTS FOR PLANNING AND EVALUATING FATIGUE TESTS [IN GERMAN]

For the sake of a better informative value of fatigue tests, certain important factors of influence have to be considered during test planning. To obtain maximum information from the experiments, the planning should be based on technical statistics. Some of such test schemes are discussed. On the basis of the most frequently used scheme, the author gives a report on the research work carried out to find a technically appropriate model law for estimating the minimum fatigue life or the fatigue limit of steel.

Dengel, D. (Institut I fur Werkstofftechnik der TU Berlin, West Germany), Materialprufung, Vol 13, No. 5, May 1971, pp 145-151, 3 figs., 4 tables, 34 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag (repr., PC).

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0892

AN EXAMINATION OF THE LOCATI ESTIMATION OF THE FATIGUE LIMIT

The sensitivity of the Locati fatigue limit to variation in the test parameters--stress and cycle increments and initial stress--was tested statistically. Factorial experiments performed on both carbon-steel plate material and high-strength steel wire showed that the Locati fatigue limits differed significantly from those estimated by the "staircase" method. The magnitude of cycle increment and initial stress significantly affected the predicted fatigue limits of both materials. In addition, the predicted fatigue limit of the carbon steel was significantly affected by the magnitude of the stress increment.

Reemsnyder, H. S. (Bethlehem Steel Corporation, Bethlehem, Pa.), Materialprufung, Vol 11, No. 4, April 1969, pp 109-114, 6 figs., 4 tables, 1 appendix, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0893

ADDITION OF RARE-EARTH METALS FOR IMPROVING THE PROPERTIES OF ALUMINO-THERMIC WELDED RAILS [IN GERMAN]

The rare-earth metals added, the level of additions, and their influences during the steelmaking process on the quality of the steels and of steel castings are considered. The effect of additions of Ce-mischmetal, Ce, La, or Pr oxides, and Ce, La, Pr or Nd fluorides on the P- and S- level in the thermit-weld metal and on the static bend strength, flexibility, hardness, and impact strength is described. Best results were obtained with the addition of Ce-mischmetal, Pr, or Nd fluoride.

Novak, W. (Magdeburg, West Germany), Schweisstechnik (Berlin), Vol 22, No. 4, April 1972, pp 168-169, 3 figs., 1 table, 11 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Schweisstechnik (Berlin) (repr., PC).

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0894

EFFECT OF PLASTIC ZONE ON THE CRACK PROPAGATION UNDER CYCLIC LOADS [IN GERMAN]

In this paper, the results of crack-propagation measurements on plates under cyclic loads are evaluated and discussed. It has been found that cracks originating from pulsating stresses can be closed at the crack tip up to 50% of the stress maximum. This phenomenon has been disclosed by measurements of the crack-opening displacement and can be interpreted by the effect of the plastic zone before and behind the crack tip. Additional results on the behavior of a crack during and after a change of load amplitude are discussed.

Elber, W. (NASA, Langley Field, Virginia), Materialprufung, Vol 12, No. 6, June 1970, pp 189-193, 6 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0895

AN APPROXIMATE DETERMINATION OF THE WOHLER RANGE

The structure of the Wohler range can be analytically described in an adequate approximation by two simple expressions, a function of service life and a distribution function. These two functions assign to any oscillating load the corresponding probability of failure, or they determine the maximum permissible load amplitude if after a given number of cycles a specified quota of ruptures should not be exceeded. Thus the safety range to be observed is statistically established and no longer left to the subjective judgment of the designer.

Using a logarithmic scale for the fatigue-strength ordinate and a goniometric one for the service-life abscissa, a linear representation of the Wohler curve is obtained, the linearity being retained also for the extreme parts of the diagram (number of cycles = zero and ∞, respectively).

To describe the Wohler range, four characteristic values are sufficient. These are determined from the available measuring points independently of the analyzer's individual judgment. The proposed manner of evaluating fatigue tests is intended to make an approach to a more economical assessment of endurance.

Muller, R. (Volkswagenwerk, Wolfsburg, West Germany), Materialprufung, Vol 7, No. 1, January 1965, pp 6-11, 6 figs., 1 table, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0896

REMARKS ON THE EVALUATION OF THE FATIGUE STRENGTH OF STEEL AND SOME INVESTIGATIONS FOR THE DETERMINATION OF THE RANGE OF INFINITE LIFE [IN GERMAN]

It is proposed that the conventional splitting of the fatigue range into the ranges of finite and infinite life be changed to a system split into finite-, transition-, and infinite-life range. Theoretical and practical differences by calculating the probability of either survival or fracture are pointed up, and standardization is demanded. The difference between model functions and autocatalytical functions for the correlation of probability of break to load amplitude or to number of cycles to failure is mentioned. It is recommended that the probabilities 0 and 100% not be calculated, but only the 1 or 10 and 90 or 99% probabilities.

Some functions for estimating the probability of fracture are investigated for the practical application of the Gaussian cumulative frequency distribution as a model function in the range of infinite life. It was found to be sufficient to use only two well-chosen steps of load amplitude for the evaluation of the range of infinite life, if the Gaussian cumulative frequency paper is used. This leads to the successful testing of a new limiting process which enables the satisfying evaluation of the range of infinite life with 20 to 23 specimens, pretests included.

Haenniq, W. W. (Bundesanstalt fur Materialprufung, Berlin-Dahlem, West Germany), Materialprufung, Vol 12, No. 3, April 1970, pp 124-131, 7 figs., 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0897

APPLICATION OF FRACTURE MECHANICS AND INSTRUMENTED NOTCHED-BAR IMPACT TESTS FOR THE DETERMINATION OF BRITTLE BEHAVIOR OF STEELS [IN GERMAN]

The effect of temperature on the stress-intensity factor and the crack-opening displacement as well as the transition from plane-strain to plane-stress situation (transition temperature T_{Ic}) are investigated with respect to the influence of anisotropy on the results of C.O.D. tests and transition temperatures T_N and T_S, obtained in the instrumented notched-bar impact test. Also, different tempering temperatures affect the course of the K-temperature curve and the T_N and T_S values of a high-strength, water-quenched steel. The importance of plane-strain fracture toughness K_{Ic} and transition temperature T_{Ic} on the determination of brittle-fracture behavior of steels is discussed.

Schmidtmann, E., and Mall, H. P. (Institut fur Eisenhuttenwesen der TH Aachen and Mitarbeiter desselben Instituts, West Germany), Materialprufung, Vol 12, No. 7, July 1970, pp 221-228, 11 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0898

METALLOGRAPHIC STUDY OF NONMETALLIC INCLUSIONS IN EXPERIMENTAL RAILS

The results of studies conducted with several experimental samples of rail steel produced by using different methods of deoxidation and smelting are described. The authors also studied rails rolled from the steel obtained by the method of continuous casting which is known to provide nonmetallic inclusions that are nonoriented in the volume of the metal. The results of these studies were compared with similar data for standard rails and the characteristics of the investigated rails are presented in tabular form. The investigation was prompted by several other studies which showed a connection between the contact fatigue of rail heads and the presence of local accumulations of inclusions in the form of small chains of alumina and silicates which are considered to be stress concentrators. It was concluded that the proposed method for establishing a criterion for contamination, based on determining the density of line inclusions as the total length of all lines related to the area under investigation, made it possible to find the optimum variant for deoxidation and smelting. The least quantity of line oxide inclusions was obtained with deoxidation of open-hearth steel by calcium silicon and ferrovanadium.

Devyatkin, V. P., and Kleshcheva, I. I. (All-Union Scientific-Research Institute of Railway Transport, U.S.S.R.), Zavodskaya Laboratoriya [Industrial Laboratory], Vol 37, No. 4, April 1971, pp 570-572, 1 fig., 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0899

TEST METHODS IN FRACTURE MECHANICS [IN GERMAN]

There are two main stages in a fracture-mechanics experiment. The first is concerned with the fatigue growth of a flaw from a notch in the specimen, while the second stage is concerned with the static pull test of the fatigue-cracked specimen. The fatigue precycling is a necessary preliminary to the pull test. As such, it is best carried out as quickly as permissible, to permit the operator to perform the pull test. The static pull test, however, needs only modest levels of test speed, but does require unusually large ranges of load and stroke. These are, of course, conflicting requirements which eliminate many of the traditional types of fatigue machines and static test machines. The electrohydraulic test system, working in "closed loop" control, can satisfy both of these requirements. The different elements (basic loop, programmation, readout, fail-safe) which go to make up a typical fracture mechanics test system are discussed.

Swanson, S. R. (MTS Systems Corporation, Minneapolis, Minn.), Materialprufung, Vol 12, No. 7, July 1970, pp 229-235, 6 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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0900

RELATIONSHIP BETWEEN THE ENERGY OF BRITTLE FRACTURE AND THE RESISTANCE TO CYCLIC LOADING IN THE DAMAGED CONDITION

Fully shaped rails made of steel containing from 0.56-0.76% carbon, condensate-quenched after high-frequency heating with subsequent self-tempering, were impact and fatigue tested to determine the relationship between the size of the fatigue spot before brittle fracture during cyclic testing and the course of brittle fracture at -60 C. Fatigue strength was evaluated by the conditional wear limit and by the size of the fatigue spot before fracture. Results indicate that rail fracture during dynamic testing decreases with increased carbon content. Size of fatigue spot and the fatigue limit of the rail are similarly related to carbon content. It was determined that the optimum amount of carbon in rail steel, subjected to water quenching after high-frequency heating, should be 0.60-0.65%.

Velikanov, A. V. (All-Scientific Research Institute of Railroad Transport, U.S.S.R.), Zavodskaya Laboratoriya (Industrial Laboratory), Vol 31, No. 7, July 1965, pp 1079-1081, 2 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Consultants Bureau (repr., PC).

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0901

SOURCES OF END DEFORMATIONS IN VOLUMETRIC HARDENED RAILS AND THE STUDY OF POSSIBILITY OF STRAIGHTENING THEM [IN RUSSIAN]

The effect of heat treatment on the size of rail end deformation was determined according to profilograms obtained through use of a longitudinal-butt profilograph. The feasibility of straightening the rails at their ends in the area of bolt holes was studied by investigating two possible methods which employ existing equipment. Schematic illustrations of the methods are presented. The numerical data given show the change in residual deflection as a function of sag and face shift during various modes of straightening. From the results of the investigation, it was concluded that the major source of rail end deformation is the heat treatment. The solution submitted was that the rails should have deformations prior to heat treatment which are opposite to those caused by the heat treatment.

Mikhalev, M. S., Fedorov, M. I., and Rabinovich, D. M. (All-Union Scientific Research Institute of Railroad Engineering Transport, U.S.S.R.), Trudy Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 434, 1971, pp 205-212, 2 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0902

PRODUCTION OF HEAVY TYPES OF RAILROAD RAILS FROM CONTINUOUSLY CAST BILLETS OF OXYGEN CONVERTER STEEL [IN RUSSIAN]

The process for producing K-76 rail steel which has a composition similar to M-75 (GOST 8160-63) martensite steel is described. The rail steel was smelted in a 10-ton oxygen converter at the Novo-Tula metallurgical plant. Production and heat-treatment details are given, and tests performed on rails from the steel are described. Tabulated data show a comparison between the plasticities of the transverse and longitudinal samples, thus confirming the presence of anisotropy. Tests were made, on R-75 and R-65 rails, and the results are presented. The conclusions were that the rails made from continuous cast billets of oxygen converter steel are almost as good in quality as rails produced at the Azovstal' plant in regards to mechanical properties. However, the former rails are better because they are free of stitch-type nonmetallic inclusions.

Polyakov, V. V., Chernyakov, V. I., Fradina, M. G., Kretova, G. V., Barbarov, V. L., and Ovsyannikov, Yu. P., Metallurgicheskaya i Gornorudnaya Promyshlennost', (Metallurgical and Mining Industry), No. 5, 1973, pp 15-16, 2 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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0903

EXPERIENCE IN THE PRODUCTION OF WEAR RESISTANT RAIL STEEL WITH INCREASED MANGANESE CONTENT [IN CZECHOSLOVAKIAN]

A high degree of wear resistance in rail steel can be achieved by using a method of air hardening, i.e., changing the chemical composition of steel without thermal treatment. However, the wear-resistant rail steel has to be sufficiently tough and rupture resistant. The Trinec Steel Works made a series of test melts with rail steel containing a lower amount of carbon and a higher amount of manganese. The production and evaluation tests of the rail steel with increased manganese content are discussed. Tabulated information is presented which shows the metric density and cross-sectional areas of the rails, and the basic data on the course of vacuum degassing. Information on the hydrogen content in the steel before and after vacuum degassing is given. The mechanical properties of the steel, based on specimens removed from designated areas of the rail, and samples taken from the melt are described.

Macak, M. (Trinecke Zelezarny VRSR, Trinec, Czechoslovakia), Hutnik, Vol 22, No. 7, 1972, pp 262-266, 2 figs., 9 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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0904

A FEATURE OF THE COOLING OF RAILROAD RAILS DURING THEIR HARDENING IN A HOT MEDIA [IN RUSSIAN]

Studies conducted at the Gorkiy Metallurgical Plant on the features of controlled cooling of rails in a salt bath are discussed. Dimensions of the bath, composition of the salt melt, and the methods of heating and assuring agitation of the bath are given. A special device is described for addition of water which permits a constant bath temperature that is maintained at $\pm 5°C$. The special feature of the bath is that the temperature control is independent of the amount of heat introduced by the pieces being hardened. A study was made of the speed of cooling of various parts of a R65 rail, and a description of the application of thermocouples for temperature measurements is given. Curves were constructed which describe the relationship of the rail cooling speed to the content of water in the melt and to the melt temperatures. A comparison of the results obtained indicates that the effects of the temperature and water content of the melt on the rail cooling speed are similar.

Babich, A. P. (Gorkovskiy Metallurgical Plant, U.S.S.R), Metallurgicheskaya i Gornorudnaya Promyshlennost', No. 2, 1972, pp 33-34, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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0905

CHANGE IN THE MECHANICAL PROPERTIES OF RAIL STEEL BY HYDROGEN EFFUSION [IN GERMAN]

Change in mechanical properties of rail steel by hydrogen effusion is reported. Different grades of rail steel were aged at 20, 100, 200, and 275 C. Determination of mechanical properties, including fatigue, and of hydrogen content as a function of time showed that treatment effected considerable improvement in properties because of hydrogen elimination. Activation energy of hydrogen diffusion averaged 10,490 cal/g-atom over the temperature range investigated. Revision of acceptance tests is proposed.

Heller, W., and Jaeniche, W. (Hutten- und Bergwerke Rheinhausen AG, Huttenwerk, Rheinhausen, West Germany), Stahl und Eisen, Vol 83, No. 3, January 31, 1963, pp 145-154, 14 figs., 4 tables, 27 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0906

CONTROLLING THE DEPTH OF SURFACE HARDNESS IN RAILS [IN RUSSIAN]

Ultrasonic control of hardening depth during the process of surface hardening of rails is discussed. The processes of ultrasonic energy reflection, scattering, and transformation of vibrations are reviewed. Illustrations showing the relation of size of energy losses of the ultrasonic vibrations in steel as a function of the ratio of wavelength to average grain size are presented. The process used for monitoring the depth of hardening is described. The device used for the monitoring is briefly discussed, as well as the methods used for arranging the emitters and receivers on a surface of the test specimen. It was concluded that at certain ratios between the wavelength and the average grain dimensions in the zones of hardening and of raw metal, it is possible to monitor the hardness depth of rails heat treated by high-frequency induction-current heating.

Zarochentsev, G. V., and Yushkevich, I. N. (All-Union Scientific Research Institute of Railroad Transport), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 508, 1974, pp 36-43, 6 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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0907

MANUFACTURE OF WEAR-RESISTANT RAIL STEEL BY THE OXYGEN-CONVERTER METHOD WITH SUBSEQUENT VACUUM TREATMENT OF THE MOLTEN STEEL [IN GERMAN]

The manufacturing processes for wear-resistant rail steel through the use of the oxygen-converter method followed by vacuum treatment of the molten steel are described. Quality control attributed to the recording of measured quantities making up the chemical compositions and impurities and the ability associated with accurate reproducibility provide special advantages in the use of the described methods. (Carried as RRIS Accession No. 080311.)

Hammer, R., Philipsen, D., Schmedders, H., and Trenkler, J. (August-Thyssen-Hutte AG, Duisburg, West Germany), Eisenbahntechnische Rundschau, Vol 23, No. 1, November 1974, pp 463-468, 11 figs., 13 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Hestra-Verlag (repr., PC, microfilm).

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0908

DEVELOPMENT OF A SCHEDULE FOR THE HEAT TREATMENT OF HIGH-STRENGTH RAILS

Results of laboratory trials to determine an optimum method for heat treatment of high-strength rails produced by the Nizhnii-Tagil and Azovstal' works are reported. The mechanical properties of rail-steel specimens and full-section rails were compared after normal treatment, isothermal quenching, a process described as HTMT and one described as HTMT followed by isothermal decomposition of the austenite. Difficulties in obtaining a combination of high contact fatigue strength and resistance to brittle fracture (impact strength and endurance under fatigue loading after initiation of a crack) through the use of conventional methods are discussed. A schedule incorporating differential tempering, which comes highly recommended for the purpose of compliance with current practices and available equipment, is described.

Rausin, Ya. R., Shur, E. A., Zenov, P. N., and Velikanov, A. V. (All-Union Institute of Railway Transport, U.S.S.R.), Stal [in English], No. 12, December 1974, pp 1121-1125, 3 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: British Steel Institute and The Metals Society (repr., PC).

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0909

IMPROVING THE QUALITY OF TEMPERED RAILS

The effect of chemical composition and conditions of heat treatment of rails on the hardness and mechanical properties was investigated. The relationship of average tensile-strength with carbon and manganese contents is shown graphically from data obtained on tests on rail steel. The processes of heat treatment, quenching, and rail straightening being used at the Nizhnii Tagil Combine are discussed, and the increases in rail strength by 30 to 60% are explained on the basis of relations between the various metallurgical phases and how each contributes to the improved quality of the rail steel.

Loshkina, N. A., Rabinovich, D. M., Freidenzon, E. Z. and Vinokurov, I. Ya. (Nizhnii Tagil Combine, U.S.S.R.), Stal [in English], No. 12, 1970, pp 1121-1124, 3 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: British Steel Institute and The Metals Society (repr., PC).

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0910

INVESTIGATING THE STRUCTURE AND PROPERTIES OF RAILS HARDENED THROUGHOUT THEIR LENGTH AFTER INDUCTION HEATING

Work of the U.S.S.R. and other countries on the surface hardening of rails is reviewed. An experimental installation for the surface high-frequency hardening of Type R50 and R65 rails was designed for operation at the Azovstal' Works in 1962. Several experimental batches of rails were hardened and then field tested. The induction heat treatment of these rails is described in detail. Elongation and impact and fatigue tests were performed on the rails to determine their mechanical properties. The data from these preliminary test measurements are presented in tabular form. On the basis of the tests, it was concluded that (1) when rails are hardened by induction heating in water (condensate) no significant increase in rail operational life can be achieved either by altering the chemical composition of the rails or by varying their hardness; (2) the considerable nonuniformity of the structure of the hardened layer and the associated nonuniform hardness throughout the rail head can be eliminated by using a water/air mixture as the cooling medium; (3) the tendency to longitudinal failures in the web found in rails hardened in water by induction heating can be eliminated by hardening in an elastic-curved state and, in many cases, by tempering.

Rausin, Ya. R., Velikanov, A. V., Gordyuk, Ya. V., and Shur, E. A. (Azovstal' Steel Works, U.S.S.R.), Stal [in English], No. 12, December 1965, pp 1001-1004, 5 figs., 2 tables, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0911

ISOTHERMAL TREATMENT OF RAILS

Comparisons are made between rails processed by the normal hardening and tempering treatments and those subjected to isothermal treatment in molten alkali nitrate at approximately 300°C. To obtain data for the comparisons, tests using 1-meter-long specimens were conducted. Considerable improvement is shown for rails subjected to the isothermal treatment in that their tensile strength is increased throughout the entire section and good ductile properties are maintained while the tensile strength of the medium alloy chromium rails reaches 142.5 kg/mm^2 in the head. Experiments with full-profile rail samples confirmed that there was potential in carrying out the heat treatment of rails in their molten media with the transformation of austenite approaching the isothermal state so that high tensile strengths are obtained in rails of low- and medium alloy steel.

Pridantsev, M. V., Kazarnovskii, D. S., Danilov, V. N., Vekser, N. A., Nikonov, A. G., and Bykov, N. P. (Ukrainian Research Institute for Metals and the Scientific Research Institute for Railroad Transport, U.S.S.R.), Stal [in English], No. 4, April 1965, pp 314-317, 7 figs., tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0912

RAIL REPLACING PLAN FOR THE NEW TOKAIDO TRUNK LINE [IN JAPANESE]

Rail wear develops more quickly in curved track sections, and consequently replacements of rails in such sections have been partially carried out up until the present time. On the other hand, although rail wear develops more slowly in the straight track sections, it is necessary to replace rails in these sections because the rails develop fatigue under the repeated load of trains.

For these reasons, it will be necessary, considering the future transportation volume on the New Trunk Line, to complete the replacement of the rails on the line approximately by the year 1981.

In view of this goal, it was decided that various facilities required in connection with the planned replacement of rails should be newly constructed by August, 1972, with an investment of approximately 830 million yen.

Mitsu, W. (Japan National Railways), Tetsudo Senro, Vol 19, No. 9, 1971, pp 493-494, 3 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0913

DEVELOPMENT OF RAIL CLAMPING DEVICE FOR SLAB TRACK [IN JAPANESE]

The clamping device for rails for slab track is to perform, at the clamping device section, the compensatory function and the buffer action which have hitherto been undertaken by the road bed ballast.

The present study presents a descriptive account of the design conditions, design policies, characteristic features of the clamping device for 60-kg rail (direct-coupling rail clamping device - Type 4) and for 50N rail (direct-coupling rail clamping device - Type 5) for use on slab track, together with the results obtained by laboratory tests and field tests.

The results of the study indicate that the task awaiting future accomplishment in the area concerned is a further inquiry into countermeasures against poor subsoil, sound insulation measures, and anticorrosion measures.

Umeda, S. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 21, No. 11, 1973, pp 623-626, 2 figs., 3 tables, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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0914

COMPUTERIZATION FOR CONTROLLING RAILWAY COMPONENTS [IN JAPANESE]

Since 1972, the Japan National Railways has been controlling railway components and materials by means of a new system built around the EDPS, which was introduced with a view of accomplishing a reform in the control over the maintenance of its railway tracks.

The matters having bearings on systems analysis are the objectivity of data, preparation of materials for a proposal for a budget, preparation of informative materials, and development of implementation plans.

For the new system, there are 90 volumes of processing programs related to rails and 35 volumes of such programs related to turnouts, and the present report contains detailed explanation of the processing theories relevant to each of these two areas.

Horie, K. (Japan National Railways), Tetsudo Senro, Vol 20, No. 7, 1972, pp 412-417, 4 figs., 6 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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0915

COMPARISON OF STATISTICAL DATA ON RAIL FAILURES IN JAPAN AND IN THE UNITED STATES AND FUTURE DIRECTION OF JNR STATISTICS ON RAIL FAILURES [IN JAPANESE]

This work represents an attempt to examine the approach used by the American Railway Engineering Association (AREA) in compiling its statistical data on rail failures in the hope that it will suggest a feasible method which can be used for developing statistical data on rail failures in Japan.

Although the U.S. statistical data and the Japanese data cannot be directly compared because of the difference in the methods used for collecting data, a comparison of the U.S. data (1968) with the Japanese data (1970) shows that the number of rail failures is larger in the United States than in Japan. The ratio of inherent failures is 22 percent for the Japan National Railways and 36 percent for the United States. The ratio of failures detected by the failure inspection car is extremely high in the case of the AREA.

The points which will be useful to Japan are (a) service failures vs. detected failures, (b) statistical data on failures in short-lived rails, (c) statistics on failures per mile/year (kilometer/year), (d) comparative data by manufacturer, (e) comparison of the new-section rail with the old-section rail, etc.

The areas to be aimed at in compiling and analyzing statistical data on rail failures in the future will be: (1) comparison of the new rail with the existing type of rails and a grasp of the merits and demerits of the new type rails and (2) compilation of tables showing the numbers of rail failures by the type of failures, the position of failures (the rail end or middle), the consequent disruption of train operations, the method of detection, and the class of the railway line at which rail failures take place.

Kuroda, S., and Matsumura, H. (Railroad Transportation Research Institute and the Japan National Railways), Tetsudo Senro, Vol 20, No. 7, 1972, pp 444-446, 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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0916

A CONSIDERATION OF HIGH SPEED RAIL (PART 1) [IN JAPANESE]

This study presents an analysis of problems that arise in rails as a result of the high-speed running of railway carriages. Primarily, the work contains a survey of the force working on the clamping device as well as the degree and force of acceleration exerted on the track, presenting calculation formulae for determining these, and describes the relation between the value of acceleration and cant.

In addition, with reference to the results obtained by applying the technique to the Tokaido line, the work touches upon the lateral force working on the rim of a wheel, the derailment coefficient, and the distribution of vibrational acceleration.

Tokuoka, K. (JNR Establishment Office), Tetsudo Seiro, Vol 22, No. 11, 1974, pp 572-574, 5 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0917

A SUGGESTION OF A MEASURING INSTRUMENT OF RAIL DEFLECTION OF A LONG WAVELENGTH [IN JAPANESE]

The existing method for measuring rail deflection by means of the 10-m string is capable of amplifying the rail deflection amplitude up to twice the magnitude of the actual amplitude being measured when measurement is conducted at a wavelength of 10 m, but the amplification gain gradually declines for any wavelength greater than 10 m, being reduced to one times the magnitude of actual amplitude at a wavelength of close to 20 m and to less than one times the actual amplitude at any wavelength greater than 20 m.

However, the results of various tests recently conducted indicate that many freight cars have such characteristics that their running safety decreases with rail deflections of 15 to 25 m in wavelength.

In view of this fact, the present work puts forward the principles and structure of a measuring and recording instrument capable of detecting rail deflections by measuring at a wavelength other than 10 m without requiring any change in the structure of the track-testing car currently used for rail measurement.

Sato, U. (Railway Technical Research Institute, JNR), Tetsudo Seiro, Vol 18, No. 10, 1970, pp 522-523, 4 figs., 2 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0918

NEW METHOD OF MEASUREMENT OF WHEEL LOAD AND LATERAL FORCE IN RAIL [IN JAPANESE]

For measuring, on the ground, the dynamic wheel load and lateral force of wheels in operation, the method hitherto used has involved setting a wire strain gauge at the right and left ends of the rail bottoms in the longitudinal direction midway between two sleepers, to measure the sum or difference of the strain recorded for the right side and that recorded for the left side, and to convert the said sum or difference into wheel load or lateral force. However, this approach does not permit accurate measurement because it is susceptible to the influence of the wheels adjacent, forward or backward, to the one subject to measurement and also to the influence of floating sleepers.

With a view to solving this problem, efforts have been made in this study to develop a new measuring method based on shearing strain, and the present work describes the measuring method together with the results of measurement obtained by its application.

Tanahashi, H. (Railway Technical Research Institute, JNR), Tetsudo Seiro, Vol 18, No. 9, 1970, pp 469-470, 4 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0919

RAILWAY STRUCTURE IN ACUTE CURVE [IN JAPANESE]

In an effort to find solutions to various problems that arise in regard to the curved sections of rails, the present study sets forth novel railway structures such as rails, check rails, slacks, sleepers, and clamping devices on the basis of actual measurement of the maximum value of the lateral force that occurs on railways in operation and also on the basis of the checking of such factors as the planned load, etc.

The novel railway structures have not presented any problems in the tests conducted on them after the rails were laid down.

Shinozaki, M. (Nagoya City Office, Nagoya, Japan), Tetsudo Senro, Vol 18, No. 9, 1970, pp 433-437, 10 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0920

ULTRASONIC RAIL INSPECTION (PART 1) [IN JAPANESE]

This study describes portable-type ultrasonic rail inspection equipment. The main unit of the inspection equipment generates pulsating vibration voltage at 2 MHz, which is applied to the searching unit to yield acoustic vibration. The vibration voltage generated in the searching unit by the echo received from a flaw is amplified and displayed on the cathode ray tube in the form of pulse waves. The present study discusses the calibration of the point of incidence of the probe, the angle of incidence of the probe, the contraction scale of the timing axis, and the origin of the timing axis prior to rail flaw inspection.

Serizawa, M. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 9, 1971, pp 481-484, 7 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0921

ULTRASONIC RAIL INSPECTION (PART 2) [IN JAPANESE]

The present study reveals how to make a flaw positioning scale and how to set up an inspection sensitivity with regard to (1) a joint section with a fishplate on it and (2) an intermediate section and a welded-joint section. A preliminary survey is made of flawless rails in terms of the fundamental relations between the positions of the probe on the wheel tread surface and the echo patterns appearing on the cathode ray tube, and an assumption is made of the existence of a flaw whenever the echo pattern obtained in an actual rail inspection differs in mode from the fundamental relations mentioned above. The method for determining the position, shape, and size of a flaw with reference to the nine different patterns appearing on the cathode ray tube is explained.

Serizawa, M. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 10, 1971, pp 550-552, 5 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0922

ULTRASONIC RAIL INSPECTION (PART 3) [IN JAPANESE]

This study, the third in a series, gives examples of the results obtained through rail inspection conducted by the procedure described in the preceding articles. By comparing the results obtained by ultrasonic inspection and those obtained by magnetic-particle inspection in two instances of bolt-hole cracking and transverse fracture in a welded part, it is demonstrated that it is possible to detect the position of flaws with sufficient accuracy by the ultrasonic rail inspection method.

Serizawa, M. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 11, 1971, pp 610-612, 6 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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0923

STUDY ON FASTENING DISTANCE OF RAIL FASTENING DEVICE [IN JAPANESE]

With regard to the question of the fastening distance relative to the rail fastening device, the present work presents views and results obtained through examination from the standpoint of such factors as the advantages to be derived from widening the fastening distance, the ratio of dispersion of the weight of wheels, the rate of dispersion of horizontal weight, and the angle of the tilting of rail.

Toyoda, M. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 31, No. 4, 1974, pp 151-154, 4 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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0924

RESULTS OBTAINED WITH CONTINUOUS WELDED TRACKS [IN GERMAN]

The article outlines the relationships between rail temperature and rail stresses and describes the method of joining, laying, and welding of rails. This is followed by a discussion of the resistance of continuous welded tracks to warping, which according to stability calculations is increased by a factor of 4 to 5 with respect to vertical warping. The resistance to horizontal warping is limited by the ballast and directional distortions. The effect of fastening is obvious. The results obtained by the use of continuous welded tracks are presented. Furthermore, they relate to the welding of switches, to the growth and cause of rail fractures and their elimination, and to economic aspects, in view of the increased susceptibility to transverse fracture.

Birmann, F. (Bundesbahn-Zentralamt, Munich, W. Germany), Eisenbahningenieur, Vol 13, No. 10, 1962, pp 268-280, 41 figs., 3 tables, 18 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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0925

INVESTIGATION OF WEAR ON VARIOUS PAIRS OF MATERIALS BY MEANS OF A ROLLER TEST RIG OF THE TECHNICAL UNIVERSITY OF AACHEN [IN GERMAN]

The question of the technologically and economically most favorable pairs of materials for wheel and rail is of importance with regard to high-speed traffic and lightweight construction. The paper presents a report on investigations of wear which were carried out on a roller test rig and permit valuable relative comparisons to be made.

Birmann, F. (Bundesbahn-Zentralamt, Munich, W. Germany), Leichtbau der Verkehrsfahrzeuge, Vol 10, No. 1, 1966, pp 28-29, 4 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Ernst Kieser KG (repr., PC).

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0926

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF INTERNAL STRESSES IN RAIL HEADS [IN GERMAN]

The internal stresses in rail heads were determined by means of the half-space theory, and the effect of the bending stresses in the rail and rail head is explained. In addition, a formula is derived for determining the shear stresses. It is shown by experiment and computation that the stresses in the rail head are much higher than those at the contact area of wheel and rail. Rail head fractures occur at a depth of 3 to 7 mm below the rail surface if the fatigue shear strength of the rail steel is exceeded. The most heavily stressed point is close to the inner edge of the rail.

Hanna, A. N. (Dept. of Constr. Engrg., Technical University of Munich, W. Germany), Doctor of Engineering Thesis, No. 10, 1967, 146 pp, 73 figs., 6 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Technical University, Munich, W. Germany (repr., PC).

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0927

A CONTRIBUTION TO THE THEORETICAL INVESTIGATION AND EXPERIMENTAL TESTING OF RAILS [IN GERMAN]

The different types of rail stresses are described and their orders of magnitude are determined. The investigations were carried out on rails of different profiles with minimum ultimate strengths of 70 and 90 kg/mm^2. In S-49 (70) rails on routes travelled by all kinds of trains, minute incipient cracks are frequently formed in the rail head because of cyclic shear stress which in the course of time lead to transverse fracture. This is proved by practical experience. The above damage is avoided in UIC-60 (90) rails since these rails have a higher strength. High axle loads require a large rail profile, a small wheel diameter, and a rail steel of high tensile strength.

Oberweiler, H. G. (Technical University, Munich, W. Germany) Doctor of Engineering Thesis, No. 17, 1973, 99 pp, 60 figs., 32 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Technical University, Munich, W. Germany (repr., PC).

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0928

METHODS FOR TESTING RAILS EMPLOYED BY THE US RAILROADS RESEARCH INSTITUTE [IN GERMAN]

The extensive rail testing procedure developed by the US railroads research establishment permits evaluation of the rails under service conditions with respect to their resistance to plastic deformation, their susceptibility to transverse fracture and breakage of the running edge, the degree of impurity content, and the composition of the steel used. The test program involves testing rail sections, several feet long, by rolling load, impact, and bend tests. In addition, the mechanical properties are further evaluated by tensile, hardness, and Charpy tests. Also the chemical analysis as well as macro- and microscopic examinations are carried out for determining the composition segregations and nonmetallic inclusions in the steel.

Oberweiler, G. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 21, Nos. 7 & 8, pp 269-271, 7 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0929

RIGOROUS CALCULATION OF RAIL STRESSES CAUSED BY GUIDING FORCES [IN GERMAN]

As a result of the horizontal forces acting on the rail head during the travel of a rail vehicle, both pure torsion (Saint Venant) and torsion due to buckling occur in the rail cross section. Differential equations are derived for lateral deflection of the rail and the angle of torsion, as well as formulas for the total stresses of rail head and rail base. A computational example for the rail S-54 completes the discussion and shows that the stresses caused by a lateral guiding force rapidly decay along the rail. Hence, there is weak interaction of the forces originating from several axles.

Hanna, A. N. (Canadian Transport Commission Res. Div., Ottawa, Canada), Strasse, Brucke, Tunnel, Vol 22, No. 3, 1970, pp 70-73, 7 figs., 3 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Wilhelm Ernst & Sohn (repr., PC).

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0930

A CONTRIBUTION TO THE CLARIFICATION OF RAIL HEAD BREAKAGES [IN GERMAN]

A simplified theoretical method is presented for the determination of stresses in rail heads under the action of repeated loading. The investigation permits a prediction to be made on the service life of the rail until the occurrence of rail-head breakages, the fatigue stresses encountered in practical service being taken into consideration.

Hanna, A. N. (Canadian Transport Commission, Res. Div., Ottawa, Canada), Strasse, Brucke, Tunnel, Vol 24, No. 1, 1972, pp 8-13, 11 figs., 14 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Wilhelm Ernst & Sohn (repr., PC).

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0931

FLAME-HARDENING OF RAIL HEADS [IN GERMAN]

Experimental procedure for the hardening of rail heads is described. Details of steels used and their transformation characteristics are mentioned. The heat treatment involved: preheating to about 600 C, heating the rail head by gas torches to austenitizing temperature, and finally quenching. After passing through quench jets, heat is allowed to reach the head from the rail body to produce tempering before a final quench is given. The effects of water, oil, and oil-water emulsion quenches were studied and a suitable practice is recommended. Results of a hardness survey along the cross section of rails are presented.

Geiss, A., and Rose, A., Werkstatt und Betrieb, Vol 103, No. 6, June 1970, pp 393-402, 15 figs., 2 tables, 14 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Carl Hanser Verlag (repr., PC).

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0932

THE INTERACTION BETWEEN WHEEL AND RAIL WITH REGARD TO SAFETY AGAINST DERAILMENT, WEAR, SMOOTH RUNNING, AND STRESSES ON WHEEL SETS [IN GERMAN]

The set of wheels can be considered only in its interaction with the track. The new methods of measurement during service have closed the gap between theory and practice. They enable the designer and the manufacturer to make predictions and thus to adapt their product to the conditions of rail traffic.

Kurek, E. G., (Rhein. Westf. Technical University, Aachen, W. Germany), Eisenbahntechnische Rundschau, Vol 15, No. 9, September 1966, pp 338-346, 10 figs., 12 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0933

A METHOD FOR THE EVALUATION OF RAIL STRESSES USING THE THEORY OF TRACTION FORCES [IN GERMAN]

The rail is stressed by the normal force exerted by the wheel flange at the point of contact between wheel and rail. This force, which cannot be measured directly, can be calculated by measuring other forces between the railroad vehicle and rail. The contact area on the one hand and the effects of static and dynamic forces on the other can be kept small by adequate shaping of wheel and rail.

Kurek, E. G. (Rhein. Westf. Technical University, Aachen, W. Germany), Glasers Annalen, Vol 91, No. 9, September 1967, pp 303-304, 1 fig., 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Georg Siemens (repr., PC).

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0934

INVESTIGATIONS INTO THE STRUCTURE OF CORRUGATED RAILS [IN GERMAN]

The metallographic, X-ray, and hardness investigations undertaken to analyze the structure underneath the running surface of corrugated rails are described. The results show clearly that the bright zones below the crests of the corrugations on rails made of bessemer and Siemens Martin steel consist of martensite. Martensite may also form locally on the actual running surface of corrugation-free rails. Hardening is believed to be promoted by the absorption of nitrogen. Regions of cold work were identified under the crests of the corrugations, down to a depth of 4 mm. A relationship is found to exist between tendency to ripple formation and chemical composition of the rail steel. The results suggest that the hardenability and work-hardening ability of the steel influence the formation of corrugations.

Neumann, F. K. (Max-Planck-Institut fur Eisenforschung, Duesseldorf, W. Germany), Arch. fur Eisenhuttenwesen, Vol 32, No. 9, 1961, pp 617-626, 21 figs., 5 tables, 5 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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0935

STRESSES IN RAILS---NEW FINDINGS [IN GERMAN]

Experimental results relating to the stressing of the rail head by shear and bending forces are presented. Because of the higher axle loads and smaller wheel radii, the shear and bending stresses in rail heads have increased and lead to fatigue fractures. Several methods of counteracting these stresses are discussed, e.g., use of a steel of higher tensile strength and smaller impurity content, and use of the rail S-54 instead of S-49, which reduce the additional stress by 15 percent and provide greater safety against permanent deformations. The good economic prospects for practical application of the results obtained are pointed out.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahningenieur, Vol 17, No. 7, July 1966, pp 171-177, 16 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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0936

SERIES OF MEASUREMENTS ON RAILS FOR DETERMINING THE GUIDE FORCES [IN GERMAN]

The article describes a process for measuring the load on the rail due to the guide forces under motive power and freight rolling stock for various track conditions, track radii, and speed ranges up to 200 km/hr. The measurements are carried out by means of the "rail-head bending" processing, which is considered to be sufficiently accurate. Comparisons are made with running qualities and rail wear. In tracks on electrified routes, the lateral rail wear (of steels with minimum tensile strength 90 kg/mm^2) shows a parabolic dependence on the radius of curvature of the track. The guide forces for the investigated locomotives and stock cars also show a parabolic increase with decreasing track radius for track radii smaller than 700 m.

Birmann, F., and Eisenmann, J. (Bundesbahn-Zentralamt and Technical University, Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 15, No. 5, May 1966, pp 155-164, 21 figs., 3 tables, 10 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag-Hestra (repr., PC).

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0937

RAIL STRESSES AND GUIDING FORCES PRODUCED BY PASSENGER CARS WITH REGARD TO LIGHTWEIGHT CONSTRUCTION, RUNNING SMOOTHNESS, AND WEAR [IN GERMAN]

Measurements show that the guiding forces for a lightweight car (28 t), and hence the wear of wheel flange and rail, are 15 to 20 percent lower than those for a normal express-train car (38 t). The guiding forces increase at higher traveling speeds only insignificantly because the friction-dependent directional force is reduced although the centrifugal force rises. The steel-steel friction coefficient decreases with increasing speed. The guiding forces have a minimum at radii of curvature between 700 and 1200 m. The limits for aberrations in the weight according to track specifications ensure the same running efficiency for all speeds. The guiding forces occurring at the first truck in the case of directional errors are up to 45 percent higher than those measured at the second truck.

Birmann, F., and Eisenmann, J. (Bundesbahn-Zentralamt and Technical University, Munich, W. Germany), Leichtbau der Verkehrsfahrzeuge, Vol 8, No. 6, 1964, pp 201-206, 10 figs., 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Ernst Kieser KG (repr., PC).

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0938

CONSIDERATIONS ON THE STRESS OF A RAILROAD TRACK [IN GERMAN]

Under the action of a vertical wheel load, Q, and a horizontal guiding force, Y, the track experiences a stress which may lead to rail-head fracture, to plastic deformations of rail head and rail base in the horizontal direction, to fatigue cracks in the rail base, and to foundation failure in the ballast or subsoil. Rail-head fractures are caused by high shear stresses at a depth of 4 to 6 mm near the contact area between wheel and rail and occur if the fatigue strength of the rail material is exceeded. The most important parameters in this respect are wheel load and wheel diameter.

Eisenmann, J. (Technical University of Munich, W. Germany), Leichtbau der Verkehrsfahrzeuge, Vol 13, No. 6, 1969, pp 281-282, 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Ernst Kieser KG (repr., PC).

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0939

STRESSING OF RAILROAD TRACKS AND THEIR FURTHER DEVELOPMENT FOR HIGHER SPEEDS AND AXLE LOADS [IN GERMAN]

Using modern rails with a tensile strength of 90 kg/mm^2 the conventional road bed with ballast tracks allow an axle load of 25 to 28 t, depending on travelling speed, height of the center of gravity of the vehicles, and wheel diameter. At a tensile strength of 110 kg/mm^2 and a rail weight of 64 to 70 kg/m it is possible to increase the axle load to values between 37 and 42 t. In this case, the ballast bed has to be reinforced. At travelling speeds of more than 220 to 250 kg/hr the maintenance costs rise substantially with the rigorous requirements of track quality. This calls for a new development in track construction aiming towards a frostproof concrete deck and resilient rail fastenings. Initial experiments are being performed at present in several countries. The new type of track could reduce the construction and maintenance costs and promises to be economical in case of vehicles with higher speed and axle loads.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 17, No. 5, May 1968, pp 184-196, 27 figs., 12 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0940

STRESSES IN RAIL HEADS---COMPARISON BETWEEN THEORY AND PRACTICE [IN GERMAN]

Rail-head breakages are fatigue failures due to shear stresses near the wheel-rail contact point. The critical shear stress can be calculated by means of the half-space theory. Comparison with the permissible shear stress allows the permissible wheel load or the permissible wheel radius to be calculated. Model experiments were made of rails of synthetic resin to verify the theory. It is pointed out that damage in practice can be explained by the theory and avoided by using rail steels of appropriate qualities.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 16, No. 10, October 1967, pp 355-361, 17 figs., 4 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0941

THEORETICAL CONSIDERATIONS OF STRESSES IN RAIL HEADS AT THE POINT OF CONTACT [IN GERMAN]

At the point of contact between rail and wheel, the rail is subjected not only to bending but to compressive stresses. Their effects were investigated by Timoschenko, Langer, and Schlumpf. On the basis of these investigations, further theoretical findings and experimental results from the Institute for Railroad and Road Construction of the Technical University of Munich are reported. An increase in shear stress (e.g., due to higher axle loads, reduced wheel diameters, or increased guide forces) can be counteracted by using a rail of higher tensile strength. For this purpose, the rail material has to be free from nonmetallic inclusions in the stressed zones. The additional bending stress can be reduced by enlarging the rail section, in particular the rail head.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 14, Nos. 1 & 2, January 1965, pp 25-34, 16 figs., 16 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0942

STRESSING RAILS LIKE GIRDERS [IN GERMAN]

A method is described for determining flexural, thermal, internal, and other supplementary stresses in rails, as well as the "bedding coefficient" which takes into account the underlayer and the ballast bed. With these data it is possible to calculate the permissible traveling speed and axle load for a specific rail profile. It is pointed out that on rails having a conventional profile S 49/70, the axle load has to be reduced from 20 to 16 t at a speed of 200 km/hr and that S 60/90 rails should be used because of the unreliability of the underlayer and the high axle loads of freight trains. The S 54/90 rails, because of insufficient strength, do not permit an increase in the running speed to more than 200 km/hr or an increase in the axle load of freight trains running at a speed of 120 km/hr.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 18, No. 8, August 1969, pp 306-312, 10 figs., 2 tables, 10 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0943

THE RAIL AS A TRANSPORT ROUTE [IN GERMAN]

To investigate the stresses in railroad tracks, extensive studies were conducted in the last few years with the aim of giving practical recommendations for the dimensioning and design of rails, ties, and roadbed. The result of the research is briefly reported. The report deals with the stresses in the rail base and rail head, and shows that between the rail profiles S 70 and IC 60 there is hardly any difference with respect to the permissible axle load. It is therefore recommended that if the weight of the rails is increased the tensile strength should be increased as well, since this raises the load-carrying capacity of the rails.

Eisenmann, J. (Technical University of Munich, W. Germany), Eisenbahntechnische Rundschau, Vol 20, Nos. 1 & 2, 1971, pp 64-70, 9 figs., 2 tables, 8 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0944

SOME MEASUREMENTS OF RAIL-TYRE ADHESION

The adhesion between the wheels of a motorized bogie and the rails on which it runs was measured under a variety of rail surface conditions. The effects on adhesion of contaminants such as oil, water, rust, clay, and wear particles were examined. A number of materials, including abrasives, detergents, and silicones were tested to determine their effectiveness in increasing adhesion, and curves are provided which show the results of these tests. A brief description of a short test track used for making measurements of wheel/rail adhesion by the British Transport Commission's laboratory at Wilesden Junction is given. General observations are presented from results obtained in the experiments performed on the test track.

Spurr, R. T. (Messrs. Ferodo Ltd., Stockport, Great Britain), Wear, Vol 3, 1960, pp 43-59, 6 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0945

IMPROVEMENT IN RAIL-WHEEL ADHESION BY SPARK-DISCHARGE

A brief outline is given of research conducted at Battelle-Geneva over the period between 1958 and 1968 on the spark method of increasing adhesion between a locomotive wheel and rail. The results of laboratory and field tests carried out in France, Switzerland, and England show agreement and consistent improvement in the adhesion values obtained for a variety of contaminants. An important feature, which is discussed, is the memory capability of sparked rail sections, which it is hoped may lead to improved adhesion values by routine sparking. Mention is made of test speeds which, for all experiments conducted so far, have been confined to the range of 0 to 5 km/hr, where power is minimal. Further development of the method of spark-cleaning at much higher speeds is deemed necessary so that its application may be available for practical railway usage.

Pichaux, H., and Moore, D. F. (Institut Battelle, Geneva, Switzerland), Wear, Vol 11, No. 1, January 1968, pp 51-67, 15 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0946

THE N.E.L. (NATIONAL ENGINEERING LABORATORY) CONTRIBUTION TO ADHESION STUDIES

This paper describes a number of studies that have been conducted at the N.E.L. of the British Railways Board on the subject of rail adhesion. In their research, the term "coefficient of adhesion" refers to the ratio of tangential force to the normal force at the wheel/rail interface when slipping is about to occur. The study was divided into three parts: (1) observation of the actual phenomenon occurring in a railway, (2) laboratory simulation of field conditions, and (3) basic experiments to elucidate laws governing friction in various atmospheric environments. A brief review is presented of phenomenological studies that involved sound recordings which demonstrated the incidence of slipping which was indicated by the sudden change in frequency of the exhaust beats of a locomotive. The rail-and-tire machine used in simulation studies at the N.E.L. is described along with the procedures for its operation. The data obtained are plotted to show how adhesion varies as a function of humidity and rail surface conditions. The latter involved wetting with various fluids and sands. Various ways of improving adhesion are suggested.

Barwell, F. T., and Woolacott, R. G. (National Engineering Laboratory, British Railways Board, Thorntonhall, Glasgow), Paper No. 9, presented at the Convention on Adhesion, arranged by the Railway Engineering Group, London, November 27-28, 1963, Proceedings of the Institution of Mechanical Engineers, Vol 178, Part 3E, 1963-1964, pp 145-160, 14 figs., 3 tables, 26 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0947

FRICTION ON RAILWAY RAILS

This paper describes the author's efforts and special investigations carried out between 1955 and 1962 to clarify the causes of decreases in the coefficient of adhesion that occurs between locomotive wheels and rails, and to find a possible remedy for this phenomenon. Work is described on studies that are based on the frictional properties of rail surfaces subjected to atmospheric and traffic contamination such as slipping of the wheel rolling surface relative to the surface of the rail, the wobbling of the locomotive wheel-pairs, all types of impacts of the wheels against the rails, and the peculiarities of the locomotives themselves. To determine the frictional capacity of the rail adhesion surface, a very sensitive method of evaluation was used. It was based on the value of coefficient of static friction capable of responding to slight changes in the physical and chemical conditions on the friction surfaces. The program for the investigations included work both in the field and in the laboratory of the Soviet Institute of Physical Chemistry.

Lujnov, J. M., and Kossikov, S. I. (Institute of Physical Chemistry of the Academy of Sciences, Moscow, U.S.S.R.), Paper No. 3, presented at the Convention on Adhesion, arranged by the Railway Engineering Group, London, November 27-28, 1963, Proceedings of the Institution of Mechanical Engineers, Vol 178, Part 3E, 1963-1964, pp 16-23, 5 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0948

78-FOOT RAIL VS 39-FOOT RAIL

The economies resulting from the use of 78-foot rail as compared with conventional 39-foot rail were studied. Test stretches were installed at three locations. Each location included 1 mile of track laid with 78-foot rail and 1 mile of track laid with 39-foot rail. Test results indicate that there has been a saving through the use of 78-foot rail. There should be an increase in savings credited to 78-foot rail when the need for reformed bars develops. Relatively larger joint gaps on the 78-foot rail as compared with the 39-foot rail have not as yet shown an appreciable effect on rail end batter or surfacing costs. End hardening of rail has apparently prevented excessive batter. The additional rail anchors applied to the test stretches in 1954 have been successful in preventing further accumulation of wide joint gaps in the 78-foot rail, and have also prevented welds from moving into tie-plate areas. (Carried as RRIS Accession No. 040342.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 552, October 1961, 16 pp, 7 figs., 3 photos, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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0949

STRESS CORROSION OF RAIL WEB STEEL (STATIC)

The test included six rail-joint segments containing one bolt hole with a bolt inserted to make the joint. It also included 20 steel specimens taken from rail steel which were subjected to static bending stresses. The 20 corrosion test specimens were tested after nearly 12-1/2 years of exposure to the elements. The joint segments were tested approximately 1 month later. All of the test specimens were cleaned thoroughly and examined in the laboratory by Magnaflux and Magnaglow methods for the presence of corrosion cracks. While there was considerable pitting to be found, the laboratory examination disclosed no cracks in any of the specimens. This test shows that static stress combined with corrosion has little or no effect upon the development of cracks in rail web steel. (Carried as RRIS Accession No. 040273.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 475, November 1960, 16 pp, 2 figs., 9 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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0950

RAIL WEB STRESSES IN HIGH SPEED TERRITORY

The purpose of the present test was to determine, if possible, the cause of frequent split web failures in the joint on 131-lb RE rail on the Fort Wayne Division, and in 152-lb PS rail on the New York Division. Web failures in 131-lb and 152-lb rail on the Fort Wayne and New York Divisions are adequately explained by the corrosion-fatigue theory. The occasional bolt-hole failures in 133, 140, and 155-lb rail are not readily explained. A 50% allowance for impact is justifiable on the basis of measured wheel loads. Application of reformed bars changes stress distribution in the rail web and in many cases increases web stresses, accelerating rail web failure. Loose bolts and an increase in rail end gaps increase rail web stress. The results of this test emphasize the need for protection of rail steel against corrosion, maintaining standard bolt tension, a good fit between bars and rail, and good surface through joints. (Carried as RRIS Accession No. 040279.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 597, June 1960, 6 pp, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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0951

DISCUSSION IN SESSION 3 (CONVENTION ON ADHESION) PAPERS

This section of the Proceedings of the Institution of Mechanical Engineers is devoted to a discussion by a panel of 10 individuals who have been given a prior opportunity to review the papers presented in Session 3 of the 1963 Adhesion Convention. Session 3 dealt primarily with the physics and chemistry of adhesion, although some attention was directed to the mechanics involved. The discussion includes comments on O.R.E.'s efforts, techniques for measuring slippage, effects of atmospheric conditions on adhesion, contact stresses and creep induced by transverse tangential forces, transverse sliding friction, weight-transfer compensation, application of nonabrasives, secondary conditioning, and a review of activities conducted in the United States. Members of the panel, in some cases, presented their comments by showing data in plotted form, numerical tabulations, charts and diagrams, and mathematical expressions.

Discussion (Session 3), presented at the Convention on Adhesion, arranged by the Railway Engineering Group, London, November 27-28, 1963, Proceedings of the Institution of Mechanical Engineers, Vol 178, Part 3E, 1963-1964, pp 206-215, 6 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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0952

IMPROVEMENT OF TRACK MAINTENANCE USING CURVE METHODS [IN RUSSIAN]

Investigations have shown that horizontal, transverse, and vertical components of acceleration occur as a result of unevenness of a rail line. A rail line must be considered along with centrifugal force if a smooth ride is to be achieved. The Murmansk section of railroad, has more than 50 percent, and in some cases, 70 percent of the curves with radii between 230 and 700 meters, and the intervals between curves are short. This article gives Shperling's formula for calculating a smoothness factor, and shows some of the curves which are recorded. Also included are suggestions of changes that should be made in maintenance standards needed to improve track conditions at curves. Graphs are provided which show Shperling's curve for smoothing factor calculation, and data taped by the track geometry measuring car for curves of 625 and 714 meters in radii.

Sharoyko, V. S. and Kupriyanov, N. V. (LIIZHT, USSR), Put i Putevoye Khozyaystvo, No. 5, 1974, pp 23-24, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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0953

TESTS OF F-70-23 MODIFIED AND UNMODIFIED BAGGAGE FLAT CARS

These tests were made to determine the modifications that would be necessary to improve the stability of flat cars. Tests made with instrumented wheels and truck bolsters showed the following: on trucks with unmodified clearance, lateral force of wheel to rail reached 10,000 lb with 200,000-lb squeeze, resulting in derailment of test car--L/V ratio exceeded 0.68; further tests on unmodified trucks with 450,000-lb squeeze developed lateral force of wheel to rail up to 15,000 lb resulting in turning rail over the derailing--L/V ratio exceeded 0.68; and on trucks with modified clearance, lateral force of wheel against rail reached a maximum of only 2,000 lb for an L/V ratio of 0.22. It was determined that the limitation of the truck bolster to truck frame clearance did not adversely affect the curving ability of the modified car, and rendered the car stable under all tracking conditions. (Carried as RRIS Accession No. 039695.)

Flebbe, P. E. (Research and Standards, Union Pacific Railroad, Omaha, Nebr.), Report No. 400-310-3/413-011, 1969, 22 pp, 1 fig., 7 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Union Pacific Railroad (repr., PC).

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0954

CHICAGO, BURLINGTON, AND QUINCY RAILROAD-STRESS

A test was conducted by the Electro-Motive Division, G.M.C., to measure stresses in 60- and 72-lb rerolled rails on branch track. AAR believes that the maximum computed rail stress, including impact or speed effect, should be limited to 35,000 psi for speeds of 35 mph and less. Over 35 mph, the stress should be limited to 30,000 psi. For 72-lb rail, the EMD diesel had a computed rail stress of 35,000 psi at 4 mph so it would not seem advisable to operate this locomotive at more than 10 mph. For C. and N.W. diesel, the maximum speed of 35 mph is the limiting speed for the allowable stress of 35,000 psi. The 35-mph limit is also applicable to a loaded coal car. The EMD diesel should not be operated on 60-lb rail. The C. and N.W. diesel had a computed rail stress of 35,000 psi at 34 mph. The loaded coal car reached this stress at 19.5 mph on 60-lb rail. (Carried as RRIS Accession No. 040040.)

McGee, G. M. (Association of American Railroads, Chicago, Ill.), Test Report No. T2252, September 1951, 26 pp, 24 figs., 3 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Association of American Railroads (repr., PC).

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0955

THE EFFECTS OF JUMBO (HEAVY AND HIGH CUBE) CARS ON THE M OF W EXPENSES

Studies, research, and field observations show that the heavier wheel loads imposed on the rail today cause higher rates of rail failures, severe flaking, spalling, pitting, and shelling. Track geometry also deteriorates faster. The two remedies are stronger rail material and stiffer track. But these are quite costly and economically not always possible. Instead, it is more likely that the movement of heavy loads will be continued on the present track at the expense of higher maintenance costs. This paper presents estimates and approximations with regard to the magnitude of the penalty M of W departments must pay in the area of track maintenance as a result of operating jumbo cars. (Carried as RRIS Accession No. 040394.)

Reiner, I. A. (Manager of Engineering Research Projects, C&O RY--B&O RR, Baltimore, Md.), prepared for the AAR Accounting Division's 1970 Annual Meeting, May 25-27, 1970, New Orleans, La., 18 pp, 3 tables, 4 refs.

ACKNOWLEDGMENT: Railroad Research Information Center.

PURCHASE FROM: Chesapeake & Ohio Railway (repr., PC).

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0956

LATERAL RAIL FORCES DUE TO VARIOUS LOCOMOTIVE AND TRAIN CONSISTS

A series of tests was performed to determine the lateral forces developed by various types of locomotives and train consists. Analysis of the data indicates that no excessive lateral forces were developed by any of the test consists. The maximum average force, 7,400 pounds was developed by the T.P.F.C. freight. The effect of roadway irregularities on lateral forces generated by normal consists remains largely unknown. On the basis of the results of this test series, it is concluded that light locomotive, passenger and freight consists generate relatively low lateral force on good roadway. There is a slight reduction in maximum lateral forces as training tonnage is increased. A study of the available research literature on the forces required to overturn rail shows that the maximum pressures measured were about 30% of the forces theoretically needed. (Carried as RRIS Accession No. 037598.)

Luebke, R. W. (B&O and C&O Railroads, Research Services, Planning Dept., Baltimore, Md., and Cleveland, Ohio), Test Report, April 1967, 8 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: B&O and C&O (Chessie) Railroad (repr., PC).

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0957

THE NATURE, MAGNITUDE, AND FREQUENCY OF LOADS AND FORCES APPLIED TO RAILROAD ROADBED

The magnitude, nature, and frequency of loads imposed on railway roadbed by track structures and by traffic on the track structure is summarized for use by engineers in designing alternative types of roadbed construction. An SD-40 locomotive was studied to test severe loads. Magnitude of reactions in the roadbed depends not only on the loads themselves but also on the spacing of the loads and the type and composition of support. In conventional track, the contact pressure on the bottom of a tie is not uniformly distributed either laterally or longitudinally. The total load on an individual tie depends on track conditions, size and distribution of load, and size, spacing, and condition of the ties. There are traditionally two ways of handling impact loads, i.e., "equivalent static load" and "energy load". Of the two, "equivalent static load" is usually given for railroad situations and is used in this article. Longitudinal loads come from inherent stress (from manufacture and laying of rails), reaction to locomotive traction, wheel flange friction and braking, thermal rail stress, and longitudinal component of train weight on grades. The longitudinal component of train weight can be calculated statistically knowing gross weight, grade, length of train, etc. (Carried as RRIS Accession No. 037597.)

Way, G. H. (Research Services, Planning Dept., C&O and B&O (Chessie) Railroads, Baltimore, Md., and Cleveland, Ohio), Test Report, May 1967, 22 pp, 7 figs., 2 tables, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Chessie Railroad Company (repr., PC).

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0958

SUITABILITY OF SIX-AXLE LOCOMOTIVES FOR C&O-B&O SERVICE--THE INTERACTION WITH TRACK STRUCTURE

A series of tests was conducted with 6-axle locomotives in heavy, coal drag service on Cranberry Grade to investigate the interaction of locomotive tractive power and track conditions. Particularly, the performance of 6-axle locomotives in this service was investigated to determine the relative merits of that design versus the 4-axle units previously used. Five major areas were found to be significant and completely interdependent: (1) locomotive wheel life with 6-axle units, (2) rail cleanliness affects locomotive adhesion, (3) the condition of the track and the rail govern overall acceptability of 6-axle locomotives, (4) operating practices covering the use of sand are related to increased wheel wear and increased track maintenance, (5) instrumented wheel tests to determine to what extent and under what circumstances the wheel and rail wear attributable to 6-axle locomotives exceeds that of 4-axle units, the effect of track surface on locomotive riding qualities, and the suitability of 6-axle locomotives. (Carried as RRIS Accession No. 040076.)

Schmidt, J. J. (C&O Railway, Cleveland, Ohio, B&O Railroad, Baltimore, Md.), Research Report, February 1966, 27 pp, 4 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Chessie Railroad Co. (repr., PC.)

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0959

RAIL LAID WITHOUT EXPANSION ALLOWANCE VS. RAIL LAID WITH NORMAL EXPANSION ALLOWANCE

The purpose of this test is to determine by service test the practicability and advantages of laying end-hardened rail without expansion allowance and with joints "frozen", as a means of reducing rail-end impact, noise, and batter. The design and laying of the test track is described. Walking inspections and observations of the test during the recording of field data have indicated superior surface and rail-end condition of the tight rail as compared with the standard. Riding the Aero Train, which was noticeably noisy, showed a lower level of joint noise on the tight rail. The joints in the tight rail have lost less camber than those in the standard rail. During 9 year's service it has been determined that rail laid without expansion offers reduction in joint bar wear and reduction in loss of joint camber as well as a better maintained track for equal expenditure. (Carried as RRIS Accession No. 040340.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 510, Progress Report, June 1958, 9 pp, 1 fig., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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0960

SOME FACTORS AFFECTING METAL DEFORMATION IN T-GROOVES FOR HEAVY RAILS

Rail quality depends equally on the conditions of deformation during rolling, heat treatment of the finished section, the alloying of the metal, etc. This paper deals with the aspects of deformation in depth during the rolling of rail heads which may be achieved by using thicker billets, reducing the compression of the metal within limits so as to not affect the conditions for the shaping of thick bars, increasing the height of the wedge in the bottom rolls, and its angle of evolution and radius of curvature (inside the limits set by the grooving of the metal at the rail head and base). A graph is shown which enables one to choose the desired degree of deformation in the base and the rail head for T-sections, and to select the appropriate compression. Schematic diagrams are provided which show the T-grooves with different profiles of the cutting wedge. The processes involved with the rolling mill practices as well as changes made in the operation for conducting experimental work are described.

Arshavskii, V. Z., and Stefanov, V. E. (Ukrainian Research Institute of Metals, and the Azovstal' Works, U.S.S.R.), Stal [in English], No. 9, September 1964, pp 718-721, 2 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0961

THE MELTING OF RAIL STEEL IN ELECTRIC FURNACES

This paper covers studies made for the purpose of investigating possible improvements in the service properties of rail steels produced in an electric furnace and the comparison of these rails with those produced from steel manufactured by the open-hearth furnace. The investigation involved the melting of M76 rail steel in a 60-ton electric furnace using the same process associated with the melting of Type B65 rail steel. The trial rails, as compared with the open-hearth steel rails, possessed high tensile strength, elongation, and area reduction. However, the melting furnace involved using aluminum for deoxidation which increased the amount of aluminum oxide and thus the level of nonmetallic inclusions. Data associated with the chemical properties, amount of stringers and their lengths, and mechanical properties are given. The conclusions were that there were no advantages with regard to life and reliability in the melting of rail steels by the electric furnace process over those produced by the standard production practice.

Derfel', A. G., Serookii, S. F., Tsaluiko, V. I., Sviridenko, F. F., Vistorvskii, N. T., and Dolinenko, O. V. (Ukrainian Scientific-Research Institute of Metals, U.S.S.R.), Steel in the USSR, No. 2, February 1972, pp 117-119, tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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0962

PLANE PROBLEM OF ELASTICITY THEORY FOR A RECTANGULAR RAIL OF FINITE LENGTH [IN RUSSIAN]

A new method of solving the plane problem of elasticity theory for a rectangular rail of finite length is proposed which makes it possible to better satisfy given boundary conditions for accurate solving of the basic equations of the plane problem of elasticity theory. The method can be expanded to the solution of the problem for a rail made of an anisotropic material. Solutions are provided for the equilibrium equations in lamellar displacements for a random plane deformation.

Deyev, V. M., Soprotivleniye Materialov i Teoriya Sooruzheniy, No. 13, 1971, pp 46-51, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kankin Bookstore (repr., PC).

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0963

THE EFFECT OF VACUUM DEGASSING ON THE QUALITY OF STEEL [IN POLISH]

Conditions associated with the need for vacuum degassing of rail steel are investigated. High volume of carbon and manganese increases the occurrence of flaking, and rail cracking is caused by the decrease in hydrogen solubility when the temperature is lowered. The latter condition is caused by a change in atomic state of hydrogen into a molecular state. An investigation is described in which steel was degassified using the D-H method, a search for a suitable deoxidation technology involving three series of melts was also undertaken. The chemical compositions of the metals were based on UIC-860 requirements. Data are plotted on curves showing the hydrogen content before and after degassing for melts involving different amounts of deoxidizers. During the period of degassing, 50 percent of the inherent oxygen was dissolved, which simultaneously eliminates most of the nonmetallic inclusions. Data are plotted which show differences in inclusion contents for nonkilled- and degassed-steels.

Kliniewicz, Z. (Instytut Metalurgii Zelaza-Gliwice), and Lipowczan, K., Huta-1 Maja, Poland), Wiadomosci Hutnicze, Vol 29, No. 9, 1973, pp 296-299, 3 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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0964

A METHOD FOR DEGASSING MOLTEN RAIL STEEL (UTS 90 KG/MM^2) [IN POLISH]

A jet method for degassing molten steel for use in high-tensile-strength rails is described. Results are compared with those obtained using the batch method of degassing. The important characteristic of the vacuum chamber which concerns the final pressures in the chambers and the relative efficiencies between the two methods of degassing are discussed. The vacuum-pump operational parameters are reviewed in connection with subsequent requirements of molten-metal heating temperatures. The chemical compositions of various rail steels are tabulated and the special mechanical properties of the finished rails are listed. Charts are provided that illustrate the distribution of hydrogen volume in degassed steel and temperature drops when each of the two methods is used. Interdependency between the volumes of hydrogen and vacuum pressures is illustrated. It was concluded that the application of jet degassing guarantees a 34 to 62 percent hydrogen reduction.

Mazanek, T. (Politechnika Slaska-Katowice), Kliniewicz, Z. (Instytut Metalurgii Zelaza-Gliwice), and Gudra, P. (Huta-1 Maja, Gliwice, Poland), Hutnik (Katowice), Vol 40, No. 1, 1973, pp 6-10, 6 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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0965

THE STRENGTH OF AN UNJOINED TRACK WITH R75 RAILS DURING TRACK MAINTENANCE OPERATIONS [IN RUSSIAN]

The strength characteristics of heavy duty (R75) rails were studied from the standpoint of rail maintenance of jointless track. A review of studies conducted by the Railroad Ministry's Central Scientific Research Institute showed that the supercritical temperature at which track fractures and ruptures occurs decreases when heavy rails are used. The dependencies of critical temperature on the displacement of tracks with reinforced concrete and wooden crossties, and certain aspects of curved tracks with and without elevation are examined. Simulations of track operations were conducted in the laboratory and the results of these experiments were correlated with those observed in the field. Practical recommendations covering the temperature conditions under which jointless track with R75 rails and calculations of rail strengths are presented.

Chirkov, N. S. (All-Union Scientific Research Institute of Railroad Transport), Vestnik Vsesoyuz Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 2, 1972, pp 35-38, 4 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kankin Bookstore (repr., PC).

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0966

PERFORMANCE OF A BATCH-SYSTEM VACUUM STEEL DEGASSING PLANT [IN POLISH]

The influence of principal parameters on the batch-vacuum degassing of rail steel is investigated. Among the parameters investigated are: degree of steel killing before degassing; total amount of steel in the vacuum chamber per unit processing; molten steel circulation coefficient; quality and quantity of alloy additions; pressure of the vacuum chamber; and the temperature and period of time involved in degassing. Information is provided in relation to the factors that affect the final hydrogen content of the steel. The processes that take place in the vacuum chamber during degassing are described in regard to increases in carbon dioxide pressure and the secondary reduction effect that occurs when alloying is done. Graphs are provided which present results of analyses conducted to determine the hydrogen volume and oxygen content. The influence of degassing on the oxygen content of the rails steel (St90PA) is tabulated.

Bialowas, W. (Instytut Metalurgii AGH, Krakow), and Kunick, H. (Kosciuszko Huta, Chorzow, Poland), Hutnik, No. 1, 1974, pp 11-14, 4 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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0967

THE INFLUENCE OF RIGIDITY OF A RAIL ON CUMULATION OF VERTICAL DEFORMATIONS OF A TRACK [IN POLISH]

The effects on the range of safe functioning of rail transportation as influenced by ballast deformation connected with the rigidity of the rail is discussed. The author examines and compares results of Soviet experiments with those he obtained through theoretical computation. Methods advocated by others who have studied the influences of rail rigidity, such as Kuznetsov and Obuchowice, are reviewed with applications to the S-60 and S-49 rails. Mathematical expressions for determining rail pressures on the ties and the safe range of rail-track operation based on permissible deformations are discussed. Tabular data are shown which reveal the dependence between rails types and track settlements. Charts are provided that involve the intensity of deformation, functions of rail loading, and maintenance factors.

Obuchowicz, B., Czasopismo Technicsne, Series Budownictwo, Vol 1, No. 162, 1973, pp 39-43, 3 figs., 5 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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0968

VIBRATIONS OF THE INDEFINITE BEAM ON AN ELASTIC FOUNDATION UNDER ACTION OF AN IRREGULAR WHEEL [IN GERMAN]

An introduction into the problem of the effect of noncircular wheels on rails is presented. Noncircular wheels are caused by braking operations of rail vehicles when the locked wheel slides over the rail and is ground down at the point of contact. The problem is presented as that of forced vibrations of an infinite beam on an elastic foundation and a system of two degrees of freedom. The method of integral transformations is used for solving of the differential equations. The author showed in previous work that the influence of the speed with which the wheel pressure moves over the rail can be disregarded for ordinary railroad vehicle speeds. The influence of the noncircular wheel is regarded in such a way that the distance between the wheel's center of gravity and the rail center line changes, and this may be caused by rail corrugations. In this regard, the author explores the use of the Hertz equation to obtain a relative approximation of the center of gravity of the wheel and the rail center line. The ultimate solution of the problem involves four mathematical expressions for the equilibrium conditions, the transverse vibration that applies to the rail, and an equation associated with the premise that the wheel remain in contact with the rail at all times. Numerical examples are given which point to the critical speed as being approximately 30 km/hr.

Fryba, L., Zeit. fuer Angew. Math. Mech., Vol 40, No. 4, April 1960, pp 170-184, 4 figs., 2 tables, 23 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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0969

LATERAL RAIL PRESSURES DUE TO LIGHT LOCOMOTIVE CONSISTS

A series of tests were performed to determine the lateral pressures against curved rail due to various light locomotive consists under various operating conditions. Analysis of the data indicates that an 8-unit consist generates somewhat higher lateral pressures than does a 5-unit consist. However, these pressures are less than half the pressures generated by head end and helper locomotive consists under heavy load. It was further noted that 6-axle light locomotives generate greater lateral pressures than 4-axle light locomotives by a factor of 30% to 60%, depending mainly on speed. The pressures due to dynamic braking are the same as or less than the pressures generated by the use of air brakes. In both cases, these pressures when braking are about the same as pressures when coasting around a curve. (Carried as RRIS Accession No. 037664.)

Luebke, R. W. (B&O and C&O Railroads, Research Services, Planning Dept., Baltimore, Md., and Cleveland, Ohio), Test Report, February 1967, 14 pp, 1 fig., 8 tables.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: C&O and B&O Railroads (repr., PC).

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0970

WHEEL-RAIL ADHESION

Wheel-rail adhesion has been the subject of vital interest to locomotive builders and the railroad. This area continued to receive considerable attention during the past decade due to the significant increase in horsepower available for traction of internally powered locomotives. For background information, this publication briefly reviews the factors that affect adhesion and some of the published data on available adhesion between locomotive wheels and rail as a function of speed. Instrumentation, testing procedure, and results of adhesion tests on an SD-45 locomotive are discussed, and developed adhesion versus speed curves for different operating conditions are presented.

Harta, H. A., and Mels, K. D. (General Motors Corporation, La Grange, Ill.), Journal of Engineering for Industry, Trans. of the ASME, Series B., Vol 9, No. 8, August 1969, pp 839-854, 6 figs., 1 table, 34 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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0971

PROCESS FOR HEAT TREATMENT OF RAIL HEADS [IN GERMAN]

Service life and wear of rails are described, as well as counter-measures taken by the railroad companies and steel manufacturers from the aspect of the materials used. The investigation included continuous heat treatment of rail heads S 49 by flame and induction hardening of steels used for switches (DB-TL 98/254), hardness and structural tests, tensile tests, impact tests, notch-impact bending tests, roll-slide wear tests, and fatigue tests. The residual stress pattern was determined by X-ray analysis. TTT-diagrams and end quench curves are given, also for wear-resistant steels of Grades B and C according to UIC 816. Specifications of the West German Federal Railroads for frogs are discussed.

Geiss, A. (Dept. of Mechanical Engineering, Technical University of Hannover, West Germany), Doctor of Engineering, Thesis, 1969, 102 pp, 92 figs., 4 tables, 62 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Technical University of Hannover (repr., PC).

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0972

SUPPRESSION OF STICK-SLIP-INDUCED NOISE OF RAIL CURVES BY PHYSICOCHEMICAL SURFACE TREATMENT [IN GERMAN]

An effective method of suppressing rail noise is a bonderizing process which provides the rails with coatings having cleaning properties. This raises the coefficient of friction, and the friction behavior becomes less dependent on the water vapor content of the air. For investigating the static friction behavior, a device was developed with which the differences between static and dynamic friction values were measured. The bonderized surfaces proved to be much more advantageous than the untreated surfaces, since these are highly subject to the effect of the external conditions.

Hubner, H. (Dept. of Material Sciences, Technical University of West Berlin, West Germany), Doctor of Engineering Thesis, 1973, 129 pp, 43 figs., 9 tables, 55 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Technical University of West Berlin (repr., PC).

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0973

DEFORMATION OF RAILS DURING STRAIGHTENING ON THE ROLL STRAIGHTENING MACHINE [IN GERMAN]

The deformation is significantly influenced by roll adjustment, initial height of the rail, and the material of which it is made. Plastic deformation during straightening leads to a decrease in rail height, an increase in the width of rail head and rail base, and shortening of the rail in the longitudinal direction. Numerical values are given for the dimensional changes.

Fromman, K. (Rheinisch-Westfalische Technical University, Aachen, West Germany), Dr.-Ing. thesis, 1965, 66 pp, 108 figs., 2 tables, 19 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Rheinisch-Westfalische Technical University (repr., PC).

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0974

THE RAILS OF THE WEST GERMAN FEDERAL RAILROADS--PRESENT-DAY QUESTIONS AND NEW DEVELOPMENTS [IN GERMAN]

The properties, service behavior, and economic aspects concerning mainly the S 49 and S 54 rails used by the German Railways are discussed. Because of the widely differing traffic conditions on first-class tracks, the use of S 54 (90) rails (minimum tensile strength = 90 kg/mm^2) for routes with high axle loads and high travelling speeds and of S 49 (90) rails for less heavily stressed routes is technologically reasonable and economically advisable.

Doll, A. (Bundesbahn-Zentralamt, Minden, West Germany), Eisenbahntechnische Rundschau, Vol 16, No. 10, 1967, pp 341-350, 10 figs., 4 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0975

MILLING AND PLANING MACHINES FOR THE MANUFACTURE OF SWITCH ASSEMBLIES FROM UIC 60 RAILS AND ZU 1-60 SWITCH TONGUES [IN GERMAN]

For the manufacture of the new switch assemblies made of UIC 60 rails and Zu 1-60 switch tongues (minimum tensile strength 900 N/mm^2) for track curvatures up to 2000-mm radius, a fully automatic NC portal milling machine and for the stock rails a semiautomatic portal planing machine for the switch tongue is used. The paper describes the production programs, the cost-savings incurred, and the design of the machines.

Heckner, J. (Bundesbahn-Zentralamt, Munich, West Germany), Eisenbahntechnische Rundschau, Vol 22, No. 10 & 11, 1973, pp 398-402 and 452-459, 14 figs., 2 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0976

WEAR-RESISTING RAIL STEEL (YESTERDAY AND TODAY) [IN GERMAN]

The paper describes the development of wear-resisting rail steels in Germany from the turn of the century to the present. In the first class tracks, S 49 and S 54 UIC rails of grade B were introduced in 1965. The supply requirements concerning steel specifications, production, and acceptance criteria are outlined for the normal and wear-resisting grades. The cutting and welding (aluminothermic and flash butt welding) problems associated with wear-resisting rail steels are investigated.

Koppen, H. (Bundesbahn-Zentralamt, Minden, West Germany), Eisenbahningenieur, Vol 19, No. 9, 1968, pp 256-258, 4 figs., 2 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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0977

TESTING OF RAILS BY THE BRITISH RAILWAYS [IN GERMAN]

A train for ultrasonic testing of rails was constructed from a 300-hp two-car diesel train; the cost of reconstruction amounted to £250,000. The network of main lines extending over 18,000 km is tested once a year. The testing speed is 32 km/hr, the daily target is 160 km. For each rail there are four test detectors which can locate defects up to a length of 3 mm. The sound recordings are photographed and evaluated centrally by experts.

Yearsley, I., Eisenbahner Ausg., Vol 26, No. 1, April 1973, pp 31-32, 1 fig.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: J. Keller-Verlag (repr., PC).

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0978

DYNAMIC EFFECT OF A FLAT WHEEL ON TRACK DEFORMATION [IN GERMAN]

A number of test runs were made with artificially produced flat spots between 50 and 100 mm long. The impact values due to bending stress on the rail and the pressure between the rail base and tie increase rapidly and reach a peak value at velocities between 20 and 30 km/hr; thereafter they begin to decrease until a velocity of 100 km/hr is reached. Up to a velocity of 200 km/hr, no noticeable rise in impact value is observed. The vibrational acceleration of the rail, tie, and ballast increases with velocity up to 50 km/hr.

Satoh, I., Monatsschrift IEKV (now Schienen der Welt), Vol 52, No. 11, 1965, pp 727-734, 13 figs., 2 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Int. Eisenbahner Kongress Vereinigung (repr., PC).

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0979

BALLAST IN RAILWAY TRACK

The functions and various tests for ballast as well as their qualities and requirements are described. The relationship between ballast cushion and pressure on formation is also discussed. A comparative study was made of Indian practice and that in other countries. Classical theory is used for the determination of the wheel load, which takes into consideration the effects of impact and adjacent wheel loads. Mathematical expressions for determining the relation between the sleeper load and the pressure on ballast are examined on the basis of studies conducted in Japan and the United Kingdom.

Sinha, N. (Railway Staff College, Baroda, India), Indian Railway Technical Bulletin, Vol 24, No. 164, February 1967, pp 15-26, 2 figs., 13 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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0980

DEVELOPMENT, PRODUCTION, AND PROPERTIES OF GROOVED RAILS [IN GERMAN]

Where rail and road vehicles use the same traffic area, the track has to be made of grooved rails. They are required mainly for streetcars but frequently also for railroad cars. Their development since 1832 is briefly described, as well as the rolling procedure and their technological properties.

Weber, L. (Friedr. Krupp Huttenwerk AG, Rheinhausen, West Germany), Eisenbahntechnische Rundschau, Vol 20, Nos. 1 & 2, 1971, pp 83-87, 10 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0981

MODERN INSPECTION AND MAINTENANCE METHODS INCREASE THE SAFETY ON RAILROADS [IN GERMAN]

Using EDP and modern testing techniques (ultrasonics, photoelectric cells) the British Railways are mechanizing the routine maintenance of vehicles and tracks, including the overhead lines on electrified routes. The acquired experience is passed on at a training center in Derby (Ultrasonics Training School) where railway personnel of several nationalities are trained.

Cooper, B. K., Eisenbahn-Techn. Praxis, Vol 23, No. 4, 1971, pp 30-33, 5 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Gewerkschaft der Eisenbahner (repr., PC).

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0982

SWITCHES WITH MOVABLE FROG POINTS OF UIC 60 RAIL PROFILE [IN GERMAN]

Switches with movable frog points improve safety and comfort in traveling at high speeds. The use of UIC 60 rail profiles also for switches was made necessary by the increase in axle load and running speed. The paper deals with spring-mounted frogs, articulated frogs, frogs with wedge-locked switch range and frogs on concrete. Test installations and trials are also reported.

Woltjen, H. (Bundesbahn-Zentralamt, Munich, West Germany), Eisenbahningenieur, Vol 24, No. 10, 1973, pp 301-302, 304, 8 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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0983

ADVANCED TECHNIQUES FOR SERVICING TRACKS [IN GERMAN]

The track inspection car designed for mechanical scanning and electronic evaluation measures changes in curvature and longitudinal level over extended distances and is combined with an analyzer which determines the cumulative frequency and the excess frequency of track defects. Using the Plasser and Karlsruhe repair techniques it is possible to service 2 km per shift and to recover rail lengths of 120 m. A new repair train is to achieve an operating speed of 500 m/hr. A machine operating without picks is designed to avoid scarification of the ballast bed due to lifting of the yoke in conventional machines. Tamping machines mounted on road-rail vehicles eliminate such hazards. Two-tie tamping and straightening machines are provided with recorders registering the camber and relative level of the ties.

Riebold, K. (Bundesbahn-Zentralamt, Minden, West Germany), Europa-Verkehr, Vol. 18, No. 2, 1970, pp 78-87, 11 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Otto Eisner (repr., PC).

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0984

CORRUGATIONS AND PITS IN ROLLING BODIES--ARE THEY CAUSED BY ULTRASONIC WAVES? [IN GERMAN]

The running surface of rail wheels tested for a period in a test rig shows corrugations in the form of periodically occurring spots whose distance are proportional to the test speed and depend on the resonant frequency excited in the wheel disk. The influence of the amplitude distribution of ultrasonic waves on the formation of transverse corrugations and periodically occurring pitted regions is described. It appears that the corrugations and possibly the pits, too, could be avoided if a method were found to dampen low-frequency vibrations and prevent the excitation and spreading of intensive ultrasonic fields in the contact region between wheel and rail.

Werner, K. (Bundesbahn-Zentralamt, Minden, West Germany), Eisenbahntechnische Rundschau, No. 4, April 1973, pp 142-149, 10 figs., 18 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0985

DEVELOPMENT TRENDS IN TRACK CONSTRUCTION [IN GERMAN]

The change from semi-flexible to fully flexible rail clip Skl 3 has paved the way for a track that is capable of withstanding higher axle loads and higher traveling speeds with smaller wheels. It will be necessary to use a rail shape S 70 instead of S 64 and a steel grade A with 0.6 to 0.75% C in order to reduce the maintenance cost of the track. For traveling speeds above 250 km/hr tracks carried on concrete decks are required.

Munch, W. (Bundesbahn-Zentralamt, Minden, West Germany), Railway Technical Review, No. 12, 1970, pp 22-30, 6 figs., 3 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0986

BEHAVIOR OF RAIL STEEL USED BY THE WEST GERMAN FEDERAL RAILROADS [IN GERMAN]

In the past two decades the West German Federal Railroads have increasingly used heavy rails of wear-resistant steels with a minimum tensile strength of 90 kg/mm^2. Since 1970 use has been made exclusively of wear-resistant rails of grade A, which differ from grade B in carbon and manganese content. This decision was determined by the favorable transformation behavior of grade A during welding. Details are given to prove the successful use of these rails. In the future rails with a minimum tensile strength of 100 kg/mm^2 will be needed.

Munch, W. (Bundesbahn-Zentralamt, Munich, West Germany), Eisenbahntechnische Rundschau, Vol 22, No. 6, 1973, pp 214-218, 8 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0987

A PRACTICAL SOLUTION FOR THE TORSION (TILTING) OF RAIL [IN JAPANESE]

This study presents a theoretical analysis of transversal deformation (horizontal bending and torsion) that occurs when wheel load (axial and lateral force) is exerted on the head of rail whose bottom is supported by elastic fastening devices positioned at a certain fixed interval.

Above all, the study demonstrates the fact, in view of torsion which has been hitherto regarded as a factor of secondary importance, that the influence of bending torsion is not negligible with regard to the torsion of rail, through numerical analysis with a practically applicable formula obtained for stress resulting from torsion and horizontal load of rail.

Hoshino, Y. (Dept. of Civil Engineering, Shibaura Institute of Technology, Japan), Proceedings of the Japan Society of Civil Engineers, No. 210, February 1973, pp 33-46, 16 figs, 3 tables, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Civil Engineers (repr., PC).

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0988

BASIC PROBLEMS OF ADHESION OF WHEEL-RAIL CONTACT IN HIGH SPEED [IN JAPANESE]

In relation to the systems for studying and developing railway systems capable of operating at higher speed than ever, the primary question is to what extent the travelling speed can be raised by the currently used system based on contact between wheels and rails.

This report discusses various factors relating to the phenomenon of basic adhesion which have become important, along with the higher operating speed of railway systems. The fundamental features of friction are reviewed with special attention being directed to phenomena occurring in the area of contact between wheels and rail.

Oyama, T. (Railway Technical Research Institute, Japan), Journal of Railway Engineering Research, Vol 30, No. 9, 1973, pp 457-465, 11 figs., 11 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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0989

FRICTION IN HIGH-SPEED ROLLING CONTACT OF WHEEL AND RAIL [IN JAPANESE]

Rolling contact between wheels and rail is discussed from a fundamental viewpoint.

The study includes a discussion of such elements as the contact area between the wheels and rails in relation to the higher operating speed of railway trains, slip and friction, basic theories on rolling contact which transmits tangential force, and friction under rolling contact, as well as related experimental studies.

Maruyama, H., and Oyama, T. (Railway Technical Research Institute, Japan), Journal of the Japan Society of Mechanical Engineers, Vol 76, No. 650, 1973, pp 217-225, 7 figs., 81 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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0990

CORRUGATION-RESISTING METHOD OF THE RAILWAY TRACK MATERIALS [IN JAPANESE]

A report is presented in two types of vibration-proof rail developed as a means of reducing the vibration and noise, and rail corrugation generated as a result of higher operating speed of trains.

In the study, the strength and noise-reduction effects of each type of rail are examined, together with a survey of material tests of the vibration-proof rubber damping. The results of the examination indicate that the two types of rail have sufficient strength, that the vibration-proof damping rubber ensures safety and reliability, and that the noise level outside the car travelling on the vibration-proof rails is found to be lower by approximately four decibels than that on the ordinary rail, both on the elevated track section and the bridge section.

Ono, Y. (Institute of National Railway Engineering Research), Journal of Railway Engineering Research, Vol 27, No. 1, 1970, pp 475-481, 9 figs., 6 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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0991

VIBRATIONS OF THE RAILWAY TRACK IN THE SOLID BED AND DEVELOPMENT OF CORRUGATED WEAR IN THE RAILS [IN JAPANESE]

This study deals with the results obtained through a survey of rails in a tunnel with respect to corrugation that develops in rail running surfaces on railway tracks laid on solid bed.

As a train travels at the speed of 70 to 90 km/hr, vibrating forces of the order of 50Hz are exerted on the rail and develop a groove-type wear on them. The authors attribute corrugation to the vibration of the wheels and thus consider that the unevenness on the running surface of the rail caused by impacts on it and that the resulting vibration in the contact area cause corrugation.

Ono, K., and Ito, I. (Dept. of Civil Engineering, University of Kanazawa, Japan), Proceedings of the Japan Society of Civil Engineers, No. 203, July 1972, pp 53-65, 31 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Civil Engineers (repr., PC).

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0992

INSULATION OF TRACKS FOR AVOIDING STRAY CURRENTS ON RAILWAYS OPERATING ON DIRECT CURRENT [IN GERMAN]

The direct current for operating subways may lead to serious corrosion, in particular of the tunnel reinforcements The E-committee of the VOV has, in a 3 years' effort, worked out recommendations for methods of reducing the danger of corrosion due to stray currents. The contamination of the track bed and the salt-containing snow thawing off the undercarriages increase the risk in occurrence of stray currents. A description of rail insulation is given. The insulation does not cost much and has proved to be successful in Cologne.

Schumacher, H., and Tabert, P., Mahverk. Praxis, Vol 14, No. 12, 1966, pp 438 and 440, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ernst Arnold GmbH (repr., PC).

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0993

NEW METHOD OF DETERMINING THE SERVICE LIFE OF RAILS [IN GERMAN]

The author describes a new method for determining the service life of rails, which takes into account the fatigue stresses with stress cycles of various amplitudes which occur during operation. The method distinguishes between fatigue fractures originating in the rail head and those originating in the rail base. This method of calculation permits a statement to be made about the permissible axle loads and wheel diameters. The method is based on a statistical survey of the frequency of the various fatigue stresses as well as on tests to determine the strength values of the rails.

Hanna, A. N. (Technical University of Munich, West Germany), Osterreichische Ingenieur Zeitschr., Vol 12, No. 11, 1969, pp 384-388, 3 figs., 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Springer-Verlag/Vienna (repr., PC).

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0994

RAIL LUBRICATION IN THE AUSTRIAN FEDERAL RAILROADS [IN GERMAN]

In 1965, the Austrian Federal Railroads (OBB) began to equip track sections with rail-lubricating devices where severe wear was observed on the sides of the rail head in the outer curved rail. The various methods of rail lubrication, the lubricating device, and the positive results achieved with it are described. Calculations show that the service life of rails was increased by about 10 years and that the lubrication of rails and wheel flanges is very economical.

Czuba, W. (OBB-Austrian Federal Railroads, Vienna, Austria), OBB in Wort und Bild, No. 4, 1973, pp 13-16, 4 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Austrian Federal Railroads (repr., PC).

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0995

SUBWAY-EXPERIMENTS CONCERNING INTERACTION OF WHEEL AND RAIL WITH RESPECT TO NOISE GENERATION, RUNNING BEHAVIOR, SHOCK TRANSMISSION, FRICTION, WEAR AND FORMATION OF CORRUGATIONS [IN GERMAN]

Wheel sets and tracks were investigated to study the phenomena between wheel and rail with respect to noise generation, running behavior, shock transmission, friction, wear, and formation of corrugations. The results are reproducible. Eight different types of wheels are compared in terms of sound emission, lightweight construction, running behavior, and shock degradation. Reference measurements showed that the running smoothness is affected only by the wheel profile and not by the wheel construction. Formation of corrugations and maintenance of the adhesive properties of rails are also treated.

Bulgarcic, H. (Hamburger Hochbahn AG, Hamburg, West Germany), Leichtbau der Verkehrsfahrzeuge, Vol 17, Nos. 5 & 6, 1973, pp 119-130, 24 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Ernst Kieser KG, (repr., PC).

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0996

A CONTRIBUTION TO THE DEVELOPMENT OF SWITCHES FOR HIGH-SPEED TRAFFIC [IN GERMAN]

The increase in traveling speed to more than 200 km/hr has called for new types of switches. The article outlines the dependence of the design of tracks and switches on the local service conditions, the track gauge, and the geological, climatic, and economic conditions in various countries. Preliminary experiments at high speeds, relating to the load-carrying capacity of tongues and frogs in switches, have been carried out on the route Paris-Dijon. Several frog designs intended to reduce the load exerted by the wheel flange on the frog gaps are presented, e.g., movable frog tips and wedge-locked frog gaps.

Topp, G. (Rheinstahl AG, West Germany), Rheinstahl-Technik, Vol 11, No. 1, 1973, pp 92-95, 12 figs., 1 table.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Rheinstahl AG (repr., PC).

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0997

LAYERS OF REACTION PRODUCTS ON THE RUNNING SURFACES OF RAILS [IN GERMAN]

The reactions products on the running surfaces of rails resulting from frictional oxidation under various atmospheric and laboratory conditions have been examined by X-ray diffraction analysis. Under atmospheric conditions the reaction products comprised SiO_2, alpha-Fe, alpha-Fe_2O_3, Fe_3O_4, alpha-FeO(OH) and gamma-FeO(OH) with SiO_2 while under laboratory conditions they comprised alpha-Fe, alpha-Fe_2O_3 and Fe_3O_4. A definite relationship is found to exist between atmospheric humidity and the formation of these products. The mechanism and the kinetics of oxide and hydroxide formation are affected by the degree of deformation.

Krause, H. (Institut fur Fordertechnik und Schienenfahrzeuge der Technischen Hochschule Aachen, West Germany), Industrieanzeiger, Vol 89, No. 11, November 1967, pp 1935-1938, 3 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: W. Girardet (repr., PC).

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0998

ON THE DEVELOPMENT AND IMPROVEMENT OF THE QUALITY AND SERVICE PROPERTIES OF PRESENT-DAY RAIL STEELS [IN GERMAN]

Following a survey of the most important service properties of rails, the progress made in manufacture and testing is discussed. The resulting development of different properties and the behavior of the rail up to the present state of development are described and illustrated by diagrams.

Heller, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Eisenbahntechnische Rundschau, Vol 20, Nos. 1 & 2, 1971, pp 71-78, 14 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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0999

RAIL PRODUCTION AND DEVELOPMENT IN GREAT BRITAIN, THE UNITED STATES OF AMERICA, CANADA AND JAPAN [IN GERMAN]

The author points out the different normal lengths of rails used in Great Britain, the USA, Canada, and Japan and discusses the steel making practices, the varying specifications of chemical composition and mechanical properties and the consequences resulting from these differences. An attempt is made to establish a relationship between rail defects and their causes and the effects of different production methods, standard values, and process variables in the different countries. A discussion on heat-treatment practices and properties of American and Japanese special-quality rail steels is presented.

Heller, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Stahl und Eisen, Vol 90, No. 17, August 1970, pp 922-928, 11 figs., 5 tables, 3 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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1000

DAMAGE ON RAILS AND SWITCHES [IN GERMAN]

An investigation of the damage on railroad rails and switches shows that the most frequent damages are fatigue fractures in the form of shelling of inner edges and transverse fractures. Since the conventional high-strength rails are no longer adequate for tracks subjected to great stresses, new special-quality rails with a yield strength greater than 600 N/mm^2 were developed and have already been used with success.

Laisner, H., and Schossmann, R. (Voest Alpine A. G., Leoben and Donawitz, Vienna, Austria), Berg- und Huttenmann. Monatsh., Vol 119, No. 7, 1974, pp 268-275, 22 figs., 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Springer-Verlag (repr., PC).

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1001

WEAR RESISTANT FROGS FOR RAILWAY POINTS [IN GERMAN]

The requirements to be met by steel frogs for railway points are outlined and the mechanical properties and wear behavior of the materials used for the frog (i.e., 50CrV4-grade steel), connecting and guardrails (e.g., Alpine SWMo-grade steel), and line plates (St 37 M-grade steel) are considered. The submerged-arc-welding fabrication of the frogs is described and the repair buildup welding of frog surface defects is discussed.

Moser, A. H., and Laizner, H. von (Osterreichisch-Alpine-Montangesellschaft, Zeltweg-Donawitz, Austria), Berg- und Huttenmann. Monatsh., Vol 117, No. 11, November 1972, pp 438-445, 9 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Springer-Verlag (repr., PC).

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1002

A CONTRIBUTION FOR DETERMINING THE PERMISSIBLE SERVICE LIFE OF RAILS [IN GERMAN]

For the rail shapes S 49, S 54, UIC 54, UIC 60 and UIC 64 of continuously welded track, the stresses in the rail base were investigated with regard to the nature of the track, the temperature, the residual stresses, the tie spacing, the traveling speed and the service load. In addition, the permissible number of load cycles under constant loading and the service life of the rail under different loads were determined by means of Miner's hypothesis. The limits of the load-carrying capacity of rail shapes S 49 to S 54 are shown. Freight trains with the axle load of 25 t and a traveling speed of 100 km/hr require the use of UIC 60 rails with a tensile strength of 90 kg/mm^2.

Kopp, E. (Dept. of Construction Engineering, Technical University of Munich, West Germany), Doctor of Engineering Thesis No. 14, 1970, 58 pp, figs., tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Technical University of Munich (repr., PC).

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1003

DETECTION OF FLAWS AND CRACKS IN METALS [IN GERMAN]

The Admiralty Materials Laboratory (AML), Poole, Dorset, U.K., developed a device called "Amlec" with which flaws can be detected below protective coatings having a thickness of more than 1 mm. The device can also be used for detecting cracks in rails at speeds of up to 50 km/hr. Several British companies modified the device. Daws Instruments Ltd. developed an ultrasonic flaw detector (Type 8000A) for testing welded joints.

Lee, J., Metall, Vol 25, No. 8, 1971, pp 879-880, 3 figs., 5 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Metall-Verlag (repr., PC).

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1004

ULTRASONIC NONDESTRUCTIVE TESTING ON RAILWAYS [IN GERMAN]

Ultrasonic testing of axles has become part of the routine maintenance work. Rails are tested in the workshop as well on the tracks with inspection vehicles. Test methods and auxiliary equipment developed by the West German Federal Railroads are described.

Egelkraut, K. (Bundesbahnversuchsanstalt, Minden, West Germany), Railway Technical Review, No. 12, 1970, pp 32-39, 6 figs., 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1005

ULTRASONIC TESTING OF RAILS [IN GERMAN]

For more than ten years the West German Federal Railroads have used ultrasonic detectors for testing rails with respect to inner flaws and cracks. With these devices extensive experience has been gained, which supplements the results published earlier. Description of the new devices and auxiliaries used for these tests is given. Improvements that can be achieved by their use include: increased speed of testing, possibility of testing with an inspection car in both directions without having to turn around.

Egelkraut, K. (Bundesbahn-Zentralamt, Minden, West Germany), Eisenbahn-technische Rundschau, Vol 14, Nos. 1 & 2, 1965, pp 49-59, 35 figs., 4 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1006

UNIVERSAL TRACK-MEASURING CAR FOR RAILROADS [IN GERMAN]

An electronic track-measuring and experimentation car for measuring tracks in the Austrian Federal Railroads (OBB) network was developed as early as 1962. The new OBB car makes it possible to detect flaws in the railroad track even at high speeds. Exact values were registered even at a speed of 170 km/hr. Some of the track variables that can be recorded and measured are: rail surface (corrugations, chatter marks etc.), height differences between the two rails, distortions, and changes in curvatures. The car covers all main routes of the OBB (3,500 km) in 9 days. The results achieved with this new vehicle show that track measurement with mechanical means has no future. The OBB car contains, among other things, the following equipment: two-time-eleven multichannel recorder, universally usable carrier-frequency bridges, additional filters, analogue computer, and classifying units.

Schenkir, L., and Dultinger, J. (OBB-Austrian Federal Railroads), Eisenbahntechnik, Vol 3, No. 3, 1968, pp 107-112, 5 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Rud. Bohmann (repr., PC).

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1007

RECENT TRENDS IN TRACK RESEARCH ON INDIAN RAILWAYS: PART III--STANDARDIZATION OF "TWO-LOAD" METHOD OF TEST DETERMINING TRACK MODULII; RDSO DEPRESSOMETER--FOR MEASUREMENT OF TRACK DEPRESSION DUE TO STATIC LOAD; MODIFIED DIPLORRY-LOADING UNIT

This article covers the procedure and instrumentation used for determining track modulus. The RDSO (Research Design and Standards Organization) depressometer described in this paper is an instrument used to measure track deflection. A modified BG diplorry is described as embodying

a measuring wheel through which the load is brought to the rail and it is the test vehicle. The author reviews previous articles on the subject of the "two-load method" and his studies of track modulus and bending stresses on the rail. The depressometer and its application to measurement of track deflection are discussed and some data which have been obtained are presented.

Ramakrishna, H. S. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 24, No. 164, February 1967, pp 27-33, 8 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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1008

FORMING PARAMETERS IN RAIL GROOVE DESIGN [IN GERMAN]

Trends in the manufacture of rails and methods of improving the rail steel quality are discussed. The author studies problems of rolling rails with weights from 7 to more than 50 kg/m using different groove designs, all based on the system of vertical groove design which makes it difficult to obtain a rail with proper dimensions and well-defined foot and head. Change from the system of vertical groove design to diagonal groove design results in a substantial improvement of the rail quality. Forming parameters used in rail groove design such as finishing groove, selection of elongation, groove width, web dimensions, open and closed groove foot and head sections, design of cutting groove, groove rounding, design of edging groove, first and second primary grooves, cross-sectional dimensions of initial pass, and groove design for a rail 54.03 kg/m are investigated.

Causevic, M. (Metallurgical Institute Zenica, Yugoslavia), Kalibreur, No. 17, pp 43-74, 1972, 24 figs., 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Kalibreur (repr., PC).

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1009

ADHESION CONTROL IN HIGH-SPEED WHEEL-RAIL INTERACTION

This paper presents experimental findings on a rolling contact apparatus and discusses a potential approach for improving the adhesion limits at high speeds by controlling the microvibrations in the contact area. The work of the author and others is briefly reviewed on the subject of adhesion to emphasize that the use of foreign materials in the contact area as well as plasma torch cleaning involves the low-speed regimes as opposed to high-speed wheel-rail interactions. In the author's earlier papers he reported on experimental work that led him to believe that the effect of vehicle speed on creep and adhesion was due to the microvibrations in the rolling contact area. The experimental apparatus is shown pictorially and the operational aspects are described. The data from experimental investigations were analyzed and are presented in graphical form.

Paul, I. L. (Massachusetts Institute of Technology, Cambridge, Mass.), Paper No. 1522, presented at the Joint ASCE-ASME Transportation Meeting, Seattle, Wash., July 26-30, 1971, 27 pp, 11 figs., 1 table, 21 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC, microfilm).

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1010

FIELD EVALUATION OF 130 LB PS 39 FT ROLLED RAIL

It was the purpose of the test to determine by service if briquetted sponge iron scrap used in the manufacture of steel rail instead of the usual steel scrap would develop any advantage or superiority from the standpoint of wear or other service conditions. The rails were laid alternating five special and five ordinary rails on the outer and inner sides of curve. After a service of 13 months, and immediately before removal from track, measurements of head wear were taken on 12 special and 12 comparative rails (6 high and 6 low) around the curve. This test has shown considerable

increased wear on an 8 deg 00/min curve in heavy traffic territory for 130-lb PS open-hearth rail manufactured with briquetted sponge iron scrap compared with same weight and process rail manufactured by regular products which include scrap steel. (Carried as RRIS Accession No. 040794.)

Boyd, J. K. (Penn Central Transportation Company, Philadelphia, Pa.), Final Report, Test No. 102, January 1949, 3 pp, 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Railroad Company (repr., PC).

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1011

CORRUGATIONS ON RAILS, THEIR INVESTIGATION AND PREVENTION, PART II: STUDY OF MATERIALS AND REMEDIAL MEASURES [IN GERMAN]

The formation of corrugations on rails is caused by vibrations in connection with certain mechanical and chemical characteristics of the rail material. In order to determine the relationship more exactly, a large experimental track section was established in 1951. It was found that procedures in the production and treatment of rail steel have a definite influence on the formation of corrugations. In connection with these results, the author discusses theory for the formation of corrugations by means of segregations in the rail steel, a physicochemical approach to the interaction between wheel and rail, and results of wear research relating to the formation of corrugations. Recommended remedial measures are reducing the buffeting of tires, reducing the frictional vibrations by decreasing the differences between the wheel diameters, adopting the appropriate rail manufacturing practice, and grinding and planing rails that already are corrugated. A review of the development of the railroad and its structural components illustrates the relationship between the advances in rail traffic and the formation of corrugations.

Birmann, F. (Bundesbahn-Zentralamt, Munich, West Germany), VDI Zeitschrift, Vol 100, No. 30, October 1958, pp 1453-1462, 38 figs., 1 table, 33 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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1012

CORRUGATION ON RAILS, THEIR INVESTIGATION AND PREVENTION, PART I: VIBRATION STUDIES [IN GERMAN]

The German Federal Railroads established special experimental track sections, employed the necessary vehicles and measuring instruments, and used statistical data to investigate the problem of formation of corrugations on rails. The paper first describes the types and occurrence of rail corrugations and then reports on the investigations into the causes which have, in more recent times, shifted from purely mechanical to physicochemical aspects. The German Federal Railroads are investigating the corrugation problem from the aspects of vehicle technology, track engineering, and materials engineering. The paper covers investigations of vibrations in tracks, wheels, and wheel sets, and studies concerning the Hertzian area and on test runs with wheels of different sizes. The importance of the rail material is emphasized.

Birmann, F. (Bundesbahn-Zentralamt, Munich, W. Germany), VDI Zeitschrift, Vol 100, No. 26, 1958, pp 1253-1262, 31 figs., 4 tables, 37 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: VDI Verlag GmbH (repr., PC).

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1013

ELIMINATION OF RAIL CORRUGATIONS [IN GERMAN]

The West German Federal Railroads eliminated surface damage to the rail head first by means of the Krupp grinding train consisting of one car with a power generating set and three cars equipped with rotating, elastically suspended grinding wheels, later by means of the Schorling grinding train with four grinding cars, each provided with four pairs of grinding stones 70 cm in length. Since 1970 the much more rapid Speno grinding train was used which reaches 15 km/day or 5000 km/year at an operating speed of 6 to 7 km/hr. The train consists of nine grinding cars with 58 rotating, tiltable grinding wheels, one car with a power generating set, one control car and one accommodation car. The treatment includes running surface and running edge. In 1971 a track length of 3555 km was treated on a grinding travel of 4875 km.

Van Harlem, D., Eisenbahn Magazin, Vol 12, No. 3, March 1974, pp 14-16, 6 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Alf Teloeken Verlag KG (repr., PC).

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1014

CONFERENCE ON TRACK CONSTRUCTION, SEPTEMBER 1970 [IN GERMAN]

The Conference on Track Construction held in Essen, West Germany, in September, 1970, is briefly described:

W. Heller reported on the quality and service properties of present-day rail steels: wear behavior, resistance to plastic deformation, resistance to breakage of the running edge of rails, homogeneity and impurity content, resistance to brittle fracture, and weldability.

F. Weber dealt with the manufacture of rails, in particular with the formation of stress cracks in rails of wear-resisting grades and their prevention, the rolling procedures, and the test methods.

J. Eisenmann discussed the research results concerning stressing of rails and tracks. The topics covered are the stress in the rail head, the bending stress in the rail base, and the dependence of the stress on wheel load and wheel diameter.

L. Weber's report on development, manufacture, and properties of grooved rails dealt with the state of the art, the weldability, and the rolling of grooved rails.

H. Schmedders and H. Biensteisler reported on the improvement of steel ties for first-class tracks and discussed in detail the use of steel caps for ties.

Heller, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, W. Germany), Stahl und Eisen, Vol 91, No. 7, April 1971, pp 399-403, 9 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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1015

INVESTIGATION OF RAIL HEAD HARDNESS

Transverse rail head specimens were taken from three pieces of rail, 131-, 140-, and 155-lb sections received for examination of failure. Hardness readings were taken from the running surface toward the interior of the rail head for a distance of approximately 1/2 in. The hardness on the gauge side was usually maximum at 1/16 to 3/32 in. below the running surface, with slightly lower hardness between this point and the surface of the rail head. It is concluded that where rails have experienced sufficient traffic under heavy loads to develop approximately 1/8 in. head wear the hardened metal resulting from cold work extends 1/8 to 3/16 in. below the surface with a maximum hardness at a depth of 1/16 to 3/32 in. Rail grinding to a depth of .007 to .010 in. should cause no anxiety with respect to loss of surface hardness with such rails. (Carried as RRIS Accession No. 040292.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 745, April 1960, 2 pp.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1016

FLAME HARDENED AND HEAT TREATED STOCK RAILS

Flame-hardened and heat-treated stock rails were installed at locations where the open-hearth stock rail had shown short life due to excessive wear, primarily flange wear. Flame hardening and heat treating produced a Brinell hardness on the rail head of approximately 350. Both the flame-hardened and heat-treated stock rails gave better performance than the open-hearth stock rail; however, the flame-hardening process resulted in considerable vertical distortion of the stock rail, as much as 5 ft in 60-ft. As a result, this type of hardening was discontinued. While this test was installed initially to investigate the reduction in flange wear, the use of heat-treated stock rails to date and the results of

heat-treated rails used for other purposes indicate that they provide greatly increased life and reduced maintenance as compared with ordinary stock rails where crushing and plastic flow cause frequent renewal. (Carried as RRIS Accession No. 040282.)

Code, C. J. (Penn Central Transportation Company, Philadelphia, Pa.), Test Report No. 608, April 1960, 10 pp, 1 table, 6 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1017

FIELD END HARDENING OF RAIL BY THE AIR REDUCTION COMPANY METHOD

Two and seven-tenths miles of 140-lb PS rail, laid in No. 3 track was utilized for this test. End hardening rail in track was completed on June 15, 1953, in conjunction with the laying of new 140-lb PS rail. A total of 279 joints were hardened at a cost of $0.39 per joint. The high temperatures necessary for the end-hardening process had a damaging effect on the No-Ox-Id protective coating applied to the rail web in the joint area. The heat treatment caused an average increase in Brinell hardness of about 50 points. A visual inspection of the test stretch in 1959 confirmed previous observations that mill end-hardened rail was more resistant to impact and had fewer battered joints than did either of the other two types. In view of the fact that mill end-hardened rail is now available from all mills serving the Pennsylvania Railroad there is no advantage to be gained from end hardening new rail in the field, except as indicated above for cut ends in continuous welded rail. (Carried as RRIS Accession No. 040287.)

Code, C. J. (Penn Central Transportation Company, Philadelphia, Pa.), Test Report No. 620, February 1960, 22 pp, 11 figs., 2 tables, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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1018

QUALITY RAILS MADE OF CONTINUOUSLY CAST CONVERTER STEEL [IN GERMAN]

The development of high-performance oxygen furnaces for steel production and the improvement of rolling equipment which permits the processing of large billets are discussed. It is noted that for large billets, the structural and chemical inhomogeneity increases, and this may contribute to the development of fatigue cracks. The use of continuously cast rail steel is of particular interest because of the product's fine crystalline structure which provides a favorable degree of nonmetallic inclusion distribution and high chemical and structural homogeneity. The melting technology for continuous casting of K-76 rail steel was developed at the Central Institute of Ferric Metallurgy of the U.S.S.R. in cooperation with the Novotulskii Metallurgical works. The rolling-mill practice associated with the rail fabrication is described. Tests were conducted to determine the distribution of nonmetallic inclusions and mechanical properties. Fatigue-strength tests were conducted and the details concerning the resulting data are discussed. Comparisons are made between the rails produced through the use of continuous casting and those produced by conventional methods. Some economical aspects of the process are discussed and monetary savings are mentioned.

Lempitzkij, W. W., Gurskij, G. L., Wlasov, W. I., Poljakov, W. W., and Kan, J. E. (Central Institute of Ferric Metallurgy, Novotulskii Metallurgical Works, Nishne-Tagil Metallurgical Combine, U.S.S.R.), Neue Hutte, Vol 18, No. 1, January 1973, pp 52-53, 2 figs., 4 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Veb Deutscher Verlag Fuer Grundstoffindustrie (repr., PC).

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1019

CORROSION-RESISTING RAIL [IN JAPANESE]

This study deals with electrolytic corrosion of an F-shaped tie plate in relation to the rail. Electrolytic corrosion is reduced as the voltage of rail to ground is lowered. As a method of lowering the voltage, the study expounds on a theory that it is

necessary to shorten the distance between one transformer substation and another or to set up an electrical circuit, other than the rail, for feedback of electricity to a substation.

The routes for leakage current and those points where electrolytic corrosion is apt to take place are also discussed. Covering the tie plate with nylon coating is an effective way to increase leakage resistance. If metal material is to be used for preventing electrolytic corrosion, stainless steel containing 13% chromium or above will be required.

Tsukamoto, K., Hirata, I., Arai, S., Chino, S., Sawada, T., Ito, Y., and Umekubo, S. (Institute of National Railway Engineering Research), Journal of Railway Engineering Research, Vol 28, No. 10, 1971, pp 38-45, 6 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (JNR) (repr., PC).

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1020

HEIGHT-OF-DROP IN IMPACT TESTS ON RAILS OF ANY SECTION [IN GERMAN]

On the basis of experimental results and theoretical considerations, a method is suggested for calculating the height-of-drop for the same maximum value of deformation work done per unit volume, irrespective of the configuration of the profile. The height-of-drop for flat-bottomed, filled section, crane, tongue or a live rail can be obtained from the following equations: $h = 0.168w/e$ (in case of two impacts of similar strength); and $h = 0.240w/e$ (in case of a single impact), where h represents the height-of-drop in meters, w the moment of resistance in cm^3, and e the distance between the neutral and furthermost peripheral axis in cm. The height-of-drop values in the case of flat-bottomed rails correspond to those mentioned in the UIC supply-specification 860.

Wink, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Stahl und Eisen, Vol 87, No. 13, June 29, 1967, pp 788-792, 2 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen (repr., PC).

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1021

INVESTIGATIONS INTO THE SERVICE BEHAVIOR OF RAIL STEEL [IN GERMAN]

Introduction of ultrasonic testing has led to a significant reduction of fatigue damage in normal-grade rails of basic converter steel, but such damage continues to occur in wear-resistant rails under high stresses, e.g., in narrow curved tracks. Examination of outer rails at curves with good and poor service life showed that for steels with low inclusion content the tensile strength and, consequently, the fatigue strength determine the service behavior. In the tensile strength range between 700 and 1400 N/mm^2 the fatigue strength increases linearly with the tensile strength. Service experience shows that it is advisable to use rails of wear-resisting grades if normal quality rails exhibit fatigue damage without showing signs of damage by ultrasonic inspection, and to use rails of special grades with a minimum tensile strength of 1100 N/mm^2 if rails of wear-resisting grades exhibit fatigue damage.

Heller, W., and Schweitzer, R. (Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Archiv fur Eisenbahn-Technik, No. 28, 1973, pp 81-89, 18 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1022

140-LB. RAILS OF FINE GRAIN STEEL (ALUMINUM ADDED TO THE INGOT)

The purpose of this test was to determine whether inherently fine-grain steel will resist shelling better than rails of ordinary steel. The test installation was inspected frequently, and it was observed that the fine-grain and ordinary rails performed nearly alike. In 18 months' time the flaking and head checks were much in evidence, and after 2 years of service, head checking and flaking were well advanced. A derailment in November 1956 damaged three of the fine-grain rails. A previous laboratory examination of the rails had revealed that the fine-grain steel had practically the same mechanical properties as the coarse-grain steel as measured by tensile tests and Brinell hardness. It was concluded that fine-grain steel

produced by addition of aluminum to the ingot as used in this test offers no advantage for use in rails. (Carried as RRIS Accession No. 040277.)

Code, C. J. (Penn Central Transportation Company, Philadelphia, Pa.), Test Report No. 588, December 1959, 9 pp., 2 figs., 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr , PC).

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1023

ALLOY STEEL RAIL (CHROME-VANADIUM OR "CV")

The CV rail was laid in October 1953 in connection with regular rail renewals. The location was selected because it was one where moderate shelling had developed in the previous 131-lb rail over a period of about 11 years. A total of 47 CV rails were laid--16 on the low side and 31 on the high side of the curve. Gauge superelevation, ordinates, and rail-head wear were measured. A final inspection of CV rail was made on October 29, 1959, at which time 30 CV rails remained in track. There was no indication of shelling, although some flaking was noted on the CV rail, and there was no indication of rail end defects. The results of this test have shown the CV alloy steel of the composition used to be unreliable. Its good wearing qualities and superior resistance to shelling are overshadowed by its poor resistance to impact. (Carried as RRIS Accession No. 040281.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 645, January 1960, 23 pp., 3 figs., 15 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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1024

INVESTIGATING THE EFFECT OF THERMO-MECHANICAL TREATMENT ON THE PROPERTIES OF RAILS

A method has been worked out at the Kuznetsk Metallurgical Combine for rolling rails, in which provision is made for a high degree of deformation of the section head in a universal pass, with subsequent hardening of the rolled surface of the rail head. The possibilities of the new method of strengthening are demonstrated. The rolling of rails in the universal pass with the application of thermomechanical treatment leads to an improvement (refining) of the structure and to enhanced mechanical properties. The strength properties of the rails are at the level of oil-quenched rails, tempered at 450°C, and the plastic properties are higher.

Nekrasov, S. G., Chelyshev, N. A., Gossman, A. A., Kobyzev, V. K., and Voroshilshchev, V. I. (Siberian Metallurgical Institute, U.S.S.R), Steel in the USSR, No. 10, October 1974, pp 93-95, 2 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: British Steel Institute and The Metals Society (repr., PC).

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1025

INVESTIGATION OF RAIL HEATING AND THERMAL CONDITIONS IN CONTINUOUS ROLLER-HEARTH FURNACES

A study has been made of temperature distribution across the individual P-65 type, 25-m long rails heated in batches of 14 in the quench section (186.6 m, 7 zones) and tempering section (262 m, 10 zones) of continuous roller-hearth furnaces in a line for through-hardening rails at the Nizhne-Tagil' works. The thermal balance in the quench section was analyzed on a zone-by-zone basis together with the injection burners. Data collected on the maximum temperature gradients in the rail batches have been used to develop a system for more even heating of the rails and more rapid transfer of the rails from one zone to the

next. It has also been possible to raise the furnace productivity from 115 to 134 tons/hr. The results of the calculations show good agreement with measurements during actual heating.

Leont'ev, V. A., and Kobyakov, P. V. (All-Union Scientific Research Institute of Metallurgical Heat Technology, U.S.S.R.), Steel in the USSR, Vol 2, No. 8, August 1972, pp 758-763, 5 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1026

THE PRINCIPAL METHODS USED TO INCREASE THE EFFICIENT UTILIZATION OF THE RAILS OF THE SOVIET RAILROADS [IN GERMAN]

In the USSR, rails of 51.6 (R50), 64.6 (R65), and 74.4 (R75) kg/m are used. The weight percentage of rail R65 was nearly 70 in 1972. For this rail the tolerable traffic volume is 500 million tons before it is replaced. The use of welded rail joints, compensating plates with rubber elements, regular rail grinding, lubrication of wheel flanges and rails, and constant control of the flat spots on wheels increase the service life even further. Since 1972, the R65 rails have been fully hardened, which increases the rail life by 50%. Further improvements are expected to result from the use of a new material and a change in the profile of the running surface.

Albrecht, V. G., and Maientiev, L. P., Schienen der Welt, Vol 5, Nos. 7 & 8, 1974, pp 558-566, 5 figs., 6 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Int. Eisenbahner Kongress Vereiningung (repr., PC).

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1027

RECENT TRENDS IN TRACK RESEARCH ON INDIAN RAILWAYS: PART II--THE EFFECT OF SPEED ON VERTICAL BENDING STRESSES IN THE RAIL

Studies dealing with the effect of speed on the vertical bending stresses in rail are described. In the design of track on the Indian Railways up to 1964, the effect of speed was covered by the use of a speed factor. Study results on the subject in view of investigations being carried out by RDSO (Research Design and Standards Organization) are presented. Topics such as load/stress relationship, variation in bending stresses, parasitic movement of vehicles, and variations in instantaneous wheel loads are discussed. The experimental work involved the use of an instrumented train composed of representative locomotive and coach and freight cars with loads that were run at speeds ranging from 5 to 110 km over an instrumented section of track. A typical oscillograph chart for one test run and data plots are included. Tabular data taken during the tests give information on the median and average values of stresses caused during a range of speeds on the test track.

Joseph, T. V., and Ramakrishna, H. S. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 21, No. 155, November 1964, pp 59-79, 9 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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1028

RECENT TRENDS IN TRACK RESEARCH ON INDIAN RAILWAYS: PART I--TRACK MODULUS AND VERTICAL BENDING STRESSES IN RAIL

Problems on track research facing the Indian Railways are mentioned and studies made on the determination of track modulus and vertical bending stresses in rails are described. The standard method for determination of track modulus and the concept of double modulus are described in length. Deflection diagrams for loads presented by the locomotive and others by four-wheel cars are given. Data are plotted which show the observed and theoretical stresses as functions of initial and elastic modulus values for various wheel loads. It was concluded as a result of testing on various compositions of tracks that the two-load method of determining track and double-moduli methods for the calculation of vertical bending stress in the rail provide satisfactory results.

Joseph, T. V., and Ramakrishna, H. S. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 21, No. 154, August 1964, pp 54-67, 11 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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1029

INVESTIGATIONS ON TRUNK ROUTES OF INDIAN RAILWAYS--TRACK MODULUS STUDIES ON THE EASTERN RAILWAY

As part of the investigations on the vertical strength of 90R rail BG track, values of track modulus and rail stresses were determined under static loads on different locations on the main line sections of Eastern and South Eastern Railways. The data obtained from these tests have been used along with the results of the tests on the main line section prepared to specified compositions and the laboratory controlled test tracks to recommend values of track modulus to be adopted in track design. A complete description of the test conditions used in conducting the investigations on four sections of the track is given. Mathematical expressions used in determining the track modulus from rail deflection measurements are expanded to provide numerical information on track modulus. The results of the investigation confirmed the presence of a separate initial range in rail deflections and stresses and the possibility of representing the complete relationship by two values of track modulus.

Anand, Y. P. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 25, No. 169, May 1968, pp 39-44, 5 figs., 7 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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1030

RAIL FAILURES AND THEIR ANALYSIS ON THE EASTERN RAILWAY (DURING THE FOUR YEAR PERIOD BETWEEN 1962 AND 1965)

Rail failures in the Eastern Railway of India during the period 1962 to 1965 are analyzed and compared with those of British and Japanese Railways. The author indicates that the nature of the failures can be described as fractures primarily due to fatigue. The fatigue failure in rails take place because of service conditions as in boltholes or formation of scabs, engine burns, corrosion pits, and the presence of manufacturing defects either internal or external, such as piping, segregation, shattering cracks, and inclusions. A brief review covering the rate at which fatigue cracks develop and ultimately cause fracture is given. The prevention of fatigue failures and the factors affecting strength of metals are discussed. Numerical values of stress at which fatigue failures occur that are based on studies made in the United Kingdom and Japan are discussed. The stresses induced in a 90-lb rail are given by calculation to be between 8 and 9 tons/in.^{2}, with an assumed track modulus of 1600 lb/in.^{2}. Tabulated data are presented for the number of fractures per million train miles and gross ton miles between 1962 and 1965.

Sinha, H. S. (Track Modernisation Dept., Eastern Railway, Calcutta, India), Indian Railway Technical Bulletin, Vol 24, No. 166, August 1967, pp 109-115, 1 fig., 16 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research Design and Standards Organization (repr., PC).

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1031

RAIL-WHEEL CONTACT STRESSES

On the Indian Railways, with the introduction of diesel and electric locomotives to haul trains of heavier axle loads at higher speeds, the problem of wheel/rail contact stresses has assumed greater importance than ever before, because these locomotives generally carry heavier axle loads than have hitherto been carried by steam locomotives but have smaller wheels diameters. This article deals with the effect of high contact stress on rail, compares the practices followed on Indian and other major foreign railways, and suggests a method based on the recent UIC/ORE experiments for evaluating the maximum shear stress due to rail-wheel contact till such time extensive research work is undertaken by RDSO to establish the relationship between rail stress, wheel diameter, and axle loads.

Rajamani, N., and Subramanian, K. R. (RDSO Track Laboratory, Indian Railways, Lucknow, India), Indian Railway Technical Bulletin, Vol 25, No. 167, May 1968, pp 54-58, 2 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1032

RESEARCH INTO SOME FACTORS WHICH INFLUENCE THE VERTICAL LOADING OF RAILWAY TRACK

The development of a special baseplate for use in the measurement of vertical loads on railway tracks is described. By installing these baseplates on each sleeper in the vicinity of the rail joints, the maximum vertical loads which wheels impose on the running ends of rails were obtained. Based on wheels that have almost the same nominal loads and carrying very similar unsprung weights, results of measurements obtained at different sites were shown to vary considerably. It was possible then to establish that the stiffness of the track bed plays an all-important part. It was concluded that the magnitude of the maximum vertical load which the wheel imposes on the rail is primarily influenced by the speed and the stiffness of the track bed rather than by the amount of unsprung weight carried by the wheel. Data obtained are presented, including distributions of maximum vertical loads on sleepers and rail joints and the stiffness of the track bed.

Loach, J. C. (British Railways Board, Research Dept., Derby, England), Proceedings of the Institution of Civil Engineers, Paper No. 6823, April 1965, pp 731-746, 13 figs., 1 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Civil Engineers (repr., PC).

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1033

RELATIONSHIP BETWEEN THE CONTENT OF NONMETALLIC IMPURITIES AND THE SERVICE BEHAVIOR OF HEAVY STRESSED RAILS [IN GERMAN]

An investigation into the relationship that exists between the content of nonmetallic inclusions in rail steel and the service behavior of rails subjected to heavy loads is discussed. The tests for the presence of inclusions involved the use of magnetic inspection techniques. Fourteen test specimens of the rails were examined and the mechanical properties of each specimen are presented. Illustrations are presented showing the extent of wear on the rail heads. Bar charts are presented which show the differences between rails that possessed nonmetallic inclusions and those that were nominal in grade and quality.

Hunger, J., Martin, E., and Haedecke, K. H. (Bundesanstalt fur Materialforschung, W. Berlin), Braunkohle, Warme und Energie, Vol 20, No. 9, September 1968, pp 299-305, 9 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag die Braunkohle (repr., PC).

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1034

EXPERIMENTS ON RAILS USED IN THE TRACKS OF THE RHEINISCHE BRAUNKOHLENWERKE AG, COLOGNE [IN GERMAN]

Report on rails with good resistance to wear, fracture, and plastic deformation at high loads. Field tests have been carried out in the last 15 years on German and US rails of different material compositions with a tensile strength of 900 N/mm^2, on self-hardening high-strength rails of 1100 N/mm^2, on heat-treated rails with tensile strengths between 1100 and 1400 N/mm^2, and on composite cast rails with a tensile strength of the rail head between 1100 and 1300 N/mm^2. Additional experiments were conducted on German rails changed in profile to match the rail-head profile of a US rail.

Jopek, W. (Rheinische Braunkohlenwerke AG, Cologne, W. Germany), Braunkohle, Warme und Energie, Vol 25, Nos. 11 & 12, November/December 1973, pp 312-328 and 360-364, 26 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag die Braunkohle (repr., PC).

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1035

RAILS FOR HEAVY LOADS [IN GERMAN]

The increasing demand for heavy-load traffic necessitates the use of heavier rails. In addition to an adaptation of the UIC 60 rail, the development of a rail with a weight of 70 kg/m based on the latest findings of rail guidance technology and rail dynamics has been started. For axle loads up to 35 t, rails with a weight of 60 kg/m can be used. Under extremely high stresses, e.g., high traffic density with axle loads of up to 60 t, special-quality rails with a tensile strength greater than 110 kg/mm^2 have proved successful. Extensive metallographic investigations show that damage due to overload is caused by varying degrees of localized work hardening along the rail.

Koerfer, E., and Gross, K. (Klockner-Werke AG, Osnabruck, W. Germany), Braunkohle, Warme und Energie, Vol 23, No. 6, June 1971, pp 195-202, 22 figs., 3 tables, 6 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag die Braunkohle (repr., PC).

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1036

THE PRESENT STATE OF STANDARD-GAUGE TRACK CONSTRUCTION AT THE RHEINISCHE BRAUNKOHLENWERKE AG, COLOGNE [IN GERMAN]

Continuous modification of tracks at the Rheinische Braunkohlenwerke has enabled the permissible axle load to be increased to 34 t. The paper describes the stresses to which these tracks are subjected, and the different types of tracks such as rails with tensile strengths between 70 and 90 kg/mm^2, fastening to Bongossi wooden ties by means of Deenik clamping-straps, and switches with movable frogs. On certain sections of the tracks, some formation of corrugations and undulations was observed, whereas the wear of the railhead sides was quite significant. As a consequence, numerous rail lengths had to be replaced, which resulted in serious operational problems. Experiments with rails having a tensile strength of 110 kg/mm^2 are under way.

Schmidtalbers, K. (Rheinische Braunkohlenwerke AG, Cologne, W. Germany), Braunkohle, Warme und Energie, Vol 20, No. 5, 1968, pp 150-159, 10 figs., 6 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag die Braunkohle (repr., PC).

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1037

EXPERIMENTS WITH HIGH-STRENGTH RAILS AT THE RHEINISCHE BRAUNKOHLENWERKE AG [IN GERMAN]

Experiments carried out under heavy-transport conditions in the open pit Fortuna on self-hardening and heat-treated rails having a tensile strength of up to 140 kg/mm^2 and designed for axle loads between 30 and 35 t are reported on. Attempts made to derive a so-called wear profile from the damages observed on normal profiles turned out to be negative. Comparison after service over a long period of time revealed a great superiority of rails with induction-hardening heads produced by the United States Steel Corp. Good results have also been obtained so far with German rails having a rail head adapted to the US profile. Self-hardening rails with a tensile strength of 100 kg/mm^2 are necessary to carry the axle loads, imposed by open-pit coal-mining traffic, at curves having a radius of 300 m.

Schulze, H. J. (Rheinische Braunkohlenwerke AG, Cologne, W. Germany), Braunkohle, Warme und Energie, Vol 24, No. 7, July 1972, pp 219-227, 23 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag die Braunkohle (repr., PC).

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1038

PROGRESS IN RAIL CUTTING BY THE USE OF A HEAVY DUTY SAW WITH CARBIDE INSERTS [IN GERMAN]

The sawing machine provided with a carbide-tipped saw blade 710 mm in diameter and designed for rails with tensile strengths of up to 1350 N/mm^2 reduces the sawing time to one-tenth of the time required by conventional saws. Other advantages are a longer lifetime of the saw blade, less noise, and a cleaner workplace. The rails are fed to the saw at a speed of 2 m/s. The rail profile UIC 60 requires a sawing time of 24 s. The vibrations generated by the high speed of the saw blade are damped by sand filled into the hollow parts of the machine body. The feeding rolls are coated with hard rubber. By these measures the noise was reduced below the level permitted.

Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany, Stahl und Eisen, Vol 95, No. 2, 1975, pp 69-70, 2 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen mbH (repr., PC).

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1039

TECHNOLOGICAL AND ECONOMIC TRENDS IN TRACK CONSTRUCTION [IN GERMAN]

S 49 (70) rails introduced in 1927 no longer meet the demands made upon heavily stressed tracks. S 54 rails introduced in 1963 likewise do not satisfy the requirements of the future development which will lead to vehicles with an axle load in freight traffic up to 25 t and a maximum speed in passenger traffic up to 250 km/hr. In order to make possible the development of vehicles approaching these limits in the next two decades, it is necessary to use rails with a meter weight of 60 kg (UIC 60). The technical and organizational measures to be taken by the Permanent Way Service for carrying out the modifications on main and branch lines are discussed.

Fastenrath, F. (Deutsche Bundesbahn, Frankfurt/Main, West Germany), Bundesbahn, Vol 43, Nos. 3 & 4, 1969, pp 119-126, 7 figs., 10 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1040

SWITCHES WITH UIC 60 RAILS USED BY THE WEST GERMAN FEDERAL RAILROADS [IN GERMAN]

Overall length, track radius, and crossing angle of all UIC 60 switches and crossings are consistent with those of the previous switches of the Reichsbahn; a mutual exchange thus is normally possible without a change in gauge. The nominal gauge is 1433 mm, the mean tie spacing is 600 mm. For the rigid crossing three different types have been developed. The check rails are spring-mounted in transverse direction in order to reduce load peaks. For high traveling speeds, crossings with movable tips (spring-mounted and articulated) have been developed, which are used without check rails. In trials with these switches on wooden ties and concrete decks at speeds of 250 km/hr no significant shortcomings have been observed to date.

Morgenschweis, O. (Bundesbahn-Zentralamt, Munich, West Germany) Eisenbahntechnische Rundschau, Vol 23, No. 3, 1974, pp 97-104, 8 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1041

LIMIT OF TRAFFIC LOAD CAPACITY FOR S 49 RAILS IN TRACKS AND SWITCHES [IN GERMAN]

Owing to the increase in axle load, travelling speed and traffic volume, S 49 rails have in many cases reached the limit of their load-carrying capacity. The usual practice of evaluating the vertical and lateral wear of the rail head alone is no longer sufficient to determine the point in time at which the rails have to be replaced. The factors ultimate traffic load capacity, type of track construction and behavior of rails not replaced in time are discussed and explained by means of examples.

Kraft, W. (Bundesbahn-Zentralamt, Munich, West Germany), Eisenbahningenieur, Vol 25, No. 3, 1974, pp 78-81, 1 fig., 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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1042

RAIL STRESSES DUE TO LOAD AND THE NATURE OF THE TRACK [IN GERMAN]

Following a discussion of the most important determinants of rail stresses, the results of extensive measurements of the transverse forces are reported. Several factors of influence such as route, travelling speed, characteristics of track-structure and underlayer are investigated. Experiments and theoretical studies show that the rail stresses due to static and dynamic forces can be determined by means of the Smith diagram. The increase in axle load and travelling speed affects the vehicles and the structure of the track. The favorable effect of heavy rails and long ties on rail stress and positional stability is emphasized.

Birmann, F., and Herbst, W. (Bundesbahn-Zentralamt, Munich, West Germany and Technical University of West Berlin), Eisenbahntechnische Rundschau, Vol 23, No. 3, 1974, pp 104-112, 15 figs., 18 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1043

RAIL MANUFACTURE IN THE SOVIET UNION [IN GERMAN]

The use of the three rail profiles R-50, R-65 and R-75 depends on the annual traffic volumes ($\leq 20 \times 10^6$ t, 20 - 50 x 10^6 t, $\geq 50 \times 10^6$ t). The increased carbon content has a favorable effect on the resistance of the rails to wear and fatigue damage. Tensile strengths of 1020 N/mm^2 are achieved with delayed cooling. The chemical compositions are largely consistent with those of ASTM and UIC 860. Alloy steels and metallurgical techniques used to improve the rail quality are mentioned.

Heller, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, W. Germany), Stahl und Eisen, Vol 93, No. 2, 1973, pp 72-75, 5 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen mbH (repr., PC).

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1044

ANTI-VIBRATION SLAB TRACK [IN JAPANESE]

Compared with the ballast track, the slab track shows a higher noise level. Hence, it is necessary, for the purpose of taking advantage of the merits of the slab track, to have the noise level and the vibration level of the slab track reduced below the corresponding factors of existing ballast track. The antivibration slab track has been developed for the purpose of reducing the noise level through easement of the considerable impact and vibration caused at the time a train passes any given point. This is done for antivibration slab track by maintaining a spring constant smaller than that of the ordinary slab track. Compared with ordinary slab track, the antivibration slab track has a smaller acceleration of vibration at elevated road bed and at elevated column sections, and thus the effect of the antivibration slab track will increase in proportion to the increase in the train speed. The helpful effect of the antivibration slab track centers around the vibration and noise reduction achieved in the rubber mat and those components which are placed below it. However, it is believed that noise and vibration may increase in the various components placed above the rubber mat. For this reason, it is necessary to use antivibration rails and various kinds of noise barriers in combination with the antivibration slab track.

Tokuoka, K. (Japan National Railways), Tetsudo Senro, Vol 21, No. 11, 1973, pp 617-621, 18 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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1045

INFLUENCE OF END DEFLECTION OF HIGH SPEED RAIL ON CHANGE OF WHEEL LOAD (THE CRITICAL CALCULATION IN A LINEAR SPRING) [IN JAPANESE]

With regard to the end deflection of high-speed rails, it is necessary to reexamine the allowable limit with reference to the fluctuation of wheel load resulting from the unevenness which is found in the welded sections of rails. In setting up this allowable limit, it is necessary to carry out an inquiry based on practical measurement as well as studies guided by theoretical calculation.

The present study deals theoretically with the transient vibration affecting the railway carriages and tracks in those parts liable to vibration resulting from the localized unevenness in the head of rails. The study discusses the approach to setting up an allowable limit of end deflection in rail in the future, drawing on actual conditions found on the New Tokaido Trunk Line, etc.

Kuroda, S. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 21, No. 4, 1973, pp 202-204, 7 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1046

GENERAL PREREQUISITES FOR CORRECTING THE RULES OF CALCULATING RAILROAD TRACKS FOR DURABILITY AND SUGGESTIONS ON CHANGING THESE RULES [IN RUSSIAN]

This paper is an excerpt of Chapters 1 through 3 which reports background information which has led to the correction of rules for calculating the required durability of railroad tracks. Results of experiments for a resilience model of a rail used under summer conditions of road operation for a system using concrete ties are given. Data on elastic bending of rails under various loads are discussed. Calculations are made to arrive at the modulus of elasticity of the rail and the results are tabulated. The investigation and studies are concluded by establishing values of rail crosstie grid weights per meter of ballast, moving load and recommended tie stresses, and values of ballast compression.

Verigo, M. F., and Krepkogorskii, S. S. (All-Union Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 466, 1972, pp 4-50, 2 figs., 7 tables, 41 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kenkin Bookstore (repr., PC).

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1047

THE INFLUENCE OF BLOWING WITH OXYGEN ON THE VAULT OF THE BASIC OH-FURNACE DURING THE REFINING PERIOD ON THE QUALITY OF KR45 STEEL FOR RAILS [IN ITALIAN]

A brief description is given of the process for making rail steel through use of the basic OH converter process with or without the blowing of oxygen by a water-cooled lance during the refining period. The chemical composition of the rail steel, including the impurity content, is given. The mode of operations is described for the types 50 and 60 rails. The mechanical properties of each type of rail steel are discussed. Photomacrographs of rail sections are shown and discussed from the standpoint of segregations and inclusions. Data are tabulated to show the media and dispersion of mechanical properties for the two types of rails made from steel produced with and without the blowing of oxygen during the refining period.

Botto, G. (Italsider, Stabilimento Oscar Sinigalia, Genova-Cornigliano, Italia), La Metallurgia Italiana, Vol 35, No. 11, November 1963, pp 585-592, 12 figs., 8 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Association of Italian Metallurgy (repr., PC).

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1048

DETERMINATION OF PLASTIC FLOW IN RAIL HEAD

The purpose of the test was to determine the amount of plastic flow which takes place in the gauge corner of a rail on the high side of a curve under conditions which produce shelling. The track was laid with 140-lb, 1948 rail, which in August 1953, was showing flaking and light shelling. This is a 4-degree curve with 4 in. of superelevation, authorized speed of 45 mph, and carrying moderate to heavy eastward freight traffic. Records kept in connection with another test indicate a tonnage of approximately 29,000,000 gross tons annually. On the high rail of curves there is a flow of metal at the top gauge corner of the rail toward the gauge side. The magnitude of deformation is positive evidence of shear stresses well beyond the yield point of the steel. (Carried as RRIS Accession No. 040278.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 591, August 1971, 19 pp, 5 figs., 1 table, 7 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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1049

CRACKS AT RAIL ENDS

The occurrence of cracks at rail ends in the upper fillet and at the first bolt hole were investigated by the Engineering Division Research Staff. It appears that the development of these cracks is related to the use of rail joint packing, consisting of a mixture of wood flour and oil. Photographs are provided which show typical cracks; corrosive attack is clearly

indicated. Seven railways have reported the development of these cracks where joint packing was applied and found no cracks. It seems evident that in some instances the rail joint packing has contributed to the development of rail end cracks, and the indications are that a corrosive effect has either so lowered the fatigue strength of the steel that cracks developed or that stress corrosion cracking has developed in the areas of high tensile stress in the upper fillet and around the first bolt hole. (Carried as RRIS Accession No. 040250.)

Magee, G. M. (Association of American Railroads, Chicago, Ill.), Technical Memo No. e4083, October 1947, 7 pp, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1050

LATERAL FORCES ON RAILS

A piezoelectric device was mounted between the axlebox and bearing brass of 4-6-2 and 4-4-2 type locomotives to measure the lateral forces between the wheel and rail. Trials were made on the Hericy section of the Paris-Laroche line, which has curves of radii down to 1,640 lb, speeds of 75, 81, and 87 mph. The lateral forces for both locomotives on straight track and curves are reported in tabular form. Tests were made, with apparatus consisting of an indicating potentiometer for measuring changes in length of a telescopic tube placed between the wheels, to measure deformation, of the crank axle by loads on a locomotive without balance weights. Using the 4-4-2 locomotive, the distance between wheels increased from 3/8 to 11/16 in. as the speed rose from 50 to 75 mph. (Carried as RRIS Accession No. 037884.)

Railway Gazette, Vol 71, December 1939, pp 702-703, 3 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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1051

THE ABRASION OF EXPERIMENTAL HEAT TREATED AND UNTREATED RAIL ON THE HORSESHOE CURVE

After seven years and eight months in service, both rolled and heat-treated and rolled and untreated rails were removed from the Horseshoe Curve at Altoona. Abrasion measurements were taken throughout the time interval. No broken or defective rails were encountered during the service period, but some rails, particularly the untreated ones, were worn badly. Abrasion data are provided. (Carried as RRIS Accession No. 040253.)

Penn Central Transportation Co., Transportation Center, Philadelphia, Pa., Test Report No. 77, January 1935, 3 pp, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1052

BATTER TEST OF 151 LB. R.E. RAIL

This report covers a test of 151-lb R.E. rail in which the base and lower portion of the web at the rail ends is cut square while the head and upper portion of the web is mitred, the change in angle of cut taking place about the center of height of web. The mitre makes an angle of 60 degrees with the line of track. For comparison, sixty-seven 131-lb X-rails with ordinary square ends were laid at the same time adjacent to and west of the mitred rails on the same track. After one night's traffic had passed over the rail, initial measurements of rail end batter were taken. It was concluded that insofar as rail end batter is concerned there is no advantage in the use of mitred-end rails over ordinary square-cut end rails as determined by batter measurements over a period of 1-year-and-1/2-month service in heavy tonnage freight track. (Carried as RRIS Accession No. 040258.)

Penn Central Transportation Co., Philadelphia, Pa., Test Report No. 240, June 1937, 5 pp, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1053

LABORATORY INVESTIGATION OF RAILROAD BALLAST

This paper deals with test results obtained from studies of different ballasts for the purpose of studying the dynamic loading as it affects the settlement of ties caused by ballast acceleration. The tests were conducted by using the Vibrosir installed by the Japan National Railways in a freight station at Osaka City. The test equipment which provides a simulated vibratory-type load to a test roadbed is briefly described. The instrumentation for measurement of ballast shearing resistance is described. Data taken for most materials during simulated load vibrations are analyzed and presented to form curves which describe the amplitudes of tie movement as a function of the ballast depth. In addition to the studies conducted for different ballast materials, experiments were conducted in connection with a variety of crossties and the concrete road bed.

Okabe, Z. (Osaka City University, Osaka, Japan), Permanent Way, Issue No. 4, Vol 4, No. 13, December 1961, pp 1-19, 24 figs., 10 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1054

CUSHIONED TRACK

Accomplishments throughout the years in the area of track cushioning provided by Butyl rubber pads are summarized. Advantages in the use of track vibration damping are given as reduction of wear and tear imposed on the track for higher speeds and heavier tonnage. Other considerations include the reduction of rough riding, unsafe pumping of the track, and damage to equipment, ties, ballast, and subgrade of the rail. The relationship between maintenance costs for track using the damping and those without cushioning is discussed. Extensive use of Butyl pads in curved rail sections and crossings is stressed as a major improvement in the service life of the track structure.

Progressive Railroading, Vol 18, No. 12, December 1975, pp 36-38, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Murphy-Richter Publishing Company (repr., PC).

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1055

INTERNAL STRESSES IN RAILS OF THE S49 TYPE [IN POLISH]

The author reports on his experimental studies of internal stresses in rails. At the outset, macrophotographs of the rail cross section were made and examined to investigate the lack of segregation and the effects of uniform pickling on the rail's structure. Hardness measurements were made by surveying the top section of the rail head. Internal stress calculations were made which were based on equations from the theory of elasticity by using data taken in measurements of strain. Electrical strain gauges were used to measure the longitudinal and transverse strains. Drawings are provided which show the locations of the strain gauges used for measurement of vertical and horizontal forces. Data taken during the experimental phase are presented along with an analysis which points to a difference in strain values and stress distributions from one end of the rail to the other. It is concluded that the significant amount of stress appearing in the rail base can cause brittle failures, and that there is a need to establish an optimum level for internal rail stresses.

Radomski, R., and Pustelnik, I., Hutnik (Warsaw), Vol 39, No. 9, 1972, pp 464-468, 15 figs., 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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1056

ANALYSIS OF RAIL DEFECTS ON WHEEL CONTACT SURFACE [IN SLOVENIAN]

The load distribution on the contact surface of a wheel on a flat rail is investigated to assess the manner in which irregularities of rail geometry affect operations. Prior to investigating causes of damages to wheel surfaces, it was found to be necessary to analyze load conditions. A study is made of the contact surfaces between the wheel and the rail and the deformations caused by the load. The deformations and existing defects in which potential failure is present have been attributed to problems in rail fabrication. Parabolic and nonlinear loading processes are assumed because of considerations for elastic deformations of the wheel and the rail. It was established that the rounded rail profile is less prone to cause vibrations and rail deformation.

Kos, M. (Titovi Zavodi Litostroj, Ljubljana, Yugoslovia), Stroj. Vest., Vol 20, No. 1, January 1974, pp 33-40, 11 figs., 3 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1057

ANALYTICAL REVIEW OF METHODS USED FOR IMPROVEMENT OF MECHANICAL PROPERTIES OF RAILS [IN POLISH]

The factors associated with the mechanical properties of rails are reviewed. These involve the chemical compositions, temperatures related to the rolling and conditions of cooling of the rails, subsequent heat treatment, surface hardening, and other factors. Considerations are given to the fact that the methods for improving the mechanical properties of rails sometimes involve all of the factors in varying degrees. Tabulated information is presented on the chemical compositions and mechanical properties of rails made in Poland in accordance with Specification PN-70/H-93421(Norm) and those manufactured under procedures advocated by the International Union of Railways. Similar information is presented on rails produced in Japan, the United States, and the U.S.S.R. Numerous charts and tabular data are included which provide information on heat treatment, surface hardening of the rail heads, controlled cooling, and induction-hardening results.

Krywult, J., and Struk, S., Hutnik, Series 41, No. 2, pp 92-102, 8 figs., 18 tables, 17 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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1058

ABSTRACT FROM REPORT OF COMMITTEE FOR "QUALITY OF RAILS AND MEANS OF IMPROVING IT"

The report emphasizes the fact that the actual conditions of rail failures are such that some of the rails used in tracks are short lived and become unusable much faster than others. Satistical data are presented which show that the incidence of failures caused by manufacturing defects is considerably high. In light of this, the Railway Technical Research Institute of the JNR undertook a program of metallurgical tests on all rails judged abnormal in regard to their materials or whose service life on JNR tracks was less than 5 years. As a result of a thorough study of failure reports, the actual conditions of each type of rail failure were given classifications. These included rail-end failures, broken bases, rail-head transverse cracks, fatigue failures, rail-base transverse cracks, vertically split heads, horizontally split heads, shelling, flaking, engine burns, split webs, and others. Following the study of the nature of rails failures, a thorough study is presented on the measures to be taken to prevent rail failures due to manufacturing defects. The study involves all aspects of rail-steel manufacturing as well as the rolling-mill practices associated with the final production of rails.

Ito, A., and Kurihara, R. (Laboratory of Metals and Alloys, Railway Technical Research Institute-JNR, Japan), Permanent Way, Issue No. 4, Vol 9, No. 33, 1967, 48 pp, 34 figs., 12 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1059

THE LOAD-FACTOR, STRUCTURE-FACTOR, AND CONDITION-FACTOR OF A RAILWAY TRACK

A brief discussion is presented on differences between the designs of a bridge structure as opposed to a railway track system, which points out that a track is an imperfect structure which can become loose without damage to its materials. The effects of vibration at high frequencies in the rail are discussed in connection with the car factor. Mathematical expressions are derived to formulate conditions associated with the car and load faccors, and values are assigned to the various types of railway vehicles. Relationships between destruction of the track and the structure factor are defined through the use of a track-vibration model. An investigation is made into the many types of track ballasts and sleepers to obtain a reasonable estimate of the mass of rail support. In determining the value of the condition factor, other factors such as rail factor, sleeper factor, rail-joint factor, and ballast factor are examined.

Satoh, Y. (Track Laboratory, Railway Technical Research Institute-JNR, Japan), Permanent Way, No. 7, June 1960, pp 21-32, 11 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1060

EFFECTS OF THE USE OF UIC 60 RAILS ON TRACK CONSTRUCTION [IN GERMAN]

The West German Federal Railroads decided in 1969 that on routes where axle loads and running speeds are high, UIC 60 should be used, which some neighboring countries have already introduced a few years before. S-49 rails used since 1925 and S-54 rails introduced in 1963 have the same width of head and base and can be exchanged one for the other. UIC 60 rails, however, have a larger profile (the rail base is 25 mm broader) so that numerous rail fastenings have to be readapted to the changed dimensions. The report describes and illustrates the effects of the use of UIC 60 rails on tracks with wooden and concrete ties and on the rail fastenings to trackway platforms (tracks without ties). Tracks without ties will gain greater importance in the future.

Homann, K., Eisners Taschenbuch der Eisenbahntech., 1972, pp 67-82, 16 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetzlaff-Verlag (repr., PC).

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1061

THE MANUFACTURE OF RAILS [IN GERMAN]

Following a survey of the development of rails, the production of rail steel by modern manufacturing processes and the hot forming of rails in rolling mills are discussed. The paper concludes with a short description of finishing process and quality control.

Weber, F. (August-Thyssen-Hutte AG, Duisburg, West Germany), Eisenbahntechnische Rundschau, Vol 20, Nos. 1 & 2, 1971, pp 79-82, 6 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1062

A MODERN MEDIUM-WEIGHT RAIL S-41U FOR HIGH-SPEED CITY TRAINS--AN APPROPRIATE SUBWAY RAIL [IN GERMAN]

The present rail profile is S-41 having a conventional rounded rail head. For city trains, the present rail profile is S-41a, which is an intermediate form for trains having a small wheel-flange height. The new profile S-41U for high-speed and normal tracks is suitable for medium traffic densities. The new rail has a wear-reducing UIC, rounded, rail-head shape similar to S-49 rails, all other characteristics are like those of the present rail profile S-41 with the price advantage of medium-weight rails.

Braitsch, H. (Cologne, West Germany), Verkehr und Technik, Vol 20, No. 1, 1967, pp 7-9, 4 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Erich Schmidt Verlag (repr., PC).

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1063

MAXIMUM VALUE OF TRACK IRREGULARITY

The importance of knowing the maximum values of track irregularities by those in charge of maintenance is emphasized to assure safety of traffic. The states of track geometry involving the index of track irregularity, its mean value and standard deviation are discussed. The main parameters of concern, which involve the basics of track geometry, are track gauge, cross level, longitudinal level, alignment, variation of cross level, and variation of gauge and versine of curve. To gain better insight measurements made with the high-speed into inspection car (Maya-341), investigations were conducted on curved and straight tracks. Data taken in 1961 were used for this study of maximum allowable irregularities. Mathematical expressions for calculating sampling sizes, distribution functions, and accumulative relative frequencies are given. Numerical data from the measurement records are plotted for each of the track-geometry parameters.

Hiroi, I. (Office of Equipments, Japan National Railways, Japan), Permanent Way, Issue No. 3, Vol 5, No. 16, September 1962, pp 16-24, 19 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1064

DROP TESTS OF RAILS

Since the 50-T rail was adopted for use on the New Tokaido Trunk Line and the 50-N and 40-N were substituted for the PS50 and the ASCE 37 rails, the author has studied the requirements of the standard drop test to determine whether it is still valid. The standard drop test performed in the United States, Japan, England, Germany, and France is reviewed. Data are presented to show how the rail reacts to the various drop tests in terms of rail strain and deflection, and an analysis follows for the purpose of explaining the phenomena of the drop test. Numerical values of drop heights for the 50-T rail are given along with a comparison for the 40-N and 50-N rails.

Satoh, Y. (Track Laboratory, Railway Technical Research Institute-JNR, Japan), Permanent Way, Issue No. 2, Vol 5, No. 15, June 1962, pp 9-17, 12 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1065

A LATERAL PRESSURE MEASURING CAR--"YA-200"

The measurement of lateral force of a running wheel on the rail, with accuracies sufficient for practical purposes, is described. The author experimented with the use of wire strain gauges fixed to the wheel spokes to make such measurements. In recognition that the best way to measure lateral forces and pressures between the wheel and the track, the Japanese National Railways designed and built the "Ya-200" measuring car. The car is a modified "Wa-Ki 1000" 30-ton bogie freight car. Drawings and photographs are presented which provide a general view of the car and the testing truck with the lateral load mechanism. The performance specification of the measuring car is given. Procedures to be used in the vehicle's operation are included.

Tanahashi, H., and Shinoda, S. (Track Laboratory, Railway Technical Research Institute, JNR, Japan), Permanent Way, No. 6, March 1960, pp 25-34, 6 figs., 6 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1066

FRICTIONAL PHENOMENA BETWEEN WHEEL AND RAIL [IN JAPANESE]

This paper discusses the slip and creep forces in the wheel/rail contact area. A method of measuring the creep coefficient is discussed and the creep phenomenon is clarified through model tests.

Study results indicate: (1) while the slipping and tangential force are proportional when slipping between wheels and rail is small, the creep force shows nonlinear characteristics as the tangential force increases; (2) creep coefficient is related with the coarseness and size of the area of

contact and is in proportion to the two-thirds power of wheel weight; (3) axial creep coefficient is greater than lateral creep coefficient.

Yokose, K. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 29, No. 11, 1972, pp 529-533, 10 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1067

FLAME HARDENED VS HEAT TREATED AND MANGANESE CROSSINGS

The purpose of this test was to determine the relative value from a service point of view of flame-hardened crossings, as compared with heat-treated and with manganese crossings. Two flame-hardened crossings and one heat-treated and one manganese crossing were installed on new timber supports in a two-over-two track crossing making an angle of 71 degrees 38 min. All crossings were interchangeable. These crossings were installed on May 2, 1953. On the September 8, 1954, inspection it was found that excessive batter on one of the flame-hardened crossings made renewal necessary. Initial cost, maintenance required, as well as service life indicate a superiority of the heat-treated crossing over the flame hardened. (Carried as RRIS Accession No. 040283.)

Code, C. J. (Penn Central Transportation Company, Philadelphia, Pa.), Final Report, Test No. 613, December 1957, 9 pp, 3 figs., 4 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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1068

IMPROVING RAIL HEAD QUALITY BY MODIFYING THE ROLL GROOVES

This paper describes a new groove design that was investigated using the 900 breakdown stand modified by an additional edging pass on the rail mill at the Azovstal' Works in an effort to improve the quality of the contact surface at the rail head. The roll grooves of the stand for rolling R-50, R-65, and R-75 type rails from sections with a side ratio of more than 2 to 1, and the edging pass roll design are shown. In order to study the effect of the new pass design on the quality of rails, a trial run was made and subsequently inspected. The results of the inspection of five rails are presented. Comparative data are shown for rails rolled by using the conventional and experimental pass designs. It was concluded that the use of deep initial blooms enabled the surface quality of rail heads to be improved substantially, the yield of first-grade product was increased, and the proportion of surface defects was lowered considerably.

Protasov, N. F., Rudol'skii, N. L., Pogorzhel'skii, V. I., Stefanov, V. E., Valenko, N. S., Chernyakov, V. I., and Rakhanskii, B. I. (Ukrainian Research Institute of Metals, and the Azovstal Works, U.S.S.R.), Stal [in English], No. 6, 1968, pp 490-492, 3 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1069

ADOPTION OF A NEW HARDENING PROCESS FOR RAILROAD RAILS WITH HIGH FREQUENCY CURRENT [INDUCTION HEATING]

A new technique for quenching rails after high-frequency (induction) heating of the rail head over its entire length in an elastically stressed state has been developed, tested, and introduced into production. The new quenching technique enables cold straightening to be dispensed with as the total curvature over 25 m is only 0 to 30 mm. Buckling of the rail ends is avoided by heating the rails joined end to end in a continuous line. The quenched rails have a low residual stress level: the compressive stress in the running surface is up to 15 kg/mm^2 and the tensile stress ranges from 1 to 5 kg/mm^2 in the base. Carbon steel rails in R-65 quality with a standard composition show good mechanical properties.

Kazarnovskii, D. S., Pliskanovskii, S. T., Tochilenko, V. S., Zannes, A. N., and Bikhunov, L. Ya. (Ukraine Scientific Research Institute of Metals and the Zhdanov Azovstal' Works, USSR), Steel in USSR, No. 3, 1972, pp 256-258, 2 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1070

INFLUENCE OF CONTINUOUS CASTING OF RAIL STEEL ON THE PROPERTIES OF THE RAILS

It has been found that an improvement in rail steel quality can be achieved by melting in basic oxygen furnaces and continuous casting, which reduces the structural and chemical heterogeneity occurring during solidification in conventional casting. A study was made of the macro- and microstructure in rails rolled from continuously cast 290 x 320-mm blooms and from mould-cast ingots. Photomacrographs taken after deep etching of specimens of Type R-50 and R-43 rails show centerline porosity in the former and no centerline porosity in the latter. The microstructure of the rails rolled from continuously cast blooms consisted of fine lamellar pearlite and tempered martensite; the microstructure of rails rolled from ingots was composed of coarse lamellar pearlite and tempered martensite. Numerical values indicating the fineness of the tempered martensite are presented.

Monich, O. D., Paisov, I. V., Polyakov, V. V., Nekhaev, V. P., and Dolgunov, N. V. (TsNIICHM, U.S.S.R.), Steel in the USSR, Vol 4, No. 5, May 1974, pp 414-416, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1071

THE FINISHING OF HEAVY PROFILES (RAILS) [IN GERMAN]

The authors describe the procedures commonly followed in finishing shops for rails and heavy sections in order to show the factors that raise costs. Among the causes cited are delays during times of peak demand, decrease in lot sizes thereby increasing inventories, and greatly increased personnel expenses. The authors make suggestions for changes which might reduce the share of the finishing costs in the original cost of rolled products and present a concept for the construction of fully continuous finishing shops which could make rolling mill more profitable.

Zimmermann, K. A., and Robert, S. (Verein Deutscher Eisenhuttenleute, Duisburg, W. Germany), Stahl und Eisen, Vol 85, No. 8, April 1965, pp 464-471, 9 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen mbH (repr., PC).

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1072

THE EFFECT OF COMBINED AND SEPARATE ADDITIONS OF BORON AND RARE EARTH METALS ON SOME PROPERTIES OF RAIL STEEL [IN RUSSIAN]

Measurements were made of the ultimate tensile strength, yield strength, elongation, reduction in area, impact strength, and wear resistance of rail steel modified with additions of boron (0.004 to 0.016%) and/or rare-earth metal (0.25 to 1.0 kg/ton of steel). Such additions had no significant effect on strength and ductility but improved wear resistance; the optimum combination was 0.004% boron and 1.0 kg of rare-earth metal per ton of steel. The increase in wear resistance was appreciable, viz., $\leq$19% for boron-containing steels and by 20 to 30% for steel containing boron plus rare earth.

Prosvirin, K. S., and Chepeleva, V. P., Metallurgiya i Koksokhimiya, Resp. Mezhved. Nauchno-Tekhn., Sbornik, No. 30, 1972, pp 72-76, 3 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1073

GROOVE PROTECTION IN STRUCTURAL MILLS [IN GERMAN AND FRENCH]

The article deals with the different types of groove-protecting agents and their composition, the design and construction of automatically operating groove-protection systems, wear measurements, and test results obtained on rails, channels, and girders with parallel flanges. The experiments were carried out on three mill trains and showed that the groove life can be

considerably extended by means of groove-protecting agents, but only if these agents are mineral-oil based. The water-based agents such as glycol-water emulsions do not show any positive results. For effective functioning of groove-protecting agents, other requirements are thorough descaling of the feed stock and adequate cooling of the rolls. The use of groove-protecting agents was successful only in case of rails and channels; in case of girders with parallel flanges, operational difficulties have still to be overcome.

Weber, F., and Ahrens, H. (Verein Deutscher Eisenhuttenleute, Duisburg, W. Germany), Stahl und Eisen, Vol 92, No. 11, May 1972, pp 519-527, 13 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Verlag Stahleisen mbH (repr., PC).

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1074

MANGANESE CONVERTER STEEL FOR RAILS [IN RUSSIAN]

Bessemer high-strength rail steel production technology evolved for alloying the steel with Mn and treating it with Ti to a chemical composition of 0.45-0.60%C, 1.4-1.8%Mn, 0.15-0.30%Si, 0.03%Ti. The steel has 0.003-0.0047% oxygen content, reduced nonmetallic inclusions and a higher Al content in the solid solution (0.014-0.025%). Also, when the steel is treated with Ti, its N content decreases from 0.0127-0.0142 to 0.0099-0.0105 and the SiO_2 content in nonmetallic inclusions is low. Ti treatment facilitates degassing of the steel and raises its plastic properties and corrosion resistance. A trial batch of rail rolled from Bessemer Mn steel showed mechanical properties equal to those of 1%Cr steel and considerably better than those of standard production steel rails.

Gershgorn, M. A., Kravtsova, I. P., Kazarnovskii, D. S., and Ryabinin, B. G., Met. i Gornorydn. Prom. Inform. Nauchno-Tekhn. Sb., No. 5 (29), 1964, pp 23-26, 2 figs., 5 tables.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1075

THE EFFECTS OF ADDING VANADIUM TO RAIL STEEL AND AGING IT NATURALLY ON ITS PROPERTIES [IN RUSSIAN]

An investigation was conducted of Type R-50 rails made of steel from three heats. The rails were normalized from 840°C and held 45 min. Adding V greatly increases the hardness and impact strength of the rolled rails. Increasing the V content causes the strength properties and hardness to be increased by normalizing; the plastic properties and impact strength also increase. Tests on normalized rails containing 0.09-0.21% V showed that their endurance is low. It is suggested that rails be quenched from 950°C or above. The effects of natural aging on the mechanical properties of four rails were investigated. Two rail specimens were quenched in an industrial-type apparatus, using the accepted technology. After cold straightening the strength and hardness of the rails were slightly improved, but their ductility had deteriorated. The rails were aged naturally for a year. The yield stress, hardness, and impact strength of rails after rolling, without cold straightening in a roll straightening machine, did not alter during the year, and tensile strength decreased slightly. The strength properties, hardness, and impact strength of a rail which was cold straightened in a roll straightening machine were not affected.

Karpunin, A. M., and Orgiyan, V. S., Met. i Gornorydn. Prom. Inform. Nauchno-Tekhn. Sb., No. 4 (40), 1966, pp 48-51, 3 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1076

EFFECT OF OXIDATION OF FINISHING SLAGS ON QUALITY OF RAIL STEEL

In conducting this investigation, the authors found that when slags are greatly oxidized before deoxidation, which is possible with frequent additions of oxidizers and slag-forming elements and supercooling of the bath, there is no difference in the contamination of rail steel by nonmetallic inclusions or in its mechanical properties. The oxygen content of a high-carbon bath

is not associated with the quality of ferrous oxide in the finishing slag, which, if necessary, can be increased to 12 percent without adversely affecting steel quality.

Gorelkina, A. E., Nikulin, N. G., Yudin, N. S., Shetik, A. I., Sakharova, N. A., and Obsharova, I. E. (Kuznetsk Iron and Steel Combine, U.S.S.R.), Stal [in English], No. 7, July 1967, pp.561-564, 3 figs., 4 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1077

THE FORMATION AND STABILITY OF MARTENSITE LAYERS ON RAIL STEEL [IN GERMAN]

The studies on the formation of martensite on rails described in this article represent an attempt to clarify the question of whether martensite layers contribute to the formation of rail corrugation. This investigation involved tests designed to produce martensite layers by simulating the conditions of service on a wear-resistant rail. The test equipment used to create the martensite layer condition is described. During the test runs various parameters were monitored such as friction surface temperature, rubbing speed, and duration of contact. Photomicrographs are included which show the microstructures of the steel after rolling and tempering, and the formation of martensite layers. The chemical compositions and mechanical properties of the rail steels are given. It was concluded that the test data did not support the hypothesis that martensite layers cause corrugation. However, some means of preventing the occurrence of martensite layers are noted.

Stolte, E. (Hutten- und Bergwerke, Rheinhausen AG, West Germany), Stahl und Eisen, Vol 83, No. 22, October 24, 1963, pp 1363-1369, 10 figs., 1 table, 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen AG (repr., PC).

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1078

MEASUREMENTS OF VIBRATIONS IN STANDARD ELEVATED RAILWAY [IN JAPANESE]

An attempt was made in this study to measure vibration acceleration up to the high-frequency range on different parts of tracks and elevated railway bridges to determine noise generation sources, and the results of this work are reported.

The study has clarified, among other things, the differences between the slab track and the ballast track, by conducting measurements of vibration in the rails, sleepers, track slab, and elevated-railroad slab at two locations comprising a standard elevated bridge with a slab track and a standard elevated bridge with ballast situated at places with favorable foundation conditions and also at a standard elevated bridge with ballast situated at a place with unfavorable foundation conditions.

Hirata, G., Matsuura, T., and Koido, Y. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 2, 1975, p 62, 2 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1079

A CONSIDERATION OF THE GENERATION MECHANISM OF VIBRATIONS IN TRAINS [IN JAPANESE]

The vibration-generating mechanism and its method of propagation are investigated through measurement of the vibration generated by the running of trains on the New Trunk Line and through an analysis of its power spectrum.

The study revealed that the vibration power is almost entirely the forced vibration caused by the train load resulting from the train operation.

Yoshioka, O. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan) Journal of Railway Engineering Research, Vol 32, No. 7, 1975, p 264, 1 fig.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1080

ANALYSIS OF THE VIBRATIONS IN RAILWAY TRACK [IN JAPANESE]

Vibrations occurring in gravel roadbed track were studied. For this study, vibrations occurring in the sleepers and the ballast were measured, as well as the vibrations, bending stress, and earth pressure that occur on a test track with a total length of 8 m constructed in the laboratory. In addition, theoretical examination of vibration was conducted by means of a dynamic model of track developed for the study.

Ono, K., and Ito, Y. (Kanazawa University, Kanazawa, Japan), Kyowa Gitto, No. 177, 1972, pp 1001-1007, 19 figs., 7 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Kyowa Electronic Instruments Co., Ltd. (repr., PC).

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1081

DEVELOPMENT AND FUTURE TRENDS OF THE SLAB TRACK [IN JAPANESE]

Slab track has reached the stage of practical use with favorable performance recorded also on the New Sanyo Trunk Line. It has been developed into a track structure not liable to any permanent deformation under repeated load of the trains.

The author who has been in charge of the planning and promotion of slab track since its initial stage of development, describes the course of development of slab track, the structure and construction of slab track, the construction tests on it, future construction schemes for slab track, and various problems relating to slab track and their solutions.

Kitabeva, H. (Japan National Railway, JNR), Tetsudo Senro, Vol 20, No. 2, 1972, pp 61-68, 9 figs., 4 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1082

CALCULATIONS ON THE LONG RAIL IN A BRIDGE (PART 1) [IN JAPANESE]

Various considerations are taken into account in the construction of long-rail tracks on railway bridges. The present work deals with the fundamentals of long rails in an effort to provide preliminary knowledge of such considerations, and also presents an analysis of the calculation formulas related to long-rail construction.

Kitahara, I. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 21, No. 8, 1973, pp 399-405, 14 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1083

CALCULATIONS ON THE LONG RAIL IN A BRIDGE (PART 2)

Calculations on long rails on railway bridges are presented, with particular reference to the following numerical values:

Rail Type: 50 N Sectional Area of Rail; 64 cm^2

Young's Modulus: 2.1×10^6 kg/cm^2

Temperature Difference at the Time of Setting: 35 C

Coefficient of Linear Expansion: 1.14×10^{-5}

Rail Creeping Resistance: γ= 15/m/1 rail, γ_0 = 0.55/m/1 rail, 0.25 t/m/1 rail

Maximum Axial Force: 54 t

The amount of expansion at the rail end and the amount of opening at +35 C and -35 C, respectively, are also discussed.

Kitahara, I. (Japan National Railway, Chiyoda, Japan), Tetsudo Senro, Vol 21, No. 9, 1973, pp 467-471, 10 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1084

IMPROVEMENT IN THE ROLL PASS DESIGNS FOR RAILROAD RAILS AT THE KUZNETS IRON AND STEEL COMBINE

The improvement in roll-pass designs with added deep grooving and upsetting of rail billets, used on the KMK 900 mill at the Kuznets Iron and Steel combine, is discussed. The changes in roll design contribute to considerable improvement in the quality of the base and head center of the rails. Tests are described for the new rails which incorporated better metalworking in the first passes through the box pass grooves, a high degree of vertical deformation in the trapezoidal passes, and the use of deeper grooving and upsetting of the billet on the head and base sides. The average data obtained reveal that the greatest ironing out of artificially produced cracks on the head is achieved by rolling to the first version of the experimental roll pass design which is illustrated.

Kritinin, I. A., Kudryavtsev, M. P., Sharapov, I. A., Darushin, R. I., and Trynkin, A. R. (Kuznets Metallurgical Combine, U.S.S.R.), Stal [Translated by the British Industrial & Scientific International Translation Service], No. 2, 1973, pp 144-146, 3 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1085

DUAL METHOD OF LAYING HIGHLIGHTS RAIL PRACTICES

Maintenance of Way (M/W) practices followed by the Southern Railway Company and other aspects of rail technology are described. Also, the extensive use of heat-treated rails on curves, field welding of joints at turnouts, and explosive hardening of manganese insert frogs are discussed. The use of Curvemaster induction-hardened rail on all curves of 3 degrees or more and the reasons for its selection are briefly mentioned. Some statistics are given which relate to the rail life of heat-treated rails under various conditions of loading and tonnage carried. The types of rail inspection cars used to detect faulty rails and improper track geometry are briefly discussed.

Railway Track and Structures, Vol 71, No. 11, November 1975, pp 21-23, 2 figs., 1 photo.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Co. (repr., PC).

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1086

M/W POLICY ON THE SOUTHERN: THE STRATEGY BEHIND PROGRESS

The Maintenance of Way (M/W) policies and programs being acted upon in the past and present by the Southern Railway Company are described. In M/W matters, Southern for many years has gone its own way. In mechanizing its M/W forces, it started early but departed from the industry pattern in several basic areas. In recent years, Southern has undertaken accelerated programs of tie and rail renewals. Uses of the track-geometry car (R-1) are briefly described in regard to its functions in detecting rail defects and how the data are processed through the use of computers.

Railway Track and Structures, Vol 71, No. 11, November 1975, pp 16-20 and 32, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman Publishing Corp. (repr., PC).

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1087

EFFECT OF THE PROCESS EQUIPMENT ON THE END DISTORTION OF RAILS

Process-stream measurements were made of the end cambers in a group of P-65 type rails in the planes of greatest and least rigidity at the main points of process treatment in the rail and beam shop at the Kuznets Iron and Steel Combine. The greatest end distortions are produced in the rails during transfer from the hot saw and after the decelerated-cooling pits, the sign of the camber remaining almost constant at all treatment points. Opposite-sign camber can appear after the rails are straightened, but the back ends (in the direction of rolling and process flow) are not susceptible to straightening. Straightening on a stamping press may be responsible for the rails' opposite-sign camber, the amount of distortion depending to a large extent here on camber measurement accuracy as well as on the straightener's experience.

Pokatilov, Yu. P., and Lysenko, I. K. (Siberian Metallurgical Institute, U.S.S.R.) Stal' [Translated by the British Industrial & Scientific International Translation Service], No. 11, 1973, pp 1023-1024, 5 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1088

MECHANISM OF PLASTIC DEFORMATION AND WORN POWDER GENERATION [SOME OBSERVATIONS ON THE ROLLING CONTACT BETWEEN RAIL AND WHEEL]

Rolling-contact tests on rails of high-carbon steel are described. Tests were made at low speeds and low loads with measurements every 30 to 120 minutes; after 11 hr a microscopical examination was carried out. A scaly pattern develops with initiation of cracks, while the powder formed by wear adheres to the wheel surface in a layer ~5 mm thick. This is later torn off again. Wear of wheel and rail are about the same and the powder is derived from both.

Iwamoto, M., and Kono, T. (Japan National Railways, Kokubunji, Tokyo, Japan), Journal of the Society of Materials Science, Vol 21, No. 231, 1972, pp 1093-1098, 22 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1089

RESIDUAL STRESSES IN THE RAIL

The origin and causes of residual stresses generated in fastened rails are discussed, along with the methods that might be used to relieve them. The authors attempt to clarify how the residual stresses in the longitudinal direction are distributed over the cross section (plane in the right angle to the longitudinal direction of the rail) of the rail. The residual stresses are summed with stresses from external forces in an algebraic manner. Thus, in any part of the rail where there is a residual stress of 10 kg/mm^2, a stress in the same direction works as a result of a traffic load, and the result would be the same as if a stress of 20 kg/mm^2 were working. Furthermore, because generally the life of a rail is discussed from the viewpoint of fatigue strength, the existence of a residual stress as an initial stress has a seriously adverse effect on the life of the rail. Methods are discussed for use in the measurement of residual stresses. Schematic drawings showing the distribution of stresses in common and quenched rails are given.

Yasojima, Y. (Tokyo University, Tokyo, Japan), and Machii, K. (Japan National Railways, Tokaido, Japan), Permanent Way, Vol 8, No. 26, Issue 1, 1965, pp 1-11, 11 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1090

STRESSES AT RAIL JOINTS AS INFLUENCED BY BOLT HOLES

Failures of rails at their ends, caused by excessive stresses adjacent to the bolt holes of joints and considered dominant in a majority of rail breakage incidents, are discussed. The author reports on his experiments dealing with the structural joint used for 50 kg/m rails, bolts of different diameters, rails with different size bolt holes, various bolt-hole spacings, and matching fishplates, for the purpose of ascertaining the type of joint that would be most durable. A complete description of the test conditions and rail specimens is given. Tensile stresses at various points within the joints and rail heads, were measured and the data are analyzed and presented in curve plots for a variety of rail loadings.

Sasaki, N. (Railway Technical Research Institute-JNR), Permanent Way, No. 6, March 1960, pp 1-11, 12 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1091

SECTIONAL SHAPE OF THE RAIL AND ITS ABRASION

This report describes a study which had as an objective the reshaping of the rail head to reduce the abrasion caused by contact with train wheels to a minimum, to reduce the excessive contact stress inflicted on the rail, and to prevent the occurrence of shelly cracks within the structure of the rail body. To gain a better understanding as to the profile best suited for the top of the rail head, the author conducted a study of the processes of changes that occur in the shapes of the rail and wheel under various conditions of abrasion. Data were obtained in the form of rail cross-section tracings and those were coupled to information as to radii of curves and descriptions of straight track, along with the total tonnage carried. From the data analysis, it was possible to suggest redesign of the wheel tread and rail-head shapes.

Sasaki, N. (Track Laboratory, Railway Technical Research Institute-JNR, Japan), Permanent Way, No. 7, June 1960, pp 12-20, 8 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1092

UNDULATING ABRASION OF CURVED RAILS CAN BE DECREASED [IN RUSSIAN]

An investigation of methods to reduce abrasion or wear in curved rails is described. The author suggests that the solution to the wear problem would be to properly bank the outer rail in a manner that would equate the train's motion speed to the mode of the driving or guidance of the train. Tests are discussed which show that rails undergo the most abrasion on the support rails that have a curvature radius approaching 1000 meters.

Nazarov, I. I., Put i Putevoye Khozyaystvo, No. 5, 1972, pp 26-28.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1093

SELECTING THE REPAIR PROFILE OF USED RAILS [IN RUSSIAN]

The procedure for studying the wear profile of a rail for the purpose of establishing relations between the area of wheel/rail contact and the occurrence of excessive wear is described. Treatment is prescribed for the repair of worn rail heads which allows a greater degree of stress relief in the head section and the working fillet. Two profiles are selected for comparison, and differences in contact stress were found to be between 1,500 and 2,000 kg/cm^2. One solution given was to remove a 0.5-mm layer of surface metal from the head which would relocate the active zone of maximum contact stresses and this would establish optimum conditions for reusing the rail.

Poroshin, V. L. (All-Union Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 464, 1972, pp 19-26, 6 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1094

RECENT TRENDS IN TRACK RESEARCH ON INDIAN RAILWAYS: PART IV--SOME ASPECTS OF STUDY OF FISHPLATED RAIL JOINTS--BG

Detailed static and dynamic studies conducted on BS 90-R rail joints with standard IRS fishplates and bolts in a main-line track are described. The test track sections where field experiments were made are described in relation to the location, types of sleepers, ballast composition, state of roadbed condition, and the magnitudes of track and rail loadings. The measurements made during the tests comprised fishbolt axial stresses, shear stresses in fishplates, impact loads on rail ends, web stresses, rail-end deflection, bending stresses in fishplates, and sleeper deflection. The methods used in each of the measurements are briefly described. Timoshenko's equations were used to calculate the stress distribution caused by tensile stress in the area of the boltholes. Tabulated data and plotted curves are

included to justify a modified design of fishplate that the author recommends to be used for reducing stresses in the bolthole region.

Ramakrishna, H. S. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 24, No. 165, May 1967, pp 65-72, 6 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1095

RECENT TRENDS IN TRACK RESEARCH ON INDIAN RAILWAYS, PART V: TRACK MODULUS WITH DIFFERENT RAIL SECTIONS; STUDY OF ELASTIC DEPRESSION OF FORMATION; A PROCEDURE TO EVALUATE MAXIMUM PRESSURE ON FORMATION (P_{max}) WITH A NEW CONCEPT OF TRACK MODULUS (FORMATION) U_f

It is shown from tests that one value of track modulus can be used for purposes of ascertaining vertical bending stresses in rail, with rail sections ranging from 60 lb/yd to 52 kg/m. However, this value, when used in the equations of the elastic theory, yields pressures far lower than the actual maximum pressures. To explore earlier concepts, the author has conducted a study of track modulus with 90-R and 52-kg rail sections which were in service on the Ambala main track. The data used in this study cover values of average rail depression and track modulus for different track structures. Step-by-step procedures and soil pressure-transducer schematics are given. The conventional mathematical expressions used for calculating the maximum pressure and their use with numerical values are included.

Ramakrishna, H. S. (Research Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 24, No. 166, August 1967, pp 124-132, 3 figs., 8 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1096

ON THE RAIL CREEPAGE

Studies on the processes and causes of rail creepage are described. The author measured the rail creepage under traffic conditions that relates to the types of cars and the temperature of the rails. He found that the rail creepage occurred only under bogie cars, and that the sum of the rail creepages gradually increased when the rail temperatures varied. In the past, the amount of rail creepage was measured by comparing the position of a mark placed on the rail before and after the passage of the train. The author used measuring equipment to observe the process of longitudinal movement of the rails while the vehicles were passing over the rail. It was concluded that the rail creeps by the movement of the deflection of the rail under the wheel and by elongation or the contraction of the rail, which is caused generally by the passage of the train as a result of release of the pressure or tension in the rail.

Ono, K. (Kanazawa University, Japan), Permanent Way, Issue No. 4, Vol 4, No. 13, December 1961, pp 20-28, 11 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Permanent Way Society of Japan (repr., PC).

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1097

ROLLER AND DROP TESTS OF POTENTIALLY DEFECTIVE RAIL

Roller tests and drop tests were conducted on a batch of rail suspected of having interior defects. A Sperry hand testing device had been used to indicate the defects. A total of 25 rails were subjected to the roller test. A camber of 13/16 in. on rolls spaced 90 in. apart was used. All 25 rails endured the test without fracture. The rails were then subjected to drop testing. This was carried out with the rail placed on a 48-in. span with a drop of 22 ft and the blow of the tup was directed at the location marked by the Sperry hand check. Results indicated that interior defects were not present. (Carried as RRIS Accession No. 040256.)

Penn Central Transportation Company, Philadelphia, Pa., Test Report No. 172, July 1931, 2 pp, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Company (repr., PC).

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1098

TEST OF LATERAL FORCES REQUIRED TO SPREAD 133 LB. MAIN LINE RAIL UNDER VARIOUS LOADS STATICALLY IMPOSED

To determine the lateral force required to spread or overturn the 133-lb rail on the main line under static vertical load conditions, vertical loading was imposed by a freight car of known weight standing on the track with axle center-line of one pair of wheels in the vertical plane through the line of force of the jack. The curve showing the lateral forces required to spread the rail under vertical loading statically imposed is shown. (Carried as RRIS Accession No. 039495.)

Flebbe, P. E. (Union Pacific Railroad Co., Omaha, Nebr.), Test Report, July 1969, 1 p, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Union Pacific Railroad Co. (repr., PC).

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1099

TRACK STRESS RESEARCH

The purpose of this work was to: (1) verify the speed allowance formula; (2) investigate the increment of stress over and above the static effect under normal conditions from track defects; (3) investigate the conditions of supports at rail joints; (4) investigate the stability of ballast; and (5) investigate the effects on rails and sleepers of the lateral forces set up by the hunting movement of locomotives. The shape of the sleeper was found experimentally to have no noticeable influence on its deflection under a given load, but stress distribution between the sleepers and subsoil requires investigation. It was suggested to confirm the consideration that design to rolling stock to reduce nosing on the sharper main-line curves would reduce the secondary stresses and thus offset the increased stress due to centrifugal effects. It was found that experimental static deflections and stresses were in reasonably close agreement with calculated values. (Carried as RRIS Accession No. 037249.)

Gelson, W. E., and Blackwood, E. A. (Railway Dept., Calcutta, India), Railway Gazette, Vol 73, February 1940, pp 245-255, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Temple Press Ltd. (repr., PC).

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1100

WHEEL AND RAIL LOADING FROM DIESEL LOCOMOTIVES

This review is divided into the following areas: sample derailment data; basic curve negotiation mechanics; experimentally determined wheel-to-rail forces; rail profile data; the effect of dynamic brake levels; and mechanical considerations. Sample derailment data were taken from all six areas and well illustrated with examples. A summary of results is shown. There are a number of mechanical areas involved in the locomotive which can and do affect the wheel-rail loading. Among these, although there are many others, are the alignment control draft gear, matching wheel sizes, and maintenance of truck bolster stops. (Carried as RRIS Accession No. 040024.)

Marta, H. A., and Koci, L. F. (Electro-Motive), Conference Paper, pp 146-177, 30 figs., 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: ESL (repr., PC).

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1101

RAIL ABRASION AND END BATTER OF CONTROL COOLED 131 LB. R.E. RAILS

This is a progress report showing results of rail abrasion and end batter of control-cooled 131-lb R.E. rails rolled and treated by various manufacturers and laid during 1935. The Illinois and Bethlehem rails were laid on the Middle division No. 4 westbound passenger tracks on tangent

and 4 degrees 0" curve east and west of Lewistown, Pa. The Carnegie and Inland rails were laid on the Panhandle Division No. 1 eastbound passenger and freight track on tangents and curves ranging from 3 degrees 14' to 7 degrees 0" west of Carnegie, Pa. It was found that for the tangent track the differences in both abrasion and batter as between thermal treated and ordinary hot bed cooled rails are negligible, indicating that no appreciable decrease in hardness of the rail has resulted from the thermal treatment. The information for curve is not directly comparable because of the wide variations in curvature where measurements were obtained. There have been no transverse fissures or other failures in either the test or comparative rails during the three-year period between measurements. (Carried as RRIS Accession No. 040259.)

Penn Central Transportation Co., Philadelphia, Pa., Test Report No. 245, Progress Report, July 1939, 3 pp, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1102

STEADY-STATE VIBRATIONS OF RAIL ON AN ELASTIC DAMPED FOUNDATION SUBJECTED TO AN AXIAL FORCE AND A MOVING LOAD

The recent practice of continuously welded railroad rails suggests that considerable axle forces may be induced in the rails due to a change in temperature. This paper presents an analytical solution for the effect of an axial force on the steady-state vibrations of a rail continuously supported on an elastic damped (viscoelastic of the Kelvin type) foundation and subjected to a moving load. The presence of damping is shown to result in an unsymmetric dynamic deflection of the rail. Due to phase shift the largest deflection occurs slightly behind the point of application of the moving load, and the deflection ahead is always larger than the deflection behind the point of maximum deflection. The results are relevant to present studies of the temperature buckling of continuously welded railway rails. If the rail is near to the point of buckling due to thermal strains, additional longitudinal strain in the rail due to a moving load may result in buckling of the rail ahead of the moving load.

Dokainish, M. A. and Elmaraghy, W. H. (McMaster University, Hamilton, Ontario, Canada), ASME Paper No. 75-RT-3, presented at the IEEE-ASME Joint Railroad Conference, April 15-17, 1975, San Francisco, Cal., 8 pp, 6 figs., 10 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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1103

TRENDS IN SWITCH CONSTRUCTION [IN GERMAN]

The increase in the speed of passenger trains to more than 250 km/hr calls for the development of new types of switches using S-49 rails. A switch with spring-type frog point for a high-speed experimental track of the West German Federal Railroads is demonstrated.

Topp, G. (Rheinstahl AG., W. Germany), Rheinstahl-Technik, Vol 12, No. 1, 1974, pp 47-48, 5 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Rheinstahl AG (repr., PC).

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1104

THE RANGE OF ADAPTABILITY OF SLAB TRACK IN RELATION TO CONDITIONS OF TRACK CONSTRUCTION [IN JAPANESE]

In regard to the construction of slab tracks, the type of track construction with full-area support is designated as Slab Track Type A by the Japan National Railways. The present work describes the characteristic features of each of the types of track construction included in Slab Track Type A and explains the course of development that led the JNR to select A-151 Type (A-51 Type) and A-155 Type (A-55 Type) as its basic types after having examined the different types of slab-track constructions in terms of factors of safety.

The work also discusses (1) the regulations concerning those changes in such structures as elevated bridges which are to be required for the purpose of maintaining the proper functions of Slab Track Type A, (2) an inquiry into the economic efficiency and construction conditions of slab tracks, and (3) points out that the slab track should be adopted by the

JNR for all its railway networks. The study places emphasis on the need to promote the development and use of antivibration slab for the purpose of noise reduction in the areas located in the vicinity of cities.

Kikuchi, I., and Hara, S. (Japan National Railways), Tetsudo, Senro, Vol 21, No. 11, 1973, pp 589-597, 16 figs., 11 tables, 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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1105

NUMERICAL CALCULATION AND APPROXIMATE FORMULA OF BUCKLING STRENGTH OF TRACK [IN JAPANESE]

The adoption of 60-kg rail was decided in connection with the construction of the New Sanyo Trunk Line in 1967. When a program was developed for calculating the buckling strength of the 60-kg rail, the buckling strengths of various kinds of rails were also calculated. The results pointed to the fact that there can be a relatively simple approximate formula for determining the buckling strength of rail.

This paper introduces the method of such calculation, the results of computation, and the approximate formula. Additionally, by ways of instances of application, the paper discusses problematic points to be considered in connection with the use of 60-kg rail for long-rail track of narrow gauge as well as the possibilities which might be experienced when 70-kg rail is used for long-rail track.

Sato, Y., and Kobayashi, S. (Railway Technical Research Institute, JNR), Railway Technical Research Report No. 759, 1971, 38 pp, 32 figs., 8 tables, 12 refs., 1 appendix.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Research Institute (repr., PC).

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1106

SLAB TRACK POINT AND EXPANSION JOINT [IN JAPANESE]

This work describes those items for which caution should be exercised in the course of track construction and maintenance work for points and expansion joints, which have been converted into slab track. Also discussed are the constructional features and the purpose of design.

The clamping device for the point for the slab track consists of a device for receiving lateral force, the base plate, or the branching tie plate. The components for expansion joints, i.e., rail and accessory items (excluding the base plate), are the same as those which are used for the ballast road bed.

As the two items mentioned above have more complicated designs for those applications where they are joined to the slab in comparison with the same items used for slab track in ordinary sections, elaborate precautions are given in the present paper with regard to the working procedures to be followed in laying tracks.

Torikoshi, S. (Japan National Railways), Tetsudo Senro, Vol 21, No. 11, 1973, pp 605-616, 30 figs., 6 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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1107

NUMERICAL CALCULATION AND APPROXIMATE FORMULAE FOR BUCKLING STRENGTH OF TRACK [IN JAPANESE]

Evaluation of buckling strength and changes in buckling temperature in tracks constructed with 60-kg rails and rails such as Types 50T, 50PS, 50N, 40N, 37ASCE, 30ASCE has revealed that there are approximate formulae for calculating their buckling strength.

This paper presents an outline of the basic formulae, the method of calculation, and the approximate formulae together with examples of their applications.

Sato, Y. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 10, 1971, pp 577-580, 3 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1108

A STUDY OF RAIL LIFE IN SEAWATER CORROSIVE ENVIRONMENT [IN JAPANESE]

This study represents an inquiry into proper uses of rails exposed to high temperature (30° to 40°C) and high humidity in an environment in which they are susceptible to corrosion by sea water. In the environment just mentioned, the life of rails is determined by such factors as wear, corrosive fatigue, fatigue failures in the head of rail, corrugated wear, and lateral cracking in the head of rail at the welded section.

As measures for prolonging the life of rails, the present study considers modification of rail shape, anti-corrosion treatment with zinc metalicon, and the improvement of materials. The study examines problems that involve each of these proposed measures.

Kato, Y., Kurota, S., Sugiyama, T., and Sakurada, S. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 22, No. 11, 1974, pp 589-592, 3 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1109

TENSILE STRESS IN THE TOP OF RAIL [IN JAPANESE]

The present study discloses the results obtained, through laboratory studies and actual measurement in the field, of the stress that occurs chiefly in the head of the rail in the area close to the point of contact between the wheels and the rail.

The results revealed by the present study clearly demonstrate, among other things, that lateral pressure exerted on the rail yields large tensile stress on the area of the head of the rail facing the external side of the track. Also this stress, though it corresponds to approximately one-half of the stress that occurs in the bottom part, will require caution in case any fatigue damage develops in the rail head.

Suqiyama, T. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 18, No. 10, 1970, pp 519-520, 5 figs., 2 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1110

WEAR OF RAILS [IN JAPANESE]

In most cases, rails are replaced when they are found no longer usable for such reasons as wear and corrosion. The present report explains the functions of rails, the materials of rails, and actual instances of wear in rails together with countermeasures for them.

As rail hardness is increased, rail wear decreases. This fact indicates that the finer the dispersion of cementite in a particular variety of steel, the greater will be the resistance of the steel to wear. The present work contains an explanation of corrosion wear, wear resulting from fatigue caused by rotating movement, flaws caused by the slipping rotation of wheels, and wave-shaped wear.

Pearlitic steel is the variety of steel most widely used for rails at present, but it has a high sensitivity to notch brittleness and requires a high preheating temperature for welding. Hence, it is stated that the use of high-strength low-alloy steel will be required in the future.

Ito, A. (Railway Technical Research Institute, JNR), Journal of Japan Society of Lubrication Engineers, Vol 16, No. 1, 1971, pp 3-14, 21 figs., 4 tables, 14 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Lubrication Engineers (repr., PC).

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1111

VACUUM DEOXIDATION OF STEEL FOR RAILS [IN POLISH]

The mechanism and kinetics of vacuum deoxidation of rail steel is theoretically investigated for the purpose of arriving at a kinetic equation for the reaction that takes place during the process. Equations are derived which take into consideration such variables as mass of carbon dioxide gas cavities, volume of molten metal, reaction speed, and the amount of oxygen excess in the molten bath. Subsequently, an expression for the volume of oxygen emitted from the metal was formulated. The usability of the equations was tested in the laboratory and again during actual application in the steel mill process of deoxidation. The results of the investigation are shown in charts and tabulated data, and are discussed in regard to the final success of the study.

Klisiewicz, Z. (Politechnical Institute, Slaska, Katowice, Poland), Hutnik, Series 40, No. 7, 1972, pp 309-313, 3 figs., 5 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon & Sagner (repr., PC).

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1112

ROLLING CONTACT PHENOMENA ASSOCIATED WITH HIGH-SPEED TRAINS [IN JAPANESE]

This work presents an account of basic adhesion between wheels and rail, adhesion at high speed, and matters related to these.

It discusses such subjects as: (1) features characteristic of the contact between wheels and rail, (2) factors having significant bearing on the condition of contact between wheels and rail together with evaluation of such factors with special emphasis on the measurement of surface conditions and influences of such factors, (3) problematic points relating to the wheel-rail contact of high-speed trains and particularly critical adhesion at high traveling speed and fatigue developing in the point of contact between wheels and rail, (4) rolling friction at the point of contact between a wheel and rail.

Shiba, S. (Railway Technical Research Institute, JNR), Journal of Japan Society of Lubrication Engineers, Vol 16, No. 8, 1971, pp 626-631, 4 figs., 3 tables, 11 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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1113

THE WEAR OF A RAIL STEEL CONTAINING MICRO-ALLOY ADDITIONS [IN RUSSIAN]

The effect of micro-alloying on the wear of a rail steel containing C 0.73-0.98, Mn 0.79-1.39, Si 0.17-0.56, S 0.024-0.029, P 0.018-0.035, As 0.055-0.149, and Cr 0.0-1.5% was studied. Additions were made to the ladle, of alloys of various compositions containing Ti, B, Mg, Al, Mn, and Fe. These gave increased wear resistance, the best results being given by micro-alloying with Ti-B-Al, or Ti-Al and Mg-Al alloys. Increased strength and hardness of the steel is accompanied by improved wear resistance. An increase in Si in the steel (>0.5%) leads to rapid wear caused by plastic deformation. Taking into account all wear factors, the simultaneous micro-alloying of the steel with Ti-Al and Mg-Al alloys gives the optimum results.

Maslov, A. M., and Melkov, V. A., Met. i Gornorydn. Prom. Nauchno-Tekhn. i Proizv. Sb., No. 4, 1968, pp 40-42, 2 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1114

THE PRODUCTION OF HIGH-STRENGTH RAIL STEELS WITH OPTIMUM IMPURITY LEVEL [IN GERMAN]

The requirements to be met by high-strength rail steels in terms of mechanical properties and chemical composition and the occurrence and causes of defects in rails are mentioned. Four different deoxidation treatments were investigated. In one, complex deoxidation was carried out with Mn- and Si-bearing alloys and 0.5 kg Al/t.

In the other treatments, deoxidation with a higher proportion of aluminum was carried out, and in one case it was followed by flushing with nitrogen. The effects of the various treatments were assessed by observing the cleanliness of the steel, the interdependence of reduction in oxygen and inclusion content, distribution and morphology of nonmetallic inclusions, the distribution of oxygen in the ingot, and the tensile properties.

Pochmarski, L., and Moser, A. (Osterreichisch-Alpine Montangesellschaft, Leoben-Donawitz, Austria), Berg- und Huttenmann. Monatsh., Vol 117, No. 9, September 1972, pp 307-316, 12 figs., 1 table, 15 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Springer-Verlag/Vienna (repr., PC).

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1115

RAIL STRAIGHTENING PLANT FOR A CANADIAN STEEL MILL [IN GERMAN]

A rail straightening plant designed for an annual output of 600,000 tons was supplied to the Sydney Steel Corp. The increasing demands made upon the strength of rails is a consequence of the increasing running speeds of rail vehicles. Rails with a weight of 65 kg/m and a length of 30 to 40 m are straightened in the new plant. The rails pass through a cooling zone where they are cooled from 800 to 900 C down to 50 to 60 C, and are then conveyed over roll tables to the straightening machine unit where the horizontal and vertical axes are treated simultaneously by two straightening machines operating at speeds of 45 and 68 m/min, respectively. Less than 20 percent require an additional treatment on a hydraulic straightening press.

Maschinen und Bohrgeratefabrik, A. Wirth und Co., Erkenlenz, W. Germany (Firm's Report), Werkstattechn., Vol 61, No. 7, 1971, p 457, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Springer Verlag (repr., PC).

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1116

RAILS, SHAFTS AND ROLLS [IN JAPANESE]

This work treats strain resulting from the middle frequency induction hardening of rail (induction heating using frequencies below 10 kHz) and measures for preventing such strain. For the heat treatments of rails, the Japan Industrial Standards provide that the hardening depth should be 15 mm or more. In the case of 60-kg rail, the hardening depth is 35 mm. Accordingly, the frequency adopted is as low as 2 KHz.

However, the thermal strain that develops at the time of heat treatment in the heating and cooling processes is so great that it is necessary to take special strain-prevention measures. The present work indicates that strain can be prevented by having the rail inclined downward under its own weight in the portion of the rail on which heat treatment is completed and by allowing the top of the rail to expand through relative bending of the rail by the theoretical expansion volume.

Ohno, A., and Koyama, H. (Japan Spring Company), Kinzoku Zairyo [Metal Materials], Vol 14, No. 10 (no date), pp 36-39, 5 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Nittsukan Kogyo Shinbun (repr., PC).

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1117

RAILS MADE OF LOW-ALLOY ACID CONVERTER STEEL

This paper is concerned with an investigation dealing with rails produced from steel with various low-alloy chemical compositions, or those with small amounts of such alloying elements as chromium and manganese. The purpose of the investigation was to produce rails with high mechanical strengths and properties in the quenched state. The current processes for producing carbon steel ingots and the rolling-mill practices at the Dzerzhinskii Works are discussed. The chemical compositions of rails used in

the investigation are given along with information on specific phases of heat treatment. The authors conclude that rails alloyed with chromium and small amounts of vanadium possess good mechanical properties in the quenched state and a quenched layer of increased thickness.

Karpunin, A. M., Prosvirin, K. S., Besedin, P. T., Orgiyan, V. S., Baptizmanskii, V. I., Shcherbina, P. A., and Rekhlis, G. N. (Dzerzhinskii Works, Dnepropetrovsk Metallurgical Institute, and the Ukrainian Institute of Metals), Stal [in English], No. 5, May 1964, pp 389-391, 2 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1118

THE PROPERTIES OF A BESSEMER RAIL STEEL DEOXIDIZED WITH VARIOUS QUANTITIES OF ALUMINUM [IN RUSSIAN]

The composition and quantity of nonmetallic inclusions, the mechanical properties, and the impact strength of notched and unnotched specimens of a Bessemer rail steel were determined and related to the quantity of Al used in the deoxidation. Steel from two melts was deoxidized in the ladle with secondary Al. Extra additions were made to the metal stream in the casting molds; this additional Al was not added to one of the billets. The best combination of properties was found with the supplementary deoxidation by 300-400 g/ton of Al. For this purpose it is recommended that all the Al be added to the ladle.

Karpunin, A. M., Polyakov, S. N., Kudlai, A. S., Kutsenko, A. D., and Orgiyan, V. S., Met. i Gornoryda. Prom. Mauchno-Tekhn. i Proizv. Sb., No. 1, 1969, pp 35-36.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1119

THE TRANSITION AND PRESENT STATUS OF RAILS FOR RAILWAYS [IN JAPANESE]

The present work contains a survey of the transition of railway rails from 1901, when the first rail was produced in Japan, to the present and it also provides a description of the present-day status of rails for railways.

At present, a total of more than 500,000 tons of rails per year are produced in Japan at the Yahata Iron Works of Nippon Steel Corporation and the Fukuyama Iron Works of Nippon Kokan Kabushiki Kaisha. These iron works produce such varieties of rails as 60-kg/m-50m rails, hyper-hardened-head rails having improved resistance to wear and improved resistance to contact pressure, and rails with head flanges strengthened by heat treatment, representing a strengthening of the rail edge, which has a structural weakness.

This study points out that it will be necessary for the future production of rails to employ such techniques as vacuum degassing and continuous casting of blooms as well as introducing alloy steels.

Kurihara, T. (Railway Technical Research Institute, JNR), Journal of the Japan Society of Mechanical Engineers, Vol 78, No. 683, 1975, pp 941-947, 9 figs., 2 tables, 13 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Mechanical Engineers (repr., PC).

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1120

A STUDY ON THE EXPECTED LIFE OF RAILS IN THE SEIKAN TUNNEL [IN JAPANESE]

Seikan tunnel, which connects the Mainland of Japan to Hokkaido, is approximately 54 km in total length, and the part of the tunnel located under the bottom of the sea is in a seawater corrosion environment. The rails to be used for the track in the tunnel should have strong resistance to wear and fatigue. The present report concerns itself with an estimate of 60-kg/m rails when applied to Seikan tunnel. The 60-kg/m rail in its present shape cannot be regarded as being sufficient for the purpose, and it is necessary to improve on its sectional shape for application there. In doing so, the rail should be given a different sectional shape and greater weight. While zinc metalicon prolongs the rail life by about 5 years, it is necessary to remove zinc completely from the rails in case long rails are adopted, and this will create a problem at the time of field welding.

Kato, Y., Kuroda, S., Sugiyama, R., and Sakurudu, R. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 2, 1975, pp 63-64, 1 fig., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1121

SERVICE AND MAINTENANCE OF THE LONG RAIL [IN JAPANESE]

The present work deals with calculations carried out on the basis of the long-rail theory hitherto developed and drawing on the basic data obtained through a survey of the actual conditions of the ballast track section on the Arita River Bridge. The standards for future maintenance and service for long-rail tracks which have been worked out on the basis of both the actual measured values and the calculated values are also considered.

Hase, I. (Japan National Railway), Tetsudo Senro, Vol 19, No. 4, 1971, pp 183-186, 7 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1122

WHEEL LOAD CHANGES ON THE SHINKANSEN TRAIN [IN JAPANESE]

The wheel-load fluctuation developing in the New Truck Line cars is much larger in comparison with that observed in the railway cars used on the existing lines, and it is known that the wheel-load fluctuation is caused by the unsprung vibration in the truck axles.

In this paper, the overall relationship between the car vibration and the fluctuation of wheel load is examined through a frequency analysis of the wheel load and the acceleration in different parts of railway cars. There has hitherto been little experimental analysis of the vibration in the unsprung area of the truck axles, and hence, this present study serves to clarify its characteristics.

Miyaishi, M., and Yamashita, H. (Railway Transport Research Institute-JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 7, 1975, pp 259-262, 8 figs., 2 tables, 1 ref.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1123

RAIL MAINTENANCE IN SHINKANSEN [IN JAPANESE]

This summary account of the presentation made by the Head of the Facilities Department at a meeting of the Railway Safety Council of the Japanese National Railways Corporation outlines track constructions and deals with such considerations as track-maintenance methods, the transition of track conditions, fundamental improvement in track structures, the renewal of rails, and anticipated future problems, with respect to the maintenance and service of the New Tokaido Trunk Line.

Takemura, K. (Japan National Railways-JNR), Tetsudo Senro, Vol 19, No. 2, 1971, pp 71-76, 10 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1124

WROUGHT IRON BULL HEAD RAIL [IN JAPANESE]

The author presents the results of tests conducted on the material properties of the wrought-iron bull-head rail, which was used at the time the Japan Railways was started (in 1872) and which was discovered during field work. The rail manufacturing technology in those early days is described through comparison of the test results with the quality and grade of the rails currently in use.

Kurihara, T. (Railway Technical Research Laboratory-JNR, Kokubunji, Tokyo, Japan), The Heat Treatment, Vol 15, No. 2, 1975, pp 102-107, 9 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: The Japan Heat Treatment Association (repr., PC).

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1125

WHAT ITEMS ARE WE STUDYING ON RAILS? [IN JAPANESE]

The author details the subject matter awaiting future studies on rails by the staff of the Japan Railways Corporation in terms of a classification of the subject matter into (1) the optimum track structure, (2) rail life, (3) improvements on rails, (4) studies on the rails for the nationwide new trunk-line networks, and sets forth study themes by subdividing the subject items.

Kurida, S. (Railway Technical Research Laboratory-JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 19, No. 4, 1971, pp 213-216, 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1126

WEIGHTING TREND [IN JAPANESE]

By way of an approach to coping with the changes in loading conditions and the sharp increases in the maintenance cost, it is conceivable to adopt rails of heavier weight. In order to cope with the sharp increases in the labor cost, an economical approach is to adopt 50-kg rails for total traffic tonnage of 3,000,000 tons or above and 60-kg rails for total traffic tonnage of 12,000,000 tons or above. The work also discusses a rail application policy for the future. It is stated in the work that the maintenance cycle and the rail replacement cycle can be prolonged by 15 to 20 percent, with an accompanying reduction of the track repair cost by 10 to 15 percent, by adopting heavier rails under this rail-application policy.

Togashi, S. (Japan National Railways, Marunichi, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 22, No. 6, 1972, pp 262-264, 6 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1127

STUDY OF HIGH-SPEED RUNNING ON A CURVED TRACK [IN JAPANESE]

High-speed running on a curved track is a problem of real importance to be solved for railroad vehicles so that the time required for transportation may be shortened.

To solve this problem, the roll control of a car body and the reduction of the lateral force acting on a wheel should be investigated.

In cooperation with Odakyu Electric Railway Co., Ltd., the authors have studied the pendulum car with air springs, the bearing type pendulum car, and the automatic roll control with air, as well as the reduction of the lateral force by the link mechanism.

In the present paper, the problems associated with high-speed running on a curved track are discussed and the results of the study conducted are described.

Nishio, A., Kikuchi, I., Shirane, Y., Yamada, J., and Nishimura, S. (Sumitomo Metals Co., Ltd., and The Osaka Steel Works, Japan), Sumitomo Metals, Vol 22, No. 4, 1970, pp 467-475, 20 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Sumitomo Metals Co. Ltd. (repr., PC).

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1128

STABILITY OF LONG-RAIL TRACKS DURING EARTHQUAKES [IN JAPANESE]

Among the damages inflicted on the railway tracks by a large earthquake, it may be that only the track, though showing no obvious damage, shows a deformation which leads to the belief that the track has buckled under axial pressure, i.e., a phenomenon known as corrugated bending. Unlike the ordinary track, the long rail track is particularly susceptible to temperature and axial pressure. Thus, this is the subject of the present study. In the case of the New Tokaido Trunk Line, it is required that the lateral resistance on the road bed be 581 kg/m. This means that the structure of the track will endure 92 t of the minimum buckling axial pressure and temperature fluctuation of 51 C, thus maintaining a safety

factor of 1.275 against an estimated maximum temperature change of 40 C. The existing lines also have a safety factor ranging from 1.15-1.20.

Soto, Y. (Railway Technical Research Laboratory-JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 17, No. 10, 1969, pp 589-592, 5 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1129

THE SELECTION OF AN ECONOMICAL RAIL SECTION

This study was conducted to establish economic ranges for various rail sections and to select a suitable standard--preferably a single section for the combined C&O-B&O railroad system. Six existing rail sections of six different rail weights ranging from 115 to 140 lb were analyzed which have been designed or improved to meet requirements of heavy, high-speed loads with an adequate margin of safety. With at least a 9 percent rate of return for both railroads, a combination of the existing sections was needed to satisfy the various requirements of the new rail territories--140 lb for the high, 133 lb for medium, and 115 lb for the low traffic density and speed territories. A new 122 lb rail section was designed which embraces 98 percent of the B&O-C&O new rail territories. Cost savings through use of the single 122 lb section for both railroads are estimated. (Carried as RRIS Accession No. 037599.)

Law, C. W., Diamond, L. P., and Reiner, I. A. (The B&O Railroad Company), Report No. 486, 1963, 77 pp, 9 figs., tables, 10 refs., 8 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: B&O Railroad Company (repr., PC).

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1130

NEW METHOD OF ROLL-HARDENING RAILROAD RAILS

A new method of roll-strengthening rails, involving heavy vertical reductions of the head of the pre-finished section in a universal finishing stand with low overall reduction of the section, was devised and tested. Laboratory investigations together with full-scale experiments with heavy-section rails on a rail and structural mill proved the efficiency of this new method and gave grounds for recommending its application to production.

Kobyzev, V. K., Salov, E. M., Kachurin, D. S., and Kritinin, I. A., Stal' [Translated by the British Industrial & Scientific International Translation Service], No. 4, April 1971, pp 337-340, 5 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1131

LONG WELDED RAILS (INSTALLED IN BADSHAHNAGAR-MALKAUR SECTION OF THE NORTH EASTERN RAILWAY)

The procedures for installing long welded rails, the justification for rail welding, theory of expansion of welded rails, prerequisites for using welded rails and other requirements are discussed. The disadvantages of the fishplate rail jointed track are discussed in relation to occurrences of rail-end batter, loosening of bolts, and rail buckling. The theory of rail expansion is treated, and an estimate of the forces exerted on the sleepers due to thermal elongation of the rail under extreme temperature ranges is given. Test equipment for measuring the rate of rail expansion is described and some measurements are presented to show the seriousness of the phenomena.

Aiyangar, S. L. (North Eastern Railway, Lucknow, India), Indian Railway Technical Bulletin, Vol 24, No. 164, February 1967, pp 34-43, 7 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1132

THE INVESTIGATION OF RESIDUAL STRESSES IN RAILS WELDED BY ALUMINOTHERMIC PROCESS [IN GERMAN]

Residual stresses were experimentally ascertained in nonwelded and aluminothermic-welded rails with and without weld reinforcement. Strain gauges were used to measure the deformation caused by stress relaxation as components were sectioned. In nonwelded rails, tensile stresses were found to be present in the head and the foot in a direction parallel to the rail axis, and compressive stresses were present in the rail web. In welded rails, the pattern was reversed, with tensile stresses present in the web and compressive stresses present in the head and foot. The stress pattern in the welded rails is advantageous because it increases the capacity of the rail to withstand tensile stresses imposed by the load.

Dhose, R. (Elektro-Thermit GmbH, Essen, W. Germany), Schweissen und Schneiden, Vol 19, No. 10, October 1967, pp 471-476, 7 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Deutscher Verlag fur Schweissentechnik GmbH (repr., PC).

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1133

AN EXPERIMENT ON THE IMPROVEMENT OF FATIGUE STRENGTH IN WELDED JOINTS [IN JAPANESE]

The fatigue strength of rails declines because of the shape of the portion of the toe of the weld which develops at the time of rail welding. In view of this situation, an attempt was made at improving the welding conditions by making the reinforcement of the weld as flat as possible for the purpose of moderating stress concentration. As one-side welding is employed for large-size structures such as railroad bridges, this point was also investigated. While it is possible to make the surface of a welded section flat by selecting an adequate welding condition, it is not possible to completely remove minute undercuts and the like. When double-side welding is applied under this improved condition, a significant improvement is observed in terms of fatigue strength. In the case of one-side welding, however, there are considerable fluctuations in the resulting fatigue strength.

Ohta, S., and Kudo, S. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 7, pp 271-272, 2 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute (repr., PC).

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1134

LONG-RAIL TRACKS BY GLUED RAIL JOINTS FOR INSULATION [IN JAPANESE]

The insulation joint of rails is an obstacle to the adoption of long rail tracks for railways in the neighborhood of cities. A long-rail track having a total length of 1,100 m was laid down through the adoption of a "glued insulation joint", which was developed for removing the obstacle associated with the insulation joint. The course of development is described, from the manufacture to the field construction, of the "glued insulation joint" which was manufactured on a trial production basis by a newly examined engineering technique based on the "wet method" developed by the Japan National Railways.

Suzuki, O., and Umekara, K. (Tokyo Express Co., Tokyo, Japan), Journal of Railway Civil Engineering Research, Vol 18, No. 3, 1970, pp 111-115, 12 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1135

DETECTION OF BASE SEAMS IN INLAID RAILS

A test apparatus for the detection of rolling mill defects located at the base of new rails installed less than 2 years prior to the appearance of failure signs is described. Upon evaluation of the commonly known nondestructive testing methods, only ultrasonics was retained as having potential to perform the work required. The probe arrangement, selected from three being considered, is described. Illustrations showing beam fractures and decarburized seams are presented to demonstrate the nature of the problem of base and web probing.

Various types of acoustical couplings being considered for this study are discussed. The study led to the development of a semiautomatic, self-mobile ultrasonic rail test car, capable of detecting detrimental base seams in laid rails at an average speed of 5 km/hr. The results of field tests of the rail inspection car are tabulated, and photo-micrographs of defects observed in rails are presented.

Veniza, G. E. (Canadian National Railways), Report No. H-4, Presented at the 6th International Conference on Nondestructive Testing, 1970, pp 37-46, 25 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Deutsche Gesellschaft fur Zerstorungsfreie Prufverfahren (repr., PC).

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1136

HIGH SPEED TRACK INSPECTION MACHINE [IN JAPANESE]

The speed improvement tests conducted on the new Sanyo Trunk Line have revealed the necessity for control over the short-wavelength track irregularities that possibly result from the shape of the rail-head section, as well as the long-wavelength track irregularities such as those detectable by the level transit. The author describes the structure of the high-speed track-inspection equipment (HISTIM), which has been developed for inspection and measurement of such track irregularities, and presents the results of the tests conducted with the equipment.

The short-wavelength irregularities occur under the fluctuations of the wheel load and changes in lateral force, while the long-wavelength irregularities are considered as the disorder of surface in relation to travelling comfort.

Sato, Y. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 3, 1975, pp 171-175, 9 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1137

ESTIMATING THE WEIGHTS OF RAILS IN THE TRACK

The Railimeter measures rail in two directions simultaneously, and indicates the weight of the section in pounds per year by a pointer on a scale. If side cutting is present, a reading from a side-cut gage is subtracted from the reading of the Railimeter. Where the rail is galled it is of course necessary to displace the seat at the gall when measuring the weight of this section. A chart estimating rail life based on the Railimeter reading is illustrated. The results obtained with this instrument compare favorably with more laborious methods previously used. (Carried as RRIS Accession No. 037687.)

Brown, G. W. (London Midland & Scottish Railway, England), Railway Gazette, Vol 73, August 1940, pp 203-204, 2 figs., 1 photo.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Temple Press Ltd. (repr., PC).

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1138

RAILROAD ACCIDENTS AND NONDESTRUCTIVE INSPECTION

Railroad accident data published annually by the Office of Safety in the Federal Railroad Administration are analyzed to indicate the most severe causes of railroad accidents. The severity is judged by viewing both the frequency of accidents and the dollar damage per accident. Most of the components or conditions in the groups found to be severe accident causes are amenable to nondestructive inspection. An analysis shows the maximum benefits of an extensive nondestructive inspection program to appear in the wheel and axle category followed in order by track geometric and dynamic conditions and rails and joints. A review is provided for nondestructive inspection methods in current railroad use and potentially useful for the future.

Bray, D. E. (University of Oklahoma, Norman, Okla.), ASME Paper No. 74-WA/RT-4, presented at the Winter Annual Meeting, November 17-22, 1974, New York, N.Y., 15 pp, 3 figs., 6 tables, 59 refs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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1139

WELDING OF RAILS WITH FLASH REMOVAL IN THE FLASH WELDING MACHINE

The authors describe trials conducted by the Baltic Railways with the flash welding of rails K-190P using a flash remover positioned between the moving column and the rigid frame of the machine. The flash welding of rails ensures high technical and economical characteristics of the process, and makes it possible to mechanize and automate the operations. A brief comparison is made between the flash remover process used in other countries and that used in the Soviet Union. Technical data and specifications are presented for the Soviet flash remover, and the manner in which the equipment functions is described. Comparisons are made between chemical compositions, steel hardness, and procedures used by three different steel combines in the Soviet Union.

Genkin, I. Z., and Gridin, A. P. (Baltic Railways, U.S.S.R.). Svar. Proiz. (Welding Production), No. 7, 1974, pp 22-24, 3 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1140

ON THE RESIDUAL STRESS IN RAIL [IN JAPANESE]

The author measured the residual stresses of rail, and, as a result, it has become clear that the residual stresses tend to decrease and that the unequilibrium stress arises, giving rise to deformation of rail. Fortunately, this force is not so strong as to overcome the force caused by the dead load and fastening load of the rail itself. To clarify the relationship between the residual stresses and the rail breakage as well as the generation mechanism of the residual stresses, there still remain several difficult problems, such as the relationship between the fatigue intensity of the rail and the residual stresses, the quantitative treatment of the source of initial stress, and the dynamic condition to which a rail is exposed during manufacture.

Yasoshima, Y. (University of Tokyo, Tokyo, Japan), Journal of the Faculty of Engineering, Series A, No. 5, 1967, pp 4-5, 4 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: University of Tokyo, Japan (repr., PC).

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1141

EFFECT OF AIR POLLUTION ON THE FIELD STRUCTURE: IN THE CASE OF THE RAILWAY MATERIALS [IN JAPANESE]

With regard to the influence of atmospheric pollution on the railway facilities, aeration tests were conducted in industrial, farming, and sea coast areas to measure the degrees of pollution. The quantitative data on the resulting corrosion in each of these areas were compared and examined by the type of materials.

Kaiho, Y. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Corrosion Control, No. 12, pp 11-15, 1973, 9 figs., 3 tables, 7 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Corrosion Control Engineering Association (repr., PC).

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1142

THE EFFECT OF THE HARDNESS OF HEAT-TREATED RAIL STEEL ON THE WEAR AND CONTACT FATIGUE FRACTURE OF SPECIMENS SIMULATING THE "WHEEL/RAIL" COUPLE [IN RUSSIAN]

The effect of thermally strengthening rails (HF heating and volume quenching) on the wear resistance and resistance to contact pitting of the 'wheel/rail' couple was studied. Heat treatment to HB values of up to 340 significantly increased both these factors for the rail, and although the wear resistance of the wheel was not reduced, its resistance to contact pitting was lowered by 30%. Resistance to plastic deformation, more than any other factor, controls the wear of both components under conditions of friction and rolling and friction slip.

Vekser, N. A., Kazarnovskii, D. S. and Khurgin, L. S. (Ukrainian NII Metallurgical Institute, U.S.S.R.) Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 19, 1972, pp 63-72, 5 figs., 3 tables, 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

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1143

THE EFFECT OF ALLOYING WITH NICKEL AND CHROMIUM ON THE RESISTANCE OF A STEEL TO CONTACT-FATIGUE DAMAGE (OF RAILWAY RAILS) [IN RUSSIAN]

The effect of Ni and Cr additions on the fatigue properties of rail steels was studied. Chromium has the most effect with certain quantities of C and Mn in the steel. Numerous tests showed that the greatest resistance to tearing out of metal and chipping was given by Cr steels with Σ (C + 0.25 Mn) $\geq$ 0.88%. Rails made from Cr-Ni steels containing 0.62 C, 0.65 Mn, 0.69 Cr, and 0.62% Ni had more wear resistance than carbon steel rails. However, these experimental rails had inadequate resistance to transverse crack fatigue which is the most dangerous type of damage.

Kazarnovskii, D. S., Ravitskaya, T. M., Kravtsova, I. P., Shnaperman, L. Ya., Klimenko, A. N., Fadeeva, A. M., and Rogozina, E. A. (Ukrainian NII Metallurgical Institute, U.S.S.R.) Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 17, 1971, pp 97-101, 2 figs., 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

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1144

FEATURES OF THE ISOTHERMAL TRANSFORMATION OF AUSTENITE IN SOME LOW ALLOY STEELS [IN RUSSIAN]

The kinetics of the isothermal transformation of austenite in plain-carbon rail steels and in some low alloy steels were studied. Other factors studied included the effect of the austenitization temperature, the temperature and duration of isothermal holding, and the subsequent temperature on the hardness and microstructure. The steels contained 0.3 to 0.4, 0.6 to 0.7, and 0.7 to 0.8% carbon and were alloyed with 1.0% or less chromium, 1.3% or less manganese, 0.13% vanadium, and 0.005% boron.

Babich, A. P., Kazarnovskii, D. S., and El'chaninova, V. (Ukrainian NII Metallurgical Institute, U.S.S.R.) Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 19, 1972, pp 33-41, 2 figs., 3 tables, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

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1145

EFFECT OF PULSED STRESSES ON LOCAL PHASE TRANSFORMATIONS IN STEEL WITH INTERNAL STRESS CONCENTRATORS [IN RUSSIAN]

Low alloy rail steels containing 0.64-0.74% carbon, 0.42-0.82% manganese, and also 0 or 2.56% chromium, 0 or 0.26% vanadium, 0 or 0.90% cobalt, 0 or 1.5% aluminum, 0-0.15, 0.24, or 0.56% silicon, 0.018-0.030% sulfur, and 0.017-0.022% phosphorus were investigated. The samples were dynamically forged in a hammer impact machine at 7.8 m/sec. with a 60-kg freely dropping load. The presence in rail steel of internal stress concentrations in the form of large nonmetallic inclusions or artificially formed cavities did not affect the topography of the white zone interlayers. These interlayers were formed regardless of the presence of inclusions. They were caused by the regular character of pulsating stresses.

Ravitskaya, T. M., Kazarnovskii, D. S., Fadeeva, A. M., Klimenko, A. N. and Maleshenko, E. B. (Ukrainian NII Metallurgical Institute U.S.S.R.), Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 17, 1971, pp 42-45, 2 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

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1146

HEAT TREATMENT OF RAIL STEELS FOR HIGH STRENGTH AND RESISTANCE TO BRITTLE FRACTURE [IN RUSSIAN]

Steels 35Kh3 [C 0.35, Cr 3%] and 60KhGS [C 0.6, Cr 0.8-1.1, Mn 0.8-1.1, Si 0.9-1.2%] were strengthened to 100-200 kg/mm^2 by isothermal treatment, quenching, and then tempering, and the effects on impact fracture were studied. With increase in strength, both the impact strength and ductility fall monotonically but the dependence of breaking stress/strength passes through an extreme value. Thus, as the strength increases, the impact strength falls initially due to a reduction in ductility, but when the latter approaches zero, it falls because of the decrease in value of the breaking stress. At a strength of 150 kg/mm^2, the impact strength, ductility, and breaking stress for both steels are higher for specimens quenched to martensite and then tempered.

Babich, A. P., and Velikanov, A. V. (Ukrainian NII Metallurgical Institute, U.S.S.R.), Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 19, 1972, pp 78-83, 2 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1147

THE EFFECT OF COMPOSITION AND ORIGINAL STRUCTURE ON THE PROPERTIES OF STEEL DURING CONTACT-FATIGUE LOADING [IN RUSSIAN]

Quenched and unquenched railway rails of C steel (C 0.68-0.78, and Mn 0.7-1.0%) taken from tracks after service were studied. The outer rails of curves of 650-850 m radius that had been subjected to the passage of 230-320 M tons of traffic were also examined. These were of Cr steels (C 0.63-0.75, Mn 0.7-1.0, and Cr 0.5-1.0%) with an initial structure of fine lamellar pearlite and HB 270-316. The C steel had a similar initial structure and HB 240-260. The dispersion throughout the steel of a structure of identical character has a marked effect on the tendency of the steel to plastic deformation and damage from tearing out of metal and chipping under contact-fatigue loading. To strengthen components that are subject to such loading it is necessary to obtain a highly dispersed structure containing a lamellar form of the carbide phase of the troostosorbite type.

Lempitskii, V. V., Kazarnovskii, D. S., Ravitskaya, T. M., Kravtsova, I. P., Shnaperman, L. Ya., Fadeeva, A. M., and Klimenko, A. N. (Ukrainian NII Metallurgikaya Institute, U.S.S.R.), Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 17, 1971, pp 59-64, 3 figs., 6 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1148

SOME PECULIARITIES OF SERVICING VOLUMETRIC QUENCHED RAILS [IN RUSSIAN]

The operating strength of rails volumetrically quenched in oil was studied. The rails undergoing such quenching have about 1.5 to 1.7 times higher resistance to the formation and development of surface contact fatigue damage than the unquenched rails. Other advantages over the unquenched rails and also some deficiencies were discovered. The deficiencies included the twisting of the ends in the butt zone caused by increased dynamic loads from the rolling stock, increased sensitivity to thermomechanical damage, and large oscillations of rail length. In order to improve the quality of the volumetrically quenched rails it is necessary to decrease the twisted nature of the ends of the rail, to lower the residual stress level in the rails, and to improve their stress distr. tion.

Shnaperman, L. Ya., Yermolayev, V. N., Pavelenko, Yu. P., Karakulina, R. R., and Tsibrinskii, A. I. (Ukrainian NII Metallurgical Institute, U.S.S.R.), Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 1, 1972, pp 12-15, 2 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1149

STATISTICAL EVALUATIONS OF THE PARAMETERS OF UNMEASURED RAILS OBTAINED AFTER CUTTING OUT DEFECTS [IN RUSSIAN]

It is often necessary during normal rail manufacturing operations to cut large defect sections out and to then weld the serviceable sections together. In following this procedure, the rail milling shop of KMK has collected data on their experiences with production repairing of R-50 and R-65 rails. According to the record, cavities/inclusions, and hairline cracks were found to be the principal types of defects incurred during production of rails. Analysis of the data shows that the distribution of defects and their causes have a random characteristic. Histograms of length distributions in various ranges are presented. The hypothesis of the uniformity law of distribution on lengths and cutout sections obtained during defect removals did not conflict with experimental data, thus indicating that the concepts derived from the research and production processes for welded rails are valid.

Chernyshev, A. N., Dekhtyar, Ye. I., Tkalenko, V. G., and Dubinskiy, R. I., Nauchnyye Trudy, Dnepropetrovskiy Metallurgicheskiy Instituta (Moscow), No. 57, 1971, pp 285-287, 2 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1150

WELDED RAILS IN RAIL TRACK

The functions and behavior of welded rails in a railroad track are discussed in this paper. The advantages and conditions associated with continuous welded rails are reviewed. Some of these advantages are concerned with the reduced amount of rail-end batter, the increased span of rail life, and ease of maintenance. The condition considered important is compactness of the road ballast. Thermal effects on joined rails are discussed and some numerical examples are given with respect to the extent of expansion that can be expected in India and the United Kingdom. Methods are suggested for preventing rail buckling and these include rail-to-sleeper fastening, ballast resistance, and the proper rail alignment. The methods commonly adopted for welding of rails are reviewed. A discussion of the author's paper is included.

Sil, H. N., The Journal of the Institution of Engineers (India), Vol 45, No. 7, Part CI-14, March 1965, pp 693-700 and 936-940, 2 figs., 2 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Institution of Engineers (India) (repr., PC).

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1151

INTERACTION BETWEEN VEHICLE AND TRACK: DANGER OF DERAILMENT? (PARTS I, II, III, AND IV) [IN SWEDISH]

Starting from the classical contributions to the theory of wheel climbing, the paper deals with more recent Japanese, British, Dutch, and German studies and investigations of the ORE. The author reports on methods of measuring the track bed with EDP and the derailment factor at the vehicle. The paper concludes with a description of additional measuring methods and remarks on the parameters influencing the relation between wheel and rail.

Anderson, T., Jarnvags Teknik, Vols 37 and 38, Nos. 3, 4, 5, and 6, 1969/1970, pp 60-68, 84-88, 106-114, and 130-140, 16 figs., 3 tables, 32 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Georg Sjoestedt, Stockholm (repr., PC).

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1152

MEASUREMENT OF RAIL WEAR BY MEANS OF A PROFILE-PRINTING PROCESS [IN SWEDISH]

The profile of a rail head can be quickly, easily, and accurately determined by means of a casting process. The casting mold, which consists of two parts and can be attached to any part of the rail with a screw clamp, is filled with liquid metal (1:1 tin solder and lead) from a casting ladle. The entire process takes 7 minutes. The measurements are repeated later at the same, marked place. The main advantage of this method is stated to be the consistent accuracy.

Borup, L., Jarnvags Teknik, Vol 37, No. 5, 1969, pp 119-121, 4 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Georg Sjoestedt (repr., PC).

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1153

RAIL TEMPERATURES IN FINLAND [IN SWEDISH]

The neutral temperature range determined for the rail welding specification is 7 to 17 C. Rail temperatures at the rail head, web, flange, and ballast were measured thermoelectrically with a portable potentiometer at two locations every hour for 1 to 2 days under different weather conditions. Extreme values in winter were up to -40 C and in summer up to 55 C. Solar radiation raises the temperature of the rail head by 10 to 20 C over that of the air in the shade. Mathematical relationships between the two values are established.

Hartikainen, O. P. (Technical University of Otaniemi, Finland), Jarnvags Teknik, Vol 37, No. 2, 1969, pp 44-49, 10 figs., 3 tables, 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Georg Sjoestedt (repr., PC).

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1154

TRACK MEASUREMENT WITH LASER BEAM AS REFERENCE LINE [IN SWEDISH]

A laser beam parallel to the rail head of one of the two rails of a straight, unloaded track serves as a simple track measuring device for determining track misalignments. The indicator is located above the rail to be measured. The rail head is traced with a sliding shoe moving on a light carriage whose two wheels run on the other rail. It is hoped that the results of the measurements can be transmitted onto strip charts.

Sjokvist, T. (ASEA Vasteras, Sweden), Jarnvags Teknik, Vol 41, Nos. 1 and 2, pp 16-19, 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Georg Sjoestedt (repr., PC).

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1155

COMPUTERS AND MECHANIZED TRACK MAINTENANCE

The recordings of the NEPTUNE track-inspection car concerning track gauge, alignment, longitudinal level, reciprocal level, and cant can be evaluated by means of EDP. The different types of defects are listed and printed out separately. These defects are then assessed according to the requirements to be met by the track. The defect assessments of the whole network can be used as a basis for allocating the funds for track maintenance.

Eden, G. A. (British Railways, Eastern Region, U.K.), Railway Engineering Journal, Vol 2, No. 1, January 1973, pp 4-13, 10 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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1156

REROLLING OF RAILS AND TIES [IN FRENCH]

Rerolling of used rails and ties into small-sized bars, sections, and reinforcing rods is investigated. Sorting of rails, preheating, cutting, and lengthwise separation between head and base or between head, web, and base is discussed. Rerolling of rails into ties and operational difficulties arising from discrepancies between the dimensions of used rails and those of the ordered steel products are mentioned.

Pinchon, M. (Wendel-Sidelor Hautmont, France), Circulaire d'inform. techn., Vol 29, No. 10, 1972, pp 2257-2262, 5 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Centre de Documentation Siderurgique (repr., PC).

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1157

THE SINGOL RAIL JOINT: A RAIL CONNECTION WITH FREELY MOVING RAIL ENDS AND SMOOTH WHEEL TRANSITION [IN SPANISH]

This rail joint permits the rail ends to move freely without being subjected to shock when the wheel passes over them. The author explains the behavior of this rail joint and of the wheel's running surface on the rail. The properties ascribed to this rail joint in theory were confirmed by experiments in the section between Amorebieta and Bermeo where the joint has been in use for 2 years. It is suited for the light axle loads of streetcars and subways.

Juncosa-Lopez, J. (Montes y Obras Publicas), Ferrocarriles y Tranvias, Vol 35-IV, No. 406, pp 199-203, 13 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Vicente Olmo Ibanez (repr., PC).

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1158

STRAIGHTENING OF RAILS IN A MODERN STRAIGHTENING PLANT [IN FRENCH]

The author discusses the necessity of using a roll-straightening machine, which allows better and faster straightening. The important aspects to be considered during the cooling of rails, the existing straightening methods, and the straightening machine presently used at Micheville are discussed. The author then suggests the use of a machine with seven rolls which is coupled with a second straightening machine with a smaller moment of inertia. This new machine operates with a speed of 0.5 to 1 m/sec and straightens rails weighing 30 to 70 kg/m. This machine can also straighten girders.

Charbonnier, H. (Sidelor Micheville, France), Circulaire d'inform. techn., Vol 24, No. 9, 1967, pp 2055-2062, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Centre de Documentation Siderurgique (repr., PC).

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1159

THE "RALUS" PROCESS FOR AUTOMATIC ULTRASONIC INSPECTION OF RAIL HEADS [IN FRENCH]

The RALUS apparatus enables ultrasonic testing of rail heads at a speed of 0.5 m/sec. Inclusions, blowholes, etc., can be detected. The data obtained are recorded or stored by a computer. The deflections (amplitude and number) of the recorded curves are used as criteria for the quality of the inspected rail heads. Two classes are formed with six subdivisions each (RALUS numbers). The apparatus can be employed by rail manufacturers for control or by users as a tool for sorting rails prior to their installation or for inspection of the installed rails. Comparisons are made between the percentage of removed rails and their RALUS number.

Beaujard, L., Mondot, J., and Vinot, J. (IRSID Saint-Germain-en-Laye and SNCF-French National Railways, Paris, France), Revue General Chemins, No. 89, February 1970, pp 141-152, 12 figs., 6 tables, 3 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Soc. Nationale de Chemins de Fer Francais (repr., PC).

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1160

ULTRASONIC TESTING OF RAILS [IN SPANISH]

Some general reflections on the presently applied methods of locating defects on the surface and within the rails are presented. Ultrasonic testing which at the moment is considered the best method is discussed. The physical basis and application in a measuring vehicle at a speed of 30 km/h are explained. It is considered possible to increase the vehicle speed to 50 km/h.

Martin-Galvez, F., Via Libre (Ferroviarios), May 1972, pp 28-33, 11 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Via Libre (repr., PC).

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1161

THE STEEL RAIL: ITS STRENGTH AND DEFECTS

The causes of rail failures due to the manufacture, the chemical composition, the stressing, the speed, the axle load, and poor maintenance are discussed. On the British Railways, every rail failure is classified. Particular attention is paid to the steel composition and the heat treatment. Precautions for avoiding rail failures are mentioned.

Allen, C. J., Modern Railways, Vol 24, No. 2, February 1968, pp 68-71, 5 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ian Allan Ltd. (repr., PC).

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1162

THERMOPLASTIC SHEAR AND FRACTURE OF STEEL DURING HIGH-VELOCITY SLIDING

A steel rail severely gouged during a rocket-sled test was the focus of an investigation of the microstructural changes which occur during high-velocity, sliding contact. Metallographic analysis of the damaged rail indicated that the mechanism of gouging probably was the crude machining process in which the sled shoe played the role of a tool. Cracks in bands of martensite and severely distorted pearlite regions were the principal microscopic features of the subsurface damage; the overall configuration of

the pattern of cracks and martensite bands suggests that they formed as a result of catastrophic thermoplastic shear.

Gerstle, F. P., Follansbee, P. S., Pearsall, G. W., and Shepard, M. L. (Duke University, Durham, N. C.), Wear, Vol 24, No. 1, 1973, pp 97-106, 12 figs., 10 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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1163

COMMENTS ON "TRIBOCHEMICAL REACTIONS IN THE FRICTION AND WEARING PROCESS OF IRON"

Krause's studies of oxide films at the area of contact between two rollers are thought to be of considerable assistance in analyzing the Meyer effect occurring during contact between a locomotive driving wheel and the rail. Three studies involving the measurement of the area of contact between rail and wheel are mentioned.

Andrews, H. I., Dyson, R. W., and Krause, H. (Enfield College of Technology, Enfield, U.K.), Wear, Vol 19, No. 4, April 1972, p 451, 4 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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1164

THE MECHANISM OF ADHESION

The paper deals with the chemical treatment of the running surface of the rail. Adhesion along a length of track is affected by two forms of conditioning (contaminations): primary conditioning, which can easily be removed by mechanical means, and secondary conditioning, which is almost inseparable by normal means and can greatly impair adhesion. Photographs taken with an electron microscope show that secondary conditioning is caused by particles of oil or similar material about 1,500 A in diameter. Cleaning of the investigated surface with an ester solvent increased the adhesion value from 0.14 to 0.40. The author further describes a machine for adhesion testing of wheel/rail steel specimens, laboratory trials for improving adhesion, and a device for wetting the rails with solvents to improve adhesion at critical points.

Andrews, H. I. (Enfield College of Technology, Enfield, U.K.), Railway Gazette International, Vol 127, No. 12, December 1971, pp 473-476, 5 figs., 6 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1165

THE UNISTEEL RAIL CONTOUROGRAPH

In order to detect the plastic flow of rail head as encountered in heavily loaded rails, an instrument has been developed which draws on a card a very accurate contour of the rail head with a 1.5 : 1 linear magnification. The instrument is easy to handle. The frame is held to the rail head by a quick-release clamp so that the instrument can be rapidly removed from the rail on the approach of a train.

Babb, A. S. (British Steel Corp., Midland, U.K.), Railway Gazette, Vol 125, No. 4, February 21, 1969, pp 153-154, 2 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1166

THE ULTRASONIC LOCATION OF DEFECTS IN FLASH WELDED RAILS

The types of defects occurring in flash-welded rail joints are analyzed. The procedure for examination of welds by the pulse-echo method is described. The results obtained over an extended period of time have resulted in standardizing a practice for the inspection of butt-welded rail joints which is approved by the USSR Ministry of Railways.

Kuz'mina, L. I., and Gurvich, A. K. (Scientific Research Institute for Bridges, Leningrad Railway Engineers Institute), Automatic Welding, Vol 19, No. 9, 1966, pp 74-77, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Welding Institute-Cambridge (repr., PC).

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1167

CHOOSING THE RIGHT TRACK FOR URBAN CONDITIONS

Conventional ballasted track is cheaper to construct than ballastless track on concrete slabs, but more expensive to maintain. The choice of track is therefore influenced by the availability of initial capital and by the cost of labor. From the engineer's point of view, preference should be given to concrete track because maintenance in tunnels may be very expensive and involve great operating difficulties. Since the installation and fastening of concrete-slab track require a high degree of precision, preference should be given to those types of fastening which provide for minor corrections of line and level. Proven installation techniques are those developed at Sonneville, Cologne, Toronto, Nuremberg, Rotterdam, and Sao Paulo.

Hehenberger, W. (German Railways Consulting GmbH, W. Germany), Developing Railways, 1975, pp 9-16, 7 figs., 6 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1168

WELD SURFACING ON RAILS BY THE SWEDISH STATE RAILWAYS

The methods used for repairing rails by welding are discussed. An investigation was undertaken with the aim that a method of arc welding with the associated advantages of higher welding speed, better weld quality, and increased wear resistance could be found. The techniques used are described and the optimum welding conditions and results of the field trials are presented.

Ljunggren, J., ESAB Svetsaren (English Edition), Vol 7, No. 1, 1971, pp 10-16, 20 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: ESAB Goteborg (repr., PC).

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1169

RECONDITIONING OF RAILS AT MOULIN-NEUF WORKSHOPS [IN FRENCH]

Withdrawn rails can, under certain conditions, be repaired for future use. The article describes the rail-conditioning chain at Moulin-Neuf Workshop-Stores and the financial advantages of the operation.

Boyer, J. (SNCF-Direction de l'Equipement, Paris, France), Informations Techniques, No. 10, November 1972, pp 63-72, 17 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1170

TEST OF RAILS CARRIED OUT ON THE "VELIM" CIRCUIT IN CZECHOSLOVAKIA [IN FRENCH]

The behavior in use of new types and grades of rails cannot be validly evaluated until after tests of very long duration, of the order of some 10 years on the French tracks that are used most frequently. Special test circuits enable results to be obtained much more rapidly. The article covers tests carried out on the Czechoslovakia track of VELIM from February, 1972, to July, 1973, on behalf of the S.N.C.F.

Dalichampt, G. (SNCF Direction de l'Equipement, Paris, France), Informations Techniques, 1973, pp 41-49, 4 figs., 3 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1171

DEVELOPMENT OF (CAST) POINT FROGS ON THE S.N.C.F.: PROBLEMS POSED BY THEIR IMPROVEMENT AND MAINTENANCE [IN FRENCH]

New frogs used by the French Railways (S.N.C.F.) are cast from 13% Mn steel and show improved performance over the traditional frog. The frog design, mechanical properties of the steel, steel transformation curves, and microstructures are described. Data are reported for the various steels studied. Maintenance by welding and its effect on the microstructure are considered.

Gence, P. (SNCF-French National Railways, Paris, France), Rev. de Metallurgie, No. 66, November 1969, pp 779-786, 22 figs., 3 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Soc. Francaise de Metallurgie (repr., PC).

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1172

DESIGN OF A MACHINE FOR RESURFACING RAILS AUTOMATICALLY [IN FRENCH]

The article describes an automatic machine enabling repairs to be effected, after skid marks have been ground down, by means of a wire guided mechanically which has been melted by an electric arc operating under the protection of carbonic gas. The features of this machine are: the replacement of the electrodes normally used for this type of work by a hollow wire containing the protective flux; and the automation of the guiding of the end of the wire and the deposit of the metal in accordance with the specifications in force. The advantages of this machine are: elimination of the human factor in achieving the quality of the deposit, and high working speed enabling a layer to be deposited without interruption between two trains.

Gence, P. (SNCF-French National Railways, Paris, France), Informations Techniques, No. 7, July 1970, pp 65-67, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1173

LONG WELDED RAIL TRACKS: BEHAVIOR AND STABILITY UNDER THE ACTION OF TEMPERATURE VARIATION [IN FRENCH]

Long welded rail tracks have been the subject of a great many studies in France and abroad, which were theoretical as well as experimental, and which the experts have heatedly discussed. Without waiting for a general theory that would reconcile the different opinions - which would hardly have been possible for such a complex matter - welded tracks have been developed at an ever-increasing pace, and experience has confirmed that this type of track offered all indispensable safety features suggested in the first theories, provided, however, that certain precautions were taken. This condition is very important, and research work carried out during the last few years has shown precisely the relative influence of the various factors that are capable of affecting the stability of long welded rail tracks, and has made it possible to draw practical conclusions. This article deals with the definition of long welded rail tracks, their history, thermal stress distribution, and the behavior of long welded rail tracks resulting along the length from such stresses.

Prud'homme, A., and Janin, G. (SNCF Direction des Installations Fixes, Paris, France), Informations Techniques, October 1967, pp 15-30, 16 figs., 16 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM. Direction des Installations Fixes (repr., PC).

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1174

LONG WELDED RAIL TRACKS: BEHAVIOR AND STABILITY UNDER THE ACTION OF TEMPERATURE VARIATIONS (PART 2) [IN FRENCH]

The article deals with instability phenomena which longitudinal stresses may produce under certain conditions. After having established the general equilibrium equations, the authors describe the experimental data linking track deformations to stresses exerted by the ballast and the fastenings which are necessary for carrying these studies further. The causes of instability resulting solely from faulty track levelling are then analyzed.

Prud'homme, A. and Janin, G. (SNCF-Direction des Installations Fixes, Paris, France), Informations Techniques, No. 3, 1968, pp 19-34, 21 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1175

CONTRIBUTION TO DETERMINING THE STRESSES IN RAILS DUE TO SERVICE [IN FRENCH]

Up to a fairly recent date, the stresses existing in service in a rail have been computed using either beam theory, in which bending effects alone were considered, or Hertz's theory, applicable to two semi-infinite bodies in contact, where only the effects due to this contact are considered. Investigations taking both effects into account have recently been undertaken. A similar approach is taken in the article which summarizes a doctoral thesis prepared under the

direction of Prof. Kammerer. The author is concerned with the special case where the mathematical is limited to a plane considering that, in practice, wear generates a stable profile for the rolling track and wheel rim. The results have been expressed as a set of curves representing the loci of the points in the plane where Mohr's circle radius is constant. These results can be compared with those obtained by photoelastic methods and an explanation can be given for the slope of transverse internal fissures and the depth, in the rail head, of the region where this type of crack originates.

Stremsdoerfer, J. (SNCF-French National Railways, Paris, France), Mecanique-Electricite, No. 241, January 1970, pp 35-45, 13 figs., 7 tables, 15 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Science et Industrie, Paris (repr., PC).

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1176

THE RAILS: DEVELOPMENT IN THE IRON AND STEEL INDUSTRY [IN FRENCH]

The overall international development of the iron and steel industry, the technological advancements, and the relationship between production and transportation with special reference to new processes are discussed. The French iron and steel industry developed in a similar manner despite some handicaps due to unfavorably located plants. Rails supplied now to the S.N.C.F. will certainly be affected by new manufacturing methods, and the most important change concerning rails is the improvement in inspecting methods, including the introduction of ultrasonic testing.

Vinot, M. J. (SNCF-French National Railway, Paris, France), Informations Techniques, No. 9, 1971, pp 31-42, 2 figs., 3 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1177

THE GENERAL DESIGN OF RAIL WELDING LINES IN THE FRENCH NATIONAL RAILWAY COMPANY [IN FRENCH]

The continuing expansion of the use of welded long rails by the French National Railways has led to the development of "welding lines". The article introduces these facilities. It examines successively: the origin of these facilities, their present design, the results achieved, and the outlook for the future.

Maucodie, M. (Service de la Voie et des Batiments de la Region du Sud-Ouest), Informations Techniques, No. 5, 1969, pp 65-72, 12 figs., 1 table.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Direction des Installations Fixes (repr., PC).

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1178

THE POSSIBLE USE OF ULTRASONICS FOR IN-SERVICE TESTING OF WELDED RAILS [IN ITALIAN]

A method of examining continuous lengths of welded rail with ultrasonic probes sliding on the rail surfaces has been studied in the laboratory. Defect signals were related to sectioned test pieces and known artificial defect sizes. Alternative probe positions and multiple reflection paths were examined.

Costenzo, B. (Italian States Railroads, Rome, Italy), La Metallurgia Italiana, Vol 63, No. 8, August 1971, pp 375-382, 13 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Italian Metallurgy (repr., PC).

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1179

MEASUREMENT OF THE TORSIONAL VIBRATION OF A WHEELSET [IN ITALIAN]

An investigation into the formation of corrugations on rails is described. The axle vibrations are recorded by a

so-called "torsiovibrometer", a ring connected with the axle by a helical spring. The forward and return movements of the ring toward and away from the axle are recorded. This device was later supplemented with a shock absorber. A description of the apparatus and the test results are given.

de Falco, F., and Corazza, G. R. (University of Rome, Italy), Ingegneria Ferrovaria, Vol 26, No. 10, 1971, pp 893-901, 13 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ugho Cantutti-Rome (repr., PC).

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1180

TORSIONAL VIBRATIONS OF AXLE SHAFTS AND FORMATION OF CORRUGATIONS ON RAILS [IN ITALIAN]

The relation between the torsional vibration of the axle shafts and the formation of corrugations on the rails was investigated in an experiment under service conditions on route B of Rome's subway. The torsional vibration, which is measured with magnetic torsion meters, depends on the axle shaft, the wheels and the components wedged to the axle shaft (drive plate, brake disk etc.). This phenomenon appears especially during starting, accelerating, braking, and taking curves. The calculation based on the Holzer method confirmed the experimental result obtained with photographic recording and the Amsler track-measuring car. The result shows two groups of characteristic variables, one of which corresponds to the track and the other to the vehicle. It seems that the resilient wheel is able to reduce the undesired effects.

de Falco, F., and Corazza, G. R. (University of Rome, Italy), Ingegneria Ferroviaria, Vol 26, No. 3, March 1971, pp 231-254, 12 figs., 33 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ugho Cantutti (repr., PC).

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1181

REMARKS ON THE BEHAVIOR OF THE TRACK OF LINE-1 OF MILAN'S SUBWAY [IN ITALIAN]

Since subway cars are of uniform design and the running behavior is virtually constant in all sections, the loads acting upon the track repeat themselves regularly and with the same force. This means that even slight technical errors can occasionally have serious and increasingly aggravating effects. The author first describes the technical problems besetting the track of line 1 of Milan's subway, then presents a hypothesis explaining the problems (e.g., corrugations on the running surfaces of the rails) and suggests measures for their prevention or alleviation.

Ceron, E. (Servizio impianti della Azienda Trasporti municipali, Milan, Italy), Ingegneria Ferroviara, Vol 24, No. 1, January 1970, pp 3-17, 27 figs., 5 tables, 31 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ugho Cantutti (repr., PC).

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1182

TRACK CONSTRUCTION FOR HIGH SPEED TRAFFIC [IN ITALIAN]

The author discusses the theory of superelevation and its shortcomings, presents formulas for the parabolic curve and for acceleration and its derived function, and explains why accelerations result from alterations in a curve and imperfections in the railroad track. In addition, he describes principles of track laying in Japan, in Germany, and on the "Direttissima" Rome-Florence. Different rail designs are also described.

Angelari, G. (Italian States Railroads, Rome, Italy), Ingegneria Ferroviaria, Vol 25, No. 11, 1971, pp 899-915, 7 figs., 9 tables, 29 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ugho Cantutti (repr., PC).

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1183

RAIL RESEARCH

The research work being done by British Rail scientists covers a very broad spectrum, and is concerned both with the operating problems of efficient, day-to-day running of the railways, and the development of new technologies to serve the railways of the future. Some aspects are discussed, including: nondestructive testing; surface corrosion-protection problems, specifically those associated with cooling systems of diesel engines; the effects of

vibrations on corrosion processes; lubrication; and new experimental braking blocks, some with high P contents, and others nonferrous.

Jones, S. (British Railways/British Rail Hovercraft Ltd., U.K.), Advance, No. 4, April 1968, pp 28-35, 6 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institute of Science and Technology, University of Manchester (repr., PC).

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1184

COMPUTER DETECTS TRACK IRREGULARITIES

British Rail has introduced a computer (NEPTUNE) into the process for evaluating track irregularities with standard track-inspection vehicles. Five factors are considered: right-hand and left-hand "top", right-hand and left-hand versine, and "twist". "Twist" is the phenomenon caused when two rails of unequal height impart a twisting motion to a vehicle. The mechanical readings are converted into electronic impulses and recorded by the computer on rolls 2-1/2 inches wide. Each roll can cover up to 500 miles of track, with a complete record of every 1/4-mile section. A punched-tape record is also produced for more critical analysis, the information being fed to a further computer which helps to plan the maintenance schedule.

Electronics and Power, Vol 12, October 1966, pp 339-340.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Electrical Engineers (repr., PC).

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1185

BROACHING HOLES IN RAILS

In order to increase the resistance of rails to fractures emanating from fishbolt holes, the British Railways have adopted the practice of broaching all boreholes, thereby increasing the bore diameter by 1/32 to 3/64 inch (original bore diameter 1-3/16 inches). This technique work hardens the inside surface of the holes and improves the fatigue strength of drilled rails by at least 25%. The features of a broaching machine, which is simple to handle on the track, are described.

Railway Gazette, Vol 124, No. 23, December 6, 1968, p 892, 1 fig.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1186

NETHERLAND RAILROADS (NS) ADOPTS GLUED INSULATED RAIL JOINTS

The Netherlands Railroads have devised the following process for the production of insulated rail joints of great strength and rigidity: sawing through the rail base and rail web from below; inserting the insulated joint; when the glue has hardened, sawing through the rail head; and filling the gap in the rail head with cement. Because this technique produces such a perfect joint between the two rail ends, it is now used in all areas of track insulation, including switches.

Railway Gazette, Vol 125, No. 4, February 21, 1969, p 144, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1187

RAIL FAILURES: SOME OF THE CAUSES

The factors influencing rail failures are investigated. The influence of composition and rail section on service performance, causes of failures at bolt holes and welded joints, and methods of failure detection at the British Railways are briefly discussed.

Dearden, J. (British Railways Research Dept., Derby, England), Railway Gazette, Vol 121, No. 5, March 1965, pp 195-197, 5 figs., 3 tables, 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press, Ltd. (repr., PC).

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1188

RECENT RESEARCH ON ADHESION

The effect of surface contamination on the frictional properties of a steel-rail/steel-wheel couple was investigated. The effect of layers of oil, a few molecules thick and of H_2O as well as the effects of finely crushed powders of iron and iron oxides were studied.

Both oil and H_2O were found to reduce cohesion considerably, while the solids increased it.

Collins, A. H., and Pritchard, C. (British Railways Research Dept., Derby, England), Railway Engineering Journal, Vol 1, No. 25, September 1972, pp 19-28, 12 figs., 8 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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1189

THE APPLICATION OF FRACTURE MECHANICS TO RAILWAY FAILURES

An attempt is made to demonstrate both the potential and current limitations of fracture mechanics in the context of railway engineering. The main limitations are the need for detailed service stress data and the establishment of appropriate stress-intensity factor calibrations. If tougher materials are brought into service it will be necessary to characterise crack-tip conditions in the presence of extensive plasticity. The benefits of applying a fracture-mechanics approach to railway failures are outlined.

Cannon, D. F., and Allen, R. J., Railway Engineering Journal, Vol 3, No. 4, July 1974, pp 6-17, 22 figs., 1 table, 33 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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1190

THE APPLICATION OF RAIL STRESS TO LOCOMOTIVE DESIGN

The stresses produced in rails by the passage of loaded wheels were analyzed and the effects of speed, wheel spacing, and curvature of track are discussed. The design of locomotives to minimize rail stress is considered and examples of the results stemming from design modification are presented.

Radley, R. (The English Electric Company Ltd., U.K.), Journal of The Institution of Locomotive Engineers, Vol 57, No. 2, 1967/1968, pp 196-205, 15 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Locomotive Engineers (repr., PC).

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1191

ULTRASONIC TESTING OF RAILWAY COMPONENTS

A short description of basic principles is given, present practices in B.R. for the testing of axles and rails are described in detail, and reference is made to the testing of welds, castings, and forgings and to thickness measurement on structures exposed to corrosion. The need for careful training of operators and the paramount importance of proper knowledge of the significance of flaws are stressed. The organization required to conduct effective inspection is described and discussed.

Wise, S. (Railway Technical Centre, Wilmorton, Derby, U.K.), Journal of the Institute of Locomotive Engineers, Vol 58, No. 1, 1968/1969, pp 77-103, 19 figs., 4 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Locomotive Engineers (repr., PC).

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1192

RAIL STEELS APPRAISED INTERNATIONALLY

The papers presented at the Iron and Steel Institute's meeting on "Rail Steels", London, November 23, 1973, are summarised. The papers were grouped under three headings: "User Experience", "Toughness Requirements for Rail Steels" and "New Developments". The British were mainly interested in reducing the number of rail fractures (particularly rail end failures associated with bolt holes), the Europeans were interested primarily in improving the wear resistance of rails and reducing the internal flaws by quality control at steel works, and the Americans were interested in improving both the fracture and wear resistance.

The West German Federal Railroads now purchase mainly rails of profiles S 54 and UIC 60. These rails, as well as the remaining rails of profile S 49, are supplied with minimum tensile strength of 90 kg/mm^2, which is achieved

by a carbon content of 0.75 to 0.8 percent. The Swiss Federal Railroads use rails with tensile strengths between 105 and 125 kg/mm^2 on mountain routes with high loads. In the USA a new compact rail-head section has been developed which is highly resistant to cold working. British, Swedish, and German investigations show that in wear-resistant rails with tensile strengths between 110 and 125 kg/mm^2 the carbon content must not be higher than 0.65 to 0.8 percent and that Cr, Ni, Nb, V or Cu and Si have to be added to ensure sufficient toughness.

Jones, E. G., McMurdo, A. W., Frederick, C. O. (British Railways Board, Derby, U.K.), and Pickering, F. B. (Sheffield Polytechnic University, U.K.), Rail Engineering International, Vol 3, No. 4, 1973, pp 158-172, 6 figs., 4 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Broadfields Technical Publishers Ltd. (repr., PC).

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1193

AUTOMATIC ANTI-SLIP FLUID APPLICATORS AND FLANGE AND RAIL LUBRICATORS

The Pammek and M. Co. Ltd., Britain, specializes in the manufacture of mechanized track-maintenance equipment, which largely eliminates the need for human labor. Because of the greatly increased power-weight ratio of electric and diesel-driven locomotives, particular importance is attached to the Maxi-mu adhesion fluid applicator designed for spraying ethyl capryllate diluted in water which is capable of dissolving strongly adhering secondary rail contaminations frequently encountered on routes with high traffic densities which create a constant danger of slipping. The fluid applicator is operated by the train wheels. Its protective effect extends over a length of 200 to 400 yards and is maintained for several weeks. Flange and rail lubricators operate in a similar way but on graphitized grease. They increase the life of curve rails by a factor of 3 and that of wheel flanges by a factor of 10.

Modern Railways, Vol 24, No. 1, January 1968, pp 36-37, 4 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ian Allan Ltd. (repr., PC).

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1194

THE EFFECT OF TRACK AND VEHICLE PARAMETERS ON WHEEL/RAIL VERTICAL DYNAMIC FORCES

The paper deals with investigations into mechanisms and characteristics of track-vehicle forces as well as with field trials and the application of test results to vehicle and track design. Measurements made on tracks and vehicles for different axle loads, rail fastenings, various types of ties and ballast, and with rigid and resilient wheels revealed new relationships between the various parameters. The appendix presents a method for calculating forces and contact stresses at rail joints. In essence, the paper revolves around P_1, the peak wheel impact force reacted by the rail, and P_2, the peak force transmitted to the ballast. P_1 and P_2 are found to increase with the increase in vehicle speed, the vehicle unsprung mass, the ballast stiffness, and the stiffness of the vehicle suspension, whereas an increase in the track mass increases P_1 but decreases P_2.

Jenkins, H. H., Stephenson, J. E., Clayton, G. A., Morland, G. W., and Lyon, D. (British Railways, Derby, England), Railway Engineering Journal, Vol 3, No. 1, January 1974, pp 2-26, 22 figs., 4 tables, 8 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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1195

NEW DEVELOPMENTS IN THE TECHNIQUE OF RAIL LUBRICATION ON SHARP CURVES [IN FRENCH]

The wear on the outer rail (sometimes also the inner rail) and on the tire on sharp curves (diameters of 100 to 200 m) used to be prevented with graphite coatings on the running edge. Mechanical application of this coating was very difficult on account of poor distribution; manual application produced good results but was too expensive. This problem has now been solved with the development of the rail-lubricating vehicle "Geismar" which has been in use in Cameroun since 1967. This vehicle, which is pulled by a track motor car, applies a 1-mm-thick and 8-mm-wide layer of grease to the underside of the rail head. It uses about 2.3 kg of grease/km and can cover 50 km of track a day. Although exact figures are not yet available, it can already be said that

rail and tire wear have been reduced greatly at a low cost. On the whole, this system is simple, effective, safe, and inexpensive.

Vie du Rail Outre, No. 178, March 1969, p 24, 4 figs., 2 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office Central des Chemins de Fer d'Outre (repr., PC).

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1196

MAGNETIC PARTICLE AND DYE PENETRANT TECHNIQUES AS AIDS TO THE NDT OF RAILS

Nondestructive testing techniques are discussed with special reference to crack detection in rail sections. Ink, dry-powder, and dye properties and practices are described. Magnetic crack detection and the use of dye penetrants are advantageous, as a visual picture of the surface defect is produced containing complete information except that concerning the depth of the crack.

Banks, J. (Permanent Way Section of British Railways, England), Journal of Non-Destructive Testing, Vol 15, No. 6, November 1973, pp 176-178, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Non-Destructive Testing Society of Great Britain (repr., PC).

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1197

RAISING TRACK STANDARDS TO CATER FOR HIGH SPEEDS

In addition to the increased wear on tracks due to rising traffic density and speed, the riding characteristics of some modern locomotives and freight vehicles cause severe dynamic loading on the track. The paper discusses briefly the improvements needed in track construction and maintenance on the British Railways to keep pace with increase in speed and traffic density. Maintenance tamping over long lengths is being increasingly replaced by intermittent tamping at regular intervals, because this method disturbs the track bed less. New equipment and methods will have to be developed which will allow renewal work to be done more quickly so that track restrictions can be kept to a minimum. Higher train speeds can be made possible by track realignments and the removal of crossovers on curves.

Beatty, W. F. (British Railways, Midland Region, London, England), Railway Gazette, Vol 126, No. 6, March 1970, pp 225-228, 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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1198

WHEEL-BURNT RAILS: THE CAUSE AND MEANS OF DETECTION

Railroad engineers have for years been working on the problem of rails with surface damages that are caused by the slipping of wheels. Some progress has been made by changing the parameters of the track and by repositioning signals. The locomotive engineers have also cooperated by making modifications in the design of tractive vehicles. But as yet it has not been possible to find a solution which will completely eliminate this costly and dangerous effect. Several methods of flaw detection are described: the Audigage rail flaw detector, the pulse-echo method, and the magnetic-ink detection method. The possibility of wheel-burns by antislip machines is also discussed.

Banks, J. (British Railways, Southern Region, England), Journal of the Permanent Way Institution, Vol 84, 1966, pp 210-219, 8 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: The Permanent Way Institution (repr., PC).

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1199

RAIL TESTING AND CLASSIFICATION BY COMPUTER

The new rail testing and classification installation at the rail-welding plant of the Louisville & Nashville Railroad at Nashville is at present the most modern of its kind. At an operating speed of 120 ft/min, the equipment tests and classifies new and used rails measuring between 25 and 35 feet and weighing between 90 and 155 lb/yard. The conventional ultrasonic rail-testing method is used, but all steps in the process are fully automatic and monitored and controlled by a computer.

Railway Gazette International, Vol 127, No. 12, December 1971, pp 477-478, 2 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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1200

A NON-DESTRUCTIVE METHOD OF MEASURING INTERNAL RAIL FORCE

British rail scientists have developed a rail-force transducer which permits nondestructive measurement of the longitudinal force in a continuously welded rail. The transducers which are cylindrical are inserted into drilled holes (30-mm diameter) on the neutral axis of the rail. Each transducer contains a vibrating wire whose resonance frequency, which changes with the tension transmitted in the rail, is measured.

Modern Railways, Vol 32, No. 3, March 1975, p 123, 1 fig.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ian Allan Ltd. (repr., PC).

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1201

MEASUREMENT OF RAIL WEAR

An instrument for measurements of rail wear has been developed in Sweden which achieves a very high accuracy. It is capable of detecting variations from the original rail profile which are less than 0.02 mm. The variations are measured by a sensor which moves along the rail and displaces the position of the core of a differential transformer. The output impulses from the transformer are registered in a coordinate system as ordinate values. The associated abscissa values are measured by a potentiometer.

Railway Gazette, Vol 125, No. 11, June 1969, p 435, 1 fig.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: IPC Business Press Ltd. (repr., PC).

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1202

THE RAIL SHELLING AT EIDAN SUBWAY (PART 1) [IN JAPANESE]

This is a report by the Tire and Rail Investigation Committee, which was organized in April, 1964, for the purpose of clarifying the causes of rail shelling and establishing preventive measures. The Public Corporation Subways had an occurrence of rail shelling at first in the heat-treated hard head rails in the outer track having a curve radius of 200 m in October 1960, and, as of March, 1966, rail shelling had occurred in 286 units of 25-m rails covering a track length of 147.8 km. The instances of shelling which actually took place did not show growth into lateral cracks, but this is because the safety standards established required rail replacement. It was found that the ratio of occurrence of rail shelling was the highest in track sections having a curve radius ranging from 400 to 450 m, that the wear of rails which exhibited shelling was extremely small, and that a considerable reduction in the amount of wear in the rails was noted as the amount of oil applied to them increased.

Kazamaki, T., Fujiwara, T., and Otani, U. (Railway Technical Research Institute, JNR, Chiyoda, Tokyo, Japan), Tetsudo Seiro, Vol 16, No. 5, 1968, pp 215-219, 8 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1203

THE RAIL SHELLING AT EIDAN SUBWAY (PART 2) [IN JAPANESE]

Part 2 of this report deals with rail shelling, and describes tests on the material properties of damaged rails, the mechanism of occurrence of shelling, preventive measures for shelling, and problems to be considered for the future. The observed rail shelling is usually characterized by an exfoliation and absence of a part of the rail from the area close to the gauge corner on the rail head, the area of separation assuming a fatigue fracture, its starting point of failure located in the inner side of the rail, and the direction of development being in the direction opposite that of the movement of the train. There are four countermeasures which are considered to be effective for preventing rail shelling, and there are also four problematic points for which no conclusion has yet been drawn.

Kazamaki, T., Fujiwara, T., and Otani, U. (Railway Technical Research Institute, JNR, Chiyoda, Tokyo, Japan), Tetsudo Seiro, Vol 16, No. 6, 1968, pp 273-277, 4 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1204

A PROTECTIVE RAIL FOR DERAILMENT [IN JAPANESE]

This work discusses the policy and guidelines for installation of derailment-preventing rails and rail oiling units in locations having special track conditions and movement conditions. An analysis of 30 cases of derailment accidents recorded for freight trains in the past 15 years has revealed that derailments are more likely to occur under the condition that the train is coasting with moment of inertia at a speed of 55 km/hr or above as it comes down an inclination with a gradient of 5% or more at a curve having a radius of 500 m or less with the longitudinal alignment showing a straight line or a concave form. In view of the fact that there are many points of location which meet these conditions, it was decided that the derailment-preventing rails and the rail oiling units should be installed only in those track locations which would meet the following conditions and should be considered to be in need of such devices in view of the operating speed and other operating conditions. The conditions are: (1) double-track sections and (2) those points of location where there is a change in upward gradient by 10‰ or more toward the plus side from a downward gradient of more than 5‰ (with a total length of 300 m or more) with a curve having a radius of 600 m or more located in the area.

Sakurazawa, T. (Japan National Railways, Marunouchi, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 1, 1968, pp 27-30, 6 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1205

A PROTECTIVE GUARD FOR DERAILMENT [IN JAPANESE]

The current derailment-preventing rails have a disadvantage in that they cannot be readily installed or removed, which poses an obstacle to track maintenance work. The present report discusses a derailment-preventing device, termed "derailment-preventing guard", developed for use also for the PC-sleeper sections and describes the design of the device. A summary of the results obtained by the tests conducted on it, the method of installation, and the sequence to be followed in its installation are also given. The newly developed derailment-preventing guard is supplied in two types, one for the wooden sleeper sections and the other for the PC-sleeper sections. As a result of experimentation with this guard on an experimental track at train speeds of 48.5 km/hr and 49.0 km/hr in the PC sleeper section and at the train speed of 70.0 km/hr in the wooden sleeper section, it has been confirmed that the derailment-preventing guard provides a measure for improving the traveling safety of trains by positive prevention of derailment of railway cars.

Hirata, I., and Mogi, J. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 11, 1968, pp 519-522, 17 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1206

THE RAILWAY TRACK OF SANYO SHINKAN-SEN (OKAYAMA-HAKATA) [IN JAPANESE]

The tunnels occupy 56% of the total track length and elevated railroad sections occupy 22% of the total service distance of the Sanyo Shinkan-Sen from Okayama to Hakata. The rail used for the track is 60 kg, and, as long rails are to be chiefly used for the railroad, 50-m rails have been standardized with new specifications and are used in addition to the 25-m rails at a rate of about 30% of the total. Dead head killed (vacuum degassed) steel is used for the rails. The expansion joint for the slab sections is a type that can be directly joined to the slab. The turnout is the same as the turnout for the 60-kg rails. The track specifications, the track structure, and the track materials are basically not very different from those used for the existing New Trunk Line, but the notable features are that these new rails and others reflect consideration for future train operations at higher speed and that they have evolved out of the experience with the New Trunk Line over a period of more than ten years.

Isoura, K., and Yamaguchi, A. (Japan National Railways, Marunouchi, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 3, 1975, pp 125-134, 26 figs., 12 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1207

BANNING OF THE MACHINING OF RAILS [IN JAPANESE]

A derailment of a freight train occurred which was caused by the rupture of a long rail. It was found that this long rail had had an old flaw from the web to the bottom, and this old flaw developed suddenly into a rupture as the train passed over it. An inquiry into the cause of this old flaw revealed that a fatigue crack that had developed from a hole existing in the rail web gradually became larger.

In view of this situation, the Japan National Railways Corporation issued warnings concerning the manufacture and processing of rails and turnouts, and this work presents a brief explanation of the prohibition items related to their processing, drawing chiefly on instances of rail failures.

Sato, Y. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Seiro, Vol 17, No. 9, 1969, pp 507-510, 12 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1208

STUDY OF UNUSUAL RAIL WEAR IN CURVED TRACK AND RAIL CROSSING: EFFECTS ON WHEELS [IN JAPANESE]

Increased transport volume and higher speed train operation on railways have brought with them heavier loads on the tracks, developing unusual rail wear in the curved track sections and in turnouts. In view of this situation, the present study deals with an inquiry into the causes for such unusual wear with special reference to the relation between wheels and rails.

The forms of such wear fall into five categories including the wear of the outer track and the abrasion of the groove in the central part of the inner track railroad surface. The causes for such wear, as ascertained through the field tests, are cant, slack, rotating resistance, the forms of wheels and track surface, train speed, etc.

Ogawa, S., and Abe, S. (Technical Research Institute of Kinki, Nippon Railway Co. Ltd., Amagatsuji, Hara, Japan), Technical Report of Kinki Nippon Railway, Vol 2, No. 1, 1970, pp 94-98, 12 figs., 7 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Technical Research Institute of KNR (repr., PC).

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1209

MEASUREMENTS OF THE IMPACTS APPLIED TO THE RAILWAY TRACK UNDER THE RUNNING VEHICLES [IN JAPANESE]

It is known that the railway track is placed under the dynamic wheel load of running vehicles and that heavy impact load occurs in the event of the development of any failure or irregularity in the track surface or in the tread surface.

This article discusses the results obtained by field measurement of the wheel load resulting from damages in the wheel treads, or from vibrations of various kinds of vehicles operating on the existing lines of the Japan National Railways.

Ito, Y. (Ishikawa Technical High School, Tsubata, Kawakita, Ishikawa, Japan), Memoirs of Ishikawa Technical High School, No. 6, 1974, pp 97-108, 17 figs., 7 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Ishikawa Technical High School (repr., PC).

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1210

EXPERIMENTAL TESTS ON VIBRATION-PROOF TRACKS AND THEIR EFFECTS

Various types of anti-vibration track structures designed to decrease the vibration and noise caused by the operation of subway trains, thus reducing the effect on aboveground structures, were investigated. Measurements were conducted at ten locations with different track constructions and different structural types of buildings. It was found that an anti-vibration mat made of used tires which was spread out under crushed stone was most effective for vibration reduction, and, compared with a concrete roadbed, there was a reduction of 18 db in the foundation, 11 db in the wall, and 5.5 db in the ceiling, the effect in the low-frequency range being particularly remarkable. The application of neoprene

rubber and asphalt to the slab concrete also yielded good results, although it was not so effective as the tire mat under crushed stone.

Fujiwara, T., and Nakamura, S. (Teito Rapid Transit Authority, Japan), Permanent Way, Vol 15, No. 3, 1974, pp 20-27, 8 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1211

ADHESION CHARACTERISTICS AND DYNAMIC PHENOMENA OF ELECTRIC ROLLING STOCK DURING SLIPPING: FIRST REPORT - SLIPPING PHENOMENA AND ADHESION IMPROVING METHODS OF RECTIFIED-AC LOCOMOTIVES [IN JAPANESE]

This paper reports on the actual measurement of the slipping phenomena of a standard type four-axle AC electric locomotive and clarifies the relationship between the speed of slipping on the rails and the dynamic friction coefficient. Moreover, a detailed theoretical formula for slipping phenomena is derived, the calculated numerical values are compared with the actual measurement values, and the influence of two or three factors, which have hitherto remained unclarified, is examined. Additionally, on the basis of the results obtained, a method for improving adhesion was developed, and the paper also discusses the results of an inquiry into the effects of this method.

Hirotsu, T. (Hitachi Seisakuzo, Katsuta Ibaraji, Japan), Transactions of Japan Society of Mechanical Engineers, Vol 34, No. 265, 1968, pp 1523-1532, 18 figs., 4 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Mechanical Engineers (repr., PC).

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1212

SPEED-UP OF COMMUTER TRAINS IN A CIVIL RAILWAY [IN JAPANESE]

This work is a study, by item, of the direct restrictive factors in the way of improvement of the operating speed of the commuter trains on civil railways. The factors related to the rails will include the safety against derailment, vibration, traveling comfort in relation to oscillation, and track strength with regard to resistance to breakage. An inquiry has been made in this study into the possibility of train operation at the maximum speed ranging from 120 to 130 km/hr. As the train speed is increased, track failures increase. Thus, it is necessary to improve the tracks which still remain at the lowest level of structural requirements.

Okamoto, K., Traffic Techniques, Vol 30, No. 4, pp 106-109, 1975, 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Traffic Association (repr., PC).

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1213

RAILWAY GRINDING MACHINE [IN JAPANESE]

When unevenness develops on the surface of a rail, it causes vibration to occur in passing trains which places an excessive load on the track and also produces vibration in the track. In effect, this gives rise to loosening the clamping device, not only creating such maintenance problems as a higher rate of rail failures, but also decreasing riding comfort and increasing the noise level.

In view of this situation, the development of a rail-grinding corrector, primarily for the purpose of reducing maintenance, preventing rail failures, and improving riding comfort has been investigated. The present study describes the power transmission mechanism, grinding mechanism, etc., of such rail-grinding correctors.

Isoura, K. (Japan National Railways), Tetsudo Semro, Vol 22, No. 11, 1974, pp 557-559, 8 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1214

STRENGTH AND WEAR OF RAILS AND THEIR INFLUENCE ON THE SELECTION OF THE MOST ECONOMICAL SECTION

This paper deals with questions that must be considered from time to time concerning the renewals of rails in the track. The questions are whether the existing rails require renewal and what would be the most economical section to use for renewal. The latter question requires consideration when selecting a rail to be used in a new line. The concept associated with the limits of rail strength is reviewed in regard to existing rails on the track and those to be considered for relaying of rail. In determining the maximum stress which a rail may be subjected to by a certain wheel axle-load at unrestricted speeds, the effects of oscillation and impact, hammer action of the counterweights, and impact due to sudden application of the moving load must be considered. To arrive at the probable life of a rail, efforts were made to establish the permissible limits of wear. These limits were established on the basis of rail-head cross section, proximity of wheel flanges to other rail parts and joints, and the strength of the worn rail. The selection of the most economical section of rail was determined through knowledge of the probable life in the main line and also the estimated cost, laid in the track, of the rail and fastenings.

Harvey, A. F. (Indian Service of Engineers, India Railway Board, India), Technical Paper No. 238, Government of India, Central Publication Branch, Calcutta, April 1924, 17 pp, 1 fig., 2 tables, Addn.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Government of India Central Publication Branch (repr., PC).

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1215

RAIL-WHEEL ADHESION IN LOCOMOTION

The vital role which adhesion plays in train movement and brake application is discussed. The factors upon which adhesion depends to a great extent in the railway working are defined as mainly track condition (wetness or dryness), curvature, ballasting, etc., and mechanical and electrical conditions. Extensive tests carried out on adhesion by British, French, U.S.S.R., and Indian Railways are discussed in this paper. The replacement of the steam locomotive by electric and diesel locomotives is viewed as an approach to easing the problem of adhesion because all the axles are propulsive and thus the whole of the locomotive weight is available for adhesion. Railways are currently examining this problem so as to obtain a better understanding of the phenomenon of adhesion for the purpose of improving the tractive effort available at the wheel rim.

Bhattacharya, K. (South Eastern Railway, Kharagpur, India), Indian Railway Technical Bulletin, Vol 27, No. 177, May 1970, pp 56-60, 2 figs., 2 tables, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1216

SIGNIFICANCE OF DEFECTS IN METALS AS AFFECTING FAILURES IN SERVICE

The types of failures considered in the article are fatigue, corrosion, and brittle fracture of rails, wheels and boilers. Defects and cracking in welds are also discussed at some length, and the effect that such failures can have under normal service conditions. Examples of a number of service failures are given and their causes identified. The importance of correct designing in avoiding failures is pointed out and the need for more information, particularly on the relationship among stress, crack size and rate of propagation under service conditions, is emphasized.

Wise, S. (Railway Technical Centre, Wilmorton, U.K.), Railway Steel Topics, Vol 8, No. 2, 1965, pp 24-33, 16 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: M.H.A. While (Publishers) (repr., PC).

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1217

LOAD-MEASURING WHEEL AND ITS MANY APPLICATIONS

The load-measuring wheel is a very effective means of continuously recording the vertical and lateral forces exerted on the rails. It permits a reliable determination of the effectiveness

and safety of new designs. The use of this new device and subsequent detailed statistical evaluation of the records will help to test the reliability of the running gear and the riding qualities of locomotives.

Koffmann, J. L. (British Railways Board, U.K.), Rail Engineering International, Vol 1, No. 4, September 1971, pp 162-169, 13 figs., 3 tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Broadfields Technical Publishers Ltd. (repr., PC).

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1218

SEARCH FOR A METHOD OF MAKING SHORT-RANGE FORECASTS OF MAXIMUM RAIL TEMPERATURE [IN FRENCH]

Rail temperatures must be checked on hot days to determine track safety. This used to be done individually in the different districts, with the responsible official of each district deciding personally in the morning whether it would be necessary to send out a crew to measure the rail temperatures. The SNCF conducted investigations aimed at rationalizing this procedure by forecasting the rail temperature on each day on the basis of air temperature measurements taken the preceding day and very early in the morning. The method developed by the SNCF makes it possible to draw up diagrams which, together with existing weather conditions, permit a rational decision on whether rail temperature measurements are necessary.

Gent, M. L. [French National Railways (SNCF), Paris, France], Revue Gen. des Chemins de Fer, Vol 83, No. 2, 1967, pp 91-104, 15 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Societe Nationale des Chemins de Fer Francais (repr., PC).

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1219

SOME ASPECTS OF MAINTENANCE OF CURVES ON HIGH SPEED ROUTE: EASTERN RAILWAY

Some important aspects associated with the maintenance of railway curves, particularly in reference to the high-speed curves on the Howrah-Mughalsarai section of the Eastern Railway are discussed in this paper. A complete description of the curves on this 675-km section of line is given. This includes the radius of curvature, number of curves, length involved, and the percentage ratio with respect to the total line. Specifications and standards set forth by the Railway Board's Efficiency Bureau for curve geometry are discussed and compared with those of the German Federal Railway. Emphasis is placed on the nature of faulty alignments and how they tend to increase the lateral forces and result in dynamic action that causes rail distortions. A few examples which illustrate how speed restrictions have been removed/relaxed on the Eastern Railway are provided.

Charan, K. (Railway Board, Indian Railways, Bhawan, New Delhi, India), Indian Railway Technical Bulletin, Vol 29, No. 186, August 1972, pp 79-91, 8 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1220

MODERNIZATION OF TRACK ON THE INDIAN RAILWAYS

This paper presents a brief discussion covering physical and financial statistics related to the Indian Railways system and how it has progressed during the past 15 years. Advantages are given for the use of long welded rails in relation to greater comfort of passengers and less maintenance. The elastic fastener and concrete sleepers, as well as the use of track laying machinery are discussed. The effects of heavy ore movements on the Eastern and South Eastern Railways in India on the rails are discussed. These involve accelerated wear, joint battering, rail fractures, and the shortening of rail life. The solution to the problem was to replace the 44-kg rail with the heavier 60 kg/52 kg rail with higher tensile strengths and wear-resistant characteristics, and to weld joints. The wear-resistant rails are being manufactured at the Hindustan Steel Ltd. plant.

Charan, K. (Civil Engineering Railway Board, New Delhi, India), Indian Railways, Vol 19, No. 1, April 1974, pp 51-53, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Indian Railway Board (repr., PC).

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1221

WEAR OF RAILS IN IRON- AND STEELWORKS

The results of comparative tests of rails of different steel qualities that were carried out in the tracks of several iron- and steelworks are described. The results show that the principal causes of wear are abrasion, oxidation, and plastic flow. Some typical worn profiles are illustrated. In straight tracks and in curves of moderate radii carrying normal railway axle loads (up to 25 tons), wear is caused mainly by oxidation and there is little advantage in any change of rail steel. In sharper curves where abrasive wear in the form of side cutting makes up a more significant proportion of the total, both harder steels and lubrication produce worthwhile reductions in wear. Where axle loads are higher (especially if above 35 tons) and/or wheels are of small diameter and/or there is high slip, plastic flow of the rail head results. The only countermeasure to this is the use of harder steels which give greatly increased rail lives. Crossings are subject to plastic flow (battering on the crossing noses) while switch rails are subject to high abrasion. Therefore, harder steels are advantageous in both of these cases. A Discussion Session which was held on this and a number of other related papers is included.

Babb, A. S. (British Steel Corporation-Midland Group, Swinden Laboratories, England), paper presented at the International Conference on Tribology in Iron and Steel Works, London, September 22-25, 1969, pp 29-39, 12 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1222

RESEARCH AND RAIL

This paper deals with the design and development of improved rail sections by the Denver and Rio Grande Western R.R., as an outgrowth of photoelastic stress analysis techniques which were applied to the study of rail loads and stresses. Various factors related to rail service life and rail failures are discussed, together with various nondestructive testing and inspection techniques utilized by the Rio Grande Railroad to detect such failures in their incipient stages. Some of the unsolved problems relating to rail testing and inspection are also presented. Illustrations are included which show the nature of transverse fissures, horizontal and vertical split heads, bolt-hole fractures, and web and weld failures. Photoelastic pattern and stress diagrams are also shown.

McBrian, R., and Penney, C. O. (The Denver and Rio Grande Western Railroad Co., Denver, Colo.), paper presented at the Fourth Pacific Area National Meeting of the ASTM, Los Angeles, Cal., October 5, 1962, ASTM Special Technical Publication No. 354, pp 10-21, 12 figs., 6 refs.

ACKNOWLEDGMENT: American Society for Testing Materials (ASTM).

PURCHASE FROM: ASTM (repr., PC).

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1223

A COMPARISON OF THE DEOXIDATION EFFECTS OF TITANIUM AND SILICON ON THE PROPERTIES OF RAIL STEEL

This investigation was conducted using two series of rail steel heats, one finished with additions of ferrosilicon and ferromanganese in the ladle and the other with ferromanganese split between the furnace and the ladle, with ferrocarbon-titanium added in the ladle. The study included the followup of the manufacturing process, tests on rails for homogeneity by chemical analysis, sulphur printing, and deep etching; and tensile, impact, hardness, and endurance tests. The titanium-treated steels were found to be less segregated than others, however, they were accompanied by more piping. Titanium treatment tended to scatter the sulfide inclusions and as a whole did not provide any significant improvement in the mechanical properties of the rail steel. It was concluded that titanium in small quantities does eliminate the oxygen, reducible by carbon, and in large amounts, (10 to 13 lb ferrocarbon titanium per ton) decreases the nitrogen combined with iron and manganese.

Burgess, G. K., and Quick, G. W. (Bureau of Standards, Dept. of Commerce, Washington, D.C.), Paper No. 241, Technologic Papers of the Bureau of Standards, Vol 17, October 1, 1923, pp 581-635, 27 figs., 10 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: U.S. Government Printing Office (repr., PC).

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1224

TRACTION ADHESION PROBLEMS

The author first discusses the basic factors governing traction adhesion: wheel/tire condition, rail condition, and torque reaction. He then considers different methods of improving adhesion such as the chemical treatment of rail, mechanical rail cleaning, spark erosion, plasma-torch treatment, rail sanding, and the use of an antislip brake. Wheelslip detection is very important, and different methods adopted in Western Europe for detecting and correcting wheelslip are mentioned. The Swiss A/E 6/6 Electrics allows fine and positive control of wheel slip.

Greaves, T. A., Railway Engineering Journal, Vol 1, No. 3, March 1972, pp 38-45, 7 figs., 19 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Institution of Mechanical Engineers (repr., PC).

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1225

TRACK LAYING DATA OF DIRECT CONNECTING RAIL IN SHINKANSEN [IN JAPANESE]

Trial production of directly joined tracks for the New Trunk Line was carried out on the premises of Nagoya Station and Gifu-Hajima Station. This report describes the execution of the project as well as the types and particulars of the work performed and the conditions of the railway tracks.

Shimizu, N. (Japan National Railways, Nagoya, Japan), Tetsudo Senro, Vol 16, No. 2, 1968, pp 59-63, 17 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1226

THERMAL EXPANSION OF RAILS WITH RESILIENT FASTENINGS [IN GERMAN]

The practice of laying tracks without ballast over bridges and in tunnels is increasing here and in foreign countries. The behavior of rails due to thermal expansion is gaining particular importance for this type of track construction. The author shows how elongations, stresses, and forces for flexibly mounted rails can be calculated.

Varga, O. H. (Seetru Ltd., Bristol, U.K.), Archiv fur Eisenbahn-Technik, No. 25, November 1970, pp 85-96, 4 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1227

WELDING "IN SITU" BY QUICK THERMIT WELDING PROCESS CARRIED OUT ON LUCKNOW-KANPUR SECTION OF NORTH EASTERN RAILWAY

The experience of North Eastern Railway in field-service welding of rail by the quick, thermit welding process is described. Details of working both conventional and quick thermit processes are explained along with the economics and staff requirements. The equipment and its use are described in relation to preparation, alignment, molding, and cutting steps. Schematic drawings are included for the purpose of explaining concepts associated with thermit welding.

Chandra, K., and Aiyangar, S. L. (North Eastern Railway, Gorakhpur, India), Indian Railway Technical Bulletin, Vol 24, No. 166, August 1967, pp 91-99, 3 figs., 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1228

LONG WELDED RAILS

The experiments conducted using welded rails in Great Britain and the U.S. are reviewed. The expansion and contraction of the long rails caused by temperature changes are discussed. Ballasting and sleeper spacing techniques are important in developing a strong support against the expansion and compressive stresses created in the rails. Photographs of welded rails at Southern Railway installations are shown. (Carried as RRIS Accession No. 037869.)

Cantrell, A. H., Railway Gazette, Vol 71, July 1939, pp 101-103, 2 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Temple Press, Ltd. (repr., PC).

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1229

GAS PRESSURE WELDING OF RAIL JOINTS ON INDIAN RAILWAYS

This article describes the process of gas pressure welding of rail joints. It covers the technique of the process and the investigation which was carried out for standardization on the Eastern Railway. The operation of the gas welding plant, which involves such steps as the preparation of the rail ends, clamping and upsetting, scarfing, postweld treatment, and the grinding and finishing, is discussed. The results of metallurgical investigations which consisted of non-destructive testing, a hardness survey, transverse bend tests, and a macroexamination are given. The economical aspects of the process involving the three major welding techniques are compared.

Sarkar, N. K. (Central Railway, Bombay, India), Indian Railway Technical Bulletin, Vol 25, No. 17, pp 131-134, November 1968, 4 figs., 2 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1230

AUTOMATIC SUBMERGED-SLAG WELDING OF RAILS [IN JAPANESE]

The methods applicable to the welding of rails in the field include enclosed arc welding and thermit welding. Two problems are encountered in the use of these two methods: (1) the quality of the weld depends on the skill of the welder, and (2) a relatively long time is required for making the weld.

The present report describes the automatic submerged-slag welding method, which has been developed by the Railway Technical Research Institute of Japan National Railways (JNR) for the purpose of improving the working efficiency and the quality of the welds. Follow-up tests of this method, which has been adopted by the JNR, are being conducted in the form of actual railway welding work on the new trunk line and the Tokaido line.

Oishibashi, K., Hakamada, S., Ohara, M. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 9, 1971, pp 520-522, 5 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1231

MANUFACTURE, PROPERTIES, AND SERVICE BEHAVIOR OF SELF-HARDENED RAILS OF CHROMIUM-MANGANESE STEEL WITH A MINIMUM TENSILE STRENGTH OF 110 KG/MM^2 [IN GERMAN]

Because of the increasing traffic density, axle loads, and traveling speeds, the standard-quality rails can no longer meet all the requirements. A newly developed special grade of chromium-manganese steel shows favorable strength values and promises a longer service life. The weldability of this steel by aluminothermic and flash welding processes permits its use in continuously welded tracks. A tensile strength of 110 to 120 kg/mm^2 with an elongation of 9 percent at fracture is achieved with 0.65 to 0.8% C, 0.3 to 0.9% Si, 0.8 to 1.3% Mn, and 0.7 to 1.2% Cr.

Heller, W. (Fricdr. Krupp Huttenwerke AG, Rheinhausen, W. Germany), Eisenbahntechnische Rundschau, Vol 21, No. 5, 1972, pp 176-183, 10 figs., 4 tables, 16 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1232

ON RESTORING RAIL LENGTHS OF JOINTLESS TRACK AFTER FRACTURE [IN RUSSIAN]

This article presents the results of an investigation into the linear resistance of a jointless track in the winter season. The existing methods of calculating the extent of a gap formed in a fractured length of rail is examined. An analysis is given of the thermal-stress condition of a length of track that has been restored after maintenance.

Klinov, S. I. (Research Institute for Railroad Transport, U.S.S.R), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1966, pp 41-45, 4 figs., 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1233

LATERAL WEAR AND CRUSHING OF THE RAIL HEAD ON TRACK CURVES [IN RUSSIAN]

The initial stages of alteration of dimensional changes of the running portion of the rail head are described. Crushing of the rail head represents the greatest danger to the rail strength since cracks form under the metal outgrowths, leading to cracking of the rail heads and fracture of the rail. The various factors related to rail-head crushing are discussed. It is shown how a reduction in dynamic action of the wheels on the track considerably increases rail durability. A tabulation of data on the wear effect of the rail head contact area covering six categories of action is included.

Andrievykij, S. M. (Scientific Research Institute of Railroad Transport, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1966, pp 41-45, 6 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1234

TWO METHODS OF DETERMINING A RAIL'S COORDINATES FROM ITS MIDORDINATE-TO-CHORD MEASUREMENTS

This paper defines the midordinate-to-chord measurement and mentions how this measurement is used in the railroad industry. The paper then discusses the limitations and frequency response of a midordinate-to-chord measuring system and derives in detail two methods by which a rail's coordinates can be obtained from the midordinate-to-chord measurements. In addition, the paper discusses the limitations of each method and presents the applicable mathematical derivations associated with the Fourier Series representations of the rail.

McConnell, P., and Greenspun, R. (Melpar, Falls Church, Va.), Paper No. 69-686, Proceedings of the 24th Annual ISA Conference, Houston, Texas, October 27-30, 1969, Advances in Instrumentation, Vol 24, Part 4, 8 pp, 8 figs.

ACKNOWLEDGMENT: Instrument Society of America.

PURCHASE FROM: Instrument Society of America (repr., PC).

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1235

ROLE OF RESEARCH IN TRACK AND VEHICLE EVALUATION

This article gives a brief resume of the research being carried out in the Research, Design and Standards Organisation (RDSO) of India on vehicle and track evaluation. Introducing the subject, a brief history and structure of the RDSO together with its functions are detailed. The predominant role played in the introduction of higher speeds with least capital outlay on the Indian Railways has been highlighted. Mention is made of the research carried out to evolve a satisfactory method of appraisal of the strength of the track vis-a-vis, the loads it is subjected to. The development of suitable criteria for the evaluation of track and vehicles on the basis of behavioral pattern, and safety aspects by interaction is discussed in detail. Finally, a discussion of the development of a Track Recording Research Car, an advance test vehicle which is anticipated as being capable

of evaluating data on the speed potential of track and vehicles is also provided.

Nair, P.N.B. (Research, Design and Standards Organization, Indian Railways, Lucknow, India), Indian Railway Technical Bulletin, Vol 31, No. 192, February 1974, pp 1-4.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1236

RAIL FAILURE ANALYSIS BY ELECTRONIC DATA PROCESSING

An analysis of rail failures involving electronic data processing by using FORTRAN programming and the pattern of failures as observed from such analyses are discussed. The factors associated with rail failures such as: quality of rail and material, inherent flaws in the rail, ineffective or incorrect maintenance of track, soil conditions, type and quantum of traffic, incorrect technique of welding, environmental conditions, track characteristics, and make of rail are considered. Because proper information and inadequate reporting of failures occurred in the early days, the authors were faced with using data collected in the periods between 1968 and 1970 for their FORTRAN II programs. Data collecting, codifying, and keypunching processes are described and a flow chart is given. Data sheets are provided which present statistics of rail failures and their classifications. Based on electronic data processing, and the subsequent analyses, ordered information is possible to gain greater knowledge of types of failures, detection of defects and sections with high incidence of failure, make of rail involved in failures, traffic carried, and weld failures.

Bashyam, C. G., Verma, R. P., and Khanna, B. K. (Research, Design and Standards Organization, Indian Railways, Lucknow, India), Indian Railway Technical Bulletin, Vol 29, No. 187, November 1972, pp 137-143, 1 fig., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1237

RECENT DEVELOPMENTS IN RAIL TESTING ON THE SNCF [IN FRENCH]

The authors first describe the operation of the electromagnetic rail flaw detection system "Teleweld" developed in the U.S. Next the automatic ultrasonic detector developed by the SNCF is described, which also indicates the length of the crack. Vertical and oblique measurements are taken, from which the vertical component of transverse cracks can be derived. Special accessory instruments permit the measurement of horizontal cracks. All measurements are recorded. Somewhat difficult is the measurement of horizontal cracks with sloping side branches and of cracks outside the rail axis. The speed of the ultrasonic rail testing vehicle will have to be raised in order to permit an increase in railroad traffic.

Dory, M. J., and Perruchot, M. C. [Societe de Realisations ultrasoniques, and the French National Railways (SNCF)], Revue Gen. des Chemins de Fer, Vol 88, No. 1, January 1969, pp 30-37, 10 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Societe Nationale des Chemins de Fer Francais (repr., PC).

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1238

ROLE OF ULTRASONIC TESTING OF RAILS IN TRACK FOR HIGH SPEED TRAIN OPERATION

On the Indian Railways, ultrasonic techniques have been used for the past 10 years on the Indian Railways for periodic screening of steam locomotive wheels and their use is being extended to cover testing of other motive power axles and also carriage and wagon axles. Ultrasonic techniques have been recommended for periodic testing of rails in tracks. The rail testers, manufactured by Krautkramer (Models SZ-58, and SZ-62), are illustrated and described, and oscillograms from rail flaws using transverse and angular probes are presented. The contributions of Birmann and Dearden are reviewed with regard to rail requirements for high-speed service and track stresses.

Choudhuri, K. C., and Bhattacharya, A. K. (Research, Design and Standards Organization, Lucknow and Chittaranjan, India), Indian Railway Technical Bulletin, Vol 26, No. 175, November 1969, pp 19-23, 4 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1239

ELECTRONIC INSTRUMENTATION FOR MEASUREMENT OF RAIL GEOMETRY AND VEHICLE PARAMETERS

This paper discusses the research, design, and fabrication of Track Recording Cars. Providing safe, dependable, and economical rail transport requires extensive research work to adequately understand the interplay of various factors comprising the track-vehicle system. An objective assessment of the rail-vehicle interaction is of increased importance because of its value to investigations relating to the introduction of higher train speeds of up to 160 km/hr and more. As part of the research program, extensive instrumentation, capable of simultaneous recording of analogue parameters representing displacements, accelerations, strains, pressures, temperatures, and other variables of the vehicle-track system, was installed in specially built cars by the Indian Railways. The various parameters are analyzed and measured.

Padmanabhan, S. V. (RDSO-Ministry of Railways, Alambagh, Lucknow, India), Paper No. 73-902110, Proceedings of the Symposium on Electronics, March 8-10, 1971, Madras, India, (organized by the Committee on Electronics, Dept. of Atomic Energy, Govt. of India), pp 337-351, 7 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Dept. of Atomic Energy, Madras, India (repr., PC).

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1240

BREAKDOWN ORIGIN OF "H" TYPE DEFECTS AS A CONSEQUENCE OF INTERNALLY PRODUCED DEFECTS [IN CZECHOSLOVAKIAN]

H-type fractures are defects which are not visible on the rail surface but are detected by a loss of the indicator signal during ultrasonic testing. Such factors in steel rails initiate from internal defects, such as inclusions, segregation, and flakes, and were studied by x-ray diffraction and metallography. The fracture surfaces of the head, web, and flange sections of the rails were examined. The sources of the cracks were inclusion clusters, ferrite bands, grain boundaries, large inclusions, and flat rolling flaws. The crack-growth rate, type of crack or failure mode, and fatigue failures resulting from flakes are also discussed.

Masin, A. (Vyzk. Ustav Dopravni, Praze, Czechoslovakia), Sbornik Praci, VSD VUD, No. 56, 1973, pp 61-103, 56 figs., 2 tables, 29 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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1241

PRODUCTION OF HIGH STRENGTH RAILS IMPROVED BY ALLOYING THE STEEL IN THE LADLE WITH GRANULATED FERROCHROMIUM

When iron with high phosphorus content is used in the production of rail steel, the quality of the metal is not further improved by alloying the steel with ferrochromium in the furnace. In view of this, the possibility of alloying the metal with granulated ferrochromium in the ladle was investigated at the Azovstal' Works. The authors found that this technique simplifies the slagging conditions, reducing heat duration in the large tilting furnaces by 40 to 60 minutes. Also, the melting losses of chromium are reduced from a level of 20 to 30 percent down to only 4 to 5 percent, the amount of oxide inclusions is decreased slightly, and the toughness and ductility of the final steel are substantially improved. Chemical compositions and the results of mechanical properties tests are given.

Gershgorn, M. A., Sviridenko, F. F., Kazarnovskii, D. S., Kravtsova, I. P., Popova, A. N., and Pradina, M. G. (Ukrainian Research Institute for Metals and Azovstal' Works, U.S.S.R.), Stal [in English], No. 5, May 1965, pp 360-363, 6 figs., tables, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1242

QUALITY OF RAILROAD RAILS FROM CONTINUOUS CAST INGOTS OF CONVERTER STEEL

Rails were rolled from continuously cast ingots (280 x 320 or 250 x 360 mm) of converter steel K-76. These experimental rails hardly differed macrostructurally from those produced by conventional methods. The overall incidence of nonmetallic inclusions was identical in each, although there were fewer "stringer-like" inclusions in the experimental rails (which lead to contact-fatigue defects). The mechanical properties of the experimental rails were superior; impact strengths were generally higher (the experimental rails being ductile to -60°C); fatigue strength and sensitivity to stress concentrations were equal to those of conventional rails.

Lempitskii, V. V., Gursky, G. L., Vlasov, V. I., Polyakov, V. V., and Kan, Yu. E. (Bardin Institute of Ferrous Metallurgy and the Novo Tula Works, U.S.S.R.), Stal' [Translated by the British Industrial & Scientific International Translation Service], No. 12, December 1972, pp 1117-1118, 2 figs., 4 tables, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1243

JOINING OF HEAD HARDENED AND TEMPERED RAILROAD RAILS BY WELDING [IN GERMAN]

With the use of head-hardened rails within the railroad network of the (East) German Railroad, welding of these rails becomes necessary, and flash welding is the method used predominantly. Sufficient strength factors could be proven by means of mechanical-technological methods. With regard to wear behavior, hardening of the rails after welding proves advantageous, however, the extent of application of this variant is limited for technological reasons. By means of compressed air quenching from the welding temperature an annealed structure could be restored in the area of the heated zone. Two narrow zones, one on either side of the weld, however, remain unannealed due to the temperature gradient after welding. Currently, the wear behavior of the variants is observed on service rails. The rail steel metallurgy aspects are discussed such as the chemical compositions and the mechanical properties of the rail hardened head. The microstructures of the welded rail sections are discussed, and the equipment used for quenching welded joints is described.

Euken, H. (Brandenburg Kirchmoser, East Germany), Schweisstechnik, Vol 22, No. 6, 1972, pp 267-271, 15 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen MBH (repr., PC).

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1244

RAIL STEEL AND HEAT TREATMENT OF RAILS [IN JAPANESE]

The author provides a classification of the varieties of rail steel used in different countries of the world according to their chemical composition; describes the transition of rail steel up to the high-carbon, medium-manganese steel recently used for the rails of the New Trunk Line; and explains the dehydrogenation-treatment process for ordinary rails, as well as the heat treatment methods for rail-head rails and end-hardened rails.

Kurikara, T. (Railway Technical Research Institute-JNR, Kokubunji, Tokyo, Japan), The Heat Treatment, Vol 7, No. 6, 1967, pp 350-351, 12 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: The Japan Heat Treatment Association (repr., PC).

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1245

MEASURES ATTENDING ADOPTION OF HEAVIER RAILS (INCREASING THE WEIGHT OF POINT) [IN JAPANESE]

In order to strengthen the rail construction and to reduce the amount of track maintenance work, investigation of the structure and construction of rails, sleepers, and ballasts is being undertaken, and, since heavier weight in rails brings about higher efficiency in the work performed by the personnel and a greater economic advantage, it has been decided to promote the introduction of heavier rails.

Among the problems that arise along with the adoption of heavier rails, the present work discusses such subjects as the feasibility of increasing the weight of the point.

Yamaguchi, A. (JNR Establishment Office), Tetsudo Senro, Vol 22, No. 11, 1974, pp 560-563, 6 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1246

RAIL INSULATOR (C TYPE) [IN JAPANESE]

Rail insulators numbering approximately 250,000 pairs are used for the signaling system facilities of the Japan National Railways. The present report describes the composition and performance of the rail insulator (G-type) which the Japan National Railways selected for the purpose of achieving a longer-lived, maintenance-free rail insulator unit.

Sato, Y. (Japan National Railways), Tetsudo Senro, Vol 18, No. 10, 1970, pp 508-510, 5 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1247

UNEVENNESSES AT THE ENDS OF VOLUMETRICALLY QUENCHED RAILS

Factors responsible for roughness observed at the ends of volume-hardened railway rails are discussed in the light of extensive statistical tests. Measurements of the rail profile at distances of up to 2 m from the ends reveal substantial variations in the rail height and in the curvature of the foot; the profile of the cross section at the ends also differs from that in the middle of the rail. These defects lead to serious stresses in service. Possible ways of eliminating the shortcomings by modified production methods are considered.

Linev, S. A., Kucherenko, V. P., and Lemanskii, A. P. (Institute of Ferrous Metallurgy of the USSR Ministry of Iron & Steel and the Nishne-Tagil Combine), Stal, No. 10, October 1971, pp 944-945, 3 figs., 1 ref.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1248

LONGITUDINAL DISTORTION OF RAIL STEELS DURING VOLUMETRIC QUENCHING

The influence of the length of soaking in the final zone of a tempering oven on rail-length increase was studied. It was established that only after 2 hours of soaking does the stabilization of the rail-length come about. A series of laboratory investigations for explaining the reasons for this phenomenon was started. (Cooling speeds of the length of dilatometric samples, cooled at different speeds, were plotted). A scheme of the process of lengthwise deformation (distortion) of rails during thermal processing was constructed. It was shown that the main reason for rail-length change in the process of thermal processing is the presence of a large temperature gradient along a section of the rail.

Murav'yev, Ye. A., Rabinovich, D. M., Siunova, T. N., Vinokurov, I. Ya., and Makarov, P. Ya., Metallurgiya i Koksokhimiya (Kiev), No. 36, 1973, pp 84-86, 2 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1249

EXPLOSIVE HARDENING OF HIGH-MANGANESE STEEL

The behavior of Grade 713L high-Mn steel when exposed to explosive loads was investigated. It is shown that, when a load is applied in the form of the detonation wave from an explosive substance, the hardness is increased from 200 to 400 BHN if an explosive substance with a high detonation velocity is used. The manner in which high-Mn steel is hardened after normal deformation (high increase in hardness at the surface, dropping away rapidly into the metal) and after a pulsed load (lower absolute hardness at the surface, but the hardened region extends 5 to 10 times deeper into the metal) is compared.

One set of technological conditions for hardening railway point diamonds is described.

Deribas, A. A., Matveenkov, F. I., and Sobolenko, T. M., (Novosibirsk Physics Institute of Metals, U.S.S.R.), Stal [in English], Vol 2, No. 3, March 1966, pp 53-57, 9 figs., 4 tables, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1250

INVESTIGATION OF THE STRUCTURE OF THE METAL OF RAILS QUENCHED ALONG THEIR ENTIRE LENGTH [IN RUSSIAN]

The microstructure and mechanical properties of rails from steels containing 0.71% C and steels with 0.43% C and 1% Cr were investigated. The rails were subjected to high-frequency surface hardening from 920°C, in water at 38 to 40°C, and in air and tempered at 550 to 580°C. After quenching, the tensile and yield strengths of the carbon steels increased by 11 to 12 and 14 to 30%, respectively, and the tensile and yield strengths of the Cr steels increased by 58 and 104%, respectively. During air quenching, the increase in the mechanical properties, particularly in impact strength, is less significant than during water quenching. The wear of the steels after quenching decreased two times compared with the green state and the crushing resistance was twice as high.

Zannes, A. N., Rozmetailo, V. N., Tarasova, L. P., and Sapelkina, O. R., Met. i Gornoryda. Prom. Inform. Nauchno-Tekhn., No. 2 (32), 1965, pp 40-41, 4 tables, 4 refs.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: Kanakin Bookstore (repr., PC).

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1251

EFFECT OF SHAPE AND SIZE OF THE STARTING INGOT ON THE SURFACE QUALITY OF RAILWAY RAILS

Aluminum models were used to study the depth of induced defects during rolling of R-50 rails from continuously cast slab or section 170 x 700 mm; bloom 280 x 320 mm; strip 140 x 300 mm; and rail ingots R10. Formulas are deduced for K_s, the ratio of the reduction of the defective surface layer to that of total thickness of the strip. The coefficient K_s expresses the extent to which defects are rolled out, and was found to depend on the position of the defect on the surface and the deformation conditions. Defects on corners are rolled out to a depth of up to 30 mm, those on surfaces only to depths of ~10 mm.

Chizhikov, Yu. M., and Kondrashin, S. E., Stal' [Translated by the British Iron and Steel Industry Translation Service], No. 11, 1972, pp 1009-1011, 4 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1252

THE MANUFACTURING PROCESS OF RAILS [IN JAPANESE]

The iron works of Fuji Iron and Steel Company is equipped with three units for the production of open hearth base steel and two units for the production of LD converter steel. This paper summarizes the manufacturing processes, from the steel-making stage through the completion of the products, for ordinary rails, hard-head rails, conductive rails, rails with heat-treated ends, and high-Si rails, which are manufactured at the iron works.

One of the features characteristic of the manufacture of rails at this iron works is the reheating system (i.e., twice-heating system), which produces extremely favorable results in the manufacture of rails.

Fuji Iron and Steel Company, Kamaishi, Iwate, Japan, Kamaishi Technical Report, Vol 17, Nos. 1 and 2, pp 19-28, 1967, 14 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Co. (repr., PC).

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1253

COMPARISON OF CHARACTERISTICS OF LD CONVERTER STEEL RAIL AND BASIC OPEN-HEARTH STEEL RAIL (PART 1) [IN JAPANESE]

The present work is a report on the results of the test conducted on the basis of the test specifications on the trial-produced converter steel rail (Type N) as set forth in August 1965. The rail tested was Type 50 N, which had been manufactured at the Yawata Works of Yawata Iron and Steel Manufacturing Co., Ltd., and at the Kamaishi Works of Fuji Steel Manufacturing Co., Ltd. The former was approximately 4.7 tons in the unit weight of the steel ingot and prepared by the 1-heat system while the latter was approximately 6.4 tons in the unit weight of the steel ingot and prepared by the 2-heat system.

Among other things, the work indicates that the rail manufactured by Yawata Works showed the following:

(a) Compared with the open-hearth steel rail, the converter steel rail showed a higher content of C and lower contents of Ni and Cr. As to the gas contents, the converter steel rail characteristically showed a lower amount of hydrogen;

(b) As to the mechanical properties, the converter steel rail generally showed somewhat higher values than the open-hearth steel, and it was also found that the converter steel rail had a lower brittle transition temperature and hence had better mechanical properties under low temperature.

Ito, A. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 3, pp 109-114, 1968, 4 figs., 10 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1254

QUENCHING OF THE WELDED ZONE OF HARD-HEAD RAILS [IN JAPANESE]

Hard-head rail is a type of rail manufactured by quenching the head of the standard rail, and, as this type of rail shows less wear, it can be expected that it will have characteristics similar to those found in long-rail tracks constructed with the standard rail. In this study, a survey was made of possible problems which would be encountered in the welding of hard-head rail. A method was developed in which only the head of the rail is heated in a small-size furnace with propane gas and air flame as the heat source, and this is followed by water-cooling and self-tempering. Rather remarkable results were obtained in bend tests and no problems were found in terms of strength as the weld efficiency was upward of 90%. Thus, it was concluded that the welding of hard-head rails is entirely feasible.

Takimoto, T. (Japan National Railways), Tetsudo Senro, Vol 19, No. 5, 1971, pp 276-277, 4 figs., 1 table.

ACKNOWLEDGMENT: Mitsibushi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1255

COMPARISON OF CHARACTERISTICS OF LD CONVERTER STEEL RAIL AND BASIC OPEN-HEARTH STEEL RAIL (PART 3) [IN JAPANESE]

Subsequent to the report summarized in Part 2 of this study, the present report describes a study made in an attempt at comparing the LD converter steel rail and the basic open-hearth steel rail, which were manufactured by Fuji Steel Manufacturing Co., Ltd. The study further revealed that the converter steel showed 0.77% C and 0.94% Mn (the analysis values on actual products), which were close to the upper limits of the specified values, but that no net-like cementite was to be observed.

As shown by the three reports summarized so far, there was no observable point in which the converter steel rails were found inferior to the open-hearth steel rails. On the other hand, the converter steel rails, as compared with the open-hearth steel rails, have

such advantages as less segregation of elements and less gas content. In view of the need to maintain the present quality standard which has been attained by the open-hearth steel rails, the allowable limits of P and S should be slightly more severe than the existing specifications; P is less than or equal to 0.035% and S is less than or equal to 0.040%. On the basis of these results, the specifications applicable to both steel-making processes for the JRS rail (N-type) have been in force since September 1, 1966.

Ito, A. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 5, pp 229-232, 1968, 1 fig.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1256

COMPARISON OF CHARACTERISTICS OF LD CONVERTER STEEL RAIL AND BASIC OPEN-HEARTH STEEL RAIL (PART 2) [IN JAPANESE]

An attempt was made in this study to compare the quality of the LD converter steel rail with that of the basic open-hearth steel rail. It was found that (1) the microstructure of the converter steel rail was no different from that of the basic open-hearth steel rail.

Secondly, the rails manufactured by Fuji Steel Manufacturing Co., Ltd. showed the following:

(a) In terms of the chemical composition, those rails made of open-hearth steel with chemical components closer to the lower limits of the specified values showed a somewhat larger amount of carbon than that of the rails made of converter steel. The rails made by Fuji Steel Manufacturing Co., Ltd. showed a higher Cu-content compared with those manufactured by Yawata Iron and Steel Manufacturing Co., Ltd. As for the gas contents, the converter steel rails showed a lower value than those made of open-hearth steel at (0)% in the furnace.

(b) In terms of the mechanical properties, the converter steel was completely the same as the open-hearth steel. The difference from Yawata rails was that the two showed the same behavior in relation to impact strength.

Ito, A. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 4, pp 179-184, 3 figs., 4 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1257

DEVELOPMENT AND PRODUCTION OF 60-KG RAIL FOR SANYO SHINKAN [IN JAPANESE]

For the New Sanyo Trunk Line, 60-kg/m rails have been adopted in order to meet the requirements resulting from the higher operating speed of the trains (250 km/hr) and for greater track strength, reduced maintenance, prolonged rail life, reduced creep, etc.

The report discusses the development of the 60-kg rail; its specifications; the processes involved in its manufacture (steelmaking, soaking, blooming, steel ingot production, and rolling); and the quality and other features of the rail produced by the universal mill.

Serizawa, S. (Shinnihon Iron and Steel Co., Ltd.), The Iron and Steel Industry, Vol 21, No. 8, 1971, pp 20-25, 7 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Nippon Tekko Renmei (repr., PC).

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1258

A LOW CARBON ALLOY STEEL FOR RAILS [IN JAPANESE]

The Japan Industrial Standards (JIS) include the standards for high-carbon steel, high-manganese steel, and low-carbon alloy steel for application as rail steel. The present report describes the requirements and characteristic features of low-carbon alloy steel, for which a standard has recently been established.

This variety of steel for rail has been developed as material for use in welded crossings, and it has been standardized as rail steel as it combines resistance to wear, good weldability, and corrosion resistance. It has improved weldability and heat resistance because of its low carbon content, and better quenching characteristics because it contains Mn, Cr, Mo, and B, and improved corrosion resistance because of its Cr content.

Ido, A. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 3, 1971, pp 164-165, 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1259

MATERIAL PROPERTIES OF RAILS [IN JAPANESE]

This work presents the results obtained from tests of ordinary and heat-treated 50N rails manufactured by Nippon Kokan Kabushiki Kaisha (NKK) with its latest production facilities. Chemical composition, mechanical properties, and CCT curve are given along with the results of fatigue, falling-weight, and sulfur-print tests. The test results for the heat-treated rail are at least equal to, and in some cases superior to, those obtained for the ordinary rail.

Gocho, M., Osuga, T., Ito, M., Kido, H., Sugawara, I., and Wada, J. (Japan National Railways, Chiyoda, Tokyo, Japan), Nippon Kokan Technical Report No. 59, 1973, pp 75-90, 26 figs., 10 tables, 4 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Nippon Kokan, K.K. (repr., PC).

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1260

ON SOME PROPERTIES OF BASIC OXYGEN CONVERTER STEEL RAILS [IN JAPANESE]

The present work concerns itself with a comparison of the existing open-hearth steel rail and the 50N rail (which has just recently been produced from basic oxygen LD converter steel) with respect to the gas content, qualities of materials, hardenability, and weldability.

The rail made of converter steel has excellent tenacity, and this is attributed to the fact that this kind of steel has a lower gas content. In terms of strength (resistance to tensile force, impact value, bending strength, and fatigue strength), there is almost no difference between the converter steel rail and the open-hearth steel. Moreover, the two types of rails show almost the same weldability.

Abe, Y., Koi, K., and Omuri, H. (Fuji Iron and Steel Co. Ltd., Fuchinobe, Kanagawa, Japan), The Kamaishi Technical Report, Vol 17, Nos. 1 & 2, 1967, pp 35-39, 19 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Co., Ltd. (repr., PC).

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1261

A STUDY ON HIGH CARBON MEDIUM MANGANESE STEEL RAILS

In connection with the construction plan for the New Tokaido Line, a study was made of the trial production of high-carbon medium-manganese steel rails for use on this line. The high-carbon medium-manganese rails are more ductile than the carbon steel rails and their wear resistance and the fatigue resistance are excellent. Hairline cracks do appear frequently, but they can be eliminated by controlled cooling after rolling. Also, segregation and pipe can be controlled by proper choice of the degree of deoxidation, the method of making ingots, and top cut-offs.

Kimura, I., Hamahashi, H., and Ito, A. (Yawata Iron and Steel Co., Ltd., Yawata, Kitakyusyu, Japan), Yawata Technical Report, No. 244, 1963, pp 4489-4495, 6 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Yawata Iron and Steel Co., Ltd. (repr., PC).

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1262

ON THE MODERNIZATION OF THE RAIL MILL

The rail mill at Yawata Works was reconstructed after the end of World War II. This paper reports on the reconstruction work and shows the layouts of the facilities in 1948 and in 1963. The following three remodelling modification plans have been carried out: remodelling of the slow-cooling equipment, new equipment for disposing of pits, and replacement of the rolling mill.

Kagiyama, M., Nishio, T., and Yorioka, H. (Yawata Iron and Steel Co., Ltd., Yawata, Kitakyusyu, Japan), Yawata Technical Report, No. 244, 1963, pp 4485-4488, 3 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Yawata Iron and Steel Co., Ltd. (repr., PC).

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1263

ON THE QUALITY OF HEAT-TREATED RAILS [IN JAPANESE]

The present work contains an outline of the heat-treatment facilities owned by Fuji Steel Manufacturing Co., Ltd., and the heat-treatment process employed by it and states that products of stable quality have been obtained as a result of the establishment of periodic inspection of the steel used in producing heat-treated rails by full automatic control. The heat-treated rails manufactured in this factory (Kamaishi Works) far exceed in quality the values, a, c $\geq$ 10 mm and b $\geq$ 15 mm, prescribed by the Japan National Railways in the specifications. A comparison of the properties of the heat-treated rails with the ordinary rails is presented in a table.

Kikuchi, I., Komura, T., Ogawa, S., and Soga, Y. (Fuji Iron and Steel Co. Ltd., Kamaishi, Miyagi, Japan), The Kamaishi Technical Report, Vol 17, No. 122, 1967, pp 42-55, 10 figs., 6 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Co., Ltd. (repr., PC).

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1264

A STUDY ON HIGH-SILICON STEEL RAILS [IN JAPANESE]

The silicon content in high-silicon rails should be in the range from 0.50 to 0.80%, and, compared with the ordinary rails, the carbon and manganese content should be relatively higher. While the high-silicon rail does not compare favorably with the heat-treated rail in tenacity, resistance to wear, or resistance to fatigue, its performance with respect to these properties is definitely superior to that of ordinary rails. For this reason, it is possible to manufacture wear-resistant rails superior to the existing heat-treated rails by heat treating high-silicon rails.

Komuro, T., Ogawa, S., Aoi, K., and Omori, H. (Fuji Iron & Steel Co., Ltd., Kamaishi, Miyagi, Japan), The Kamaishi Technical Report, Vol 17, Nos. 1 & 2, pp 61-65, 8 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Co., Ltd. (repr., PC).

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1265

THE CHANGE AND THE LATEST TREND OF RAILS [IN JAPANESE]

The present work describes the transition in sections and shapes of rails from 1767 to the present time and also the change in the chemical composition of rail steels from 1929 to the present time and presents an overview of the chemical compositions and mechanical properties of rails produced in different countries with reference to their specifications. The survey which was conducted indicates that the tensile strength of the rails is 69.29 kg/mm^2 or greater, and elongation is 10% or more. The rails used for the New Sanyo Trunk Line (60 kg/m) have tensile strength of 80 kg/mm^2, greater than 10% elongation, and Brinell hardness of more than 229.

Rail-end fractures accounted for 52% of the total number of rail failures that occurred in the Japan National Railways' railroad in 1966. The number of failures of this type has been decreasing since the adoption of the N-type rail in 1961.

In addition, the work contains a report on the results of application of high-silicon rails in the United States.

Serizawa, S. (Fuji Iron and Iron Steel Co. Ltd., Chiyoda-Ku, Tokyo, Japan), The Kamaishi Technical Report, Vol 17, Nos. 1 & 2, 1967, pp 7-18, 7 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Company, Ltd. (repr., PC).

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1266

ON QUENCHED HARD-HEAD RAILS [IN JAPANESE]

A number of improvements to quenched hard-head rails contributed to the stabilization of quality and enhancement of the efficiency. In September 1961, a new method of quenching rails by the use of coke oven gas was perfected on the basis of the Kamaishi Works' own technique and it was continued till 1963. This report presents a review of its development and some metallurgical considerations on the heat treatment of rails.

Shoya, T., Ohnuma, Y., and Ohnuki, T. (Fuji Iron and Steel Co., Ltd.), Kamaishi, Miyagi, Japan), Fuji Iron and Steel Technical Report, Vol 11, No. 2, 1962, pp 140-150, 21 figs., 7 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Company, Ltd. (repr., PC).

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1267

EDGE-HEAD HEAT TREATED RAILS [IN JAPANESE]

When heat treatment is applied to the entire section of rail end to increase the surface hardness and to improve the tensile and fatigue strength, there will be decreases in rail-end fractures, exfoliations of batter on the rail head edge, the wear in the area of contact between the fishplate and the rail, and longitudinal bending of rail ends, thereby prolonging the life of rails. The present report summarizes the course of the research and development work for rails having heat-treated head as well as their performance characteristics. The standardized heat-treatment method is the hardening-tempering method or the slack/quench method, the surface hardness of the constant hardened portion being 48 ± 3 in Shore scleroscope hardness or 302 to 352 in Brinell hardness, and the Vickers hardness in the section of the constant hardened portion being 370 or less, with the length of the constant hardened portion being 100 mm ± 10 mm, and these together form an outline of the specifications.

Umitani, S. (Japan National Railways, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 5, 1969, pp 199-203, 10 figs., 4 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1268

MOTIONS OF INDEPENDENT WHEEL AXLE [IN JAPANESE]

The results obtained by a theoretical analysis of the stability of ultrahigh-speed railway vehicles having an independent wheel-suspension system and also the results of a lateral dynamics experiment using a 1/5 scale model are reported. For this study, a theoretical analysis and a model experiment were conducted with respect to the righting moment, the amount of slip at a curve and turning lateral force, the stability of the independent wheel axle, etc., by selecting an independent wheel truck system guided by a third rail. The work clarifies the fundamental characteristic features of the movement under survey, with the conclusion that it will be possible to design a truck capable of running with stability at a speed no less than 400 km/hr, provided that the structure of the guide apparatus selected and the specifications of the truck mechanism are adequate.

Koyanagi, S. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 27, No. 10, 1970, pp 475-480, 15 figs., 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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1269

STUDY ON RAIL WEIGHT: INVESTIGATION OF RAIL WEIGHT IN BUCKLING STRENGTH OF BALLAST MAT TRACK [IN JAPANESE]

The present study is directed to examination of rail weight with the focus on the buckling of long rails on track sections constructed with slab. The study also examined the amount of opening at the time fractures occur and presents the data so obtained for the purpose of comprehensive examination of rail weight in the future.

In this study, a progam for computing the minimum buckling strength of tracks was developed; the relation between rail weight and the minimum buckling strength and the relation between rail weight and thermal axial force were examined; and the maximum permissible value of rail weight was obtained. In addition, study was made of the rail weight for various kinds of track constructions including the long rails for the New Trunk Line, the long rails for the first and second class line track constructions, and the long rails for the middle and the low class lines.

Kuroda, S., and Yamachi, (Japan National Railways, Chiyoda, Nagano, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 6, 1975, pp 311-315, 9 figs., 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1270

STRESS ANALYSIS OF CONCRETE TRACK SLAB ON ELASTIC FOUNDATION USING THE FINITE ELEMENT METHOD [IN JAPANESE]

Various contradictions arise in the stress analysis of track slab if it is carried out on the basis of the beam theory. Hence, the present study proposes a new dynamic model which incorporates the constituent elements of the actual track in an effort to resolve such contradictions. Specifically, the study is based on the assumption that the rail is to be treated as a beam and the track slab as a thin flat plate and that a linear spring exists between the rail and the track slab at the point of the rail-clamping apparatus, the track slab being supported by the linear spring in its entire area.

As a result of a stress analysis conducted by the finite-element method, the contradictions attending an analysis by the beam theory have been resolved and the condition of stress at the edge of the slab, which has not been successfully clarified by any analysis based on the beam theory, has been determined.

Saito, T. (Railway Technial Research Institute, JNR), Journal of Railway Engineering Research, Vol 31, No. 4, 1974, pp 164-169, 4 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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1271

STUDY ON OPTIMUM SPRING CONSTANT OF RAIL PADS--TESTS IN ARITAGAWA BRIDGE [IN JAPANESE]

This study was conducted for the purpose of obtaining data relevant to the determination of an adequate spring constant for the track pad which is used for railway tracks of direct-joint structure. Measurements were made by means of a vehicle with artificially provided flat wheels running on a track having direct-joint structure and located on the Arita River bridge. The spring constant of the track pad under the tie-plate was varied in three stages, in an effort to determine the influence it exerts on rail pressure, rail displacement, the acceleration of vibration, the fluctuation stress of the coil spring of the rail clamping device, etc. Test results indicate that, in general, the spring constant of the track pad to be used for direct-joint track structure should be limited to approximately 50 t/cm.

Toyoda, M. (Railway Technical Research Institute, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 4, 1968, pp 161-165, 11 figs., 2 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1272

THEORETICAL ANALYSIS OF STATIONARY LATERAL FORCES OF RAILWAY VEHICLES ON CURVED TRACK [IN JAPANESE]

This study is directed to a theoretical analysis of vehicle movement with a view to obtaining basic data for designing railway vehicles that will show excellent performance on curves, i.e., vehicles that will show small constant lateral force of the wheels. The study discusses the relation between the lateral force of wheels and the flange force, the influence exerted by the spring constant of the wheel-supporting spring on the flange force, the influence exerted by such external forces as centrifugal force on the flange force, etc. Measures for reducing constant lateral force occurring as a train passes a curved section of track are also discussed.

Kunieda, M. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 27, No. 1, 1970, pp 4-7, 6 figs., 2 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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1273

A METHOD FOR MEASURING SPRING AND DAMPING CONSTANT OF TRACK [IN JAPANESE]

The author proposes a method for determining the spring coefficient of the spring system of the track, the vibration attenuation coefficient, and the contact spring coefficient between the wheel axle and the rail utilizing a wheel axle dropping test. The results obtained based on existing data are described.

In this work, a model was set up for the spring system of track, taking note of the form of the impact force generated by the dropping of the wheel axle and its characteristics. A theoretical analysis was conducted with the model, and it has been found that by drawing on the existing data, it is possible to calculate the spring coefficient, the diminution coefficient, and the contact spring coefficient between the wheel axle and the rail, which are characteristic values of the spring system of the track.

Sato, Y. (Japan National Railways, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 7, 1975, pp 360-364, 16 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1274

STUDY ON THE IMPROVEMENT OF WELDED BOND [IN JAPANESE]

The welded bond on rails is subject to the development of cracks under the shearing force and the bending moment caused by the impact of the trains. These cracks continue to propagate until the weld fails completely. There is a lack of uniformity in the welding techniques employed by various welders to repair the bonds. In response to this problem, the author has developed a procedure for standardizing the welding repair technique and has incorporated a number of changes which should improve the integrity of the bond.

The principal feature of the newly developed procedure involves a change from the existing brazing system to a sheet of copper which minimizes the braze filler-metal thickness. Also, the triangular form of the lug at which the element wire is fixed reduces the area of contact with the flange of the wheel.

Sekiguchi, M. (Japan National Railways, Tokyo, Japan), Signaling, Vol 25, No. 2, 1970, pp 68-71, 6 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Signaling Association (repr., PC).

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1275

TRACK FAILURE AND SPEED UP [IN JAPANESE]

This paper discusses the limit of high-speed train operation, from the viewpoint of track breakage, primarily on the assumption that the vehicles are to be built with lighter tare and that there will be no considerable change in

the curve conditions of the existing lines. In the present study, a testing car and a regular-service vehicle were operated at 5 to 110 km/hr on track having a curve radius of 443 m and a cant of 120 mm in the railway section between Masuo and Ise-Asahi on the Nagoya Line of Kinki Nippon Railways. Measurement was made of the rail lateral force, pressure, roadbed vibration acceleration, etc. The results thus obtained are examined and also compared with the standards adopted by the Japanese National Railways.

Yasue, S. (Technical Research Institute of Kinki Nippon Railway Co., Ltd., Amagatsuji, Nara, Japan), Technical Report of Kinki Nippon ailway, No. 1, 1969, pp 56-63, 14 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Technical Research Institute of KNR (repr., PC).

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1276

STUDY ON LONG WELDED RAIL ON BRIDGE IN SERVICE TRACK [IN JAPANESE]

When a railroad bridge exists in some part of long-rail tracks, the difference between the rails and the bridge girders in the respective amount of expansion under temperature fluctuation produces large axial force reciprocally in the rails and the girders. Thus a number of difficulties are encountered in laying long rails on a railway bridge.

This report concerns itself with methods for calculating the counter-buckling force, the amount of opening at the time of fracture, the amount of expansion, etc., giving some "examples of calculations."

Ito, S. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 2, 1968, pp 53-58, 17 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1277

RAILWAY TRACK CONSTRUCTION BY THE SYNTHETIC RESINS ELASTIC PACKING METHOD: ADHESIVE RAIL POINTS AND CROSSINGS FOR CONCRETE TRACK STRUCTURE [IN JAPANESE]

This work is a report on the track construction method for the direct-joint type turnout which has been developed for use in the underground tracks in Tokyo Station. In application to tracks directly joined to a concrete road bed, high precision is required of turnouts, and, as the sleepers will be very long, sufficient consideration should be given to replaceability. In view of these facts, the development work has been carried forward under these guiding principles: (1) the sleepers are not buried in the road bed, (2) reinforcement of the sleepers and their clamping structure along with active utilization of the elastic resin packing method. A follow-up investigation which has been continued since 1972 on the turnout track construction has revealed that the amount of track irregularity developed in the track under study was equal to that of the slab-type turnouts.

Shimizu, K., Kakezawa, H., and Yashida, H. (Teito Rapid Transit Authority, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 8, 1975, pp 417-420, 11 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1278

TRIAL MANUFACTURE OF RAIL JOINT FOR SANYO SHINKANSEN [IN JAPANESE]

This report presents a summary description of the design requirements and the structure of the expansion joint which has been produced on a trial production basis for the New Sanyo Trunk Line.

Principally, the work discusses measures to be considered in anticipation of railway cars in the future and measures for high-flange wheels in view of the increase in the flange height of wheels in the future.

Kurokochi, M., and Kagami, M. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 5, 1968, pp 191-193, 9 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1279

MACHINE LAYING OF 60-KG PC LONG WELDED RAIL IN KAMUI [IN JAPANESE]

A summary description is presented of the construction of a section of track with 60-kg long rails and PC sleepers on a 250-mm-thick slab bed in the Kamui tunnel (total length = 4,523 m). The special conditions existing in the tunnel (located in a serpentine turgor pressure zone), the quality of the track maintenance work that might be expected, the difficulty in executing the track construction work, the safety of the track, etc., in this particular situation are discussed.

Maruoka, T. (Japan National Railways, Sapporo, Kokkaido, Japan), Tetsudo Senro, Vol 17, No. 10, 1969, pp 559-562, 9 figs., 6 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1280

IMPROVEMENT IN METHOD OF LAYING LONG WELDED RAIL IN KINKI NIPPON RAILWAY CO., LTD. [IN JAPANESE]

When long rails are laid at night, it is customary to bring them to the set temperature by using a rail heater after they are laid. This process requires a great deal of labor and expense. This study was performed in an effort to develop a process which would permit the simultaneous heating and laying of the rails. The report describes the process and discusses its effects and advantages.

Sakamoto, S. (Kinki Nippon Tetsudo Co., Ltd., Uehonmachi Osaka, Japan), Tetsudo Senro, Vol 23, No. 5, 1975, pp 232-236, 8 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1281

GAS PRESSURE WELDING OF RAILS [IN JAPANESE]

This report describes the gas-pressure welding process applied to the production of long rails using welding equipment developed by the Japan National Railways, together with the results of tests conducted on rail welds.

As favorable results were obtained in the laboratory tests, falling weight tests and bending tests were conducted on the production rails. In the bending tests of the 50T and 50N rail welds, a significant correlation between the carbon equivalent and the breakage load and between the carbon equivalent, and the amount of deflection (C eq. = C + 1/6 Mn) was found. The breakage load increases and the amount of deflection decreases as C eq. increases. However, no such correlation was observed with regard to falling-weight strength.

Hyuga, T., Nakamura, K., Abe, Y., and Aoi, K. (Fuji Iron and Steel Co., Ltd., Kamaishi, Miyagi, Japan), The Kamaishi Technical Report, Vol 17, Nos. 1 & 2, 1967, 9 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Fuji Iron and Steel Co., Ltd. (repr., PC).

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1282

A NEW WELDING MACHINE FOR RAILS [IN JAPANESE]

The present work deals with the rail gas-pressure welding machine which Japan National Railways has developed with a view to promoting the use of long rails, and the on-rail type flash butt welding machine produced in the U.S.S.R. Two units of a trial production model of the rail gas-pressure welding machine were assembled, and a field test in which rail sections were joined with the welding machine yielded satisfactory results. This welding machine, small in size and light in weight (180 kg), is adequate for welding at the base plant, as well as for welding in the field (in-track). The flash butt welding machine produced in

the U.S.S.R. will work well with 180-kva power source. This welding machine, also lightweight, has been developed for in-track welding and produces excellent weld strength. There is no significant difference in the weld strength obtained with the Japanese, gas-pressure welding machine and that obtained with the flash welder made in the U.S.S.R., and both machines ensure great reliability in the welded sections.

Kusuno, T. (Japan National Railways, Chiyoda, Tokyo, Japan), Traffic Techniques, Vol 29, No. 8, 1974, pp 250-255, 13 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Traffic Association (repr., PC).

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1283

AN AUTOMATIC FUSION METHOD OF RAIL WELDING FOR USE IN THE FIELD [IN JAPANESE]

In an effort to promote the increased use of long rails, an automatic fusion welding technique, termed the "submerged-slag" method, which combines the submerged-arc and consumable-nozzle-electroslag welding methods, has been developed for use in the field. In this method, three layers of submerged-arc welds are applied to the rail base, and the intermediate and head sections are welded by means of the consumable-nozzle-electroslag method. The mechanical properties of the welded sections have been found to be satisfactory in terms of the results of static bending and fatigue tests, and hardness of the rail head surface. A follow-up test is being performed with a trial production model of a rail welding car on rails welded by the present method and laid on the New Trunk Line and the Tokaido Line.

Ohishikashi, K., Hakamada, S., Okara, M., and Ohi, I. (Nippon Yakin Kogyo Co. Ltd., Tokyo, Japan), Welding Techniques, Vol 20, No. 2, 1972, pp 65-68, 8 figs., 4 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Welding News (repr., PC).

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1284

ENCLOSED-ARC WELDING OF 60-KG RAIL [IN JAPANESE]

Enclosed-arc welding, a manual welding process applied without any edge preparation on the rail end, was used for the construction of the New Tokaido Trunk Line. The present report describes the performance of welded joints in 60-kg rail and reexamines the distribution of mechanical properties found in enclosed-arc-welded sections. While most of the tension-test values satisfy the specification values of the rail-base material, these property values are somewhat lower than those specified for the head and the web regions of rail. An impact test proved that the notch toughness in the rail base in the heat-affected zone also was satisfactory. The HAZ grain size is small in the rail base but the HAZ grain structure is coarse in the head and in the web of the rail.

Mori, S. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 19, No. 7, 1971, pp 385-387, 4 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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128.

NEW TRACK MATERIALS [IN JAPANESE]

This paper deals with the state of development of slab track; PC sleepers No. 6, Type 9 and No. 7, Type 10; glued rail joints for insulation, turnouts for the New Sanyo Trunk Line, expansion joints; and 90S rail. All of these components were developed for use in a railway track structure capable of satisfying the requirements in higher operational speed of trains additionally ensuring labor saving in track maintenance since there is practically no permanent deformation. The high-speed turnout discussed in this work permits a maximum traveling speed of 130 km/hr on the straight line side, and the results of an actual operation test were favorable.

Sato, Y. (Japan National Railways, Chiyoda, Tokyo, Japan), Traffic Techniques, Vol 25, No. 12, 1970, pp 482-485, 7 figs., 2 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Traffic Association (repr., PC).

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1286

RAIL UNDULATING DEFLECTIONS [IN JAPANESE]

A regular unevenness (longitudinal bending) has been noted on the rail head surface in the joint sections or welded sections of rails of the New Sanyo Trunk Line which have been laid down in the field. This paper concerns itself with the circumstances leading to the discovery of such longitudinal bending and also with the results, etc., of surveys of the causes of the development of such longitudinal bending.

Uduka, N., and Sugiyama, T. (Japan National Railway, Kokubunji, Japan), Tetsudo Senro, Vol 21, No. 3, 1973, pp 153-155, 4 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1287

STUDY OF SAFEGUARDS AGAINST TRACK IRREGULARITIES IN LONG WELDED RAIL EXPANSION [IN JAPANESE]

More than 10 years ago, long rails were laid on the railway networks of the Japan National Railways. With the increased understanding of the principles involved in long rails, the use of long-rail tracks continues to increase steadily. While long rails offer many advantages, including improved traveling comfort and reduced maintenance, they also give rise to restrictions in railway construction and complications in track maintenance and control. The present paper offers the results of a survey conducted on the current situation of track warping or deviations resulting from the expansion or contraction of rails, which is one of the problems associated with long rails, and presents an analysis of countermeasures, etc., on the basis of the theory of thermal expansion, etc.

Iwaki, Y. (Japan National Railways, Osaka, Japan), Tetsudo Senro, Vol 20, No. 4, 1972, pp 198-206, 10 figs., 12 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1288

A VIEW OF THE PRESENT SITUATION AND POSSIBLE COUNTERMEASURES FOR RAIL SHELLING [IN JAPANESE]

Although it has been generally believed that head hardening of rails is effective in reducing rail shelling, shelling does occur rather extensively in heat-treated, head-hardened rails.

In the present study, an attempt was made to examine the actual conditions of rail shelling in order to determine the characteristics of the phenomenon and to compare such differences as the conditions under which shelling occurs and the conditions of use in an effort to find those factors which contribute to the shelling and to develop preventive measures. It was found that there is a correlation between the magnitude of the lateral force of the track stress and the occurrence of rail shelling. It was also noted that rail shelling is more likely to occur in cases where slippage is present. Possible countermeasures include prevention of the occurrence of large lateral force, adjustment of oil applied to the rails to an adequate level, and improvement of the material quality of rails.

Kuriharu, T. (Railway Technical Research, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 16, No. 7, pp 412-417, 1968, 13 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1289

PRESENT SITUATION AND FUTURE PROSPECTS OF RAIL APPLICATIONS [IN JAPANESE]

It has been more than 100 years since the establishment of the railway in Japan, and remarkable progress has been made in railway rails during this time. Technological achievements to the present are represented in N-rail, 50T rail, and 60K rail, which have excellent cross-sectional shape and durability. The application of these new cross-section rails has considerably reduced rail breaking. However, sufficient use has not yet been made of N-rail in the conventional narrow-gauge lines of the National Railway Corporation, and promotion of N-rail in the conventional lines and wider adoption of long rails

are important considerations. The success of the New Tokaido Line opened up a new age of high-speed railways, and the national project for new railway networks is taking shape.

The fundamental requirements for quality in high-speed rail are the absence of defects and the elimination of errors in the manufacturing process. In particular, wavy deformation is a problem which warrants review in the application of rails to high-speed railways in the future.

For the present New Tokaido Line, 60K rails are used, whereas a heavier rail may be required in the future, in view of the anticipated increase in load and the necessity for labor saving in track maintenance.

Abe, S. (Japan National Railways, Chiyoda, Tokyo, Japan), Nippon Kokan Technical Report, No. 59, 1973, pp 63-73, 10 figs., 3 tables, 2 refs., 10 appendixes.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Nippon Kokan Co. Ltd. (repr., PC).

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1290

RAIL DAMAGE OF JNR LINES IN 1969 [IN JAPANESE]

The number of rail failures recorded in 1969 in Japan was 3,373, representing the lowest level in the last ten years. Of the various types of rail failures, rail-end fracture was the most frequent. With regard to place of use, the failures of rail found in the tunnel sections showed a large-scale decrease dropping to a level of frequency almost equal to that found in the ordinary railway sections. In terms of the manner in which the rail failures were detected, minute inspection was found to be most efficient, followed by detection during a tour of inspection, and then by detection during rail-maintenance work.

The factors which are believed to account for the decrease in rail failures are: the progress made in the adoption of N-rail, which is less liable to failure; the promotion of the adoption of long rails; and the periodic replacement of rails laid in tunnel sections.

Sato, Y. (Japan National Railways), Tetsudo Semro, Vol 19, No. 1, 1971, pp 15-18, 8 figs., 8 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1291

THE TREND OF RAIL DAMAGES AT JNR LINES IN 1970 AND THE COMPARISON OF RAIL DAMAGE STATISTICS IN EUROPE AND IN JAPAN [IN JAPANESE]

In general, the types of rail failures showing high frequency of occurrence are rail-end fractures (58.2%) and transverse fissures (11.3%). Frequent failures are found in the welded sections in the case of T-rail, while in the case of N-rail failures in the rail-head surface have a high incidence (ranging from 40 to 50%).

Compared with European railways, Japan National Railways has recorded a lower rate of detection of rail failures by means of a defect detector or a defect detecting car. In terms of the relationship between rail failures and derailments, as compared on the basis of the same kind of statistics for rail failures, Japan National Railways had two incidents, from 1960 to 1969, in which derailments were related to rail failures, while there were 16 such incidents in Europe during the period from 1955 to 1964.

Matsumara, H., and Yamazuki, T. (Railway Technical Research Institute, JNR), Tetsudo Semro, Vol 29, No. 12, 1971, pp 696-699, 4 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1292

THE STATISTICAL PROPERTIES OF THE DAMAGE OF RAIL AND RAIL POINTS AND CROSSINGS [IN JAPANESE]

The concept of the Weibull distribution is applied as a method of representing the conditions of rail damages. The Weibull distribution is convenient in its applicability in correspondence to the three types of damages: initial, contingent, and abrasion. In this study, this concept is applied to an analysis of damages in rail and turnouts.

The number of years of use or the aggregate tonnage is represented along the horizontal axis while the aggregate damage ratio or the aggregate number of damages is plotted along the vertical axis, and an analysis is made of the damages occurring in the welded sections of rail. The results of the inclination in the straight-line section in the case of the turnouts, have found useful under conditions which are severe.

Sugiyama, H. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 18, No. 12, 1970, pp 634-637, 8 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1293

BASIC STUDY ON IMPROVEMENT OF ADHESION OF WHEEL-RAIL INTERFACE USING PLASMA EMISSION [IN JAPANESE]

Studies were initiated around 1970 to investigate increasing the adhesion coefficient and securing its stability by plasma radiation (radiation of electrically charged particles). Studies which were previously conducted investigated the macroscopic effects of plasma radiation and did not cover such areas as the effects of plasma radiation in relation to differences in the surface conditions of the rails, and the changes and characteristics of the adhesion effect that occur with the passage of time.

The present work focuses on a basic study of the adhesion effect achieved through plasma radiation applied to different kinds of rail surface conditions and examines the adhesion mechanism and other factors that develop after plasma radiation.

Iwamoto, M., Tomizawa, M., and Deguchi, S. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 32, No. 4, 1975, pp 128-131, 8 figs., 3 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Ken-yusha, Inc. (repr., PC).

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1294

ADHESION AND DYNAMIC PHENOMENA DURING SLIPPING OF ELECTRICAL ROLLING STOCK (SECOND REPORT ON STATISTICAL ANALYSIS OF ADHESION PERFORMANCE OF LOCOMOTIVES) [IN JAPANESE]

The present paper describes an analysis which was carried out on the expected value of the utilized adhesion coefficient of a locomotive engine (the ratio of the expected value of the total adhesion tractive force and the axle weight of all the driving wheels) with a view of arriving at at theoretical evaluation of the adhesion capacity of a locomotive engine.

As a result of the analysis, a method was established for calculating the expected value of the utilized adhesion coefficient of a locomotive engine in consideration of various factors, expressing the fluctuation of the adhesion coefficient between the wheels and the rail against the distance along the rail in terms of a generalized model.

Hirou, T. (Hitachi, Ltd., Chiyoda-ku, Japan), Transactions of the Japan Society of Mechanical Engineers, Vol 39, No. 323, 1973, pp 2082-2091, 10 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Mechanical Engineers (repr., PC).

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1295

STUDY ON PRESSURE IN HUMPS OF CONCRETE SLAB TRACK

In slab track, a notch having a radius of 250 mm is provided at the center of either end of the slab and, at the part of the foundation corresponding to the said notch, a projection having a radius of 200 mm and a full-circle or semi-circle section is provided for supporting and transmitting the longitudinal and transverse load of the track to the foundation.

In the present study, pressure and displacement caused by the longitudinal load of the long rail and the thermal load of the slab in the area between the projected part and the slab were

measured, and tests were conducted with a view to obtaining data relevant to the design of slab tracks in the future.

Yamamoto, H., and Uwasa, H. (Railway Technical Research Institute, JNR), Tetsudo Senro, Vol 20, No. 9, 1972, p 566, 1 fig.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1296

RAILS AND THERMIT WELDING [IN JAPANESE]

The present report deals with thermit welding, which has been used by the Japan National Railways (JNR) since 1957 for the welding of rails in the field.

The mechanical quality developed by the JNR-method applied for improving on the structure of the welded parts is presented with reference to the results obtained on 50t rail.

It is also pointed out that approximately 60 percent of the fractures in the welded parts of rails are attributable to flaws in the shape of the weld reinforcements and 40 percent to flaws in welding. This indicates that it is necessary to reexamine the shape of weld reinforcement and suggests that the Japan National Railways is studying thermit welding without weld reinforcement (i.e., collarless thermit welding).

Nakamada, S. (Railway Technical Research Institute, JNR), Metals, No. 3, February 15, 1972, pp 69-71, 3 figs., 4 tables, 5 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Agune (repr., PC).

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1297

THE WELD OF HIGH MANGANESE STEEL [IN JAPANESE]

The results of welding 1XC-13Mn austenite steel used for turnouts on railways are presented:

(1) The tendency toward development of cracks in welded metal increases as the content of Si and P in the base metal is increased. The effect of Si on high-temperature cracking in the bead is approximately 1/40 that of P.

(2) In welding high manganese steel and high carbon steel, favorable results can be obtained by first "buttering" the welding edge of the latter with a 16 Mn-16 Cr welding rod and then using gas shielded arc welding.

(3) Favorable results could be obtained by applying shielded arc welding as a measure for preventing season cracking which by nature occurs at the welded joint portion of high manganese steel rail and carbon steel rail.

Kimata, N. (Railway Technical Research Institute, JNR), Journal of Railway Engineering Research, Vol 31, No. 4, 1974, pp 155-159, 5 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute, JNR (repr., PC).

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1298

THE RAIL WELDING IN JNR NEW SANYO LINE [IN JAPANESE]

It is a general principle that the rails used for the New Sanyo Trunk Line should be long rails for the entire distance, and 60-kg rails have been adopted for the trunk line in anticipation of the operation of trains on the line at 250 km/hr and in expectation of reinforcement of the fatigue strength of welded sections of rails.

Welding of the rails of the New Sanyo Trunk Line is performed at the base plant and in the field. The principal welding process for the former is stationary gas pressure welding while the most frequently used welding process for the latter is enclosed arc welding.

The 25-m rails are joined into 150-m lengths at the base plant by means of gas-pressure welding equipment patented by Japan National Railways. In the

field, manual arc welding is employed with a high-tension, low-hydrogen-type covered electrode.

For inspection, a gamma-ray test is conducted, principally with cobalt-60.

Yoshida, G. (Japan National Railways), Tetsudo Senro, Vol 18, No. 9, 1970, pp 441-445, 5 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railroad Civil Engineering Association (repr., PC).

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1299

THE STABILITY OF LONG WELDED RAIL TRACKS: PART 1-STABILITY OF NONLOADED LONG WELDED RAIL TRACKS UNDER THE ACTION OF THERMAL STRESSES; PART 2-STABILITY OF TRACKS UNDER THE ACTION OF TRANSVERSE FORCES EXERTED BY VEHICLES [IN FRENCH]

Following an analysis of the longitudinal forces and longitudinal displacements of thermal origin and the stability in vertical and transverse directions, Part I of the article presents calculations of rail (nonloaded) deformations as well as experimental studies and practical applications of the results obtained. In Part II calculated and experimental deformation curves are compared for the loaded case and the minimum permissible radii of curvature are derived.

Prud'homme, M. A., and Jamin, M. G. [Installations Fixes de la SNCF (French National Railways) Paris, France], Rev. Gen. Chemins, No. 85, February 1969 and March 1969, pp 83-106, and 151-166, 39 figs., 34 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Societe Nationale des Chemins de Fer Francais (repr., PC).

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1300

LONG WELDING OF 60 LB RAILS (WITH SPECIAL REFERENCE TO NE RLY CWR)

This paper deals with the behavior of 60-lb continuous-welded rail (CWR) as observed on the North Eastern (NE) Railway (India), and some of the advantages and economics of long welding of 60R rails. Of the 96,000 km of track on the Indian Railways, about 15,000 km is laid with 10 to 12 year old 60R rails with fishplate joints. The current track policy of Indian Railways forbids long welding of 60-lb rails. To gain actual experience of the magnitude of the advantages and disadvantages of long welding, NE Railway carried out continuous welding of an 11-km stretch of 60R rails. The author states that in 4 years of experience with the CWR section "no special or insurmountable difficulties have been met, and on the whole considerable economy has resulted". A detailed discussion is presented on the technical points involved and the resulting economies. The author recommends the long welding of 60-lb rail on new and existing track and lifting the existing ban on such welding.

Raina, R. M. (Indian Railway Board, New Delhi, India), Indian Railway Technical Bulletin, Vol 30, No. 191, November 1973, pp 138-149, 3 figs., 4 tables, 5 annexes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1301

BUCKLING OF LONG WELDED RAILS

The stability of a long welded rail and its resistance to lateral buckling is analyzed in this paper, and the circumstances under which a normal track with joints behaves as a long welded rail are described. Factors affecting the buckling resistance of a rail track are examined from the standpoint of temperature variation, rail section, and ballast resistance insofar as they only expand and contract with the rise and fall of temperature. In the case of a jointed track, a series of these connections may be closed and jammed due to creep or other reasons and in this condition, the series of rail panels will behave as a long welded rail. It is also possible that the joints are rigid as a result of overtightening of the bolts or lack of lubrication. In such cases also, a series of panels will expand and contract as a long welded rail. The model chosen for this study represents a length of rail encased at each end and supported along its length by rollers beneath the ties in place of ballast. Mathematical expressions for calculating

the deflection of track on ballast under lateral loading are derived and their application to Indian railway track is shown.

Sinha, H. (Advanced Permanent Way Training School, Ministry of Railways, Poona, India), The Journal of The Institution of Engineers (India), Vol XLV, No. 3, November 1964, pp 428-435, 6 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Institution of Engineers (India) (repr., PC).

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1302

TRANSVERSE FISSURE RAILS ON ATCHISON, TOPEKA & SANTA FE RAILROAD--HEAT 41177

Failure of one of the rails (due to transverse fissures) on the Atchison, Topeka & Santa Fe Railroad, which resulted in a derailment, led to removal from service of other rails from this heat and their subsequent examination. Fifty-one 90-lb rails were removed and sent to Topeka, Kansas, for examination and testing. A 2-foot piece was cut from each rail by means of an oxyacetylene torch for chemical, tensile, and etching tests, and the two long pieces were used for drop testing. On the basis of the test results, it was concluded that the metal in the interior of the head of several of the rails of the heat was in a badly shattered condition, containing numerous cracks. A few of the cracks acted as nuclei from which transverse fissures developed in service.

Wickhorst, M. H. (AREA Rail Committee, Chicago, Illinois), American Railway Engineering Association Proceedings, Vol. 21, March 1920, pp 1079-1097, 16 figs., 9 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1303

PLASTIC DEFORMATION OF RAIL HEADS WITH CONTACT FATIGUE DAMAGE [IN RUSSIAN]

The role of plastic deformation in contact fatigue damage is examined. An experiment is described in which the distribution of the volume of the metal affected by plastic deformation in the course of service is analyzed. The experiment also provided data which allowed a comparison of the positions of the contact fatigue damage with plastic deformation distributions.

Konyukhov, A. D., and Shur, E. A. (Scientific Research Institute for Railroad Transport, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 2, 1964, pp 52-55, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1304

ANALYSIS OF THE EFFECT OF STEELMAKING AND CASTING CONDITIONS ON THE NUMBER OF REJECTS IN THE COURSE OF RAIL INSPECTION [IN POLISH]

An analysis is made of technological parameters of melting and casting steel for rails. Various types of protective coatings and hot tops, and the number of rejects of rails due to characteristic defects are described. It was observed that there is a relationship between the ratio of manganese to sulphur in the bath after melting and in the finished steel, or between the ratio of manganese to silicon, and silicon and the number of rejects due to scale. The casting of steel with the use of a mixture of graphite and fly-ash leads to a decrease of rejects from exogenic nonmetallic inclusions of about 5.5 percent.

Krucinski, M., Osika, Z., Chorobik, A., and Hensel, W., Hutnik, Vol 34, No. 2, 1967, pp 52-60, 17 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner (repr., PC).

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1305

HYDROGEN IN RAIL STEEL [IN POLISH]

The chemical content of rail steel during the process of melting and casting is discussed in connection with its relation to potential occurrence of flaking and inclusions. Suggestions are presented which recommend that when tapping, the metal should contain a slight excess of oxygen to offset action of the atmospheric moisture during casting. The mould dressing should not contain any hydrocarbons. As long as the hydrogen content does not exceed 4 to 5 ml/100 g, flaking does not ordinarily occur during casting if, at the same time, the carbon and manganese content does not exceed 0.6 and 0.8 percent, respectively. It is believed that rails containing more than 5 ml/100 g of hydrogen should be tested for inclusions by using ultrasonic defectoscopy techniques.

Wojcik, A., Hutnik, Vol 31, No. 3, 1964, pp 76-85, 17 figs., 3 tables, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner (repr., PC).

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1306

LOAD MEASUREMENT ON A STRAIGHTENING MACHINE DURING THE STRAIGHTENING OF RAILS [IN POLISH]

Rail straightening as a process of mechanical working is discussed with a method for planning and making measurements. Oscillograph records of the load and power consumption of the main drive, the relationship between the loads and shortening of the rails from the setting, and between the length of the rail and the loads are presented. The necessity for the use of a 7-roll straightening machine is considered.

Majdanik, A., and Jonca, J., Hutnik, Vol 33, Nos. 7 and 8, 1966, pp 287-294, 11 figs., 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner (repr., PC).

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1307

AGING TENDENCY OF RAIL STEEL AS A FUNCTION OF HEAT TREATMENT [IN RUSSIAN]

The effects of aging were studied for cold deformation and subsequent artificial aging on the impact characteristics of rails which had been heat-treated using two conventional methods. The chemical compositions of the rail steel are given for specimens of interest. Some of the rails were surface quenched with water streams, whereas others were quenched in oil with subsequent tempering. In both cases, the rails were heated after hardening. The initial and after-hardening Brinell hardnesses after quenching in water and oil are shown. In some cases, the rails were mechanically deformed, and in others they were artificially aged by boiling them in oil. In all cases the impact strength decreased significantly, and the percentage changes are tabulated. The most significant decrease of impact strength was noted for rails quenched in oil and this was attributed to the presence of ferrite that was formed along the grain boundaries as a broken network. This formation of ferrites was attributed to inadequate cooling.

Filonov, I. G., Orgiyan, V. S., and Karpunin, A. M., Metallurgicheskaya i Gornorudnaya Promyshlennost', No. 2, 1967, pp 41-42, 1 fig., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1308

EFFECT OF NATURAL AGING ON THE MECHANICAL PROPERTIES OF RAILS: S-49 [IN POLISH]

A determination of the effects of carbon, manganese, and silicon contents on the yield point, elongation, and strength of rails was made by means of statistical analysis. It was observed that carbon, manganese and silicon improve the strength of the rail, however, elongation is reduced. Effects of carbon on the strength and elongation are significant in the case of aged rails. The chemical composition of rails was found to be a decisive factor with regard to the mechanical properties. After natural aging, there is a loss in plastic characteristics when the carbon

content is less than 0.59 percent. The analysis showed that the improvement of rail plastic properties by aging was not the result of hydrogen evolution. In order to improve the plastic properties of rail steel an increase in carbon content and a minimum of 0.70 percent manganese are recommended.

Hansel, W., Hutnik, Vol 34, No. 6, 1967, pp 259-269, 5 figs., 7 tables, 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner (repr., PC).

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1309

SPEED INCREASE AND ELIMINATION OF SPEED RESTRICTIONS IN REGIONS DAMAGED DUE TO MINING OPERATIONS BY INSTALLING SCARFED JOINTS [IN GERMAN]

The operational and economic advantages of scarfed joints on the railroad routes of the Saarland coal mining area are briefly discussed. The article describes the special features of track construction in this area. Steep gradients, track distortions, and fissures produced by soil subsidence imposing uneconomical speed restrictions have been successfully counteracted by providing the tracks with scarfed joints. The 20 to 25 speed-restriction zones extending over a total length of 50 to 60 km have been reduced to about 10 with a total length of 17.3 km, the speed has been raised from 10 to 50 km/hr to 90 km/hr, and the maintenance cost has been reduced 50 percent.

Zimmer, G. (Deutsche Bundesbahn, Saarbrucken, West Germany), Eisenbahningenieur, Vol 18, No. 6, 1967, pp 150-151, 3 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Dr. Arthur Tetslaff-Verlag (repr., PC).

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1310

JOINT DEFLECTION AND RAIL END BATTER ON 130 LB RAIL EMPLOYING UNCONVENTIONAL METHOD OF LAYING

The purpose of this test was to determine if rails matched and laid in a continuous stretch of track with ends in the same position as when passing through the hot saws at the rail mill show less joint deflection and rail end batter than rails received from the mills and laid in the usual way. The matching and laying of rails for the test produced 92 joints where ends were matched according to ingot and rail classification. Initial measurements of joint deflections and rail end batter were taken during May 1930, and these measurements were repeated at intervals over a period of eight years. The final inspection was made during May 1938. It was concluded that to load, identify, distribute, and lay rail matched in the same order as rolled and hot sawed at the mill would unquestionably result in higher manufacturing and rail laying costs than now exist. The results of this test with a limited number of rails matched, compared with rails not matched, show no improvement over the usual method of shipping and laying rail. (Carried as RRIS Accession No. 040252.)

Penn Central Transportation Company, Final Report, Test No. 72, April 1945, 7 pp, 2 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Railroad Company (repr., PC).

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1311

FOUR BOLTS VERSUS SIX BOLTS IN JOINT BARS FOR 155-LB., 140 LB., AND 133 LB. RAILS--JOINT BARS TO BE STANDARD LENGTH

Four different punchings of bars with compatible rail drillings were compared at three test locations. All the bars used were of standard length and design, the only difference being the hole location. The test was laid out in such a manner that measurements of batter and deflection of joints could be obtained on both tangent and curved track. The curve was 1 degree 52". In the portion of the 140-lb test, rail with AREA drilling, four-hole special drilling, PRR standard drilling, and PRR standard with second hole from each end omitted was laid on tangent track only. There is no material difference

in profile or in maintenance cost among the various combinations tested. The four-hole bars tested will adequately fasten the rail, but the saving realized by elimination of two bolts would not be enough to justify the expense of the change of standard. (Carried as RRIS Accession No. 040284.)

Code, C. J. (Penn Central Transportation Co., Philadelphia, Pa.), Test Report No. 614, June 1964, 12 pp, 6 figs., 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Penn Central Transportation Co. (repr., PC).

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1312

A DISCUSSION CONCERNING JOINTLESS, EXPANDABLE RAIL CONNECTION FOR RAILROADS [IN GERMAN]

The new fishplate connection uses rail heads cut diagonally at the joint. On these diagonal surfaces lie the wedge-shaped parts of the fishplates. The fishplate connection permits smooth running without welding and, in addition, allows temperature-dependent changes in length.

Breuer, E. (Geneva, Switzerland), Wirtschaft und Technik im Transport, Vol 42, No. 4, 1973, pp 19-20, 3 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Buchdruckerei Gassmann AG (repr., PC).

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1313

IMPROVEMENT OF THE FATIGUE STRENGTH OF BOLTED RAIL JOINTS BY ENLARGING THE DIAMETER OF BOREHOLES IN THE FISHPLATES [IN GERMAN]

After a brief review of previous investigations on this problem in France, the U.K., Japan, and the U.S.A. the authors describe the procedures and results of exhaustive tests conducted by the Netherlands Railways (NS) in conjunction with the Friedr. Krupp iron and steel works, Germany, with the aim of improving the service life of fishplated rail joints. The best results were obtained by enlarging the holes by 0.8 mm with a tapered drift. The fatigue strength of rails improved by at least 65% even when effects of service conditions are taken into account. Fatigue bending tests confirm that enlarging the holes has no detrimental effect on the surrounding material.

Thomas, H., van Swaaij, J., Schweitzer, R., and Heller, W. (Netherlands Railways, Utrecht, and Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Eisenbahntechnische Rundschau, Vol 21, Nos. 7 & 8, 1972, pp 256-264, 11 figs., 3 tables, 11 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Hestra-Verlag (repr., PC).

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1314

IMPROVEMENT IN THE DESIGN OF FISHPLATED RAIL JOINT, PARTS I--STRESS AT RAIL JOINT

Various aspects for the design of a fishplated rail joint, such as bolt size, bolthole diameter, shape and size of fishplate, and joint sleeper spacing, are discussed. The mechanics of the rail joint in terms of bolthole and fishplate stresses, bending of bolts, and longitudinal resistance of the joint also are discussed on the basis of static and dynamic tests conducted recently by RDSO (Research, Design and Standards Organization) for the 90-R IRS rail joint and the recent tests conducted by the Japanese National Railways and the British Railways. Emphasis is placed on the fact that fractures at the rail ends constitute a major percentage of total rail failures. Initial stresses due to tightening of the bolts and the initial tensile stress in the rail web are calculated. Possible remedies against fatigue failure around boltholes are suggested, such as reduction of stress concentration and fatigue limit reduction; maintenance of a low mean stress caused by bolt tension; and an increase in fatigue limit by work hardening of metal near boltholes as suggested by the British Railways.

Gupta, M. L. (Research, Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 25, No. 170, August 1968, pp 74-81, 7 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1315

RAIL STEELS: MEETING REPORT

The Iron and Steel Institute's meeting on "Rail Steels, London, November 23, 1972, is briefly reviewed. The papers were grouped under three headings: "User Experience", Toughness Requirements for Rail Steels", and "New Developments".

The first group of papers covered experiences of railroad administrations in five countries on how to optimize the service life of rails and mitigate the effects of cracks, wear, and other defects that can require premature replacement of rails. A widely accepted need was expressed for a wear-resistant readily weldable rail steel. The second group of papers dealt with the use of fracture mechanics to explain the known facts regarding brittle fracture in a particular set of circumstances and how changes in the properties can in practice decrease the danger of a sudden brittle fracture. The third group of papers dealt with new developments in the field of rail steels in Western Europe. The British approach is to improve fracture toughness and has led to a lower C, higher Mn grain-refined steel. In Belgium a low-C, low-alloy, Cu-Ni-Cr-Nb steel which will precipitation harden and is readily weldable has been developed. In Germany a rail steel containing 0.7-1.2% Cr with a yield stress in excess of 60 kg/mm^2 has been developed to counteract flattening of rail heads and shelling. (A complete report of the proceedings of the meeting is at present out of print).

Swindale, J. D. (British Steel Corp., Britannia Works, Teesside, U.K.), Journal of the Iron and Steel Institute, Vol 211, No. 5, May 1973, pp 326-328.

ACKNOWLEDGMENT. Battelle Frankfurt.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1316

A REVIEW OF LATEST DEVELOPMENTS IN THERMIT WELDING ON GERMAN RAILWAYS

This paper reviews the various techniques of quick Thermit rail welding techniques that were developed on the German Railways and provides a historical discussion of the technical aspects of the Thermit process as invented in Germany at the end of the 19th century. The three types of Thermit welding, i.e., quick Thermit welding with a collar, quick Thermit welding without a collar, and quick Thermit welding with a short preheating period are described. Illustrations are provided which show the design of the burner guide and clamping devices, method of rail alignment, and the moulds. Comparisons are made among the three Thermit welding processes with regard to operation times and mechanical properties. Considerable research and development have taken place in Germany on the Thermit welding process particularly in respect to reducing the total time required at the site as well as collarless welding. On German Railways 30-meter-long rails are welded to 120 meters on long panels by flash butt welding in the workshop and long panels are converted at the site through the use of Thermit welding.

Bhargava, P. C. (Research, Design and Standards Organization, Indian Railways, Lucknow, India), Indian Railway Technical Bulletin, Vol 31, No. 193, May 1974, pp 62-67, 7 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1317

FLASH WELDING OF RAILS FOR LONDON TRANSPORT

The main features of a new welding machine of Swiss manufacture, purchased for flash welding of running and conductor rails for London Transport are described. The settings for the various welding parameters used in a number of test weld series, and the results obtained in falling-weight and metallographic tests are given. Most of the welds produced with an upsetting force of 32 tons or greater, and with an application time of 10 seconds gave satisfactory results on the falling-weight test. When linear flashing was employed, some of the welds failed prematurely in the falling-weight tests owing to the presence of inclusions. After some adjustments, it was found possible to set the welder so that it could produce 50 consecutive welds, each of which withstood at least four blows of the falling-weight without failure, this being the acceptance test which had been specified for the machine. Long-length rails for the Victoria Line produced using the mentioned settings appeared to have welds of good and consistent quality. The Discussion Session held on this paper and others dealing with this subject is included.

Faulkner, F.J.S., and Shaw, J. (London Transport, London, England). Paper No. 35, Proceedings of the Conference on Advances in Welding Processes, April 14-16, 1970, Cambridge, England, pp 34-39, 8 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Welding Institute (repr., PC).

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1318

STUDY OF A PLASMA TORCH FOR IMPROVING ADHESION: LABORATORY EXPERIMENTS TO SIMULATE RAIL SURFACES

The laboratory tests described in RP 3 have been completed. They confirm that the plasma torch improves adhesion mainly by removing oily contamination rather than by modifying its chemical properties. The amount of oil removed has been found to depend on how much is initially present. Some of the thicker oil films found on rails may require several passes of the torch to improve adhesion. The efficiency of the torch is reduced when the steel surface is rough or debris covered, and although surface water was blown aside, little or no oil was removed from a wet surface.

Alston and Dogneton (UIC Specialist Committee, Utrecht, Netherlands), Report No. B-114/RP-4/E, October 1972, 16 pp, 9 figs., 5 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1319

STUDY OF PLASMA TORCH FOR IMPROVING ADHESION: OPERATIONAL RESULTS AND PRELIMINARY LOW TEMPERATURE STUDIES

The results obtained during the systematic use of plasma torches on two railway lines worked by heavily loaded coal trains are described. Under the special conditions applicable to these tests, the adhesion required for avoiding wheel slipping phenomena had been reached and maintained for approximately 6 hours under unfavorable climatic conditions. Some tentative ideas concerning the maintenance of the plasma torch equipment and the special plasma vehicle are presented. In addition, the report deals with the problem of the use of plasma torches at very low temperature (ignition of torches and melting of ice on rails).

Alston and Dogneton (ORE/UIC Specialist Committee), Report No. B-114/RP-2/E, October 1971, 18 pp, 7 figs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1320

CALCULATIONS OF THE ELASTIC THREE-DIMENSIONAL AND THE ELASTOPLASTIC TWO-DIMENSIONAL STRESSES IN THE RAIL HEAD [IN FRENCH]

The report contains a numerical calculation for the elastic three-dimensional and the elasto-plastic two-dimensional stress behavior and an analytical derviation of the formulas for calculating the stresses according to the half-space theory. The results are compared. For low stresses the calculated values agree well with reality, but no reasonable approximation is obtained for higher stresses.

Besseling, J. F., van Bommel, P., ten Hoeve, G. [Technical University of Delft, and the Dutch Railways (NS), Netherlands], Report No. DT-9, June 1968, 47 pp, 17 figs., 5 tables, 1 appendix.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1321

BEHAVIOR OF THE METAL OF RAILS AND WHEELS IN THE CONTACT ZONE: THREE-DIMENSIONAL PHOTO-ELASTIC STUDY OF A LOADED BUT NON-BENT RAIL

Excessive stresses applied locally to the rail head produce plastic deformations which superimpose themselves as residual stresses onto the stresses due to bending of the rail and the transverse load resulting from the pressure of the wheel. This report deals with the localized residual stresses produced in a rail model subjected, without bending, to the action of a vertical load applied at mid-distance between the two supports. Photoelastic tests were carried out on models made of materials having mechanical properties similar to those of steel. These measurements can serve only as reference data for calculations, since the measurements were taken only in the elastic region and the rail steel contains zones of plastic deformation.

Palme et al. (ORE Specialist Committee, C-53, Utrecht, Netherlands), Report No. C-53/RP-2/E, October 1965, 15 pp, 25 figs., 1 table.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1322

SPECIAL RAIL PROFILE FOR TUNNELS: PROTECTION OF RAILS AND RAIL FASTENINGS AGAINST CORROSION (SUPPLEMENT TO FINAL REPORT)

The report contains a supplementary description of the measures described in the Final Report in order to deal with the corrosion of rails and rail fastenings and reference is made to some of the tests conducted with rust-inhibiting metallic and protective paint coatings.

Office of Research and Experiment-UIC, Report No. D-81/RP-2/E, October 1971, 9 pp, 1 fig., 2 tables, 9 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1323

STUDY OF A PLASMA TORCH FOR IMPROVING ADHESION: DESIGN AND CONSTRUCTION OF PLASMA TORCH EQUIPMENT

In extensive laboratory and track trials the plasma torch has been demonstrated as a tool for improving wheel-rail adhesion at speeds up to 48 km/hr. The plasma treatment was found to be effective under a wide range of climatic conditions with contaminants generally found on the British Railways network. These included oil, grease, diesel fuel, coal dust, and fallen leaves. In view of this success, a vehicle, to be put into service on British Railways, has been designed and is now under construction. This will be used mainly on the coal-haulage routes where low adhesion is frequently encountered. This plasma car will operate independently of the freight locomotives and will act as a rail-conditioning vehicle.

Alston, L. L. (British Railways, Derby, England), Report No. B-114/RP-1/E, April 1970, 19 pp, 17 figs., 8 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1324

TRAINING AND KNOWLEDGE REQUIRED BY ULTRASONIC RAIL TESTING OPERATORS

The author describes two methods of ultrasonic rail testing used in Great Britain, namely, the Audigage method which uses frequency modulation and the more advanced pulse-echo, high-frequency method which uses instruments such as the Krautkramer or the Sperry Watson. He also discusses the knowledge and skills required by the rail-testing operators and the importance of the training courses established by the British Railways at Derby, describes the precautionary measures to be taken by the operators, the different types of rail defects, and presents an outlook of ultrasonic rail testing on British Railways. At the time this paper was prepared, construction of the first ultrasonic rail testing coach of the British Railways was nearing completion in Derby. The layout and operational principle of this test coach corresponds to that of a rail-testing unit which has been used for some years by the German Railways.

Banks, J. (British Railways, Southern Region, England), Journal and Report of Proc. of Permanent Way Institution, Vol 87, No. 2, 1969, pp 153-160.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: The Permanent Way Institute (repr., PC).

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1325

INFLUENCE OF STRAIGHTENING MODES AND ORIGINAL CURVATURE ON PROPERTIES OF CARBON AND CHROME STEEL RAILS [IN RUSSIAN]

The results of tests are reported from experiments conducted to determine the influence of straightening modes and curvature on the mechanical and service properties of carbon and chrome steel rails. Rails of each type were selected on the basis of their chemical compositions and processed with a straightening machine in which the extent of warp varied from an original curvature to a severe mode of negative bending. The mechanical properties of the finished rails prior to and after straightening are given. It was found that as the deformation of rails in the roll-straightening machine increases, the strength characteristics increase without significant changes in ductility. However, the drop-test toughness values decreased, particularly in rails made of chrome alloy steels. It was noted that for rails straightened with a severe mode and at the first 48 million gross tons of cargo carried, a sensitivity to contact fatigue defects occurred.

Pavlenko, Yu. P., Kazarnovskii, D. S., Kravtsova, I. P., and Rogozina, E. A. (Ukrainian NII Institute of Metallurgy, U.S.S.R.), Sbornik Trudov, Ukrainian Nauch.-Issled. Inst. Metallurgikaya, No. 17, 1971, pp 135-144, 3 figs., 8 tables, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1326

DEVELOPING A TECHNOLOGY FOR PRODUCING HIGH-TENSILE STEEL RAILWAY RAILS

The purpose of this reported research was to establish a basis of a technology for producing high-tensile-strength, clad steel rails under semi-industrial conditions. Three grades of rail steels were selected for initial experimentation and their chemical compositions are given. In preparing the ingot, a special mold was prepared for positioning the clad metal plate. All ingots were rolled into blooms in five passes. The clad steel blooms were produced by depositing the alloy metal on the parent metal, pouring the rail steel onto a slab of the alloy metal, or joining the parent metal and the layer of clad metal by hot rolling. Details concerning the pressure exerted by the metal on the rolls during the process are provided, and a specimen of the finished clad steel rail is shown. It was concluded that clad steel rails in which the upper layer of the head has a tensile strength of about 180 kg/mm^2 can best be produced by applying a plate of the stronger metal to the steel bloom, welding around the perimeter, then rolling the bloom. During this process, an excellent continuous bond is formed between the two metals.

Kazarnovskii, D. S., Gunin, I. V., Krivonosov, Yu. I., Kravtsova, I. P., Saprygin, Kh. M., Arshavskii, V. Z., Chetverikov, A. V., Mogilevskii, I. I., and Orinichev, S. I. (Ukrainian NII Institute of Metallurgy, U.S.S.R.), Stal [in English], No. 11, November 1966, pp 1028-1029, 3 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: British Iron and Steel Institute and Metals Society (repr., PC).

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1327

VARIATION IN THE CONCENTRATION OF HYDROGEN DURING THE MELTING OF RAIL STEEL FROM PHOSPHORIC PIG IRON

The changes in hydrogen content of rail steel during its production in an open-hearth furnace from high-phosphorus pig iron are investigated. The effects of the amounts, method, timing of additions of lime, and the use of scale and ore additions at various stages of the heat on the hydrogen content are studied. The results of

this study are intended to correct for such conditions as patchy segregation, axial porosity, blowholes, and hairline cracks. The investigation involved 18 heats of rail steel obtained during the conversion of phosphoric pig iron in the tilting OH furnaces at the Azovstal' Plant. Large amounts of lime and scale were fed up to the period of meltdown and in the finishing period, thereby increasing the slag bulk in the furnace. It was found that in converting phosphoric pig iron, the hydrogen content of the steel depended on the procedures for making the additions and forming the slag.

Derfel', A. G., Tkachenko, A. I., Sviridenko, F. F. and Myazin, G. V. (Ukrainian NII Institute of Metallurgy and the Azovstal' Works, U.S.S.R.), Stal [in English], No. 8, August 1968, pp 650-651, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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1328

NINTH PROGRESS REPORT OF THE SHELLY RAIL STUDIES AT THE UNIVERSITY OF ILLINOIS

This report describes the rail shelling studies that involve rolling-load tests on Bethlehem 132-lb heat treated and companion as-rolled rails from the same heats which were laid in the tracks at the C & O and N & W Railways. Data are provided from the physical tests and rolling-load tests on six of these rails which show that the average Brinell hardness of the heat-treated rails was raised to 360 compared with an average hardness of 269 for the companion as-rolled rails. The average yield strength of the heat-treated rails was 125,600 psi, compared with 76,300 psi for the as-rolled rails. The heat-treated rails subjected to rolling-load tests were also very superior in performance to the as-rolled rails. Rolling-load tests on alloy rail steel showed that these rails have physical properties which compare closely with those of heat-treated rails (5 to 8 million cycles on the rolling-load tests).

Cramer, R. E. (University of Illinois, Urbana, Ill.), Proceedings of the 50th Annual Convention of the American Railway Engineering Association, Chicago, Ill., Vol 52, March 13-15, 1951, pp 664-679, 12 figs., 4 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1329

STUDY OF A PLASMA TORCH FOR IMPROVING ADHESION: THE EFFECT OF THE PLASMA TORCH ON RAIL HEAD CONTAMINATION

A study of surface contaminants before and after exposure to a plasma torch has shown no evidence of any prominent chemical change being brought about. Laboratory tests have confirmed that oily contamination is removed by the plasma torch. Track tests following a plasma torch rail car indicate that the persistence of the conditioning on running rails is dependent on the effect of subsequent trains.

Alston and Dogueton (ORE/UIC Specialist Committee, Utrecht, Netherlands), Report No. B-114/RP-3/E, October 1971, 21 pp, 15 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1330

(RAIL) TECHNICAL SPECIFICATIONS [NOS. 860-0, 861-1, AND 862-2]

Specification 860-0 details conditions covering the quality and the manufacture of the steel used, together with the conditions of acceptance for Vignole rails weighing between 35 and 70 kg inclusive, in nontreated steel of both normal and wear-resistant quality. The standard profiles of UIC 54 and 54E are defined (Specification 861-1). The standard sections and characteristics of the symmetrical and asymmetrical points rails adapted to the UIC 54 and 60 kg/m rail sections are defined (Specification 862-2).

International Union of Railways (UIC), January 10, 1971, January 1, 1969, and January 7, 1968, respectively, 41 pp, 6 figs., 1 appendix.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: International Union of Railways (repr., PC).

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1331

STUDY OF A PLASMA TORCH FOR IMPROVING ADHESION: FINAL OPERATIONAL ASSESSMENT OF THE PLASMA TORCH TRAIN

Data are given on two trials with plasma equipment on the Eastern and Southern Regions of British Rail. Although insufficient data were obtained for a proper statistical evaluation, these trials indicate that any immediate benefit that the plasma torch may confer is not sustained sufficiently to be of benefit to subsequent traffic.

Alston and Dogneton (ORE Special Committee, UIC, Utrecht, Netherlands), Report No. B-114/RP-5/E, April 1973, 14 pp, 7 figs., 1 ref.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Office of Research and Experiment-UIC (repr., PC).

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1332

INTRODUCTION OF THE RAJDHANI EXPRESS--THE ROLE OF RESEARCH

The introduction on March 1, 1969, of the "Rajdhani Express", operating at a speed of 120 km/hr and connecting Delhi with Calcutta is an important event in the history of the Indian Railways, marking the successful completion of the first phase of a task which the Indian Railways had set for itself. The task was the acquisition and application of technological data for the specific purpose of permitting higher operating speeds on railways in India. The extensive studies and research conducted to arrive at a decision with regard to increased speeds are described. These studies involved strength of track, effect of speed on track stresses, track tolerances, performance of motive power, maintenance of track, and other characteristics relating to the operation of the rolling stock. Typical charts indicating the effect of wheel loads on the rail head, rail deflection, bending stresses in the rail, load on the sleepers and intensity of pressure on the foundation are given. Data are presented which show relationships among speed, track modulus, and the speed factor.

Joseph, T. V. (Metropolitan Transport, Railway Board, New Delhi, India), Indian Railway Technical Bulletin, Vol 26, No. 175, November 1969, pp 10-18, 11 figs., 1 table, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Indian Railway Board (repr., PC).

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1333

METRE GAUGE TRACK GEOMETRY

As a result of the introduction of higher speeds on a few trunk routes of the Indian Railways, the concept of track tolerances, viz., keeping track irregularities in normal track maintenance below certain specified limits has become increasingly important. This paper describes the tolerances to be stipulated for the metre-gauge track which extends over nearly 25,000 km on the Indian Railways. The relationship of track geometry and higher speeds is emphasized together with the problems of emergency repairs and maintenance tolerances, assessment of track irregularities, and the recommendation of a suitable maintenance system for correcting and controlling track irregularities. The importance of a track inspection car is stressed and a description of the RDSO [Research, Design and Standards Organization (Indian Railways)] truck recording car is given. Data are provided along with the analysis of various track conditions to show the effectiveness of measurements taken by the track inspection car. It is concluded that the adoption of tolerances would go a long way toward establishing better maintenance standards, leading to increased life of the track, even though higher speeds may not be used on the metre gauge in the near future.

Mani, M. (Research, Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 30, No. 190, August 1973, pp 105-115, 7 figs., 5 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Indian Railways Board (repr., PC).

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1334

SECOND PROGRESS REPORT OF THE SPECIAL COMMITTEE ON STRESSES IN RAILROAD TRACK

This report includes the results of tests with one type each of a freight locomotive and a passenger locomotive on the St. Louis-San Francisco Railway to determine stresses in rail in relation to speed and counterbalance effect, and also the results of similar tests with one type of freight locomotive on the Illinois Central Railroad. The results are given for tests on the Illinois Central Railroad and the Chicago, Milwaukee & St. Paul Railway to determine the depression of track under loads and to find the depression and flexure of ties and their action under load for a variety of conditions found in track. The tests conducted in the Laboratory of Applied Mechanics of the University of Illinois with a view toward finding methods and principles involved in the transmission of pressure from one or more ties downward and laterally through ballast materials are reported and an analysis of the transmission of pressure is given. The following subject areas are included in the report: Tests to Determine the Effect of Speed and Counterbalance on Stresses in Rail; Track Depression; Depression, Flexure, and Bearing Pressure of Cross-Ties; and Transmission of Pressure in Ballast.

Talbot, A. N., et al. (Chairman, Committee on Stresses in Railroad Track, American Railway Engineering Association, Chicago, Illinois), Proceedings of the AREA, Vol 21, March 1920, pp 645-814, 100 figs., 19 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1335

ON THE TORSIONAL RIGIDITY OF RAIL FASTENERS IN THE LATERAL PLANE

This paper deals with the resistance of the rail fastener to torsion in the plane of the track, as a factor affecting the stability of the track structure. In addition to a review of the various mathematical models used to simulate the track, this paper also reports on the results of experimental measurements of the torsional rigidity of various types of rail fasteners in use in both the United States and Western Europe, including the type of rail fastener utilized in the construction of the high-speed test track at the High Speed Ground Test Center of the Department of Transportation, Federal Railroad Administration, located at Pueblo, Colorado. The results of these tests indicate a scheme for increasing the torsional rigidity of track panels. In conclusion, important considerations for the design and selection of rails fasteners for use on continuously welded rail are described, as well as the lateral forces and vertical loads that act upon the ties, fasteners, and the rail.

McConnell, D. P. (Dept. of Aeronautics & Astronautics, New York University, N.Y.), November 1972, NTIS No. PB-243-624, for DOT/FRA under Contract No. DOT-FR-20064, 35 pp, 12 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS, PB-243-624 (repr., PC, microfiche).

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1336

THE EFFECT OF STRAIGHTENING ON THE PROPERTIES OF R-65 HIGH-CARBON HEAVY RAILS

The author discusses the problems arising from deformation of R-65 rails during straightening, which was greater than that for the R-55 rails because of the greater depth of the transverse section. Heavy types of rail sometimes fracture while being straightened at the Kuznetsk Metallurgical Combine. The mechanical properties of straightened and unstraightened rails are compared. It was concluded that (1) the elastic limits and yield points are increased by straightening; (2) the ultimate strength is increased slightly and the relative elongation is reduced; (3) the impact strength scarcely changes; and (4) the fatigue strength of the rail head metal increases, while that of the web is somewhat reduced. The relative life of the metal in straightened and unstraightened rails under fatigue loading lengthens as the effective stress level is increased.

Shkol'nik, L. M. (All-Union Railway Scientific Research Institute, U.S.S.R.), Stal in English, No. 5, May 1959, pp 383-387, 8 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute and The Metals Society (repr., PC).

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1337

WHEEL/RAIL ADHESION---THE OVERRIDING INFLUENCE OF WATER

This is the fourth of a series of papers describing an investigation into how the various contaminants to be found on the track govern the friction between railway wheels and rails (i.e., the "adhesion"). Laboratory experiments are described which show how water reduces friction between rail and tire steel surfaces. During this work it has become increasingly clear that water contributes by far the most significant single influence. Depending on the amount of oily contamination, the friction coefficient is reduced to a value between 0.3 (no oil present) and the friction that is characteristic of an excess of the oil. Lower friction on oil-free surfaces is observed using laboratory machines which involve continuous rolling; water mixes with wear debris or surface rust to form a lubricating paste, and friction coefficients as low as 0.05 result. Trains similarly encounter low adhesion in slightly wet conditions, most noticeably on seldom used lines where a substantial coverage of debris particles is present on the wear band.

Beagley, T. M., and Pritchard, C. (British Railways Board, The Rail Technical Centre, Derby, England), Wear, Vol 35, No. 2, December 1975, pp 299-313, 7 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Elsevier Sequoia (repr., PC).

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1338

FRENCH RAIL SYMPOSIUM [IN FRENCH]

The proceedings of the French Rail Symposium held in Paris, France, on September 23-25, 1970 include 7 papers dealing with various aspects of rail technology. An assessment of the technology connected with rail stresses and rail fatigue is presented. The influence of steelmaking processes on the metallurgical quality of the rail is discussed. Fatigue transverse crack simulation tests are mentioned, and an interpretation of metallographic examinations of fatigue fractured test samples is presented. The RALUS ultrasonic rail-testing method is reviewed and its application in the French rail-manufacturing plants is described.

Prud'homme, L. A., Bassetti, A., de Leiris, H., Waeckerle, R., Vinot, J., Beaujard, L., and Penetrat, M. (French National Railways, et al.), Journees Francaises du Rail, September 23-25, 1970, 163 pp, figs., tables.

ACKNOWLEDGMENT: Battelle Frankfurt.

PURCHASE FROM: Ministre de Transports, Paris, France (repr., PC).

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1339

DISTRIBUTION OF THE RADIAL MACROSTRESSES IN RAIL HEADS AFTER HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT

X-ray strain measurement is used to study the radial macrostress distribution in R-65 type rail heads as a function of the high-temperature thermomechanical treatment parameters (austenitization temperature and amount of reduction). It is demonstrated that high-temperature thermomechanical treatment produces beneficial compressive stresses in the tread contact surface of the rail head, the overall level of which increases with decrease in hardening temperature after reduction. The rail used in the study was rolled in a special prefinishing pass on the Kuznets Iron and Steel Combine's rail and structural mill and subsequently finished on a 4-high mill at the Siberian Metallurgical Institute. The experimental data are plotted and it shows that the residual stresses tend to decrease smoothly at the center of the head. It was also concluded that the work hardening of rails by hardening in a water-air mixture results in the formation of compressive stresses with a beneficial effect on the fatigue strength of the rails.

Chelyshev, N. A., Gossman, A. A., Tsvigun, V. N., and Nekrasov, S. G. (Kuznets Iron and Steel Combine, and the Siberian Metallurgical Institute, U.S.S.R.), Isv. VUZ Chern. Met. (Translated by the British Industrial & Scientific International Translation Service), No. 6, 1974, pp 97-99, 3 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC.).

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1340

PRODUCTION OF R-75 TYPE RAILS USING FULL HEAT TREATMENT

Production of heavy R-75-type rails has been developed at the Nizhne-Tagil' Works. A 9.5 ton ingot with a smooth surface was used (yielding 4 rails including discard); resulting in an increased soaking pit productivity of 7.9 percent. The ingots are rolled using the schedule for R-65 rails; the rail profile obtained in initial trials satisfied the requirements of GOST-16210-70, and the properties of the hot-rolled and heat treated R-75 rails were also up to standard. The heavy rails show less warping and curvature during quenching than the R-65 rails. The yield of prime rail in the trial production batches was 88.5 percent. The rolling mill practices used in the rail manufacturing process are described along with the means used for rail straightening. Data taken during the study of mechanical properties for the R-75 rail are presented.

Vinokurov, I. Ya., Rabinovich, D. M., Loshkina, N. A., Yuzhakov, A. P., and Serebryakov, V. S. (Nizhne-Tagil' Combine, U.S.S.R.), Stal [Translated by the British Industrial & Scientific International Translation Service), No. 3, 1974, pp 260-262, 7 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1341

THE USE OF MOLTEN SILICO-MANGANESE TO DEOXIDIZE RAIL STEEL

The addition of manganese and silicon in the form of molten silico-manganese when deoxidizing rail steel is more effective than adding them separately as in previous practice using molten ferro-manganese and lump ferro-silicon. In the acid Bessemer shop of the Dzerzhinskii plant, molten silico-manganese with a manganese/silicon ratio of more than 4 to 1 is obtained by melting solid ferroalloy in a cupola. In this way, the metal picks up carbon up to 1.67-1.95% C and part of the silicon is oxidized from it, but a sufficiently stable composition is attained. The yield of top-grade rails, based on data from a large number of R-50 rails, increases by 1 to 2%. The rejection of rails on account of failure in the drop test and defects of macro-structure is greatly reduced.

Prosvirin, K. S., Rekhlis, G. N., Orgiyan, V. S., Vergun, A. S., and Levochich, N. V. (Dzerzhinskii Steel Combine, U.S.S.R.), Stal [Translated by the British Iron and Steel Industry Translation Service], No. 11, November 1971, pp 999-1000, 2 figs., 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1342

RAILS HARDENED WITH HEAT BY HIGH-FREQUENCY CURRENT [IN RUSSIAN]

Comparisons of rail-service capabilities were made under similar usage conditions, for R65 rails that were heat treated through the use of two different processes. One group of rails was the through-hardened NTMK-rails and the other comprised induction heat-treated rails produced at the Azovstal' plant in 1970. Both rails were laid parallel with each other along with raw (non-heat-treated) rails to determine whether the heat treatments were effective in reducing service-produced defects. Data from this investigation showed various defects in the induction-heated tempered-rails, horizontal cracks in a rail at the weld, and the distribution of weld irregularities in the three test rails.

Slivets, D. P., and Tretyak, V. A. (Putevoledovatelskaya Stantsiya, Dnepropetrovsk, U.S.S.R.), Put i Putevoye, No. 10, 1973, p 17, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kanikin Bookstore (repr., PC).

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1343

THE IMPROVEMENT OF THE STEEL RAIL

This article discusses differences in thermal treatment of rails between the U.S. and Europe. The quenching treatments used in Europe are described as well as the rationale for such treatment both of which are related to transverse cracking of rails. As a result, the control-cooled rails are also proven to be stronger and more resistant to low-temperature shocks. (Carried as RRIS Accession No. 039634.)

Railway Gazette, Vol 73, July 12, 1940, pp 39-40.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: Temple Press Ltd. (repr., PC).

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1344

THE NON-METALLIC INCLUSIONS IN RAILS ROLLED FROM CONTINUOUS CAST BILLETS, AND THEIR MECHANICAL PROPERTIES

The nonmetallic inclusions, strength particulars, and ductility figures have been investigated for rails with different sections (between R-50 and R-8) made from continuous cast billets of standard rail steel (0.70% C, 0.96% Mn) produced in converters, and also from 4.5 t ingots from the same heat cast in ingot moulds. No variations in the amount and distribution of the inclusions were recorded with relation to the degree of reduction (which was varied between 14 and 83). The inclusions in the continuous cast metal were in much less of a string form than those in the conventionally produced metal.

Monich, O. D., Paisov, I. V., Polyakov, V. V., and Nekhaev, V. P. (Moscow Institute, Stali Splavov, U.S.S.R.), Stal [Translated by the British Industrial & Scientific International Translation Service], No. 5, May 1973, pp 457-458, 2 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1345

PROPERTIES OF THE ENDS OF RAILWAY RAILS QUENCHED WITH MIXTURES OF WATER AND AIR TO VARIABLE HARDNESS

The mechanical properties, macrostructures and microstructures, and the hardness distribution at the ends of an experimental batch of R-65 rails quenched at the end of the rolling process with water and air were studied. The length of the quenched region was 350 mm. It was shown that quenching provides high mechanical properties as compared with the properties observed without quenching. The structure of the rail ends varied between troosto-sorbite and pearlite. The results of the tensile strength and impact tests are presented.

Kadykov, N. S., et al., Izv. VUZ Chern. Met. (Translated by the British Industrial & Scientific International Translation Service), No. 6, 1974, pp 135-138, 3 figs., 1 table, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1346

D-H TYPE PLANT FOR THE LADLE VACUUM DEGASSING OF STEEL

The importance of vacuum degassing of rail steel and a D-H vacuum degassing plant at the Kosciusko Steelworks is discussed. A brief discussion is presented on the reasons for modernization at the Kosciusko plant in regards to increasing the strength and wear resistance of rails by the addition of manganese. The principles associated with the vacuum degassing plant operation are reviewed and emphasis is placed on the advantages gained through reduction in nonmetallic inclusions. A schematic layout of the plant and details of subcomponents used in the process are provided. As a result of the vacuum degassing process, the hydrogen content in rail steel has been reduced by 60 to 70 percent, the oxygen content by about 50 percent, and the nitrogen content by 10 to 15 percent. Simultaneously, the content of nonmetallic inclusions is reduced to 40 to 50 percent of that in the nongassed steel.

Bialowas, W., and Kunik, H. (Organ. Stowarzyszenia Inznierow i Technikow Przemyslu Hutniczego W Polsce), Wiadomosci Hutn. [Translated by the British Iron and Steel Industry Translation Service], Vol 28, No. 4, 1972, pp 109-112, 2 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron and Steel Institute (repr., PC).

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1347

DETERMINING THE PROCESS PARAMETERS FOR THE AUTOMATION OF THE RAIL AND STRUCTURAL MILL THREE-HIGH STANDS

This paper describes an investigation into the performance of the 800 line (three-high stands) of the Nizhne-Tagil Combine rail and structural mill. The purpose of the investigation was to study the application of the optimum process parameters which were worked out in respect to the performance of three-high stands to enable the main and auxiliary equipment of the line to be automated and thus improve its efficiency. During the investigation, oscillograms were taken of the power and speed requirements of the main motor drive which made it possible to assess its performance in relation to that of 31 auxiliary pieces of rolling equipment. At the same time, the distance to which the bars were ejected from the passes was assessed. Rolling temperatures were also determined in front of the odd passes by means of optical pyrometers. From the information gained in this investigation, cyclograms of the mill working were compiled along with other parameters such as rolling speeds, main drive motor loadings, and the number of bars being rolled. Optimum rolling cyclograms were computed for the driving of the mill with automatic control of the main equipment and auxiliaries.

Musalevskii, O. G., and Rivkin, A. A. (Nizhne-Tagil' Metallurgical Combine, TSNICHM, USSR.), Stal [in English], No. 3, March 1964, pp 202-208, 8 figs., 4 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: British Steel Institute and The Metals Society (repr., PC).

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1348

PROPERTIES OF CHROMIUM-SILICON STEEL RAILS AFTER MOLTEN SALT BATH-HARDENING

Tests were carried out on type R65 rail steel manufactured from 6Khs steel (containing 0.66 C, 0.27 Mn, 0.060-1.00 Si and 1.1% Cr), by hardening isothermally at 325 C in a bath containing fused salts (55% KNO_3 + 45% $NaNO_2$) into which 0.4 to 0.6 percent water was introduced directly. The mechanical properties of the treated rails were better than those obtained by oil quenching. They possessed a low notch sensitivity and a high impact strength. The industrial salt bath was developed and built at the Gor'kii Works and its physical characteristics and the operational procedures are described. Although various parts of the rail section cooled at different rates, this did not adversely influence the properties of the rail provided austenite stability was adequate and the transformation of the austenite in the various parts of the rail occurred isothermally at the same temperature. If austenite stability was inadequate, then the transformation in various parts of the rail occurred and adversely affected the level and uniformity of the rail properties.

Babich, A. P., Kazarnovsky, D. S., Biryukova, V. N., Polushkin, N. A., and Zaichenko, S. S. (Ukrainian Scientific Research Institute of Metals and the Khar'kov Transport Engineering Works, U.S.S.R.), Stal', [Translated by the British Industrial & Scientific International Translation Service], No. 1, 1973, pp 63-66, 3 figs., 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: The Metals Society (repr., PC).

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1349

STRESS DISTRIBUTION IN 52 KG/M RAIL

This article deals with the experimental determination of stress distributions in 52 kg/m rails based on laboratory tests conducted by the RDSO (Research, Design and Standards Organization), for loads and moments equivalent to broad-gauge main-line loading at the speed of 80 mph. Observed stresses are compared with the calculated values. The rail testing frame, equipment, and strain gauging used during the tests are discussed in detail. Permissible

stresses in medium manganese rail steel for vertical bending, safe fatigue range for fluctuating stresses, and occasional stresses due to lateral loads have also been mentioned. The mechanical properties and rail profile schematic are given for the rail.

Gupta, M. L. (Research, Design and Standards Organization, Lucknow, India), Indian Railway Technical Bulletin, Vol 25, No. 168, February 1968, pp 13-25, 16 figs., 2 tables, 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Research, Design and Standards Organization (repr., PC).

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1350

FRA TRACK GEOMETRY MEASUREMENT SYSTEM VALIDATION REPORT

This report covers an extensive testing program conducted to validate the track-geometry-measurement system installed aboard the Department of Transportation Rail Test Cars. The tests were conducted to establish the accuracy and repeatability of measurements made with the high-speed, electronic measurement system installed aboard the DOT Test Cars. The validation procedure involved both laboratory and field tests of the electronic measurement system. Comparisons were made between manual and high-speed electronic measurements of rail gage, crosslevel, profile, and alignment. Results of these comparisons under various dynamic conditions, speeds, types of rail, and rail loads are included in this report.

The information contained in this report includes considerable detail which is intended for use by engineering and research personnel who are involved in the design, development, and validation of rail-measuring devices.

Ta-Lun Yang (Ensco, Inc., Springfield, Va.), Report No. FRA-ORD&D-75-05, June 1974, For DOT/FRA/Office of Research, Development & Demonstration, Contract No. DOT-FRA-20032, 156 pp, 69 figs., 33 tables, 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS, PB 243 677 (repr., PC, and microfilm).

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1351

TRACK-TRAIN DYNAMICS--ACCIDENT INVESTIGATION

The Track-Train Dynamics Program encompasses studies of the dynamic interaction of a train consist with track as affected by operating practices, terrain, and climatic conditions. This report is a manual which recognizes the concept of combination-caused derailments. This type of accident is defined as one caused by the interaction of two or more factors, which, had they occurred independently, would not have resulted in an accident. The basic wheel/rail relationships are discussed in connection with lateral-vertical loads. Basic curve negotation mechanics is also discussed.

Hoffman, R. P., and McGovern, W. R. (Lake Shore Division, Chicago & North Western Transportation Company, Chicago, Illinois), 1974. 141 pp, figs., forms, bibliography.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1352

SUMMARY REPORT ON THE EXAMINATION OF RAILS WHICH CONTAIN DETAIL FRACTURES

This report describes the results from an examination of detail fractures from shelling which had been found in rail by detector cars and laboratory work involved with determining whether the chemical composition and mechanical properties or structures of detail fracture rails varied from those of random rails. The examination of 54 detail fractures showed that they could assume a wide range of sizes and shapes, and therefore they have been categorized into four groups. Of the fractures examined, 28 percent had bright, unoxidized surfaces, indicating no contact with the surface of the rail. Approximately 70 percent of the rails containing detail fractures were taken from the high side of curves. The average chemical analyses and mechanical properties of 44 rails with fractures and 26 random rails were so nearly the same that no distinction between the two groups was possible. Examination of deep-etched structures and microstructures of fractured rails indicated that the steel was of relatively good quality. Only a few rails contained abnormal inclusions.

Campbell, J. E., McIntire, H. O., and Manning G. K. (Battelle, Columbus Laboratories, Columbus, Ohio), Proceedings of the 49th Annual Convention of the AREA, Chicago, Ill., Vol 52, March 14-16, 1950, Appendix 10-b, pp 608-620, 31 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1353

EIGHTH PROGRESS REPORT OF THE SHELLY RAIL STUDIES AT THE UNIVERSITY OF ILLINOIS

This report describes the rail tests conducted as part of the shelly rail study at the University of Illinois on two rails selected from the high side of a 4-degree curve of the Central of Georgia Railway. These rails had carried 63,385,600 tons of traffic at average speeds of 35 mph in both directions. One rail showed flaking along the gage corner over its entire length and had also developed six or seven small black shelly spots. The second rail contained 30 black shelly spots and half of them had heavy lips extending down along the gage side of the rail. No NDT method was found that would locate internal shelling which had not reached the sides of the rail head or formed black spots. Rolling-load tests were conducted on new rail specimens to provide a base for comparison. The data and information were analyzed and it was concluded that rolling-load tests can produce shelling defects similar to those found in the track rails removed for examination.

Cramer, R. E. (University of Illinois, Urbana, Illinois), Proceedings of the 49th Annual Convention of the AREA, Chicago, Ill., Vol 52, March 14-16, 1950, Appendix 10-a, pp 597-607, 11 figs., 1 table.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1354

TEMPERING OF COLD-WORKED RAIL STEEL [IN RUSSIAN]

This paper deals with studies and experiments related to a determination of rail-steel tempering temperatures and soaking periods to establish which procedure and condition will render steels with best grain structure and hardness. The investigation results yielded information which shows that tempering at 550 C to 600 C, with or without soaking for 30 to 40 seconds, leads to the formation of an evenly distributed finely dispersed grain structure. The rail steel also demonstrates a Vickers hardness of 200 to 300.

Grdina, Yu. V., and Kotov, A. V., Izvestiya VUZ, Chernaya Met., No. 4, 1963, pp 132-135, 5 figs., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1355

TEMPER BRITTLENESS OF CARBON STEELS (RAIL) CONTAINING PHOSPHORUS AND ARSENIC

The main embrittling factor, or phosphorus, in carbon steels containing between 0.38 and 0.78 percent carbon and which have been heat treated to produce a tough condition after tempering is investigated. From the studies, arsenic is also found to cause the development of reverse temper brittleness in amounts of more than 0.30 percent; however it has only one-eleventh to one-fifteenth the embrittling effect of phosphorus. The steels investigated were rail steels containing not less than 0.2 percent phosphorus and approximately 0.25 percent arsenic, and these were found to be almost nonsusceptible to reverse temper brittleness.

Kalnykov, V. V., Stal [in English], No. 1, 1968, pp 152-155, 5 figs., 1 table, 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1356

TECHNOLOGICAL FACTORS DETERMINING THE SELECTION OF STEELS FOR VOLUMETRICALLY QUENCHED RAILS [IN RUSSIAN]

The development of new grades of high-strength rails steels to be produced by volumetric oil quenching which produces hardenability according to standard quench tests, and is considered to be the best criterion of quality is discussed. The examination of eight types of low-alloy steels is described which shows their susceptibility to austenite grain growth and the kinetics of this growth, as observed from oxidation studies in the temperature range of 700-1000 C. The steels were divided into three groups according to the nature of austenite transformation thus showing that the two most suitable groups were those exhibiting a hardenability of 4-6 mm and 20 mm.

Govorov, A. A., Alaykin, A. B., Nesterov, N. A., and Mazurik, M. M. (Kuznetsk Metallurgical Combine, U.S.S.R.), Izvestiya VUZ Chernaya Met., No. 10, 1966, pp 144-149, 6 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1357

SEPARATION OF PRINCIPAL STRESSES BY MEANS OF AN IMPROVED SHEAR-DIFFERENCE METHOD

Lines of constant shear stress, derived graphically from isochromatics and isoclinics, are discussed for the purpose of separating principal stresses by means of an improved shear-difference method. The factors associated with two- and three-dimensional cases associated with using photoelastic methods are discussed to show their limitations in the processes of separating principal stresses. The method of using lines of constant shear stress where the equilibrium conditions of the elements are cut parallel to Cartesian coordinates is described. Reference is made to similar approaches by others which subsequently evolve into the use of a nomogram containing a system of Mohr's circles. Typical examples of isochromatics for crossed and parallel polarizers are given, along with isoclinics showing the lines of constant shear stress.

Kuske, A. (Technische Hochschule, Stuttgart, W. Germany), Experimental Mechanics, Vol 6, No. 1, January 1966, pp 45-53, 15 figs., 14 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Society for Experimental Stress Analysis (repr., PC).

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1358

SELECTION OF THE OPTIMUM ALLOYING COMPOSITION OF RAIL STEEL SUBJECTED TO THERMO-MECHANICAL STRENGTHENING [IN RUSSIAN]

Three groups of rail steel normally used in the production of R-50, R-65, and R-75 rails and which were alloyed with elements that raise the hardenability and recrystallization temperature of the metal were investigated. The rails were subjected to high-temperature thermo-mechanical treatment, and fine sections were removed from the rail heads and machined for the purpose of testing. From the test results, it was concluded that the strength for a given chemical composition is raised by more than 200 percent and the yield point by 240 to 250 percent with no change in plasticity and notch toughness of the steels. A chemical composition for high-strength rails is recommended.

Druzhinin, V. V., Tarasko, D. I., and Grdina, Yu. V., Izvestiya VUZ, Chernaya Met., No. 8, 1969, pp 132-134, 2 figs., 3 tables, 3 refs.

ACKNOWLEDGMENT: Kamkin Bookstore (repr., PC).

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1359

SEEK CLUES TO RAIL SHELLING

The problems associated with rail shelling and the means for detecting and correcting for it are discussed. The research done in past years by the Association of American Railroads is briefly reviewed. Attempts are made to associate rail shelling with wheel loading; however, the analysis of rail forces indicated that there is little or no correlation. Studies of the rail defect conditions are being conducted by researchers using sonic and ultrasonic vibration analysis. The equipment and some typical "Sonograms" produced by defects in rails are presented.

Shedd, T., Modern Railroads, Vol 19, No. 10, October 1964, pp 74-76, 5 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Watson Publications, Inc. (repr., PC).

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1360

REMOVAL OF STRUCTURAL HETEROGENEITY IN RAILS

Investigations into the causes of rail damages on sections of R-50 and R-65 rails are reported. A large proportion of these rails removed from the track consisted of longitudinal laminations and portions chipped off the ends and middle of the rail heads. Sulfur prints and deep etchings of cross sections revealed white spots at the damaged places. A chemical analysis showed that these damaged areas contain less carbon than the remaining portions of the rail and are of lower hardness. Micro-investigations of these spots revealed deep nonmetallic inclusions. It was concluded from the investigations that the rail defects were caused by faulty pouring technology. Increased temperature and floating top insertions with a metallic casing were found to appreciably reduce the proportion of rejects for inclusion-type defects.

Plekhanov, P. S. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 1, January 1962, pp 63-64, 1 fig., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1361

LATERAL FORCES ON TRACK AND EQUIPMENT DUE TO DYNAMIC BRAKING ON THE SOUTHERN PACIFIC LINES

This report embraces a description and analysis of data taken during the operation of regularly scheduled freight trains on the Southern Pacific Company line between Roseville, California, and Sparks, Nevada. The purpose of the investigation was to determine coupler forces and resulting lateral forces exerted on the rails by the passage of an 85-foot car coupled to a short car in a train with the locomotive using dynamic braking while operating on steep grades and curves up to 10 degrees. The lateral and vertical truck forces were measured by means of electrical strain gages mounted on the truck, with the relation between forces and strains determined before the actual test runs were started. The data indicate that there is a linear relationship between the track curvature or coupler angle and the lateral truck forces acting on the rail, and these forces can be calculated as the product of the coupler force and the sine of the coupler angle. A comparison of the calculated and recorded values of the lateral truck force per degree of curvature and the coupler force is given.

Association of American Railroads, Engineering Research Division, Chicago, Ill., Report No. ER-69, October 1966, 15 pp, 9 figs., 4 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1362

INVESTIGATION TO DETERMINE THE CAUSE OF "SUDDEN" WIDE GAGE ON THE DELAWARE & HUDSON RAILROAD

The number of derailments and the numerous occurrences of "sudden" widening of track gage on the D&H Railroad were investigated. These observations were noted on various degrees of curvature, but not on a tangent, and during very cold weather. Special equipment is described for measurement of lateral forces on the track and a special train. Strain gages were placed on the rail webs to measure vertical wheel loads. The lateral displacement between the first and second diesel units and total locomotive drawbar force were also measured. Data are presented for six runs when the maximum lateral forces were observed. They were grouped in three categories to show the effect of track irregularity; large, steady, drawbar forces; and slack action. The investigation did not result in any clear cut and specific answer to the problem of "sudden" wide gaging. However, it appears likely that the occurrences were due to lateral forces exerted against the outer rail as a result of locomotive jackknifing under dynamic braking.

Association of American Railroads, Engineering Research Division, Chicago, Ill., Report No. ER-68, October 1966, 13 pp, 21 figs., 9 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1363

RAILWAY RAILS OF OXYGEN CONVERTER STEEL

This paper describes studies conducted by the Central Research Institute for Ferrous Metallurgy and the rail laboratories of Novo-Tula on rail steels from an oxygen converter plant prior to the start-up of a similar facility at the Kuznetsk Combine. The metal satisfied the requirements of GOST 6944-54 for R-50 rails made from open-hearth steel except that they varied within wider limits because of a nonstandard charge. The processes through which the ingots were carried are described. Macrostructure of rails for each heat was checked and found satisfactory. The mechanical properties were determined on standard specimens machined from the head of slowly cooled rails. The data were analyzed and it was concluded that the chemical composition, technological properties, results of standard tests, and other properties of a trial batch of basic oxygen steel rolled into R-50 rails satisfied the standard for open-hearth rails.

Afanas'ev, S. G., Dukhanin, A. S., Kvitko, M. P., Shumov, M. M., Darushin, R. I., Koshkin, V. A., Zakharenko, N. I., and Kritinin, I. A. (Central Research Institute for Ferrous Metal and the Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 1, January 1964, pp 63-65, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1364

PROPERTIES OF RAILS MADE OF 3 PERCENT CHROMIUM STEEL [IN RUSSIAN]

Two experimental blanks of rail steel to be used for rolling rails were smelted at the Kuznetsk Metallurgical Combine. Specimens from the melts were examined for their mechanical properties, and given microphotographic examinations. These blanks were normal in their principal-alloy chemical contents with the exception of chromium which varied between 2.82 and 2.90 percent. After rolling the rails were normalized or annealed at several temperatures and for different lengths of time. The mechanical properties of the rail were determined after every treatment. Normalizing had the most favorable effect on the yield strength and plastic properties, tensile strength, elongation, and hardness. After normalizing, the tensile strength of the 3 percent chromium steel was between 67 and 68.5 kg/sq mm, whereas that of carbon rail steel is 32.6 kg/sq mm. This indicates that with an increase in yield point, the elastic properties approach those of a spring steel.

Grdina, Yu. V., Govorov, A. A., Nesterov, N. A., and Grigorkin, V. I. (Kuznetsk Metallurgical Combine, U.S.S.R.), Izvestiya VUZ Chernaya Met., No. 2, 1962, pp 125-130, 7 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kemkin Bookstore (repr., PC).

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1365

PROPERTIES OF HEAT TREATED RAILS MADE FROM 1% CHROMIUM AND NATURALLY ALLOYED CHROMIUM NICKEL STEELS [IN RUSSIAN]

The properties of heat-treated alloy rail steels were studied to determine which chemical content is best suited to provide desired strength and durability characteristics. Two batches of rail steels with different compositions were selected for tests. Data are presented from the tests which involved rail hardness, tensile strength as a function of heat treatment, elongation, area reduction, and a study of grain sizes. Both varieties of steel studied were found to be satisfactory for the production of high-strength heat-treated rails. The optimum heat treatment is quenching in oil from 850 to 870 C and 1.5 to 2 hours of tempering at 450 to 500 C. The resulting strength of the chromium-nickel steel exceeds that of the chromium steel by 25%, but the ductility is lower. The mechanical properties of these steels without heat treatment differ very little from rails of standard production.

Govorov, A. A., Alaykin, A. B., Grigorkin, V. I., Nesterov, N. A., and Vershinska, L. V., Izvestiya VUZ Chernaya Met., No. 8, 1964, pp 149-154, 4 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1366

MODIFYING RAIL STEEL [IN RUSSIAN]

This paper provides a review of the various means for alloying rail steels, the effects of additions of alloying elements on the mechanical properties of rails, and the long-term stability of modified steels. In general, small additions of alloying elements reduce the austenite grain size for final rolling at temperatures between 950 and 1070 C. However, when cerium is added, the grain size increases. Strength is generally improved by modification, but ductility is lowered. Tellurium and cerium leave tensile strength unchanged but they raise the impact strength. The best hardenability was obtained by adding titanium, vanadium, and boron, which give good surfaces and low roll wear, and the steels thus modified require less rolling power than unmodified steel.

Grdina, Yu. V., Koshkin, V. A., Gordin, O. V., Sakharova, N. A., Izvestiya VUZ Chernaya Met., No. 10, 1963, pp 129-133, 3 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1367

METHOD OF DETERMINING THE DEGREE OF CONTAMINATION OF RAIL STEEL WITH LINES OF NONMETALLIC INCLUSIONS

A method is proposed for evaluating the degree of contamination of steel based on determining the maximum length of line (string) inclusions and their combined length per square centimeter of a polished specimen. It is felt that the Soviet Specification GOST 1778-62 does not provide adequate requirements and procedures and may lead to considerable error and misjudgment. To prove this point, three batches were selected from an open-hearth furnace and tested. Samples were cut from the rail head, middle, and bottom parts. Comparisons are made between judgments based on the guidance of GOST 1778-62 and the author's suggestion. It was concluded that the proposed method produces more precise information on the degree of contamination of rail steel and makes it possible to determine the susceptibility of a given batch to fatigue defects.

Mikhalev, M. S. (Ural Section of the All-Union Scientific Research Institute of Railroad Transportation, U.S.S.R.), Zavodskaya Laboratoriya (Industrial Laboratory), Vol 30, No. 11, November 1964, pp 1692-1693, 1 fig., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1368

MODERN METHODS OF FATIGUE ASSESSMENT

This paper discusses briefly each of three steps, points out the difficulties involved at each step, and deals in detail with the developments in methods of fatigue assessment. The three steps involve three major simplifications some or all of which assume that the structure experiences some standard loading history, the use of engineering judgment in deciding dangerous load conditions and danger areas, and the use of the elasticity theory to calculate local conditions. The three areas involve a description of the nominal stress or strain conditions, a technique for stress and strain analysis as well as for deriving the local conditions from nominal conditions in those positions in the structure where fatigue damage occurs, and an improved method of testing to obtain the stress/strain life relationship.

Watson, P., and Rebbeck, R. G. (Fatigue Research Group, British Railways Research Department, Derby, England), 1975 (Advance Copy), Institution of Mechanical Engineers, 12 pp, 23 figs., 49 refs.

ACKNOWLEDGMENT: Institution of Mechanical Engineers.

PURCHASE FROM: Mechanical Engineering Publications Ltd. (repr., PC).

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1369

THE EFFECT OF PERIODIC-RANDOM LOADING ON FATIGUE CRACK GROWTH

A theory of fatigue crack growth based on the concept of damage accumulation is presented which takes some account of the effect of periodic-random loading. The Dugdale model of plasticity is used to calculate the distribution of the energy dissipated during stress cycling in the plastic zones of a crack embedded in a material sample of infinite extent. The author shows how to calculate the damage accumulated by decomposing the random group of stress levels into significant complete stress cycles of various amplitudes. A simple short numerical algorithm is presented which performs this decomposition. A crack-growth law is derived having a very simple form which automatically incorporates the condition for catastrophic failure.

McCartney, L. N. (Division of Materials Applications, National Physical Laboratory, Teddington, Middlesex, England), Pre-publication Report, No. B-630, July 8, 1975, 31 pp, 6 figs., 9 refs., 1 appendix.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: National Physical Laboratory (repr., PC).

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1370

CYCLE COUNTING FATIGUE DAMAGE

This paper describes a recently introduced counting method and presents comparisons between various fatigue-life predictions based on this and another common cycle-counting method. This new technique is known as the Rainflow or Pagoda-Roof method. It is compared in this document with Range-Mean analysis which has been used extensively in recent years. An essential step in the prediction of the fatigue life of vehicles and structures is the reduction of a service strain or stress history to a series of cycles and half-cycles (ranges). This process is known as cycle counting and can be the source of large but unnecessary errors in the subsequent life prediction.

Watson, P., and Dabell, B. J. (British Railways Research and Development Division, Derby, England), Statistical Aspects of Fatigue Testing Symposium, Warwick University, February 12, 1975, 32 pp., 15 figs., 12 refs.

ACKNOWLEDGMENT: Society of Environmental Engineering.

PURCHASE FROM: Society for Environmental Engineering (U.K.) (repr., PC).

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1371

IMPROVEMENT OF FATIGUE PROPERTIES OF BOLTED RAIL JOINTS BY HOLE EXPANSION [IN GERMAN]

Exhaustive tests by the Netherlands Railways (NS) in conjunction with Friedr. Krupp Huttenwerke AG, Rheinhausen, with the aim of improving the useful life of fishplated rail joints are described here. The best results were obtained by enlarging the rail holes by 0.8 mm with a tapered drift.

Thomas, H., Van Swaaij, J. (The Netherlands Railways, Netherlands), Schweitzer, R., and Heller, W. (Friedr. Krupp Huttenwerke AG, Rheinhausen, West Germany), Eisenbahntechnische Rundschau, Nos. 7 and 8, July/August 1972, pp 256-264, 11 figs., 3 tables, 11 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Verlag Stahleisen GmbH (repr., PC).

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1372

PURPOSES AND REQUIREMENTS OF TRACK INSPECTION AND MEASUREMENT

This is the first part of a two-part study of the general field of railway-track inspection. The entire study has been prompted by recent interest in automated inspection devices and systems. The purpose of this first part is to examine thoroughly the uses, functions, and purpose of track inspection as a basis from which a more specific study of automated inspection can be made. The second role is a generalized specification of what criteria should dictate the logical development of an automated track-geometry inspection system. The second part of the study deals specifically with automated track-geometry inspection, analysis of inspection observations, and the use of inspection data in maintenance planning and scheduling.

Way, G. H. (Chesapeake and Ohio Railway Company, Cleveland, Ohio), Report No. 71-103, February 1971, 2 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Chesapeake and Ohio Railway Company (repr., PC).

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1373

PRELIMINARY REPORT ON THE EFFECT OF BOLT HOLE EXPANSION ON THE FATIGUE OF RAILS

This report deals with an investigation of the influence of expanding rail and bolt holes on the resistance to the formation of fatigue cracks of the type UIC-A 135 from these holes. Previous fatigue test series on bolt holes of different types and simulation of the effect of corrosion are briefly reviewed. Further tests are performed on bolt holes that have been machined in different ways, and the stresses and hardening increases around bolt holes caused by an extension of these holes are reported.

Van Swaaij, J. (Laboratory of the Netherlands Railways, Amsterdam, Netherlands), September 16, 1969, 7 pp, 6 figs., 8 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Netherlands Railways (repr., PC).

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1374

PERIODIC OVERLOADS AND RANDOM FATIGUE BEHAVIOR

The occurrence of occasional high-amplitude strain cycles in an otherwise stationary random strain-time history is investigated in connection with how they reduce fatigue life of mild-steel specimens. The acceleration of damage is shown to occur throughout the cyclic damage process. The significance of this effect in terms of fatigue in railway vehicles is emphasized. The results of overload studies are often confusing because of the influence of induced residual stresses. In this work, care was given to ensure that no such effects occurred.

Watson, P., Hoddinott, D. S., and Norman, J. P. (Fatigue Research Group, Materials Engineering Section, British Railways Research Dept., Derby, England), Cyclic Stress-Strain Behavior, ASTM No. STP-519, 1973, pp 271-284, 10 figs., 33 refs.

ACKNOWLEDGMENT: American Society for Testing and Materials.

PURCHASE FROM: American Society for Testing and Materials (repr., PC).

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1375

INVESTIGATION OF INCLUSIONS IN CONVERTER RAIL STEEL CONTAINING RARE EARTH METAL ADDITIONS [IN RUSSIAN]

The contamination of acid Bessemer and O-Converter rail steel (deoxidized with a mischmetal) by nonmetallic inclusions was examined. Oxide-inclusion contamination was less with the mischmetal additions than with normal deoxidation additions, but sulfide inclusions were approximately at the same level. Chemical analysis of the isolated residues showed that the amount of stable inclusions increased with mischmetal addition because of the high concentration of cerium oxide. Within specific limits, the addition of mischmetal raises the notch toughness of medium-C steel.

Baptismansky, V. I., Bakhman, N., Lev, I. E., Petrichenko, A. G., and Prosvirin, K. S., Izvestiya VUZ, Chernaya Met., No. 7, 1969, pp 42-45, 2 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1376

INFLUENCE OF THE TEMPERATURE AT THE END OF ROLLING ON THE GRAIN SIZE AND MECHANICAL PROPERTIES OF RAIL STEEL [IN RUSSIAN]

An investigation is reported on studies aimed at determining the influence of the temperature on the grain size and mechanical properties after the ingot was rolled into rails. It was observed that when the temperature at the end of the rolling

was above 980 and 1000 C, the austenite grain was very coarse, which indicated that the end temperatures should be lower than 980 C. The tensile strength was not found to be greatly affected by the end temperature, however, the plastic properties deteriorated with the increased grain size. The best mechanical properties were obtained when the end temperatures were approximately 850 C, but this is accompanied by greater wear on the rollers and increased the cost of the rails. To obtain small grains at the higher temperature, modification of the steel is required.

Govorov, A. A., Kosakin, V. A., Gordin, O. V., Tuzovskii, A. I., Sakharova, N. A., and Lymar', A. I., Izvestiya VUZ, Chernaya Met., No. 8, 1963, pp 137-140, 3 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1377

INFLUENCE OF THE AMOUNT ADDED AND THE RESIDUAL ALUMINUM CONTENT ON THE CONTAMINATION AND FATIGUE PROPERTIES OF RAIL STEEL [IN RUSSIAN]

This paper describes an investigation involving rail steel with various amounts of aluminum additions cast into 15-kg ingots for the purpose of studying the effect of the residual aluminum content on cyclic bending fatigue strength. The fatigue strength was observed to be greatest with a residual aluminum content of approximately 0.02 percent. The fatigue limit was observed to decrease with increasing aluminum content up to 0.05 percent, after which it tended to rise slightly. A residual aluminum content of 0.02 percent was obtained with an aluminum addition of 300 to 500 g/ton of steel; with this addition, the mean inclusion diameters were at a minimum.

Zarvin, E. A., Varavkin, G. I., and Korotkikh, N. K., Izvestiya VUZ, Chernaya Met., No. 6, 1969, pp 76-79, 5 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1378

THE EFFECT OF PURITY ON FATIGUE CRACK GROWTH IN A HIGH-STRENGTH STEEL

This paper presents the results of fractographic studies which were performed to show how enhanced purity in high-strength steels improves resistance to fatigue-crack propagation at room temperature. The crack-growth rates were analyzed in terms of the stress-intensity-factor range by using mathematical expressions where parameters varied according to the material purity and test variables. The fractographic studies revealed that two modes of fracture contributed to crack propagation: a ductile mode through the tempered martensite, and brittle cracking along the prior austenite grain boundaries. The second mode was associated with higher crack-growth rates, but its incidence did not completely account for the observed differences in fatigue properties.

Evans, P.R.V., Owen, N. B., and Hopkins, B. E. (National Physical Laboratory, Teddington, England), Engineering Fracture Mechanics, Vol 3, No. 4, December 1971, 10 figs., 1 table, 24 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Pergamon Press (repr., PC).

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1379

EFFECT OF PURITY ON THE TOUGHNESS OF A LOW-ALLOY HIGH-STRENGTH STEEL

Marked improvement in the toughness of low-alloy steels at high strength levels as related to high purity is discussed. The effect of purity is attributed either to a reduction in the nonmetallic-inclusion content or to the extent of grain-boundary embrittlement caused by the segregation of trace impurities. There is some question as to what extent purity contributes to the crack toughness of low-alloy steels and so an investigation was made of the plane-strain fracture toughness of two commercial and two high-purity steels of the En24 type coupled with a detailed study of the fracture surfaces.

Evans, P. R. V., Wilkins, M. A., and Owen, N. B. (National Physical Laboratory, Teddington, England), Journal of the Iron and Steel Institute, Vol 210, Part 3, March 1972, 3 figs., 2 tables, 8 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute (repr., PC).

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1380

BRITISH RAIL'S RAIL FORCE MEASURING TRANSDUCER

A description is given of a method developed by British Railways which allows the internal force existing within a long length of continuously welded rail in service to be measured without having to cut the rail. One of the important factors in monitoring the stability of continuously welded rail is the amount of longitudinal force occurring at any time in the rail. The force is influenced by a number of factors, including rail creep, track movement, or even mining substance. The introduction of the rail force transducer, designed at the Railway Technical Center, simplifies the procedure, enabling nondestructive measurements of longitudinal force. Physical descriptions of the sensing transducer, its mounting on the rail web, signal conditioning, and calibration are given. Graphs are included for the purpose of calibration.

Gage Technique Ltd., Technical Brochure, No. BRT-415 (no date), 6 pp, 8 photos, 3 graphs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Gage Technique Ltd. (repr., PC).

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1381

ALLOY RAILS [IN RUSSIAN]

The mechanical properties of alloy rail steel containing approximately 1 percent chromium are better than those of ordinary carbon steel. Tests which were conducted showed that the 1 percent chromium steel had 10 percent higher ultimate tensile strength, 20 percent greater elongation, and, under practical conditions, exhibited only one-half the wear of ordinary carbon steel. The authors state that further improvement could be expected following heat treatment of the alloy steels. The effect of higher chromium content was also examined. It was found that steels containing 2 percent chromium are less useful for rails, and those containing 3 percent chromium are not recommended even with an addition of 0.2 percent vanadium.

Grdina, Yu. V., Govorov, A. A., Nesterov, N. A., and Grigorkin, V. I., Izvestiya VUZ, Chernaya Met., No. 10, 1963, pp 120-124, 3 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1382

RAILS HEATED FASTER FOR REROLLING IN SPECIAL FURNACE

Rails to be rerolled are heated more rapidly in a new furnace incorporating thick firebrick insulation in walls and roof and a highly flexible and efficient firing arrangement. Flat-flame burners in a flat roof provide faster, more even heating than end-wall burners could accomplish alone. The roof refractory is quickly heated to incandescence for high heat transfer by radiation. Lower courses of furnace walls are conventional dense firebrick because of its resistance to mechanical damage, such as gouging by the rails.

Industrial Heating, Vol 33, No. 4, April 1966, pp 732, 734, 736, and 738, 3 photos.

ACKNOWLEDGMENT: Metals Abstracts.

PURCHASE FROM: National Industrial Publishing Co. (repr., PC).

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1383

REVERBERATION METHOD FOR INSPECTING METALLIC STRUCTURE

A nondestructive reverberatory method of inspecting heterogeneous structure of surface-hardened metal in a thickness range of 5 to 25 mm is described. The inspection principle is based on plotting the relationship of the magnitude of the structural signal to the distance between the points of lead-in and pickup of the ultrasonic vibrations. Structural changes, occurring as a result of cyclical repeated load change, are also detected by this method. Eleven surfaces of rail steel, surface hardened by various techniques (totally tempered, normalized, quenched, and without heat treatment), were inspected and structure was determined.

Zarochentsev, G. V., and Yushkevich, I. N. (All-Union Scientific Research Institute for Railroad Transportation), Zavodskaya Laboratoriya, Vol 31, No. 2, February 1965, pp 198-201, 4 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1384

IMPROVING THE STRENGTH AND DUCTILITY OF CHROMIUM-NICKEL STEEL RAILS

The problems incurred in the use of rails of normal carbon steels laid on curves with small radii are briefly reviewed with the intent of depicting the future need for alloy steel rails because of the trend for increased rail loading and traffic density. Experimental studies were conducted at the Kuznetsk Metallurgical Combine to provide data on the use of alloy steels in rails and to gain some understanding as to what new problems may occur in the rolling of the rails. The melts were inspected in order to detect such defects as scabs and cracks. Data obtained in mechanical properties tests of rails that were accepted are presented. Data plots show the changes in impact strength in sections taken from the rail as a function of the test temperatures and controlled cooling. As a result of this study, the ideal chemical composition of the rail and the steps to be taken in heat treatment were derived.

Plekhanov, P. S. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 5, May 1963, pp 397-398, 2 figs., 4 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1385

EFFECT OF THE MEANS OF DEOXIDIZING ON THE FATIGUE PROPERTIES OF RAIL STEEL AND ITS CONTAMINATION WITH NON-METALLIC INCLUSIONS [IN RUSSIAN]

Methods are explored in an effort to determine the best means of deoxidizing rail steel so as to reduce the amount of contamination from nonmetallic inclusions and to improve fatigue properties. Laboratory samples were prepared using rails steels that were produced by deoxidation with silicon-calcium and with aluminum. Test rods were machined from portions selected from the rail heads. These specimens were subjected to fatigue stress tests and examined for nonmetallic inclusions. It was found that the use of silicon-calcium rather than aluminum in the final deoxidation reduces the amount of stable nonmetallic inclusions and makes their presence less objectionable, thus improving the fatigue limit of the rails and their length of service.

Zarvin, E. Ya., Shirokov, N. I., and Gordeeva, L. T., Izvestiya VUZ Chern. Met. No. 10, 1964, pp 41-44, 2 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1386

EXPERIENCE OF AN IRON AND STEEL WORKS WITH GAS DEPOSIT WELDING OF RAILWAY RAILS [IN GERMAN]

This paper reports on the maintenance of the railway system in an iron and steel works with special reference to the gas deposit-welding of shunting-point parts. The advantages of using gas welding for this purpose and the increased surface hardness resulting from the deposited material are pointed out. The economic benefits of this type of shunting-point reclamation are discussed.

Schneider, K. (Abt. Gleisbau der Hoesch AG, Westfalenhutte, Dortmund, West Germany), Schweissen und Schneiden, No. 16, March 1964, pp 81-86, 18 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Deutscher Verlag fur Schweisstechnik GmbH (repr., PC).

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1387

EFFECTS OF SELF-TEMPERING AND FURNACE TEMPERING ON THE MECHANICAL PROPERTIES OF RAILS HARDENED ALONG THEIR WHOLE LENGTH BY HIGH FREQUENCY CURRENT HEATING [IN RUSSIAN]

A technique for hardening the surfaces of rails by using high-frequency induction heating has been developed and successfully applied. The rails can either be self-tempered or subjected to subsequent furnace tempering. The mechanical properties of rails subjected to the two processes were compared, and it was found, in general, that furnace tempering was unnecessary, as it did nothing to improve the technical properties of the rails.

Zannes, A. N., Sapelkina, O. R., Zubarev, V. F., Demakova, A. V., and Pereverzeva, E. G., Izvestiya VUZ Chern. Met., No. 2, 1964, pp 118-123, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1388

FATIGUE STRENGTH OF HEAT-TREATED RAILS CONTAINING ARSENIC

Two types of rail heat treatment are examined: water quenching of the rail head and overall quenching in oil. Four casts with various carbon and arsenic contents were used for the tests; however, they were within the standard specification since it was previously established that an increase in the arsenic content from 0.14 to 0.23 percent does not adversely affect the fatigue strength of the rails. Data are presented on the mechanical properties and fatigue strength of rails subjected to the two modes of quenching. Macrostructures are presented which show the character of the quenched layer of the rail and the center portion of the head. It was concluded that the water-quenched rails had much higher fatigue strength than the oil-quenched rails.

Pinkhusovich, L. L., Mar'yanovskaya, T. S., and Fridman, Z. G. (Academy of Sciences, Institute of Metallurgy, U.S.S.R.), Stal [in English], No. 4, April 1959, pp 306-309, 7 figs., 3 tables, 6 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1389

EXPERIENCE IN ROLLING HIGH-MANGANESE RAILS

The possibility of producing rails with satisfactory mechanical properties and structure from high-manganese steel is investigated. The processes used, from the cold ingot through the production of the rails, including the cutting and cropping, drilling, and grinding are described. Tests were conducted on the finished rails in accordance with GOST 6944-54. After the test data were analyzed, it was concluded that the rolling of rails made from large and small high-manganese steel ingots was possible. Also, rails from ingots which have been given a homogenizing anneal can be laid without additional quenching in water since these rails in the "as-rolled" state demonstrate good plasticity properties.

Plekhanov, P. S., Koshkin, V. A. and Kritinin, I. A. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 5, May 1961, pp 340-342, 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1390

INFLUENCE OF SLOW COOLING ON THE PROPERTIES OF BESSEMER RAILS

A comparison is made of mechanical properties of Type R-43 rails from three Bessemer melts which differ in their carbon content for the purpose of investigating the influence of delayed cooling. Information is presented on the chemical compositions and rates at which cooling has been maintained. Data from mechanical-property tests show that slow cooling reduces the ultimate tensile strength of rails by 3 to 5 kg/mm^2, which reduces wear considerably and a decrease in the impact strength of

rails was also observed. The overall results indicate that slow cooling reduces the mechanical properties of Bessemer rails.

Karpunin, A. M. (Dzershinsk Works, U.S.S.R.), Stal [in English], No. 3, March 1959, pp 229-230, 3 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1391

THE INFLUENCE OF DEOXIDATION AND MODIFICATION ON THE CONTAMINATION IN AND ON SOME PROPERTIES OF RAIL STEEL [IN RUSSIAN]

This paper describes various investigations and current practices of deoxidation of rail steel that use aluminum and silicon-calcium. Improved mechanical properties are shown to occur for the simultaneous deoxidation with aluminum (150 grams/ton) and silicon-calcium (500 grams/ton) and modification with vanadium (0.06%). It is shown that the fatigue-strength properties of the rail steel are determined not only by the mechanical properties of the metal, but principally by the dimensions of nonmetallic inclusions.

Zarvin, E. Ya., Grdina, Yu. V., Verevkin, G. I., Tov, G. M., and Lykhin, I. D., Izvestiya VUZ Chern. Met., No. 11, 1967, pp 51-59, 4 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kanikin Bookstore (repr., PC).

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1392

INERTIAL PROFILOMETER AS A RAIL SURFACE MEASURING INSTRUMENT

A description is given of a pair of profilometers that were modified from an original design, built, and installed on the Department of Transportation's rail test car. The inertial profilometer system is capable of accurately measuring variations in rail surfaces of both short wavelengths (a few feet) and long wavelengths (a few hundred feet). In addition to its application in vehicle-dynamic simulation, the measured inertial profile can be used as a data base for extracting mid-chord (or other types of relative profile measurement) at any selected chord length. The field and laboratory tests, conducted to evaluate the performance of the profilometers are discussed, as well measurements performed on tangent, spiral, and curved track systems. The results show good agreement between the profilometer data and the accurate stringline measurements.

Rudd, T. J., and Brandenburg, E. L. (ENSCO, Inc., Springfield, Va.), ASME Paper No. 73-ICT-102, presented at the Intersociety Conference on Transportation, Denver, Colo., September 23-27, 1973, 9 pp, 15 figs.

ACKNOWLEDGMENT: American Society of Mechanical Engineers.

PURCHASE FROM: American Society of Mechanical Engineers (repr., PC).

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1393

INCREASING THE OUTPUT OF A RAIL AND BEAM ROLLING MILL

Two groups of basic equipment used in the rail and beam rolling mill at the Nizhne-Tagil' Combine are described. The first group consists of a single 900-mm two-high reversing roughing stand with a 5000-hp mill-drive motor, while the second group consists of three 800-mm stands in line with two three-high stands with a common drive of 6200 hp, and a finishing two-high stand with separate drive of 2500 hp. A layout of the principal equipment of the rail and beam rolling mill and a diagram of the contours of the passes are given. This paper describes the introduction of a new roll-pass design for the 800-mm work rolls, providing for simultaneous rolling of round and square billets. The new design has made possible an appreciable increase in the output of the rail and beam rolling mill with a simultaneous improvement in the quality of rolled stock and a reduction in electrical power and fuel and work roll consumptions.

Merekin, B. V., Shakun, V. V., and Peigin, G. D. (Nizhne-Tagil' Combine, U.S.S.R.), Stal [in English], No. 12, December 1959, pp 897-899, 4 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1394

IMPROVING THE ROLL-PASS DESIGN OF T-PASSES FOR ROLLING TYPE R-65 RAILS

Joint research conducted by the Ukrainian Metallurgical Research Institute and engineers of the Azovstal' Iron and Steel Works on the conditions of deformation of the metal in the T-passes when rolling heavy-type rails is reviewed. As a consequence of this research the Institute investigated, on one of its own mills, the nature of deformation of the metal which forms the rail head as a function of the gripping of the strip by the side walls of the pass and of the height of the initial billet. A proposed redesign of the pass redistributes the reduction between the head and the base of the rail increasing the extent to which the most important part of the rail (the head) is worked through to produce better rails. he output of top grade rails in the last 6 months of 1965 rose by 2.5 percent as shown by trials on an industrial scale.

Arshavskii, V. Z., Gunin, I. V., Protasov, M. F., Stefanov, V. E., and Fradin, M. D. (Ukrainian Metallurgical Research Institute and the Azovstal' Iron and Steel Works, U.S.S.R.), Stal [in English], No. 2, 1966, pp 131-134, 4 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1395

HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT OF RAIL STEEL [IN RUSSIAN]

This paper deals with a study of high-temperature thermomechanical treatment of rail steels, a practice well established for alloy steels, to determine whether mechanical and physical properties are sufficiently improved to make the process useful in the production of railroad rails. Tests were conducted on rail steel specimens which had been subjected to thermomechanical treatment, and the data obtained were compared with similar data for alloy steels with like treatment. The results were, in general, satisfactory, showing a good combination of strength, ductility, and toughness, together with a fine grain structure.

Grdina, Yu. V., Tarasko, D. I. and Druzhinin, V. V., Izvestiya VUZ Chern. Met.,.No. 12, 1965, pp 112-113, 2 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1396

HIGH FREQUENCY SURFACE HARDENING OF RAILS OVER THEIR ENTIRE LENGTH AT THE AZOVSTAL' PLANT

An experimental device for the high-frequency surface hardening of rails over their entire length, that was designed and used at the Azovstal' plant for the purpose of determining the basic parameters of the hardening of carbon steel rails, is described along with the equipment and processes used for induction hardening. The camber and transverse and longitudinal configurations of the hardened layers of arsenic-containing rails are shown along with the distribution of hardness around the perimeter of the surface layer. Data are presented showing a comparison between mechanical properties of hardened and unhardened rails. It is concluded that the hardening of arsenic-containing rails by using high-frequency heating improves the mechanical properties of the hardened layer to a depth of 14 mm with hardness increase from about 240 to 420 BHN.

Zamaev, A. M., Rudol'skii, M. L., Fradin, M. D., Sapelkina, O. R., Bikbunov, L. Ya., and Glozman, M. I. (Azovstal' Metallurgical Combine, U.S.S.R.), Stal [in English], No. 8, August 1964, pp 639-641, 6 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1397

FLAME-HARDENED RAIL UPS CURVE LIFE

Results of tests being conducted by seven railroads of a new flame-hardened rail on severe curves have shown promise of increased rail life of four to five times as compared with conventional rail on curves. An integral part of the new hardening process is the method by which the rail is maintained straight, in both the vertical and the horizontal planes. The rail is said to possess near-ideal stress characteristics - specifically, biaxial compressive stresses of approximately equal magnitude in both longitudinal and transverse dimensions. Thus, it requires no gaging or straightening and is, therefore, easy to align for track-laying operations and for welding. A typical Brinell hardness pattern of a rail-head section is shown after flame hardening indicating a range of between 310 and 380 BHN in the surface layer. Although prices for the new hardened rail range from $.50 to $.80 per foot more than conventional rail, it is anticipated that savings in maintenance costs and extended life will justify its use.

Modern Railroads, Vol 19, No. 9, September 1964, pp 135-137, 2 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Watson Publications, Inc. (repr., PC).

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1398

HEAT TREATMENT OF ALLOYED RAILS [IN RUSSIAN]

Heat treatment of chromium-nickel and chromium steels to improve their mechanical properties was investigated. Experiments involving five different steel specimens with varying amounts of alloying elements are described. The mechanical properties and chemical compositions of the test specimens are given, and test data are plotted which show the effects of varying alloying additions on the mechanical properties. It was concluded that the best alloy (Type KhN-4 Cr-Ni), containing both chromium and nickel, was superior after it was oil-quenched from 840°C and tempered at approximately 500°C. Problems were encountered in rail straightening; however, the means for dealing with this are discussed.

Govorov, A. A., Alalykin, A. B., Grigorkin, V. I., Nesterov, N. A., and Vershinina, L. V., Izvestiya VUZ Chern. Met., No. 10, 1964, pp 132-136, 3 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kemkin Bookstore (repr., PC).

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1399

THE INFLUENCE OF SULPHIDE INCLUSIONS ON THE DEVELOPMENT OF MICROCRACKS IN RAIL STEEL [IN RUSSIAN]

The influence of sulphide inclusions in rail steel of a standard manufacture on the processes of crack formation under conditions of cyclic deformation is investigated. It is established that microcracks originate on both types of inclusions, i.e., solid solutions of FeS in MnS and of MnS. The formation of cracks occurs either by breaking away of the matrix from the inclusion or by the destruction of the inclusion itself. Under further cyclic deformation the microcracks are formed at the inclusions and then they develop into main cracks causing the failure of the specimen.

Tushinskaya, K. I., Stafeeva, L. I., and Tushinskii, L. I., Izvestiya VUZ Chern. Met., No. 8, 1968, pp 114-117, 4 figs., 4 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kemkin Bookstore (repr., PC).

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1400

INFLUENCE OF TECHNICAL FACTORS ON THE CHANGE IN LENGTH OF BATCH-QUENCHED RAILS

This paper describes a study that was conducted for the purpose of examining such factors as chemical content,

heat treatment, hot and cold rail straightening, batch quenching, and other factors with regard to how they affect rail lengths during the rail manufacturing process. Examination of the elongation of rails during heat treatment showed that the rails elongated during heating, but contracted while holding at temperature before quenching and during straightening in roller-type machines. This contraction was more pronounced in rail steel containing vanadium.

Rabinovich, D. M., Murav'ev, E. A., Kolosova, E. L., and Vinokurov, I. Ya. (Ural Scientific Research Institute for Ferrous Metals and The Nizhnii-Tagil Metallurgical Combine, U.S.S.R.), Stal [in English], No. 8, August 1968, pp 670-671, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1401

CALCULATION OF RAIL BENDING STRESS FOR 125 TON TANK CARS

A chart showing the calculated bending stresses produced in the base of six types of rail section by a 125-ton, 67-ft, 2-1/2-in. tank car carrying rolling loads at speeds up to 75 mph is presented. Also included is the recommended acceptable working stress which should not result in rail bending or breakage for light rail in branch lines where speeds will not exceed 35 mph, jointed rail in the main line, and continuous welded rail in the main line. The recommended stresses assume a standard of maintenance of line and of surface to accommodate speeds up to 35, 60, and 75 mph, respectively. An explanation is given of the method of calculating the rail bending stresses and of establishing the acceptable working stress.

Association of American Railroads, AAR Research Center, Chicago, Ill., Report No. 19506, April 1, 1965, 3 figs., 11 tables, 1 ref.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1402

REPORT ON FIELD INSPECTION OF VACUUM DEGASSED STEEL RAIL ON THE NORFOLK AND WESTERN RAILWAY

This report covers the results of a field inspection that was conducted to observe the condition of 132-lb RE vacuum degassed steel rail on the Norfolk and Western Railway near Hardy, Virginia. A physical description of the section test site is given. Observation was made of the rail condition, line and level of the track, condition of track components such as tie plates, spikes, rail anchors, ties and ballast as well as recording the gage of the track at the sites of rail contour recording. The history of the rail and track and traffic features is discussed. The rail cross-section contours as taken at this inspection are presented and they show the wear pattern as compared to the as-rolled section when the rail was laid new.

Schoeneberg, K. W. (AAR Technical Center, Chicago, Ill.), Report No. 65986, August 24, 1971, 8 pp, 28 figs.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1403

A NEW METHOD DEVELOPED BY BRITISH RAIL SCIENTISTS PERMITS MEASUREMENTS OF INTERNAL RAIL FORCES WITHOUT CUTTING THE RAIL

The method of using a load transducer implanted within the rail for the measurement of internal force is described. The rail force transducer is inserted in the rail and its output is connected to an associated portable measuring instrument. The transducers are cylindrical in shape (29 mm in diameter--the standard fishbolt-hole size on British Railways), and can be installed on site in a short length of rail which can then be welded into the track to be measured. Calibration is performed on site by using a web loading tensor which loads the rail over a range of 1000 kN, from 700 kN compressive to 300 kN tensile forces.

International Railway Journal, Vol XV No. 3, March 1975, p 67.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Simmons-Boardman (repr., PC).

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1404

HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT OF RAIL STEEL

The processes and results of an investigation on the influence of high-temperature thermomechanical treatment (HTTMT) on carbon steel rail are discussed. The treatment involves rolling of the rail at 850 C, followed by water-spray cooling and annealing. A diagram is provided showing views of the sliding water-air sprayer and the flow of cooling water. The results of a test are given which show the effects of varying degrees of deformation on impact and ultimate tensile strengths. Photomicrographs of rail samples subjected to impact tests show variation of fracture with degree of deformation in HTTMT and subsequent tempering.

Khait, D. M., and Savenko, A. N. (Belorussian Institute of Railroad Engineers, U.S.S.R.), Metallovedenie i Termicheskaya Obrabotka Metallov, No. 4, April 1968, pp 72-73, 3 figs., 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kankin Bookstore (repr., PC).

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1405

TEEMING RAIL STEEL INTO INGOT MOULDS PROVIDED WITH INSULATION INSERTS [IN CZECHOSLOVAKIAN]

Two techniques of rail steel teeming into standard tapered ingot molds are presented in this paper; the old process, i.e., top quenching with pressure after-teeming is compared with a new process of teeming into ingot molds provided with thermal insulation shot-in inserts. Rails made of steel teemed by the new technology show a lower proportion of surface defects. The course of the segregation in the rails (from the ingot part close to the head) made of steel teemed into insert-ingot molds is more favorable than in the rails made of ingots teemed by the old process. Costs for producing rails by the new process using shot-in inserts are higher because of lower output; however, the improved quality of the rail steel and better service life appear to warrant its use.

Cechura, F., and Kaczmarczyk, E. (Trinecke Zelezarny YSR, Trinec, Czechoslovakia), Hutnik, Vol 19, No. 8, August 1969, pp 296-302, 4 figs., 6 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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1406

NATURAL AND ARTIFICIAL AGING OF RAILS [IN CZECHOSLOVAKIAN]

The principal aging processes of rails are discussed in this paper which covers an investigation into finding the differences between natural and artificial aging. Experimental work involved the testing of 18 rail specimens divided into two groups: one group was aged for six months with mechanical properties being measured after the first, third, and sixth months; and the second group was subjected to a short-term tempering with similar measurements being made. It was found that changes in the mechanical properties of rails observed under atmospheric conditions could be artificially induced by short-term tempering for 8 to 12 hours at a temperature of 100 to 120 C. Brittleness induced in the rails by aging is attributed to lattice stresses and their thermal deformation character which cannot be regarded as material defects.

Hons, J. (Trinecke Zelezarny VRSR, Trinec, Czechoslovakia), Hutnik (Prague), Vol 19, No. 8, August 1969, pp 322-325, 2 figs., 8 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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1407

ECONOMIC FORECASTING TO IMPROVE THE QUALITY OF FERROUS METALS

The need for using increased-strength rails on railroad tracks bearing heavy traffic weights up to 1200 million gross tons annually is stressed. The interest here mainly centers about a desire to reduce rail failures and to enable maintenance crews more time between repairs by factors greater than the increase in total tonnage carried. Emphasis is placed on the use of heat treatment to improve the service life, and reduce rail wear and fracture incidence of R-65 and R-75 heavy rails. The economical benefits derived through the use of high-strength rails are shown by comparing the costs of heat treatment with the reduced cost in maintenance. It was concluded that the increase in economic effect iveness of heat treatment to strengthen rails justifies accelerating the increase in production of such rails even though it is accompanied by higher costs.

Zusman, L. L. (Institute of Ferrous Metallurgy of the U.S.S.R., Ministry of Iron and Steel, U.S.S.R.), Stal' (Translation No. M-21342, National Lending Library for Science and Technology, Yorkshire, England), No. 12, 1971, pp 1121-1125.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1408

IMPROVEMENT OF THE SERVICE PROPERTIES OF STEELS FOR RAILWAY PRODUCTS BY HEAT TREATMENT

This article describes the methods used for the improvement in wear resistance and contact fatigue strength of solid wheels, tires, and railroad rails. Emphasis is placed on the need to ensure that all layers in the rail head contain highly dispersed austenite decomposition products and have a fine-grain structure. It is explained that granular pearlite, formed after quenching of the steel to martensite and tempering such that it contains finely dispersed spherical carbide particles, exhibits poor wear resistance and contact fatigue strength. Mention is made of the prevention of the precipitation of free ferrite in the structure by accelerated quenching which greatly improves tensile and impact properties.

Uzlov, I. G. (Institute of Ferrous Metallurgy of the U.S.S.R., Ministry of Iron and Steel, U.S.S.R.), Stal' (Translation No. M-21184, National Lending Library for Science and Technology, Yorkshire, England), No. 7, 1971, pp 648-650, 5 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1409

THE RESISTANCE WELDING OF RAILS

A brief review is given of the reasons for changing from jointed track to welded track along with some statistics as to the extent the Soviet Union has progressed in making this change. Research that has been performed to improve the service life of continuous track and the economical benefits gained are discussed. Bar charts are presented which show comparisons of the fatigue strengths of welded and bolted butt joints subjected to bending by vertical loading. The service life of the welded rails has been examined and typical fatigue cracks in rail webs of R-50 rails are shown. Plotted data giving the fatigue strengths of the webs as a function of finishing and manufacturing processes, impact and tensile strength tests, and welding techniques are included.

Genkin, I. Z. (Mosgorsovnarkhoz Experimental Welding Works, U.S.S.R), Welding Production, No. 7, July 1959, pp 34-43, 10 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1410

UNDERGROUND RAIL TRANSPORT INSTALLATIONS AT MOUNT ISA MINES, LTD., QUEENSLAND

During the past eight years the underground rail system at the Isa mine has been upgraded, resulting in an increase in haulage capacity from 3 to 10 million tons annually. This sophisticated haulage system reduced the haulage cost per ton by 15 percent in fiscal year 1974-75. The approach to be taken for the proper selection of haulage rail is described. Installation of the 47 kg/m A.S. rails was based on observations of rail wear and life. Adjustments were made for adverse underground conditions such as ore spillage, heavy braking, acceleration, and inadequate maintenance. Data are given for expected rail life based on rail size and tonnage hauled. A brief description is given of the ultrasonic track-inspection equipment, its use, and the action taken when a defective rail is detected.

MacHunter, P. M. (Mount Isa Mines, Ltd., Mount Isa, Queensland, Australia), Institution of Mining and Metallurgy Transactions, Section A., Mining Industry, Vol 84, No. 827, October 1975, pp A139-A146, 10 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institution of Mining and Metallurgy (repr., PC).

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1411

METAL DEFORMATION IN THE ROLL-PASSES WHEN ROLLING TYPE R-50 RAILS

A study of the deformation occurring when rolling rails at the Kuznetsk Metallurgical Combine is described. It was found that vertical reductions in the lower portions of the rolled bar were in excess of those at the top of the bar in the roughing tee roll passes. Because of these vertical reductions and the deep profiling and smooth turn in the flanges, the quality of the base is improved; however, the rail head is very weakly worked. By increasing the size of the billet the deformation shifts to the middle portion of the base and to a lesser extent to the rail head. It was concluded from the study and data analysis that a slight enlargement of the billet dimensions improves the working of the metal and a decrease in lateral reduction improves the working of the rail-head.

Chelyshev, N. A., Droshchinskii, V. M., Darushin, R. I., Kritinin, I. A., Pshenichnov, P. I., and Kuchko, I. I. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 11, November 1964, pp 1013-1016, 5 figs., 1 table, 1 ref.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1412

CERTAIN CHARACTERISTICS OF THE MECHANISM OF MODIFYING RAIL STEEL [IN RUSSIAN]

The effects of various alloying additions on the grain structure of rail steel were investigated. It was found that the addition of some elements reduces grain size. In the case of Ti, B, V, and Te, finely dispersed chemical compounds are formed and distributed at the boundaries as well as inside the grains, hindering their growth on heating. Al and Ca tend to concentrate at grain boundaries and this also retards grain growth.

Grdina, Yu. V., and Gordin, O. V., Izvestiya VUZ, Chern. Met. No. 12, 1963, pp 152-157, 5 figs., 3 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1413

NEW GRADES OF STEEL FOR RAILS WITH TENSILE STRENGTH--UTS MORE THAN 90 KG/MM^2 [IN POLISH]

The manufacturing of new high-strength alloy rails steels in Poland and other countries is described. These high-strength steels are not used in

the conventional Type S-42 and S-49 rails. However, the heavy Type S-60 rail which has high tensile strength (between 90 and 110 kg/mm^2) is made of the alloy steel. Comparisons are made between the steel manufactured in Gliwice and steels manufactured according to the UIC-860 V and the GOST 8160-59 specifications. The results of laboratory tests of the mechanical properties are correlated with a variety of chemical compositions to show the advantages gained in the use of alloy steels for railroad rails.

Struk, S., and Otrembnik, B. (Instytut Metalurgii Zelaza, Gliwice, Poland), Hutnik, Vol 37, No. 5, 1970, pp 232-237, 1 fig., 3 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kubon and Sagner (repr., PC).

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1414

CAUSE OF FLAKES IN RAILS OF OPEN HEARTH STEEL [IN CZECHOSLOVAKIAN]

The cause of flaking in rails that were produced from open hearth steel is explained. Rail flaking is considered to be caused by the combined effects of hydrogen and internal stresses. A method of rail manufacture that would eliminate this defect is described in detail. Recommendations are given for chemical compositions of the steel and the possible use of vacuum degassing is suggested. Other recommendations for preventing flaking involve the handling of the ingots, and ingot and finished rail treatments. Photographs showing rail flaking conditions, rail head transverse fractures, and shelling are included.

Vondrasek, V., and Duchon, J. (VSB, Ostrava, and TZ VRSR, Trinec, Czechoslovakia), Hutnicke Listy, Vol 21, No. 12, December 1966, pp 852-858, 9 figs., 7 tables, 8 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SMTL-Publishers of Technical Literature (repr., PC).

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1415

PRODUCTION OF RAILS AT THE KUZNETSK METALLURGICAL COMBINE [IN RUSSIAN]

All aspects associated with the production of railroad rails at the Kuznetsk Metallurgical Combine are described. This book covers steel melting and casting, heating and rollings into billets, and the rolling, heat treatment, and finishing of the rails. The quality and service of the finished rails in tracks are also discussed. Special emphasis is placed on rails made from alloy and special steels. Suggestions for the selection of the heat treatment flow sheets are included.

Mikhaylets, N. S., Gorelkina, A. Ye., Koshkin, V. A., Nikulin, N. G., Derushin, R. A., Sakharova, N. A., Lymar', A. I., Loskutova, A. I., and Rudneva, R. S. (Kuznetsk Metallurgical Combine, U.S.S.R.), Metallurgiya, 1964, 223 pp, 87 figs., 60 tables, 477 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1416

A MODEL STUDY FOR VERTICAL TRACK BUCKLING

This paper contains a study of two models which represent the mechanism of vertical buckling of a track when subjected to a mechanical or thermal compression force, respectively. The post-buckling equilibrium curves and their stability are discussed and a stability criterion is defined. The effect of various track model parameters upon the buckling load or buckling temperature, is shown. The nonlinear equilibrium equations were linearized, and it was found that the buckling loads, or temperatures, obtained from a linearized analysis have no relevance to the actual values obtained from a nonlinear analysis. The results were significantly different for buckling temperatures.

Kerr, A. D. (New York University, New York, N. Y.), Report No. NYU-AA-71-31, October 1971, for DOT/FRA/Office of High Speed Ground Transportation (DOT Report No. DOT-FRA-OHSGT), 29 pp, 14 figs., 10 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS (repr., PC, microfiche), PB 209 614.

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1417

FINAL REPORT ON A THREE-DIMENSIONAL PHOTOELASTIC INVESTIGATION OF THE PRINCIPAL STRESSES AND MAXIMUM SHEARS IN THE HEAD OF A MODEL OF A RAILROAD RAIL [APPENDIX 8-C]

This report deals with a photoelastic study of the stresses in a model of the head of a railroad rail, utilizing for this purpose a recent development in three-dimensional photoelasticity. The study was undertaken in the expectation that the results would lead to a better understanding of the phenomenon of shelling in rails. After consultation with researchers at the AAR, it was decided to use as prototypes a 132-lb RE rail and the average contour of 33-in.-diameter worn wheel treads. Stresses were determined for a vertical load and for a combination of vertical and horizontal loads transverse to the rail. The photoelastic procedure used is briefly described and consists of: freezing, or fixing, stresses into plastic models of the prototype; removing thin, suitably oriented slices from these models; obtaining precision data from these slices placed in the field of polarized light of a polariscope; and processing the photoelastic data by the shear difference method. Principal stresses and maximum shears were found in the transverse section of the rail under the center of the wheel, i.e., in the plane of symmetry of the rail. The study was confined to the elastic state.

Frocht, M. M. (Illinois Institute of Technology, Chicago, Ill.), Proceedings of the 53rd Annual Convention of the AREA, March 16-18, 1954, Vol 55, pp 854-885, 27 figs.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1418

INVESTIGATION OF 132 LB./YD. RAIL MADE FROM VACUUM DEGASSED STEEL

The purpose of this investigation was to determine whether rails made from vacuum degassed steel and air cooled have properties comparable to those of rail steel produced by currently common practices. Descriptions of the manufacturing process, test specimens, and the results of the examinations are given. As measured in the laboratory, the properties of this vacuum degassed heat, without controlled cooling, were comparable to those previously measured for steels produced by more conventional techniques and subjected to controlled cooling.

Wisnowski, M. J., and Schoeneberg, K. W. (AAR Research and Test Department, Association of American Railroads, Chicago, Ill.), Report No. R-110, Project No. 70-R-42, October 1971, 57 pp, 42 figs., 10 tables.

ACKNOWLEDGMENT: Association of American Railroads.

PURCHASE FROM: Association of American Railroads (repr., PC).

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1419

HEAVY CARS—WHAT ARE THE ISSUES?

The author reviews the general trends toward greater and greater wheel loads on rails and their relation to the production of metal flow on the rails which causes severe deformation indicating that shear stresses are well beyond the yield point of steel. Rail defects are discussed in relation to their causes with special emphasis on rail shelling. Tensile strengths of rail steels are given in connection with what is required to handle the present-day loads on rails.

Way, C. M. (Association of American Railroads), American Railway Engineering Association, Bulletin 653, Proceedings, Vol 76, June-July 1975, pp 616-621.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1420

TEMPER BRITTLENESS OF RAIL STEEL CONTAINING ARSENIC AND CHROMIUM

The optimum combination of hardness and impact strength in carbon rail steel containing arsenic is investigated. The optimum combination of hardness and impact strength was found to be improved when the samples were quenched in water from 830 C and followed by tempering at 500-550 C. This steel was not very prone to reversible temper brittleness after slow cooling. The study results also show that chromium steel containing arsenic (oil quenched) exhibits the best properties after tempering at 500-550 C. With slow cooling from higher temperatures (600-650 C) the impact streength is lowered by 500-600 percent.

Zannes, A. N., Gorlach, A. A., Glozman, M. I., and Demakova, A. V. (Azovstal Works, and the Zhdanov Metallurgical Institute, U.S.S.R.), Stal [in English], No. 8, August 1963, pp 644-646, 3 figs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1421

MAGNETIC PERTURBATION SCANNING--A NEW NONDESTRUCTIVE TESTING METHOD

A highly sensitive nondestructive testing method that detects magnetic asymmetry in motor case preforms, roll-formed case segments, and other rocket motor parts is described. The test method, magnetic perturbation scanning, amplifies, by means of an induced magnetic flux, small changes in magnetic permeability caused by material defects which are then scanned and recorded. The data show resolutions of much less than 0.0005 in. for 0.25 in. of steel and indicate a sensitivity to conditions arising from grain structures. The magnetic scanner block diagram and magnet arrangement for tests are shown. Magnetic-flux and field-strength variations near large and small holes in a metal structure are illustrated. Full-scale system design and magnetic-scanner applications are discussed. The initial prototype of the test equipment was developed by the Southwest Research Institute.

Rathmann, D. W. (ACF Industries, Albuquerque, N. Mexico), Materials Research & Standards, Vol 6, No. 8, August 1966, pp 398-402.

ACKNOWLEDGMENT: American Society for Testing Materials.

PURCHASE FROM: American Society for Testing Materials (repr., PC).

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1422

FUTURE TRENDS OF THE RAIL MAINTENANCE SYSTEM [IN JAPANESE]

The existing procedure for the replacement of rails on Japan National Railways (JNR) involves using new rails for replacement on main track sections and using the replaced rails on lower class lines. However, because of the problems with labor supply and other conditions, it has become unprofitable to follow this practice. The staff of the JNR is considering alternative means for improving the efficiency and economics of the replacement procedure while still complying with all of the standards which must be met.

Horie, K. (Japan National Railways, Chiyoda, Tokyo, Japan), Kotu Gijutsu, Vol 27, No. 6, 1972, pp 234-237, 3 figs., 7 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Koto Kyoryokukai (repr., PC).

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1423

ADHESION AND THE CONTACT SURFACE BETWEEN WHEEL AND RAIL [IN CZECHO-SLOVAKIAN]

This paper contains a brief history of research into wheel/rail adhesion, and deals with the area of contact between the wheel and the rail. Included are observations concerning the correlations between the different principal factors which affect the form and dimensions of the contact surface, and which determine them in cases when the normal effort is the only outside force. Mathematical relations are constructed on the basis of which it is possible to establish considerations concerning the contact surface under the simultaneous effect of the adhesive weight and the tangential effort. The method of establishing the area of the surface contact of wheel and rail in the case of a used, and an unused, rail head as a function of the rate and magnitude of pressure in the wheel is described.

Svejnoch, V. (Vysoka Skola Dopravna, Moyzesova, Czechoslovakia), VSD VUD Sbornik Praci, No. 56, 1973, pp 5-38, 13 figs., 4 tables, 7 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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1424

THE FRICTION CREEP PHENOMENON OF ADHESION BETWEEN STEEL WHEELS AND RAILS

This paper presents a summary of the laboratory and field tests conducted by the Electro-Motive Division of General Motors to evaluate the friction and creep phenomenon of adhesion between steel wheels and rails. The available adhesion coefficient between the driven wheels and rail is a primary factor in determining the amount of power that can be converted to tractive force by the locomotive. Details are given concerning experimental investigations of the rolling contact friction-creep phenomenon which were conducted using model equipment and field scale tests on an SD-15 model locomotive. The major findings and conclusions resulting from the tests are discussed, and comparisons are made between the laboratory and field data and analytical and experimental results of published investigations in the same field. A discussion of the paper by K. L. Johnson (University of Cambridge, England) is also given.

Marta, M. A., Mels, K. D., and Itami, G. S. (General Motors Corp., Electro-Motive Division, La Grange, Ill.), 1971 Rail Transportation Proceedings, IEEE/ASME Railroad Conference, 10 figs., 31 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Institute of Electrical and Electronic Engineers (repr., PC).

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1425

TENTATIVE STUDY OF STRESSES IN A RAIL BY PHOTO-ELASTIC AND STRAIN MEASUREMENTS

The behavior of the metal in rails and wheels at the contact zone, as reported by the ORE (Office of Research and Experiment, IUC) in reports C53/RP-2 and RP-5, is summarized. These reports deal with the dependency on the magnitude and distribution of stresses in the vicinity of the contact surface. Three techniques were used in conducting these studies: mathematical, photo-elastic measurements conducted at the SCNF Laboratory at Levallois, and mechanical tests on models at the laboratory of the Ecole Polytechnique, Paris. The two reports discussed in this paper deal in detail with the photo-elastic study supplemented by a brief study of strains measured in both a simplified steel rail and a real rail.

Rail International (Monthly Review of the International Railway Congress Association and of the International Union of Railways) [Communications of ORE], Vol 1, No. 6, June 1970, pp 438-439, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Railway Congress Association (repr., PC).

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1426

MECHANISM OF ORIGIN OF CORRUGATION ON RAIL CONTACT SURFACES WITH WHEELS [IN CZECHOSLOVAKIAN]

Prevailing views on the corrugation condition (alternate bright and dull surfaces representing peaks and valleys of 4 to 6-cm wavelength and 0.5-mm amplitude) are discussed. The course of plastic deformation at the wheel-contact rail surface and its conformation to a corrugation pattern were determined. A thin oxide layer was detected at the rail-contact surface. A mechanism for the origin of corrugation is

hypothesized; the main course is considered to be the alternating sliding and rolling action of the wheels and the plastic deformation under the wheel contact surface.

Masin, A. (Vyzk. Ustav Dopravni, Praze, Czechoslovakia), Sbornik Praci VSD VUD, No. 56, 1973, pp 39-59, 22 figs., 13 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: International Union of Railways (repr., PC).

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1427

VEHICLE STRENGTH AND VIBRATION INSPECTION CAR, SUYA 11 [IN JAPANESE]

Japan National Railways has recently built a vehicle strength/vibration test car (Model SUYA 11) with a view to obtaining quickly and accurately data on the strength or stability of railway cars while running on the track.

This test car is capable of determining the following: load or stress exerted on different parts of railway vehicles while they are running; vibrations on different parts of vehicles; displacements on different parts of vehicles; load on wheel axles such as wheel weight and lateral force, and derailment coefficient; and the temperature, atmospheric pressure, hydraulic pressure, etc., on different parts of vehicles. The report outlines the construction and performance of this test car.

Kageyama, M. (Japan National Railways, Chiyoda, Tokyo, Japan), Traffic Techniques, Vol 25, No. 9, 1970, pp 354-356, 5 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Traffic Association (repr., PC).

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1428

THE MANAGEMENT OF DEFECTIVE RAILS BY THE RAIL TESTER (WITH CRT) [IN JAPANESE]

A device incorporating a cathode ray tube has been designed which permits the accurate detection and location of rail defects. By means of this device a rail defect control chart is produced which makes possible monitoring the condition of the rails. Rail maintenance and repair can be undertaken on the basis of the location of defect echoes and defect conditions shown on the chart.

Kondo, T. (Japan National Railways, Nagoya, Japan), Tetsudo Senro, Vol 12, No. 12, 1969, pp 657-661, 6 figs., 7 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1429

THE DYNAMICS OF RAILWAY VEHICLES ON CURVED TRACK (THE SIMULATION OF THE BOGIE VEHICLE ON CURVED TRACK) [IN JAPANESE]

This study presents the data obtained through simulation of a bogie-type car operation on a S-shaped curved track on a horizontal level for such purposes as improvement of the running performance of vehicles and checking their safety. For comparison, the study presents data obtained through actual measurement in tests conducted on actual vehicles. Finally, the study discusses some surveys carried out on such items as the influence of nonlinear elements.

As a result, the study confirms that the model, though it is a relatively simple one whose degree of freedom is 4, is one that will be adequate for actual use.

Ishida, M., Ishii, M., and Makai, M. (Kinki Nippon Railway Technical Research Institute, Japan), Transactions of the Japan Society of Mechanical Engineers, Vol 38B, No. 315, 1972, pp 2797-2806, 16 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Society of Mechanical Engineers (repr., PC).

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1430

RAIL SHELLING OF THE MUTUAL EXTENSION LINE AT KOBE HIGH SPEED RAILWAY [IN JAPANESE]

Since about 1970 the phenomenon of rail shelling has been observed in the tracks located in the service areas covered by shared extensions of routes by private railways in the Kansai district. This report presents the results of an inquiry into the locations where the shelling occurred and the causes of the phenomenon. It was found that shelling occurred most frequently in the rail head and in gauge corners, and many instances of rail shelling affecting the rail head occurred where the curve radius of the track ranged from 400 to 700 mm.

It was also found that those locations where lubricant oil had been amply applied showed many instances of rail shelling. Consequently, rail shelling occurred very frequently in subway sections where rails were not exposed to rainfall. However, it is difficult to determine the appropriate amount of lubricant oil from the viewpoint of shelling prevention because lubrication is effective in preventing wear and reducing noise.

Private Study Group on Shelling (Nippon Steel Corp.), Tetsudo Senro, Vol 21, No. 7, 1973, pp 325-329, 3 figs., 5 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1431

THE MODIFIED RAIL TEST CAR FOR SHINKANSEN [IN JAPANESE]

The rail defect detection car described in this report is designed to perform continuous ultrasonic inspection of rail defects, while running at a speed of 30 km/hr or above, by means of the rail defect detector installed on the car.

The report shows the results obtained by testing the detection capacity, as well as the reproducibility of defect detection of the equipment for horizontal fissures in the base of rail and horizontal fissures in the head of the test rails with artificial flaws on them. For both the artificial flaws in the base and defects on the surface, detection was repeated 16 times on each location, with a 100 percent defect detection capability.

Katayama, M. (Japan National Railways), Tetsudo Senro, Vol 20, No. 12, 1972, pp 689-693, 7 figs., 3 tables.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1432

TRACK IRREGULARITY INSPECTION EQUIPMENT [IN JAPANESE]

At high speed, it is necessary to detect the wavelength component of approximately 50 m for the track surface irregularity and to perform proper adjustment of the track. The detection work has hitherto been performed by means of the 20-m "genseiya" (20-m span chord and bow measuring method for rail irregularity) or by inspection with a long-wave track surface inspection machine in addition to the inspection performed by means of the 10-m "genseiya" method.

The present study describes the principles, as well as the construction and performance, of track irregularity waveform inspection equipment which has been manufactured on a trial production basis with a view to making it possible to perform these kinds of inspection simultaneously with one unit of inspection equipment.

Sato, Y. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Tetsudo Senro, Vol 19, No. 2, 1971, pp 112-113, 5 figs., 4 refs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1433

SCALE MODEL TEST WITH TRACK IRREGULARITY EQUIPMENT [IN JAPANESE]

This study dealt with an inquiry into the influence exerted by the irregularity of track alignment on the running of railway vehicles.

The scope of the experiment was the use of 1/5-scale model experimental equipment corresponding, in terms of actual track alignment irregularity, to a wavelength ranging from 10 to 50 m and to a wave height ranging from 10 to 25 mm while the speed employed was such as would correspond to 120 km/hr. The experiment was conducted on track irregularity, speed, vibration accelerations of the car body toward right and left and also upward and downward, lateral force, wheel load, etc., the right and left oscillation amplitudes of the wheel axles and the bogie truck frame of the model vehicle, etc.

Aoki, M. (Japan National Railways, Osaka, Japan), Tetsudo Sensro, Vol 19, No. 2, 1971, pp 109-111, 8 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Civil Engineering Association (repr., PC).

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1434

STUDY ON TRACK INSPECTION EQUIPMENT USING ACCELEROMETER (PART 1) [IN JAPANESE]

The 10-m "genseiya" method (10-m span chord and bow measuring method for rail irregularity detection), which has hitherto been used for detecting surface irregularity, is not satisfactory for a high-speed range such as that of the New Tokaido Line, which requires a still higher level of inspection capacity covering a wider range from a still shorter wavelength to a longer wavelength. This study presents a description of track irregularity inspection equipment, which was manufactured on a trial production basis, and the results of the studies of the problems encountered in the course of its operation.

Takeshita, K., and Kishimoto, T. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 3, 1975, p 104, 2 figs.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute-JNR (repr., PC).

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1435

A CONCEPTION AND PLAN OF THE 961 HIGH SPEED TRACK INSPECTION MACHINE [IN JAPANESE]

In a speed range in excess of 200 km/hr, the track maintenance with the existing high-speed track inspection car which performs inspection primarily by means of a 10-m "genseiya" method (10-m span chord and bow method for track geometry measurements) is insufficient. It is important to exercise control over the track irregularities of short wavelength (approximately 1 m) which are associated with wheel load fluctuations caused by the unsuspended mass and the elasticity of the track as well as over track irregularities in the range of several tens of meters which are associated with the natural vibration of vehicles. This work describes the conception and design of Model 961 High Speed Track Inspection Machine (HISTIM) which has been developed for the purpose of making it possible to perform inspection and measurement of such track irregularities.

Sato, Y., Takeshita, K., and Ishii, T. (Railway Technical Research Institute, JNR, Kokubunji, Tokyo, Japan), Journal of Railway Engineering Research, Vol 32, No. 4, 1975, p 140, 1 fig.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Railway Technical Research Institute-JNR (repr., PC).

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1436

APPLICATIONS OF TEST DATA OF TRACK INSPECTION CAR IN SHINKANSEN [IN JAPANESE]

With a view to performing track maintenance and control work on the New Trunk Line with greater efficiency, an electric comprehensive track inspection car was completed in October 1974. The car started its inspection work in March 1975 upon completion of the adjustment of its various measuring devices.

This paper outlines the specifications of this comprehensive track inspection car and its measuring equipment, etc., and provides a discussion of the effective use of the measurement data obtained with the car.

Kajikawa, O. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Senro, Vol 23, No. 6, 1975, pp 278-280, 6 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1437

EXPERIMENTAL INVESTIGATIONS OF RAILS [IN RUSSIAN]

Articles are presented that deal with stress investigations associated with Soviet and U.S. heavy rails. The experimental investigations being discussed involve the distribution of major stresses and the plastic deformations occurring in the upper portion of the rail head. The mechanical properties of the R-65 rails are discussed along with their physical characteristics. Experimental data are used to determine the coefficient of cycle asymmetry and the distribution of useful service life. Approximate relationships between the weight of the rails and operating factors are derived.

Shakhunyants, G. M., Turovskiy, I. Ya., Smirnova, N. B., and Nikonov, A. M. (Moscow Institute of Railroad Transportation Engineering, U.S.S.R.), Trudy-Moscow Inst. Inzhenerov Zheleznodorozhnogo Transporta, No. 271, 183 pp, 34 figs., 94 tables, 75 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1438

THE EFFECT OF RIGIDITY AND ROUGHNESS OF A RAILWAY TRACK ON DEFORMATIONS, VIBRATIONS, AND INTERACTION FORCES OF ITS ELEMENTS [IN RUSSIAN]

The results of experimental investigations of the effect of roughness on rails and rigidity of rail fastening on track deformations, vibrations, and interaction forces on track elements are discussed in relation to their involvements with ferroconcrete crossties. The causes of extreme rigidity and the effects of vertical elasticity and rigidity of rail spacer ties on track deformations are examined. The stressed state of rail-support anchors used with ferroconcrete crossties and blocks is investigated.

Lysyuka, V. S. (Scientific Research Institute for Railroad Transport, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 370, 1966, 166 pp, 76 figs., 49 tables, 105 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1439

PROFILOGRAPH FOR MINE RAILROADS [IN RUSSIAN]

The profilograph which is designed to assess track-level parameters and to obtain tracings of the longitudinal profiles of rails in horizontal mine shafts is described. The instrument is operated manually by rolling it along one rail. Typical data taken from a rail test are given and analyzed.

Katsman, V. M., and Grinberg, Ye. S. (All-Union Scientific Research Institute of Mine Surveying, U.S.S.R.), Ugol', No. 1, 1973, pp 56-57, 1 fig., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1440

SELECTION OF OPTIMUM CONDITIONS FOR THE HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT OF RAIL STEEL [IN RUSSIAN]

A process that produces a troosite steel structure by using a high-temperature thermomechanical treatment is described. The mechanical properties of two types of steels subjected to the heat treatment and metal working are discussed. The effects of recrystallization on the steel properties before and after thermomechanical treatment were studied. The best combination of mechanical strength and plasticity was found to be at the 950 C austenization temperature and 980 C temperature for deformation. The regimes of thermomechanical treatment are shown for each type of steel on the basis of their austenization and deformation temperatures.

Zonov, P. N. (Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 464, 1972, pp 3-10, 3 figs., 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1441

EQUIPMENT FOR WELDING OF RAILS [IN RUSSIAN]

This book provides extensive information and data concerning the equipment, materials, techniques, and procedures for the welding of railroad rails. These processes and equipments involve spot-welding, continuous-fusion welding, gas-rail welding, and thermit-butt welding. Miscellaneous tools used for the purpose of cutting, cropping, drilling, and edging are discussed, as well as the maintenance of these tools. The use of ultrasonic inspection equipment for the purpose of quality control of welding is discussed. The book concludes its coverage of welding by describing the organization of welding and maintenance of rails on Soviet and other countries' railroad systems.

Sharov, I. F., Kuznetsova, V. N., Kuchuk-Yatsenko, S. I., Vorob'yev, A. A., and Bulba, T. G. (Moscow, U.S.S.R.), Transzheldorizdat, 1963, 267 pp., 102 figs., 46 tables, 16 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1442

EVALUATION OF THE PLASMA TORCH: STUDY OF OPERATIONAL TESTING AND EVALUATION OF AN ARC PLASMA GENERATOR AS A MEANS TO IMPROVE WHEEL/RAIL ADHESION

The effectiveness of the d.c. arc plasma generator as a tool for improving wheel-rail adhesion has been evaluated on the British Railways network under a wide range of conditions. Two torches were used per rail, and found to be extremely effective in eliminating low adhesion areas. In general, adhesion values of 0.1 to 0.2 were increased to nearly 0.3. More specifically adhesion corresponding to the 2% slip risk level, averaged over all tests in the speed range up to 30 miles/hr was increased from 0.19 to 0.29.

Significant enhancement of adhesion has been found on the track up to six hours after treatment with the plasma torch even though climatic changes had brought about changes in the adhesion of both control and test sections. Over longer periods, the passage of large numbers of freight and passenger trains serves to distribute fresh contamination over the test and control sections thereby changing the identity of the sites.

The power level used in the trials was such that no damage could occur to the rails. Experiments in the laboratory have shown that even with much greater plasma powers the mechanical properties of rail steel were unaffected. This provides a high level of operational safety should the power control system malfunction.

With this equipment the problem of wheel slip on starting, for heavily laden freight and passenger trains, can be confidently said to be overcome. (Carried as RRIS Accession No. 0487.)

Dobbs, D. J. (British Railways Research Board, Electrical Research Division, Derby, England), Report No. FRA-RT-70-27, January 1970, for DOT/FRA/Office of High-Speed Ground Transportation, Contract No. DOT-FR-9-0009, 54 pp, 40 figs., 1 table, 11 refs.

ACKNOWLEDGMENT: Railroad Research Information Service.

PURCHASE FROM: NTIS, PB 192 885 (repr., PC, microfiche).

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1443

A NEW THEORY OF ROLLING CONTACT

The report proposes an entirely new theory of rolling contact. Surfaces are modeled as rough (although rough in this context applies even to ball-bearing smooth surfaces which are rough on the micro scale) and are described statistically. When two rough surfaces are pressed together, their peaks (known as asperities) press against each other and form junctions. Friction in the interface is caused by the shearing of these junctions. An important result of this model is that the relationship between the dimensionless friction force and the dimensionless lateral slip velocity depends on the surface roughness of the wheel and track. This surface roughness is described by a roughness (or smoothness) parameter. The influence of the roughness on the friction is postulated and described. Finally, experimental results are presented which support the conclusions that surface roughness is a relevant parameter in rolling contact and that the force-slip relationship is strongly dependent on surface roughness. (Carried as RRIS Accession No. 039100.)

Kayak, P. R., and Paul, I. L. (Massachusetts Institute of Technology, Engineering Projects Laboratory, Cambridge, Mass.), for DOT under Contract No. C-85-65t, April 1968, 156 pp, 41 figs., 36 refs., 3 appendixes.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: NTIS, PB 179 433 (repr., microfiche).

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1444

RESEARCH OF THE WORK ON TIES AND RAILS [IN RUSSIAN]

This book contains a collection of articles on the research of the work on ties and rail, specifically the work on elastic rubber packings for tracks with ferroconcrete sleepers, plastic deformation of the tread contact surface of rail heads, and the work behavior of a railroad track during initial stabilization. Also included is an article on construction advantages of glue-bolted insulating joints and the efficiency of their use.

Shakhunyants, G. M., Vorob'ev, E. V., Nikonov, A. M., Akuratov, A. F., et al. (Moscow Institute of Railroad Transport Engineering, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 354, 1971, 120 pp, 44 figs., 48 tables, 51 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1445

MEASUREMENT AND CONTINUOUS RECORDING OF INTERACTION FORCES BETWEEN LOCOMOTIVE WHEEL PAIRS AND RAILS [IN RUSSIAN]

This book contains results of experimental and theoretical investigations of methods for measurement and continuous recording of transverse horizontal forces active between the locomotive wheel and the rail. It includes an investigation of strain-gage systems used in recording the forces affecting the track and an analysis of error when measuring vertical forces associated with the impact characteristics of load application.

Shafranovskiy, A. K. (Scientific Research Institute of Railroad Transportation, Moscow, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 389, 1969, 118 pp., 42 figs., 47 tables, 47 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1446

WAYS OF IMPROVING THE EFFICIENCY OF RAILS AND FROGS [IN RUSSIAN]

This book contains a collection of articles on ways of improving the efficiency of rails and frogs. Improvement involving the rail is concerned with all the processes used in its fabrication. Discussed from the metallurgical standpoint are the hardening of rail steels by subjecting them to pulsed loads in different media, production of rails from ingots obtained by continuous casting; of steel, and research on some properties of high-strength steel. In the interest of rail quality, articles herein include research of nonmetallic inclusions and gases in experimental rails, ways to improve the contact durability of rail steel, methods and parameters of rail-life evaluation, technological factors associated with heat-treated-rail properties, quality of surface-hardened rails from Bessemer steel, and the sources of end warping of through-hardened rails. The effects of forces and loads on the rail are discussed in articles dealing with development of fatigue cracks during cyclical stressing, changes in residual stresses during production, and the kinetics of crack development in the ends of the rail.

Vlasov, V. I., Malygin, Yu. N., Polyakov, V. V., Rauzin, Ya. R., Shur, Ye. A., Velikanov, A. V., and Rabinovich, D. M., et al. (Scientific Research Institute of Railroad Transport, U.S.S.R.), Trudy Vsesoyuz. Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 434, 1971, 216 pp., 87 figs., 40 tables, 103 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1447

EXPERIMENTAL INVESTIGATION OF BASIC BENDING STRESSES IN THE VERTICAL PLANE FOR HIGH VELOCITIES OF MOTION [IN RUSSIAN]

Results of an experimental investigation of bending stresses in the lower fillet at the base of a rail in the interactions of the rolling stock resulting from a velocity of 100 to 200 km/hr are considered. It was established that stresses increase less rapidly when a velocity of 160 to 180 km/hr is reached.

Andreyev, G. Ye. (Leningrad Institute of Railroad Transportation Engineering, U.S.S.R.), Sbornik Trudov Leningradskiy Inst. Inzhenerov Zheleznodorozhnogo Transporta, Vol 71, No. 328, 1971, pp 23-43, 7 figs., 5 tables, 19 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1448

ROLLS OF STRUCTURAL AND RAIL AND STRUCTURAL MILLS [IN RUSSIAN]

The technological processes in the rolling of structural sections are reviewed. A description of the Soviet rolling mills, the rolls, the dimensions of them, and their material mechanical properties is presented. The production capabilities of the various plants are given. The rolling-mill practices involving the effects of individual elements within the system and their assembly, manufacturing, and maintenance are discussed.

Beznos, M. P. (Ukrainian Research Institute of Metallurgy, U.S.S.R.), Metallurgiya, Vol 13, No. 6, 1966, 124 pp, 31 figs., 4 tables, 25 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore and FSL (repr., PC).

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1449

MANUFACTURE OF HIGH-STRENGTH RAILS WITH THE USE OF A VACUUM [IN CZECHOSLOVAKIAN]

Production of rails of improved strength by vacuum treatment of melts during the pouring process from one ladle to another is described. The steels used contained 0.67% to 0.80% carbon and 0.70% to 1.00% manganese. It was observed that controlled cooling after rail rolling was unnecessary with this treatment because it decreases the hydrogen content by 55%; however, the process has no effect on oxygen and nitrogen content or on nonmetallic inclusions. It was concluded that the rails do not flake after vacuum degassing, and ultrasonic inspection of the rails after several months of service shows them to be free from defects. Tabulated data showing the melt temperatures, chemical compositions, and vacuum-degassing pressures are given.

Motloch, Z., Horejs, S. (Vyzkumny Ustav Metalurgicky VZKG, Ostrava, Czechoslovakia), Hutnicke Listy, Vol 20, No. 7, July 1965, pp 468-473, 2 figs., 5 tables, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: SNTL-Publishers of Technical Literature (repr., PC).

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1450

EFFECTS OF INGOT MOULD DESIGN ON THE QUALITY OF CONVERTER STEEL RAILWAY RAILS

The work of a number of researchers and their publications covering the part played by the ingot mold during the early stages of crystallization in a large ingot, as well as investigations of thin-walled ingots are reviewed. The authors note that certain factors have not been considered in these studies, such as ingot surface defects, chemical heterogeneity, and conditions of external cracking. Experiments in the use of thin-wall and small molds, in which particular attention was given to the quality of the ingots as well as to the economic benefits in the use of each size of mold, are described. Data from these experiments show that a higher proportion of transverse cracks were present in specimens taken from the thin-walled molds. It was found that although the thin-walled mold provided a decrease in mold consumption, this was out-weighed by the lower proportion of high-grade rails produced.

Kutsenko, A. D., Rekhlis, G. N., Sologub, S. L., and Karpunin, A. M. (Dzerzhinskii Iron and Steel Works, U.S.S.R.), Stal [in English], No. 5, May 1964, pp 363-365, 4 figs., 1 table, 9 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1451

NATURAL AGING OF OPEN-HEARTH RAIL STEEL

This paper contains the results of a study of the natural aging (storage at room temperature) of open-hearth rail steel which was conducted in order to justify a requirement believed necessary for rail steelmaking specifications. It is pointed out that during the natural aging process the mechanical properties of rail steel (0.60 to 0.80% carbon) do not change in the same way as the properties of low-carbon steel: the yield point, tensile strength, and hardness remain unchanged; elongation and reduction of area show a marked increase during the first 8 to 23 days; and impact strength undergoes no change for 140 days but then decreases somewhat. To justify the need for some requirement for natural aging, an experiment was conducted which involved the measurement of the mechanical properties of R-50 and R-65 rails after aging periods of between 3 and 309 days. Data plots show how mechanical properties change after a period of aging at room temperature.

Mikhailets, N. S., and Nikulin, N. G. (Kuznetsk Metallurgical Combine, U.S.S.R.), Stal [in English], No. 7, July 1967, pp 562-565, 2 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Iron & Steel Institute and The Metals Society (repr., PC).

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1452

IMPROVEMENT OF HIGH SPEED TRACK INSPECTION CARS [IN JAPANESE]

A discussion is presented on the production, increases in the number of units, and transition in the structure of a high-speed track inspection car capable of dynamic and high-efficiency measurement of items relating to such maintenance conditions of railway tracks as the irregularities or deformations of tracks and oscillations of trains. This work deals chiefly with the body and the measuring equipment, etc., of an improved model of the high-speed track inspection car.

Sakurazawa, T. (Japan National Railways, Chiyoda, Tokyo, Japan), Tetsudo Searo, Vol 16, No. 7, 1968, pp 315-319, 8 figs., 1 table.

ACKNOWLEDGMENT: Mitsubishi Research Institute, Inc.

PURCHASE FROM: Japan Railway Civil Engineering Association (repr., PC).

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1453

RAIL FAILURES CONSIDERED AS A FACTOR IN MODELING OPERATIONAL RELIABILITY OF RAILROAD TRACK SURFACE

This paper is concerned with the concept of a model of reliability of the railroad track surface and, in addition to the theoretical study, an empirical study is provided on rail reliability. The modeling of track failures must consider three operational states: fitness, unfitness, and limited fitness. The selection of characteristics of fitness depends on the purpose for which the system is intended, and the intervals between and durations of operational states. An illustration showing transitions from one state to another is given. A description of the model and a demonstration of its use in the analysis of a set of individual replacements of rails in selected sections of the Polish State Railways network are provided. An analysis of the results of simulation computations indicated that the method was effective in predicting interruptions of service caused by individual replacements of rails.

Baluch, M., and Fijelek, M., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice, Poland, November 14-16, 1974, pp 5-22, 8 figs., 4 tables, 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1454

OPERATIONAL CONDITIONS OF RAILS OF CONTACTLESS (JOINTLESS) RAIL TRACK

The advantages of continuous welded track over those of jointed track are discussed. This involves savings in steel and use of crossties, lower costs in maintenance of the track and rolling stock, lower resistance to motion and better, more efficient traction, and quiet running of faster trains. The principal disadvantage - the track's constant state of thermal stress - is reviewed and mathematical expressions are given for its calculation. Conditions of rail buckling, elongation, and contraction are assessed. Some measurements of thermal stresses which were made on sections of a continuous welded track are given. They were found to approach 450 kg/mm^2 over a period of 24 hours, and up to 1200 kg/mm^2 on an annual scale depending on the fastener temperature and the coefficient of linear expansion of the rail steel.

Bogdaniuk, B., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice, Poland, November 14-16, 1974, pp 23-31, 6 figs., 9 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1455

DAMAGE TO RAILS OCCURRING IN THE POLISH STATE RAILWAYS NETWORK

This paper consists of a coverage of reports prepared by the Polish State Railways concerning damaged and broken rails in the systems. The classification of damage and breakage of rails is based on the UIC catalog which identifies 56 basic rail defects. Graphical illustrations which show the trends between 1963 and 1973 of damage and breakage of rails by year, and some representative monthly mean temperatures for the 1963-1965 years are given. A brief discussion of defects such as longitudinal cracks, vertical split heads, bolt-hole cracks, transverse cracks, fatigue cracks, transverse fractures, and welded joint fractures is provided. The various welded techniques used in rail joining are discussed in connection with the types of failures that occurred in a particular region. Data are plotted to show the severity of damage and rail fracture according to the classifications of defects.

Pustelnik, I., and Sendur, L., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice, Poland, November 14-16, 1974, pp 32-43, 15 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish Version, repr., PC).

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1456

EFFECTS OF CHEMICAL COMPOSITION OF STEEL ON MECHANICAL AND OPERATIONAL PROPERTIES OF RAILS USED ON RAILROAD LINES

This paper describes investigations conducted by the Center for Research and Development of Railroad Technology (Poland) and the metallurgical industry for the purpose of improving the operational properties of rails through increases in manganese content of rail steel and determining the optimum carbon content. The methods used for selecting the steel samples and their production processes are discussed. The effect of chemical composition on the mechanical properties of the different types of steel was examined by means of statistical correlation. Results of the data analysis are presented graphically.

Swiderski, Z. (Center for Research and Development of Railroad Technology, Katowice, Poland), Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 44-75, 21 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1457

DEVELOPMENT OF QUALITY AND METHOD OF PRODUCTION OF STEEL USED IN MAKING RAILS IN EUROPE FROM 1935 TO THE PRESENT

The steady growth in the last four decades of loads carried by rail and the changes that were necessitated by the effects of heavier loads and higher speeds on European railroads are reviewed. The major changes that have taken place in the course of the last 40 years in rail design and the method of melting steel are described. In Europe, particularly in France, the Federal Republic of Germany, Belgium, and Luxembourg, the Thomas process was used most frequently. It has been gradually replaced by the oxygen processes,

including the LD process used for hematite raw materials, the LDAC process, and the related DLP process for the phosphorous raw materials, the Saldo process and, finally, the latest DBM. The latter has resulted in the complete replacement of the Thomas process. The problems discussed in this historical review include: types of rails steel, external purity and oxygen content, inclusions, methods of purity control, steel production, rail profiles, and rail calibration.

Conti, R., and Mauer, J., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 90-121, 5 figs., 5 tables.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1458

EFFECT OF SIZE AND SHAPE OF INGOT MADE OF KILLED STEEL ON PHENOMENA OF MACROSCOPIC AND ZONAL SEGREGATION IN ST-72 P STEEL

Studies of runner-box ingots, which are convergent downward as well as upward, and also ingots without runner boxes, weighing between 4.5 and 7.2 tons are described. The studies are concerned with distribution of zone segregation of carbon, phosphorus, and sulfur, covering the areas where sedimentation cones are formed, V segregation occurs, secondary contraction pits form in the runner-box ingot that converges upward, and the primary pits that occur in normal ingots. An analysis is presented of the distribution and degree of segregation, particularly of carbon, in the various types of ingots, while estimating their effect on the mechanical properties over the entire cross section of the ingot, with reference to the requirements specified by the standard PN-70/H-93421

Hansel, W., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice, Poland, November 14-16, 1974, pp 122-161, 33 figs., 12 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1459

EXPERIMENTS IN THE AREA OF PRODUCTION OF RAILS MADE OF STEEL DEGASIFIED BY THE VACUUM PROCESS

A brief history of the Kosciuszko Steel Works, which is one of the oldest metallurgical works in Upper Silesia and Europe, is presented in connection with its construction in 1798 and its rate of steel production throughout the years to the present time. A discussion is given of the process of installing and operating modern equipment for vacuum degasification of rail steel of the DH type, casting in runner-box ingot molds, rolling in the modern system of calibration, leveling in the horizontal as well as vertical planes on a seven-roll straightening machine and, the more recent method of checking each rail by ultrasound which guarantees a high-quality product. The qualitative results obtained with regard to finished rails show clearly that there is a definite need for further exploration of the area of possible reduction in defects by selecting the appropriate optimal conditions for casting.

Kumik, H. (Kosciuszko Steel Works, Upper Silesia, Poland), Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice Poland, November 14-16, 1974, pp 167-171, 3 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1460

LORRAINE STEEL AND LAMINATING PLANTS

The operations of the metallurgical plants of the SACILOR Company in France are described. SACILOR, the only French manufacturer of railroad fittings, has a production capacity of 500,000 tons of railroad fittings annually (heavy rails, light rails, girders, railroad washers, and fishbars), which places it in the forefront of rail manufacturers in Western Europe. The metallurgical works at Hayange can produce 360,000 tons of heavy rails annually. A description of the processes employed at the Hayange works in connection with steel production, rolling of rails, and rail finishing is given. The cooperation and exchange of information between the rail manufacturers and the SNCF is emphasized.

Poissonier and Vicens (SACILOR Company, Hayange, France), Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry in Poland, Katowice, Poland, November 14-16, 1974, pp 204-214.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1461

STUDIES OF IMPROVEMENTS OF MECHANICAL AND OPERATIONAL PROPERTIES OF RAILS

Studies which are designed to establish production of rails characterized by particularly high resistance both to wear and tear as well as flaking during railroad operations are described. Efforts devoted to increasing the mechanical and operational properties of the rails by selecting the appropriate chemical composition of the steel, and application of heat treatment to rails made of steel of standard quality or low-alloy steel are discussed. As a result of the studies, such methods as through hardening with tempering, isothermic treatment, surface hardening by induction or gas heating, and thermal improvement from the heat of the rolling process by controlled cooling have found practical application. The improvements resulting from the application of these techniques are shown in the mechanical properties of the rails. Recommendations are made regarding problems to be solved to obtain better fatigue and impact strengths.

Andrejew, L., and Struk, S., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 215-222, 7 figs., 2 tables, 8 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1462

STUDY OF INTERNAL STRESSES IN RAILS ON RAILROAD LINES

Studies of internal stresses in new and operating rails carried out in the past five years at the Polytechnical School in Gdansk, Poland, are reviewed with regard to the magnitude of these stresses and the operational factors that cause them. The rails used for the study were cut into a number of perpendicular elements and examined. The approach for determining internal stresses on the rail surface and in the rail is explained, and their specific components are shown. Details of laboratory studies conducted on rails manufactured by the Polish Metallurgical Works, including specific numerical data, are given. It is concluded that the primary factor which brings about the state of internal stresses is the process of rail straightening. The secondary factor which effects considerable change in the state of stresses (particularly in the rail head) is the initial period of operation of the rail.

Radomski, R. (Polytechnical School, Gdansk, Poland), Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 223-238, 12 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1463

EFFECTS OF COOLING AND STRAIGHTENING ON INTERNAL STRESSES IN RAILS

This paper describes a study of the process of the cooling of rails in the open air in a cooling plant with a stationary cooling bed. Not all rails are cooled under the same conditions. The conditions vary depending upon the degree to which the cooling plant maintains the sequence of rolling, interruptions of rolling, and shifting of rails which are still hot while the cooled rails are being collected. The purpose of this study was to investigate the problem and to introduce certain changes in the finishing process in order to obtain differences in the stresses which could be beneficial for the operation of the rails. The study also considers two methods of rail straightening: straightening immediately after cooling or after a certain period of time after storage, and in the "standing" or "lying" position in one or two straightening machines. Both destructive and nondestructive methods for measuring internal stresses are described.

Majdanik, A., and Struk, S., Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 239-247, 3 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1464

ULTRASONIC TESTING OF RAILS IN PRODUCTION PROCESS

Ultrasonic testing of rails in the production process at the Kosciuszko Metallurgical Works is described as the type that employs the reverberation method which uses a system of a transmitter and receiver operating at a frequency of 3 MHz. The modes of application, the equipment's general construction, and the operating procedures are discussed. The factors which affect the accuracy of ultrasonic testing, such as the quality of the surface and speed of the rail movement, are briefly considered. It is concluded that ultrasonic testing in the course of the production process effectively eliminates rails which have flake cracks and that it can be used in a system of automated rejection.

Kurek, M., Lasota, L., and Stryk, A. (Kosciuszko Metallurgical Works, Poland), Conference Proceedings by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 248-252, 2 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1465

TESTING OF OPERATIONAL RAILS BY A DEFECTOSCOPE

This report discusses the use and effectiveness of the defectoscope in detecting hidden rail damage, and describes the testing of rails on the Polish State Railways (PKP) by this means. The author states that the effectiveness of the defectoscope depends on: the proper application, frequent application, adequacy of criteria selected for evaluating hidden defects, and compliance with post-test recommendations. A general description of a manually operated defectoscope, the UNIPAN-550, is presented, and its operating procedures are discussed. The threshold of sensitivity which has been adopted at present enables the defectoscope to discover flakes, which are the cause of fatigue-crack development. References

are made to the Law of the Development of Crack No. 211 proposed by ORE in regard to tests on rail lines with a gross tonnage of between 20 and 45 million tons. These tests were carried on until the width of the crack reached 10 to 12 mm. The data are plotted and the relationship between the exponential function for crack development and gross tonnage is discussed.

Chmiel, E. (Polish State Railways, Poland), Proceedings of the Conference on Achievements and Development Trends in Production and Exploitation of Rails, published by the Association of Engineers and Technicians of the Metallurgical Industry of Poland, Katowice, Poland, November 14-16, 1974, pp 253-263, 10 figs., 1 table, 10 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kubon and Sagner (Polish version, repr., PC).

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1466

RAILS MADE FROM CONTINUOUS CAST INGOTS [IN RUSSIAN]

This article reveals the results of comparative tests of rails rolled from continuous cast slabs and from the usual ingot molds. Rails rolled from continuous cast slabs have sharply defined zonal segregations in the middle of their cross-section. This is evidenced by the occurrence of peculiarities in the crystalline structure of the slab during cooling. The segregation is attributed to certain production factors. The strength and plasticity characteristics of the continuous cast rail metal and those of the ingot metal do not basically differ. Illustrations are provided which show the macrostructure of the rail produced by continuous casting, sections of specimens used for study, and the average values of rail strengths and plasticity characteristics of the metal from various zones in the rail.

V'asov, V. I., Inshakov, N. N., and Komolova, Ye. F., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 5, 1966, pp 12-16, 4 figs., 6 tables.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1467

PROGRESS REPORT ON SHELLY RAIL STUDIES

This is a progress report on a study which was initiated in 1946 to investigate the possibility of correlating some mechanical property or metallurgical characteristic of rail steel with shelling. Seven different railroads submitted 69 shell rail specimens for examination. The Norfolk & Western Railway also provided three pairs of carbon rails (each of which included one shelled and one unshelled rail) and three chromium rails. These rails were used to compare the mechanical properties and microstructure of rails which had shelled with those which had not, although they had been subjected to the same service conditions. It has been believed by many that shelling cracks start internally and progress radially from these centers; however, examination of shelled rail specimens indicated that shelling also starts at the surface and progresses inwardly. Therefore, much of the metallographic work was directed toward: (1) determining the origin of the shelly cracks, and (2) searching for abnormal defects in the steel. Spectrographic analyses were also made of four rails to determine the amount of 13 different residual elements present in each. These analyses permitted another comparison between rails which had shelled and those which had not.

Blank, H. A., and Manning, G. K. (Battelle's Columbus Laboratories, Columbus, Ohio), Proceedings of the 47th Annual Convention of the American Railway Engineering Association, Chicago, Ill., March 16-18, 1948, Vol 49, Appendix 11-c, pp 446-462, 22 figs., 3 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1468

PHASE CHANGES DURING HEATING OF STRENGTHENED RAIL STEEL FOR USE IN SWITCH POINTS AND FROGS [IN RUSSIAN]

The characteristics of rail steel macrostructures associated with high-strength rail steels were investigated. It is believed that heat treatment through the temperature range of 550-750°C increases hardness due to the separation of high-strength carbides and phase peening. Preliminary strengthening by explosion and static compression results in lowering the initial phase transformation temperature. After explosive strengthening and subsequent heat treatment, an evenly distributed network of carbides and alpha-phases is formed in the structure which shows marked improvement in mechanical properties. Data are plotted which show changes of period of the austenite lattice as a function of heat-treatment temperature.

Strok, L. P., Vlasov, V. I., and Krasikov, K. I. (Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 6, 1971, pp 46-48, 4 figs., 6 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1469

SIXTH PROGRESS REPORT OF THE SHELLY RAIL STUDIES AT THE UNIVERSITY OF ILLINOIS

Based on research conducted and reported in the last five progress reports, two distinct types of rail shelling have been recognized and are shown. The first type starts inside the rail head as horizontal cracks which could develop large transverse fractures. The second type initiates at or near the gage corner as head checks and flaking which gradually work into the rail head. Data are presented, based on rolling-load tests made in a cradle-type machine, which list the types of steel, Brinell hardness, and the number of cycles before fractures occurred. Photos of cross sections of the rails heads that developed shelling cracks during the rolling-load tests are given. From the results of the tests it can be predicted that either heat-treated carbon steel rails or some alloy steel rails can be expected to give two to three times the service life of standard carbon steel rails.

Cramer, R. E. (Engineering Materials Department, University of Illinois, Urbana, Ill.), Proceedings of the 47th Annual Convention of the American Railway Engineering Association, Chicago, Ill., March 16-18, 1948, Vol 49, pp 437-446, 7 figs., 2 tables.

ACKNOWLEDGMENT: American Railway Engineering Association.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1470

RESIDUAL STRESSES IN WELDED VOLUME HEAT-TREATED RAILS [IN RUSSIAN]

Residual stresses in the various portions of rails are examined under various conditions after rolling, tempering, and welding. The investigations provided information on the stress state of volume tempered rails, the changes in stress distributions resulting from flash-butt welding, and the effects of local hardening on inherent stress patterns. Comparisons between the stress conditions after rolling and welding are made. Restoration of hardness in the zone of the welded joint by local heat treatment using an air/water combination for cooling results in an increase in residual stresses by a factor of 2 to 3. The presence of high residual stresses in the area of the web/head zone is believed to have contributed to the appearance of longitudinal fatigue fissure. Data are plotted to show the distributions of residual stresses in the welded and rolled conditions, and the changes in longitudinal and transverse residual stresses near the rail head and web surfaces.

Sinadskii, N. A., and Shlyapin, V. B. (Research Institute for Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 8, 1970, pp 38-41, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1471

RESEARCHERS FIND CAUSES OF RAIL CORRUGATION

This article describes the experiences and study results of the Canadian Pacific Railroad in the problem of rail corrugation that has occurred in the heavy grade/heavy curve territory of Western Canada. As a result of their investigations, Canadian Pacific has proposed a five-point program as a long-range approach to elimination of the contributing factors of the defect. The program involves concentrating on the wheel-rail interface, adoption of self-steering trucks to reduce lateral forces, improvement in rail metallurgy, reexamination of the lubrication policy, and reduction in the magnitude of dynamic rail loading. The nature of corrugation is discussed in relation to its formation and the subsequent wear process. From the study results, it appears that lubricant accumulation plays a large role in the formation of rail surface fatigue. It is recommended that railroads whose traffic levels approach 40 million gross tons per year adopt the proposed five-point program.

Progressive Railroading, Vol 19, No. 1, January 1976, pp 65-66, 3 photos, 1 fig.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Murphy-Richter Publishing Co. (repr., PC).

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1472

VIBRATION OF RAIL UNDER VARIABLE LOAD MOVEMENT [IN RUSSIAN]

This article describes a study which was conducted to investigate the problem associated with rail vibrations caused by load movement on the rail at varying periods in time. The study involved the quasi-statistical calculation of the vibrations based on published articles by N. P. Petrov. The coordinate systems for the calculation of rail vibrations and the method for conversion of contact forces between the wheel and the rail that cause deflections are shown. The frequency characteristics of vibrations in selected sections of the rail are analyzed and the impulse transfer functions associated with them are given. A diagram of the deflections of a rail which arise during the movement of forces on the rails is included.

Kogan, A. Ya., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1968, pp 7-11, 5 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1473

SERVICE LIFE OF RAIL STEEL IN THE TRACK AND ITS IMPROVEMENT [IN RUSSIAN]

This article summarizes investigations conducted in recent years to improve the resistance of rail to contact fatigue. Results are given of operational tests performed with heat-treated low-alloy rails and rails from degassed steel. Basic directions of subsequent work on increasing operational durability of rails are indicated. It is concluded that until the required quantity of heat-treated rails can be produced, alloyed steels rails (primarily with chromium) should be used, particularly in tracks with small-radius curves.

Shchapov, N. P., Zolotarskiy, A. F., and Tsukanov, P. P., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 5, 1963, pp 3-7.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1474

OPERATIONAL STRENGTH AND CHARACTERISTICS OF FAILURE OF CAST HIGH MANGANESE FROGS [IN RUSSIAN]

Field service techniques used in the repair and maintenance of railway frogs are discussed with regard to their failure peculiarities and the means for taking corrective action. In the process for facing the frog, the application of heat to the seam zone restores plastic properties which have been reduced as a result of work hardening, and reduces the danger of fissure formation below the shaft. A specific welding electrode is suggested for use in facing. The authors state that it increases the resistance to fissure formation as well as increasing the gross load tonnage to an average of from 80 to 110 million. Typical examples of horizontal and vertical fatigue fissures, and the development of horizontal separations observed to have occurred in the cores of cast frogs are shown.

Bykov, A. N., Vlasov, V. I., Gorstko, L. G., and Solodkova, V. G., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 2, 1972, pp 41-44, 5 figs., 2 tables, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1475

STUDY OF THE GROWTH OF TRANSVERSE FATIGUE CRACKS IN RAIL HEADS IN RAIL SERVICE [IN RUSSIAN]

The growth of transverse fatigue fissures (Defect 21) in the heads of rails in straight track sections is investigated. It was found that fatigue-crack propagation obeys the exponential law which specifies that the growth of transverse fissure in straight track (in either given direction) depends on the condition of the track and the speed of motion of the train. Establishing the growth intensity of transverse fissures for various section of the track permits forecasting the viability of the rails in a damaged state and the necessary times for nondestructive testing of the rails in these track sections.

Kolotushkin, S. A., D'yakonov, V. N., Kaportsev, V. N., and Poroshin, V. L., (Scientific Research Institute for Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 8, 1971, pp 36-37, 1 fig., 1 table, 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1476

CHANGE IN PROFILE OF RAIL HEADS IN OUTER RAILS OF CURVED TRACK DUE TO WEAR [IN RUSSIAN]

This paper discusses the approaches to and results of a study to determine the profile of an optimum rail for use in curved sections of tracks to reduce the conditions of excessive wear. The cross section of the head of an R-50 rail was examined by means of a profilograph to establish the extent of wear and subsequent relationship to the gross tonnage carried. It appears that a special rail for curves is needed which would have a working surface compatible with the profile of the tire. Suggestions are given which indicate the need for research and development and testing of a new shape of tire and special shapes of rails for the curved track.

Malent'yev, L. P. (Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 4, 1960, pp 42-43, 4 figs., 1 ref.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1477

HETEROGENEITIES IN THE STRUCTURE OF HARDENED/HEAT-TREATED RAILS [IN RUSSIAN]

The macro- and micro-heterogeneities observed in the structure of hardened rails, their causes and methods for improvement in rail structures are investigated. Sections of a rail were examined

in the laboratory for grain structure and hardness. Illustrations are provided to show the macrostructure of the hardened layer in the rail head, and longitudinal fatigue fissures caused by the presence of martensite. The data are plotted to show distributions of hardness after heat treatment, and the presence of sorbite and bainite in the rail steel as a function of tempering temperatures. Plasticity and rail-head ductility are also explored.

Shur, Ye. A., and Rauzin, Ya. R. (Scientific Research Institute of Railroad Transportation, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1965, pp 37-41, 6 figs., 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1478

ANALYSIS OF THE LIFE OF FULLY HEAT TREATED RAIL AND STANDARD RAIL SUBJECTED TO SUCCESSIVE HARDENING [IN RUSSIAN]

This paper describes an investigation into how the mechanical properties of worn rails removed from a track system change in relation to the traffic density and the weight carried. The study also includes investigations aimed at restoring the desired characteristics of the rail heads by successive heat treatments. Impact tests were used to evaluate the effects of volume tempering of worn rails and attempts were made to establish the relationship between the operational mode and the rail head profile on impact and fatigue strengths. Suggestions are given for reducing the risk of rail damage due to various defects, including a recommendation for periodic grinding of the heads.

Poroshin, V. L. (Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 4, 1975, pp 39-43, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1479

THE DESIGN/SELECTION OF RAILS USED ON FERROCONCRETE TIES [IN RUSSIAN]

This article presents information intended for use in the selection and design of rails, based on an analysis using various calculation methods. A method of statistical design of rails is suggested for track construction that utilizes ferroconcrete cross ties. The classical approach used in establishing the basic model of a beam with multiple supports on an elastic foundation is employed in this study.

Afanasyev, V. F., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 6, 1965, pp 19-24, 6 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1430

LOAD INFLUENCE ON THE PLASTIC DEFORMATION AND CHANGES IN THE CHARACTER OF RAIL STEEL [IN RUSSIAN]

An investigation into the mechanisms associated with plastic deformation of the surface layer of rail steels is described. Impact tests were conducted to establish the degree of indentation prior to initiating studies on the relationship between the plasticity of the metal and temperature conditions. The impact tests were conducted on chrome-alloy and Bessemer rail steels and hardness alloys of cold-worked areas were also performed. Change in the material state due to surface deformation was observed. It was found that the plastic deformation was not greatly increased for carbon steel that was heat treated.

Omberg, R. A. (Scientific Research Institute for Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 6, 1962, pp 37-40, 5 figs., 1 table, 8 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1481

LONGITUDINAL FORCES ON WELDED TRACK WITH CONSIDERATION OF THE EFFECT OF TIME [IN RUSSIAN]

This article presents a discussion of studies conducted on locally added stresses caused by longitudinal forces that occur in the middle of the running portion of the rail of welded track. It was revealed that the stresses decrease with time and tend to approach zero. The magnitude of the stress waves of added forces, and also the speed of their damping between the portion in the middle of the head, depends on the character of the vibrations and the rail temperatures.

Novakovich, V. I., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 1, 1972, pp 31-34, 4 figs., 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1482

MEASUREMENT OF LATERAL FORCES PRODUCED BY RAILS ON CONCRETE TIES [IN RUSSIAN]

The apparatus and its use in the measurement of lateral forces transmitted from the rails to ferroconcrete supports are described. This apparatus and the results obtained from its application are used for studying the effect of vertical and lateral rigidity of the ties on the magnitudes of loads which are transferred from the wheel to the elements of the track. Drawings are provided of the apparatus used in determining the loads on the foundations under the rail and oscillograms are included which show recordings of the dynamic lateral loads.

Kravchenko, N. D., and Lysyuk, V. S., Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 6, 1975, pp 48-50, 2 figs., 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1483

IMPROVEMENT IN THE UTILIZATION OF RAILROAD RAILS [IN RUSSIAN]

The reliability of rails from modern production and recommendations concerning guarantees of reliability are discussed. Suggestions are made for the improvement of rail profiles and railroad planning. More efficient utilization of the Soviet railroad budgets is also considered.

Tsukanov, P. P., and Melentyev, L. P., (All-Union Scientific-Research Institute of Railroad Transport, Moscow, U.S.S.R.), Trudy Moskovskogo Instituta Inzhenerov Zheleznodorozhnogo Transporta, No. 334, 1967, 140 pp, 46 figs., 22 tables, 55 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1484

THE INFLUENCE OF MANUFACTURE DEFECTS ON THE OPERATIONAL LIFE AND STABILITY OF RAILS [IN RUSSIAN]

The large number of factory defects and their possible relation to low tonnage reliability and increases in the probability and intensity of rail failures that eventually reduce operational reserves is discussed. The various aspects of rail production and manufacturing are examined in detail for each of the processes. The high incidence of rail failures shows direct correlation to defects that occur in the initial stages of manufacturing of rail steel. Inspection procedures are suggested which will provide higher rates of rejection at stricter quality control so that the probability of rail-relaying after installation can be reduced by a factor of 4 to 6. It is believed that modern-quality

control measures can provide rejection of volume-tempered rails with gross defects and accumulations of nonmetallic inclusions.

Zarochentsev, G. V. (Scientific Research Institute for Railroad Transport, Moscow, U.S.S.R.), Vestnik Vsesoyuznogo Nauchno-Issledovatelskogo Instituta Zheleznodorozhnogo Transporta, No. 6, 1970, pp 30-33, 2 figs., 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1485

DYNAMIC FORCES OF CONTACT BETWEEN THE WHEEL AND THE RAIL [IN RUSSIAN]

The author presents the results of investigations, conducted on an MN-7-type computer, of dynamic forces between the wheel and the rail as caused by geometric irregularities of the track and rolling-stock wheels. The results show that the irregularities may be divided into two groups based on the nature of interaction and magnitudes of dynamic effects, one group having a high level and the other a low level of dynamic effects. As a rule, increasing a system's velocity leads to a greater dynamic effect. To improve the track and rolling-stock interaction in use, evaluation is required for the wheel and rail interaction during movement over rail irregularities. The author provides drawings of the structural design with five degrees of freedom and a block schematic of solutions for a system of differential equations on an MN-7 computer.

Yakovlev, V. F., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 5, 1965, 7 figs., 1 table, 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1486

VERTICAL DYNAMIC FORCES AFFECTING THE TRACK [IN RUSSIAN]

The author presents the fundamental principles of dynamic calculation for a railroad track, once the [redacted]ts on it are given. A theory is developed for combined statistical track vibrations treated as a system with distributed parameters and the vehicle as a system with a finite number of degrees of freedom in a vertical plane. Solutions are presented in the form of frequency characteristics and impulse conversion functions. Since perturbations taken were all primary factors influencing the magnitudes of dynamic forces on wheel/rail contact during the passage of the vehicle along the track. Included are irregularities of the track and wheels of the vehicle, indentations on the rolling surface of the rails, air gaps between a rail, and subrail foundations. The most important solutions are reduced to numerical calculations.

Kogan, A. Ya. (All-Union Scientific Research Institute of Railroad Transport, Moscow, U.S.S.R.), Trudy Moskovskogo Instituta Inzhenerov Zheleznodorozhnogo Transporta, No. 402, March 1969, 206 pp, 55 figs., 30 tables, 53 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1487

DURABILITY OF RAILROAD FROGS IN THE TRACK SYSTEM [IN RUSSIAN]

The wear resistance of frogs made from G13L steel which normally operate on track sections with train speeds up to 70 km/hr is investigated. The wear resistance was found to be dependent to a significant degree on the chemical composition of the steel and the subsequent mechanical properties. With the increase in manganese

content and its ratio, the manganese-to-carbon wear resistance of frogs increases and is accompanied by a general increase in strength and plastic properties of the steel. Increase in the steel's content of carbon, silicon, and phosphorus reduces the wear resistance. An increase in train velocities, however, reduces these interrelationships by directly influencing the wear resistance.

Mikhalev, M. S., and Kats, R. Z., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 3, 1969, pp 48-51, 4 figs., 3 tables, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1488

APPLICATION OF PLASTIC EXPLOSIVE MATERIAL FOR STRENGTHENING OF G13L-STEEL: EXPLOSIVE HARDENING OF FROGS [IN RUSSIAN]

The use of plastic explosive materials for the hardening of frog steel is discussed and some comparisons are made between the use of UV pressure and free-flowing hexogen. The former plastic explosive is found to produce a greater and more uniform hardness of the reinforced surface than the latter. Its use has resulted in a better distribution of hardness in relation to the core depth and this leads to an increase in durability. Recommendations are made for the use of the method in strengthening of machine parts, including rails for curved portions of a track system.

Dyachenko, A. Z., Tsarenko, A. G., Gontar, M. V., Zamanskaya, F. P., and Khoroshko, V. P., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1969, pp 16-18, 4 figs., 1 table, 6 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1489

ECONOMIC EFFECTIVENESS OF WELDING FROGS [IN RUSSIAN]

A method to reflect the economic effectiveness of increasing the in-service period of frogs in a track and of reducing expenses for their replacement and continuing maintenance is discussed. The economic effect of frog repair by facing is summarized by pointing to the fact that it is necessary to operate with average values; for this a suitable statistical calculation of the service of frogs in the track should be made at certain intervals.

Simon, A. A., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1970, pp 59-62.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1490

CALCULATION OF LATERAL FORCES IN CURVES WITH MISALIGNMENT [IN RUSSIAN]

The results of studies and the measurement techniques for observing the railway vehicle/track interactions for sections possessing track irregularities and improper track geometries are discussed. The curvature of the track can be determined on the basis of exact measurements of bend indicators from a short cord. The arrangement of full-scale and base curves is shown. Data are given which show the results of calculations of the size of lateral forces in a curve.

Romen, Yu. S., and Pevzner, V. O., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 5, 1972, pp 6-9, 3 figs., 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1491

PROBLEMS OF PREPARATION AND ROUTINE MAINTENANCE OF RAILROADS FOR HIGH SPEED TRAINS [IN RUSSIAN]

The prospects for the development and maintenance of high-speed trains on the Moscow Railroad are discussed. An analysis covering the pecularities of arrangements and maintenance of the tracks to make them compatible with train movement at high speeds is given. The curve problems in existing railways are given thorough consideration, and examples of calculations for curves and the steps associated with straightening railroad curves by means of successive approximations are reviewed. Predictions dealing with track evenness and irregularities are considered essential for operation of rolling stock on high speed sections of the system.

Losev, A. G., Shulga, V. Ya., Shats, E. Ya., Kabish, G. T., Kubikov, V. F., Turovskii, I. Ya., and Senchenkov, I. Ya. (Moscow Railroad, Moscow, Smolensk, U.S.S.R.), Issue No. 186, 1964, 84 pp, 31 figs., 29 tables.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1492

PROBLEMS CONNECTED WITH RAILROAD TRACKS AND THEIR ECONOMY [IN RUSSIAN]

This book presents a collection of problems associated with the construction, maintenance, technical factors, and economics for railroad operations. Among the problems discussed are: determining the optional gage width of straight sections of track for the Moscow underground railway, the number of heavy types of rail in the track, areas of efficient use of intermediate rail fastenings, efforts aimed at measurement of rail loads with emphasis on longitudinal forces, and the method of measuring dynamic stresses in the subgrade and ballast.

Shakhunyants, G. M., et al. (Scientific Research Institute for Railroad Transport, Moscow, U.S.S.R.), Issue No. 177, 1963, 179 pp, 83 figs., 63 tables, 34 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1493

LONGITUDINAL FORCES IN THE RAILROAD TRACK [IN RUSSIAN]

This book is concerned with the theories of track calculations, with considerations being given to the action of thermal forces and those of driving vehicle. The theory of longitudinal forces and shifting of a nonbonded track caused by temperature is presented. The problem is solved in a general manner with the calculation of the result of the shift process of a crosstie. A solution is given for the problem of constructing a diagram of the longitudinal forces and track shifts as random functions of the length in the form of characteristic functionals. The results of an experimental investigation of the operation of nonbond track, together with the determination of parameters and functions which define its behavior under temperature influence, are discussed.

Kogan, A. Ya. (All-Union Scientific Research Institute of Railroad Tracks), Issue 332, 1967, 168 pp, 90 figs., 48 tables, 45 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1494

THE FATIGUE STRENGTH OF RAILS WITH ELECTROLYTIC CORROSION DAMAGE [IN RUSSIAN]

The effects of corrosion by electrolysis on the base of the rail are dealt with. Studies have revealed that electrocorrosion damage to the rail base rim decreases its fatigue strength, and thus leads to a decreased rail life by lowering the limit of endurance of the rail. Volume tempered rails with the same depth of corrosion as nonheat-treated rails are less affected so far as service life. With an increase in corrosion-damage depth of the base to 5 mm, the limit of endurance decreases

from 31 to 24 kg/mm^2. Typical examples of transverse fractures initiated by corrosion and finalized by cyclical bending are shown.

Shur, Ye. A., Bychkova, N. Ya., and Glonti, A. N., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 8, 1974, pp 26-29, 4 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1495

INTERACTION BETWEEN A WHEEL WITH A SLIDER AND THE RAIL [IN RUSSIAN]

The interaction of a rail and a wheel with a slider during accelerations of the unsuspended bogie mass is considered. A relationship between the vertical acceleration of the unsuspended mass and such factors as speed of movement, track rigidity, and static load on the wheel is revealed. Comments are made on the work of M. I. Kulagin's research where he shows that a similar-type change in acceleration is dependent on speed of movement. Changes in acceleration are also evoked by a geometrical sinusoidal irregularity on the rail even though the greatest accelerations due to irregularities occur at a much higher velocity than those due to the presence of a slider on the wheel.

Anisimov, P. S., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 1, 1963, pp 42-47, 4 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1496

WEAR OF TRACK AS RELATED TO TRAFFIC LOAD [IN RUSSIAN]

Attempts are made to provide a reliable determination of the full wear of certain elements of the rail on the basis of the incurred average stresses. In the general case of nonsymmetrical, relatively average stresses, it is necessary to establish both the symmetrical and nonsymmetrical limits integration. Diagrams are presented for determining the equivalent stresses and for calculating the accumulation of damages.

Margot'yev, A. N., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 7, 1975, pp 44-48, 2 figs., 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1497

STUDY OF THE GROWTH OF TRANSVERSE FATIGUE CRACKS IN RAILS [IN RUSSIAN]

The growth of transverse fatigue cracks in the active rail parts of operating railways and during laboratory tests where the rails were subjected to vibrating loads were studied, and the data taken from service and laboratory-tested rails revealed that crack-growth propagation followed an exponential law. It was also observed that a change in the degree of the gap of the transverse fatigue fissure while in its slow stages of development does not improve detectability with the defectoscope. Data are given which indicate the fissure growth in an R-65 rail as a function of stress cycles in the bending load tests. A typical break in the rail along a transverse fatigue fissure is also shown.

Kolotushkin, S. A., and Yoroshin, V. L., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1974, pp 45-47, 2 figs., 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1498

STUDY OF DYNAMIC FATIGUE DEFORMATION IN RAILS [IN RUSSIAN]

This article presents results of measurements of rail deformation found in the zone of wheels/rails contact and gives an analysis of the effect of speed, geometry of the line, forms of wear of the wheels, and the contact deformations of the rail head. Illustrations provide information on the placing of sensors in the rail heads as well as projections and relations of contact deformations of new and used rails in relation to the speed of the rolling load.

Yakovlev, V. F., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 4, 1963, pp 44-46, 5 figs., 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1499

STUDY OF CONTACT FATIGUE DAMAGE OF RAIL HEADS [IN RUSSIAN]

Changes in the structural state of the metal in rail heads of heat-treated and untreated rails as well as the conditions of hardness and distortion are analyzed. Heat factors are considered important along with certain mechanical properties and conditions of rail deformation during service. The analysis of rail damage shows that contact-fatigue defects should be considered during selection of rail-steel variables as well as heat treatment. Graphic illustrations provide information on changes in hardness before and after heat treatment, and also the distribution of rail head distortions. Typical examples of shelling of rails are given.

Vikker, I. V., and Uskova, O. N., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodoroznogo Transporta, No. 7, 1965, pp 45-48, 6 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1500

DETERMINATION OF RESIDUAL STRESSES IN RAIL [IN RUSSIAN]

This article presents methods for calculating the residual stresses in rails, establishes stress values during thermal treatment by various methods, and shows the failure dependence of rails due to end defects on residual stress and the existing state of the tracks. Rail-profile diagrams showing the extent of residual stresses in accordance with various positions within the head and web for methods of tempering are included.

Paryshev, Yu. M., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 1, 1965, pp 41-44, 4 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1501

MEASUREMENT OF WHEEL PRESSURE ON RAILS DURING MOVEMENT OF AN ELECTRIC LOCOMOTIVE [IN RUSSIAN]

This article describes a methodology and the equipment for measurement of continuous vertical forces acting between the rail and wheel of a moving electric locomotive. The methodology described permits an examination of stress relief on axles under the action of traction and under the influence of track irregularities and dynamic phenomenon during movement of the locomotive. It also permits expansion of suggestions for improving traction characteristics for these locomotives. Drawings are included which show the arrangement of gauges, stresses in wheel spokes and box centers, and oscillograms of wheel pressures on the rail.

Bychkovskii, A. V., Mikhenko, Ye. P., and Bespalov, I. P., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1964, pp 13-16, 5 figs., 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1502

STUDY OF LATERAL MOTION OF FREIGHT CARS ON TRACK MOVING ON REVERSE CURVES [IN RUSSIAN]

The length of the connecting curves and its influence on forming of the lateral force effect of the freight car on the track are investigated. Oscillograms obtained as a result of the simulation of the motion of an empty wagon on bogies along the conjugation of reverse curves at a specific speed are given. The dependence of the size of the lateral force on the length of the connecting curve and the climbing angle of a wheel pair when the freight car enters a connecting curve are shown. It is recommended that a short straight insert be removed and that the connecting curved rail be elongated for such an analysis.

Yershkov, O. P., and Kartsev, V. Ya., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 8, 1971, pp 13-16, 4 figs., 1 table, 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1503

ON THE MEASUREMENT OF RANDOM FUNCTIONS OF HORIZONTAL IRREGULARITIES OF WELDED TRACK [IN RUSSIAN]

The measurement of random functions and their stability associated with the horizontal initial irregularity of the track are studied. It was found that this stability of the function does not remain during the transfer to the factual broken baseline and that the Gaussian property follows along in the same unstable manner. The mathematically expected values of the true random functions for initial irregularity of the track remain unchanged. Ordinates of the random function of the initial track irregularity axis, measured from various baselines parallel to the track axis, are presented.

Van Tuyen, N., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 3, 1970, pp 45-47, 1 fig., 2 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1504

STUDY OF THE EFFECT OF INCLINATION (CANT) ON THE PERFORMANCE OF RAILS ON CURVES WHEN USED WITH FERROCONCRETE TIES [IN RUSSIAN]

The stresses at the base and the head of rails are examined to determine whether they are dependent on a change in cant. Data are plotted to show normal stresses on the interior and exterior edges of the rail head, shear stresses in the head, and edge stresses in the outside rail of a curve. A diagram showing points of force application to the inclined rail in a curve is presented. No undesirable effects were noted on the elastic and permanent deformations of the rail tie lattice when the inside rail line was inclined 1/20th while the outside rail was raised.

Frishman, M. A., Voloshko, Yu. D., Levenkov, I. S., and Taturevich, A. P., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 3, 1968, pp 5-9, 4 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1505

TRANSVERSE IMPACT ON RAILS [IN RUSSIAN]

A decrease in the mass of the wheel within the limits considered in this article leads to a substantial decrease in the contact and bend stresses on the rail during transverse impact. Tabular data are included which show that there is a significant increase in the impact force during the winter condition of the road as compared with the summer condition.

Blokh, M. V., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 2, 1968, pp 16-20, 3 figs., 1 table, 7 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1506

CALCULATION OF THE INTERVALS FOR INSPECTION OF RAILS IN TRACK BY RAIL INSPECTION [IN RUSSIAN]

This article presents an approach for calculation of the periodicity of maintenance control for rails using defectoscopy and based on the theory of queues.

Uspenskii, E. I., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 1, 1966, pp 35-36, 1 fig., 2 tables, 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1507

DETERMINATION OF THE SAMPLE SIZE OF RAILS FOR EVALUATION OF SERVICE LIFE [IN RUSSIAN]

This paper presents a discussion dealing with the question of applying Poisson's distribution in the process of calculating the minimum quantity of rails to be selected for providing statistical-significance assessment of operational tests used for predicting the service life when tested rails are planned for ultimate usage.

Liaev, S. A., Vorob'yeva, N. B., and Gracheva, L. F., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo, No. 1, 1966, pp 17-20, 3 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1508

COEFFICIENT OF FRICTION OF WHEELS WITH RAILS OF VARIOUS HARDNESS [IN RUSSIAN]

The increase in hardness of the rolling surface of hardened rails that accompanies an increase in the magnitude of the coefficient of friction between the wheel and the rail is considered in this paper. When there is an increase in rolling-surface roughness of the rail head, the coefficient of friction tends to decrease. The influence of roughness on the friction coefficient was found to vary with the type of rail (manufacture and metal structure). There is a reverse relation between the hardness of the head rolling surface and its roughness. The methods given for measuring the degree of roughness can serve as a basis for mass evaluation of rails in relation to the friction coefficient.

Danilov, V. N., and Kucherenko, V. P., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 2, 1969, pp 47-48, 4 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1509

AMPLITUDE FREQUENCY CHARACTERISTICS OF THE SYSTEM FOR MEASUREMENT OF VERTICAL FORCES OF RAIL/WHEEL CONTACT [IN RUSSIAN]

A method developed for experimental construction of the amplitude frequency characteristic of systems used for continuous measurement of vertical forces between the rail and the wheel is described. Determination of perturbation forces, systems for measurement of vertical forces, and oscillogram recordings and their analysis are illustrated. An application of the described method for measuring vertical forces of an electric locomotive has demonstrated the possibility of conducting static calibration of systems for the purpose of evaluating dynamic influences at various frequencies up to 110 Hz.

Shafranovskii, A. K., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1970, pp 14-16, 4 figs., 2 tables, 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1510

VERTICAL FORCES IN THE RAIL WEB AND WHEEL DISK UNDER IMPACT [IN RUSSIAN]

This paper describes a study of the nature of stress distribution in the wheel disk under conditions of impact. The characteristic of the impact stress distribution was found to be fundamentally distinguishable from that of the stress distribution in cases of static action of vertical forces in the same magnitude. Under impact, the bending stresses diminish significantly. Tensile stresses occurring under static load are almost completely absent. Strain-gage measurements of vertical forces at a point type on a rail web have certain inadequacies, such as changes in sensitivity, which are eliminated by automatic integration of stresses. This integration is achieved by unifying a series of point configurations into a continuous step scheme.

Shafranovskii, A. K., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 2, 1971, pp 33-36, 3 figs., 2 tables, 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

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1511

SPECTRAL ANALYSIS OF THE PROCESS OF WHEEL/RAIL INTERACTION [IN RUSSIAN]

A spectral analysis is described which showed that a low speed of impingement characteristic of wheel/rail interaction is accompanied by impact pulses of low frequency composition. The effective portion of the spectrum in the conditions of the experiment was limited to a frequency bandwidth of 0 to 110 Hz. The amplitude-frequency characteristic obtained by spectral analysis permits refinement of a maximal value for the impact force in the wheel disks which was less than 2.9 percent of the force in the rail web. Spectral analysis in this application allows one to reveal reasons for error in static calibration of gauging systems and to evaluate the errors quantitatively.

Shafranovskii, A. K., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 2, 1972, pp 22-24, 2 figs., 3 tables, 2 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

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1512

ELIMINATION OF THE CAUSE OF CRACKS (FISSURES) IN SWITCH POINTS [IN RUSSIAN]

The effects of increasing the radius of the recess between the rail web and head of the pressed-out portion of a switch rail are described. Increasing the radius was found to improve the operating conditions of the structural members because it decreases the absolute values of increased stresses in places where fissures occur. The alternating characteristic of increasing stresses is maintained under the conditions of change. The change in flexure point of the cover piece and a milling out of the pressed portion of the switch rail lead to a change in character of the stresses. At the greatest stress point they become single-valued. Absolute values of stresses do not decrease in this situation.

Frishman, M. A., Shaterkov, V. I., and Lipovskii, R. S., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 5, 1962, pp 50-52, 3 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

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1513

OPTIMAL PARAMETERS OF IMPULSE HARDENING OF FROG CORES [IN RUSSIAN]

This paper describes an investigation of physicomechanical properties of rail frog steel (G13L) during strengthening by impulse pressure within the range 140 to 800 kbar. Tests in the laboratory revealed that strength coefficients increase with increased pressure and that coefficients of plasticity decrease.

At a pressure of 450 to 500 kbar, strength characteristics are at a maximum and plasticity is at a minimum. The results of an investigation into the hardness of the steel in relation to the depth of the test piece along the line of impulse distribution are also given. It was concluded that an increase in impulse pressure could produce continuous reinforcement of the pieces with a thickness between 50 to 60 mm. Experiments on the pressure machine showed that with impulse pressure reinforcement at 470 to 500 kbar, it is possible to avoid plastic deformation of frogs.

Vlasov, V. I., Kozorezov, K. I., and Asaturov, A. A., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 5, 1968, pp 41-42, 4 figs., 3 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1514

ABOUT THE OPTIMAL HARDNESS OF THE ELEMENTS OF THE FRICTION PAIR: "WHEEL-RAIL" [IN RUSSIAN]

This article presents results of laboratory tests of friction pairs by simulating the action of the wheel and rail with different degrees of hardness for the pairs. The intensity in the increase of abrasion on the elements of the friction pair is found in direct relation to the degree of slippage up to a hardness of 425 BH for the wheel specimens. Greatest resistance to wear is observed when the hardness of the specimens is increased. Data are plotted to show the relations between wear of the rail and wheel and their respective ratios, as well as the degree of slippage as a function of ratio of average hardness. Tabular data are presented which give rail/wheel hardnesses, percent slippage, and wear.

Larin, T. V., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 3, 1965, pp 5-9, 6 figs., 2 tables, 1 ref.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1515

HARDENABILITY OF STEEL FOR HIGH-STRENGTH RAILS [IN RUSSIAN]

The important technical property of hardenability of rail steel is reviewed from the standpoint of increasing rail efficiency and its endurance. The efficiency of rails can be assured by increasing the contact fatigue strength of the steel by means of heat treatment. Thermal treatment results in a homogeneous structure of sorbite in the rail head at depths affected by contact stresses. Comparisons are made using data concerned with rail end hardenability according to GOST 5657-59, which involves quenching or tempering in oil of the rail heads to establish a standard. It is concluded that sufficient hardness of the rail can be obtained by complex alloying of the steel to a general content of about 3 percent.

Safonova, K. E., Trudy Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, Issue No. 509, 1974, pp 129-133, 1 fig., 1 table, 5 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1516

MOTION OF A HOMING SET OF WHEELS ALONG RAILS [IN RUSSIAN]

The trajectory of motion of a cylindrical wheel set which is a quadratic parabola shifted relative to the beginning of the coordinates is discussed. It was observed that the cylindrical wheel set with any drive does not possess the capability of centering on the rail. A conical wheel set with central as well as separate drive completes nondamping harmonic oscillations thereby transmitting the capability of centering to the

wheel set. The wheel set with separate drive has less capability of centering which is expressed as a decrease of oscillation amplitudes. The external axial force acting on the wheel set changes the character of the motion of the wheel an insignificant amount. A mathematical expression showing the motion of the wheel set can be used during analysis of multiple wheeled transport machines.

Sobolev, V. M., Izvestiya VUZ. Mashinostroyeniye, No. 9, 1974, pp 103-108, 2 figs., 2 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1517

ABOUT CONTACT FATIGUE AND WEAR RESISTANCE OF RAIL STEEL [IN RUSSIAN]

This article presents results of research on the effect of various modes of volume hardening on the distribution of residual stresses, wear resistance, and contact fatigue of rail-steel samples. The data taken during experimentation are plotted to show radial and tangential residual stresses of a rail-steel sample that was surface hardened in oil at 950 C.

Moskov, M. M., and Rauzin, Ya. R., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, 1966, pp 9-10, 1 fig., 5 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1518

EFFECT OF RESIDUAL STRESSES ON THE IMPACT STRENGTH OF WELDED RAIL [IN RUSSIAN]

The influence of residual stresses on the density of failures in welded rails is investigated. Data plotted from experiments dealing with the temperature effects on rail failures coincide with the occurrence of welded rail failures in the range of -20 to -60 C. It was observed from projection of curves that during the low temperatures and residual stresses, they display the same characteristic trends. It is believed that this similarity confirms the conclusion that residual stresses do not exert a significant influence on the failure rates of welded rails. Graphical data are presented which show the distribution of residual stresses in the weld area and the change in impact strength of welded rails in relation to their temperatures.

Sinadskii, M. A., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1971, pp 41-43, 3 figs., 4 refs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1519

USE OF THE ANALOG COMPUTER FOR STUDY OF INTERACTION BETWEEN THE WHEEL AND THE RAIL [IN RUSSIAN]

This article presents an examination of methods used for studying various computational schemes of the wheel/rail interaction in a vertical plane with the use of an analog computer. A method is described which is based on the principle of differentiating the masses of the elements of rolling stock and track that determine the interaction of rolling stock and track, and which is also for study of dynamics in a horizontal plane. The schematic arrangement of wheel/rail interactions for the computer for a system with four degrees of freedom and the perturbation functions are shown. Oscillograms of solutions for a typical case of a wheel with a slider that moves along a track at specific velocities are included.

Kudryavtsev, M. M., Vestnik Vsesoyuznogo Nauch.-Issled. Inst. Zheleznodorozhnogo Transporta, No. 6, 1964, pp 7-11, 5 figs.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: Kamkin Bookstore (repr., PC).

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1520

RAIL STRESSES AND LOCOMOTIVE TRACKING CHARACTERISTICS FOUND IN TESTS ON THE GREAT NORTHERN RAILWAY

This report covers the field work performed on the Great Northern Railway in 1929, all of which was done on the single-track main line between the eastern terminal, Wenatchee, and the western terminal, Skykomish. Rail measurements were made for all types of locomotives (steam and electric) operating over the division. The information obtained from the rail measurements included rail stresses, vertical and lateral wheel loads, position on rail head of center of pressure of vertical wheel loads, guiding of locomotives on curves, and the center of rotation of locomotives on curves. A detailed description of the methodology used in the mounting of load-measuring instruments and means for taking data are given. The data obtained are used for calculation of lateral and vertical loads.

Shamberger, J. P., and Langer, B. F. (Westinghouse Electric and Mfg. Company, Research and Engineering Dept., Pittsburgh, Pa.), Bulletin of the AREA, Vol 33, No. 339, September 1931, 91 pp, 82 figs., 5 tables.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: American Railway Engineering Association (repr., PC).

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1521

THE EFFECT OF IMPROVED METHODS IN RAIL STEEL PRODUCTION ON RAIL LIFE

Extended rail life, as well as rail performance, depends on resistance of the rail to failure as a result of improved fatigue strength and on the inherent quality or lack of quality of the steel. The fatigue strength can be enhanced by metallurgical beneficiation, such as heat treatment, or by improved control of alloy composition. It is recognized through statistical investigations of failures that they stem from slag inclusions, ceramic inclusions, slag stringers, heavy segregations, and piping. Changes in steelmaking practices and rail-steel handling are considered as a means of eliminating shatter cracks. The use of the oxygen lance in the bath is described as a factor for reducing furnace time. The author also discusses the advent of the BOP process, and its derivative the QBOP, which resulted in the elimination of controlled cooling and thus enables the production of longer rails. The merits of vacuum degassing and its general usage in Canada and the continuous casting of rails are mentioned.

Kannowski, K. H. (Central Technology, Inc., Dulles International Airport, Washington, D.C.), February 1976, 5 pp.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: (Unpublished).

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1522

OBSERVATIONS OF RAILROAD RAIL RESEARCH

Studies of the causes and the elimination of rail failures initiated by AREA, AAR, AISI, and others are summarized in relation to service tests in the field, metallurgical investigations, and the compilation of rail failures. The largest single result of the research effort was the elimination of transverse fissures due to shatter cracks by controlled cooling. It was found that transverse fissures stemmed from inclusions and hot torn steel. These studies also revealed that the largest factors leading to rail failures were rail-end defects and shelling. Initial studies of shelling occurring in curved track sections and the causes are reviewed. The introduction of alloy-steel rails as a solution to fatigue failures and rail wear is discussed. Comparisons are made between low-alloy and heat-treated steels in regard to their hardness and resistance to shelling and conclusions are given which indicate that the low-alloy rail is not comparable to the heat treated rail.

Kannowski, K. H. (Central Technology, Inc., Dulles International Airport, Washington, D.C.), February 1976, 5 pp.

ACKNOWLEDGMENT: Central Technology, Inc.

PURCHASE FROM: (Unpublished).

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1523

HORIZONTAL HEAD CRACKS IN RAILS [IN DUTCH]

This portion (Chapter VII) of the Manual of Dutch Railways deals with rail-head cracks which are usually initiated at inclusions, voids, or other structural deficiencies. Occasionally, rail-head cracks are caused by heat treatment. On the average, they become visual after a gross tonnage of 60 million tons of traffic has passed over the rail heads. Horizontal cracks at the rail end grow about 1 inch after 10 million tons of traffic. They become critical when the rail head shows widening at localized points. These cracks are normally detected through ultrasonic inspection. Typical examples of horizontal fissures and rails fractured at their ends are given.

Manual of the Dutch Railways, Chapter VII (no date), pp 195-204, 6 photos.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Dutch Railways (repr., PC).

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1524

FAILURE ANALYSIS OF CRACKED RAIL: PRELIMINARY REPORT [IN DUTCH]

A section of rail was removed from the track because of the presence of a horizontal head crack which was detected by the ultrasonic inspection car. Metallographic examinations showed that the material contained an excessive amount of inclusions. The chemical composition of the rail is given along with a cutaway view of the crack and the indications of multiple inclusions.

Van Swaaij, J., Dutch Railways, Utrecht, Holland, September 21, 1970, 6 pp, 1 fig., 4 photos, 1 table.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Dutch Railways (repr., PC).

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1525

CRACKS AT RAIL JOINTS [IN DUTCH]

This portion (Chapter V) of the Manual of Dutch Railways deals with bolt-hole cracks that develop either in the longitudinal direction or at approximately 45 degrees from it. Bolt-hole cracks are caused by stress concentrations and moisture in the joints. Since ultrasonic detection of cracks has become possible only recently, there are insufficient data that can be used to provide assessments of crack growth. Methods for preventing bolt-hole cracks are being investigated and some of the approaches involve studies of smaller bolt holes, increasing the diameter of bolt holes, thermal treatment of rail ends, and the use of welded joints.

Manual of the Dutch Railways, Chapter V (no date), pp 91-102, 9 figs., 12 refs.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Dutch Railways (repr., PC).

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1526

X-RAY MEASUREMENTS OF EXPANDED BOLT HOLES IN RAILS [IN DUTCH]

Two methods employed for the investigation of bolt-hole expansion are described. Residual stresses were determined by X-ray diffraction and by measuring hole diameter after the surrounding materials were removed. The hole-diameter expansion was found to be 3 percent of the initial diameter. Compressive stresses at a specified distance from the bolt hole were found to be of the order of 20 kpsi. In some cases, tensile stresses as high as 30 to 40 kpsi were measured at the edge of the hole. The tensile stresses were reduced to approximately zero after a smooth tapered rod was inserted into the enlarged hole. The data taken from measurements of bolt-hole diameters are tabulated and stress measurements are plotted.

Dutch Railways, Report No. M.O. 139-1, April 8, 1970, 11 pp., 6 figs., 2 tables.

ACKNOWLEDGMENT: Battelle's Columbus Laboratories.

PURCHASE FROM: Dutch Railways (repr., PC).

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