FAST Facility for Accelerated Service Testing

TECHNICAL NOTE

AD-060

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L/V RATIO VARIATIONS WITH AXLE LOADS

by
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INTRODUCTION

Lateral loads - and, therefore, L/V ratios - are not directly variable with vertical loads. In theory, one might suspect that the magnitude of the L/V ratio would decrease as the vertical load increases. In May, 1985, a test was performed with loaded and unloaded cars on the FAST oval at the Transportation Test Center, near Pueblo, Colorado, to establish whether lateral/vertical (L/V) force ratios decrease with increasing axle load.

This report presents results of that test, along with theoretical results and historical data from FAST, followed by a brief summary and discussion of the implications of the results.

TEST DESCRIPTION

The test was conducted on dry rail, with L/V ratios being measured continuously over the track portion shown in Figure 1. The test consist is shown in Figure 2. Test variables included train attitude (buff/draft operation), train speed, an incremental wheel loading. The following table gives test run details.

Run No.	Train Attitude	Speed
1	Draft	25 mph (~3" underbalanced)
2	Buff (Reverse consist move)	25 mph (~3" underbalanced)
3	Draft	35 mph (balance speed)

Wheelset data were continuously reduced to L/V values by onboard microprocessors and fed to a strip chart recorder. A sample of the strip chart is shown in Figure 3.

Peak and average L/V values for each curve in the test are taken from these strip charts and the lead axle, outer wheel is plotted in Figures 4 (peak 25 mph, draft), and 5 (peak 35 mph, draft). Figures 6 (peak 25 mph) and 7 (peak 25 mph) show the results for the "buff" operating conditions.

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TEST RESULTS

It was observed in these tests that increased axle loads generally do decrease L/V ratios, although anomalies exist in the data taken (see Figures 1 through 7).

COMPARISONS WITH THEORETICAL MODEL OF L/V VARIATION WITH VERTICAL LOADS

Theoretical models (particularly the Steady State Curving Model by J. A. Elkins) have been employed to construct Figures 8 and 9, which also show that L/V values decrease with increasing axle load. The test data indicate that the empty L/V ratios are significantly larger than that predicted by the models. This, however, is to be expected in view of the quasi-static nature of the model mathematics as opposed to the dynamic nature of the testing.

MEASURED L/V VALUES FROM FAST AND FROM REVENUE SERVICE

Figures 10 through 12 are average wheel loads from 3 years of measurement on the FAST loop. These are the measured wheel/rail loads from revenue service vehicles operating on FAST. These plots show that the inversely proportional L/V vs vertical load relationship is generally true, but not universally.

Figure 13, a typical example,[1*] shows that the L/V ratios are higher in revenue service than at FAST. Based on the foregoing data, we conclude that revenue service L/V ratios are higher, on average, because revenue service entails more empty cars (FAST is ~95% loads, whereas industry cars are loaded only 56.5% of the time.)

SUMMARY OF DATA

We observe that the L/V loading generally decreases with increasing axle load.

Other observations were:

- L/V ratio increases with speed (expected)
- L/V ratio increases with degree of curvature (expected)
- Maximum L/V in this test was observed during the "buff" train condition, under the unloaded car on the trailing axle (see consist, Figure 2).

DISCUSSION OF THE IMPLICATIONS OF THESE RESULTS

The test results imply an improved lateral track performance with higher axle loads (for those items related to L/V ratios) which could result in both economic and safety benefits. These tests have shown that:

1. Increased axle loads tend to reduce L/V ratios.
2. Empty cars probably produce more track damage than full or partial loads. This is implied in Figure 14.

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*References are listed at end of text.

ACKNOWLEDGEMENTS

The test concept and design are the creation of Mr. H. G. Moody, Technical Manager, Federal Railroad Administration. Mr. Moody is also the source of many of the technical insights reported here. Mr. Moody's technical skill and determination in this work, and his continuing efforts to support the technical progress of railroads in general, are gratefully acknowledged.

Participants in this test were Lane Maxwell (AAR), Test Controller, Ron Bidwell (AAR), Instrumentation Engineer, Kevin Kessler (ENSCO), Instrumentation Engineer, Al Simpson (ENSCO), Instrumentation Engineer, Judy Stadler (AAR), Computer Operator.

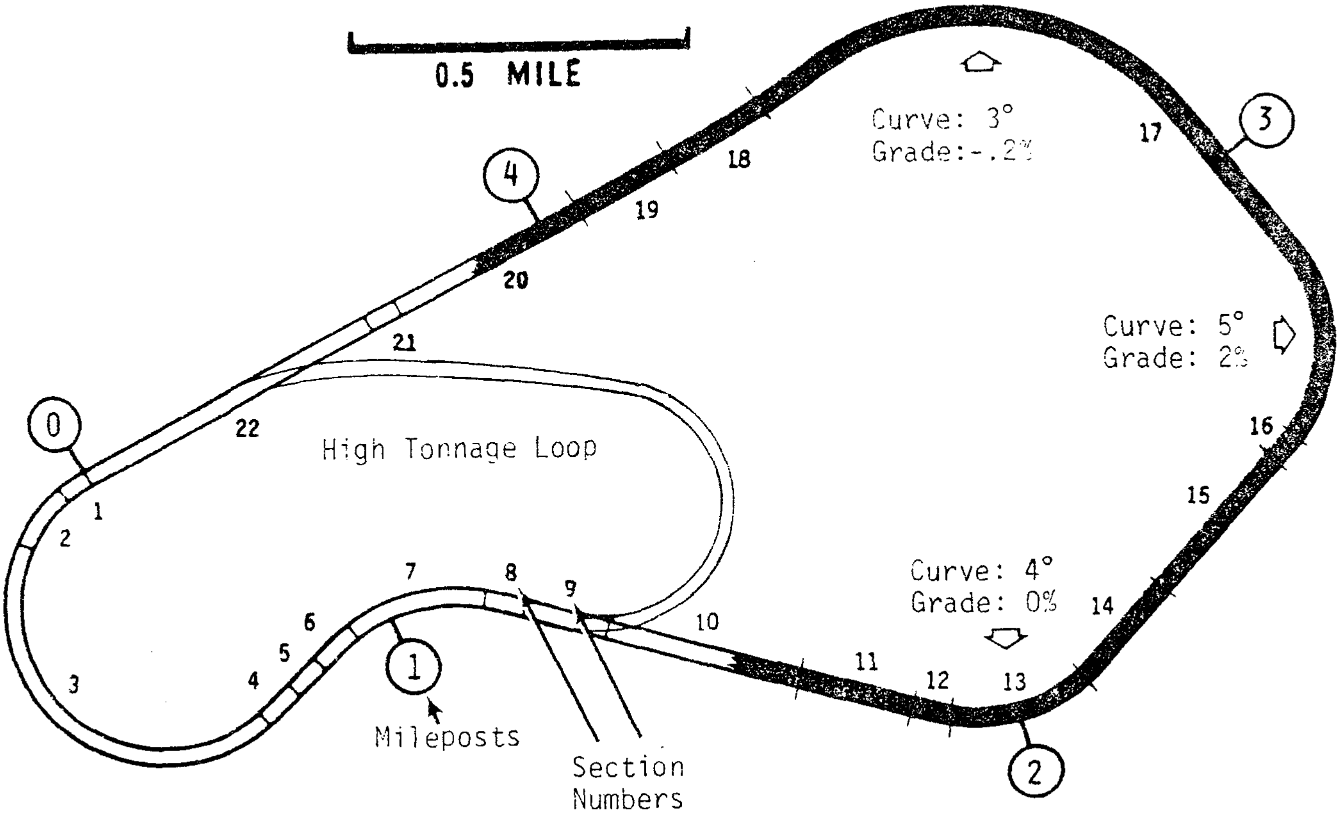
Data reduction was performed by Kathy O'Gorman, Judy Stadler, and Bev Kochevar.

Theoretical results were produced by Som Paul Singh, AAR Chicago.

REFERENCES

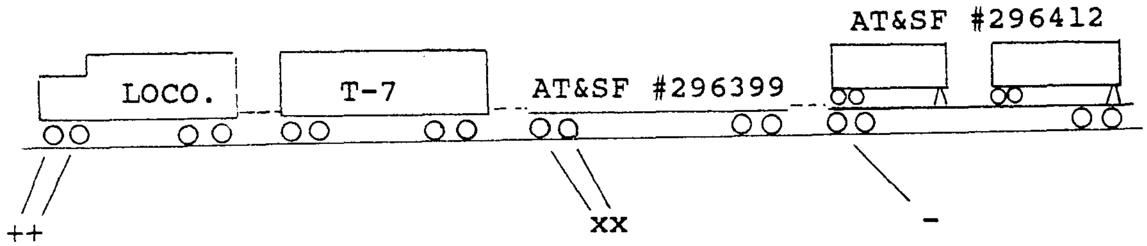
1. L. Daniels, Topic #3, Proceedings, FAST Engineering Conference, 1981 (page 65), Report No. FRA/TTC-82/01, U. S. Department of Transportation, Federal Railroad Administration, Washington, D. C., Jan. 1982.

2. Railroad Facts, 1984 ed. (page 6), Association of American Railroads, Washington, D. C.



Darkened Portion (▬) = Test Area

FIGURE 1. TRACK LAYOUT, FACILITY FOR ACCELERATED SERVICE TESTING.



Instrumented Wheelsets

Legend:
+ = ENSCO 40"
x = ENSCO 33"
- = AAR 33"

Vehicle Weights (lbs)

	Loco.	T-7	399	412 loaded	412 empty
A Axle:	130300	84050	30900	74250	30500
B Axle:	130450	80750	31950	85200	31700
Total :	260750	164800	62850	159450	62200

FIGURE 2. FAST MINI-CONSIST.

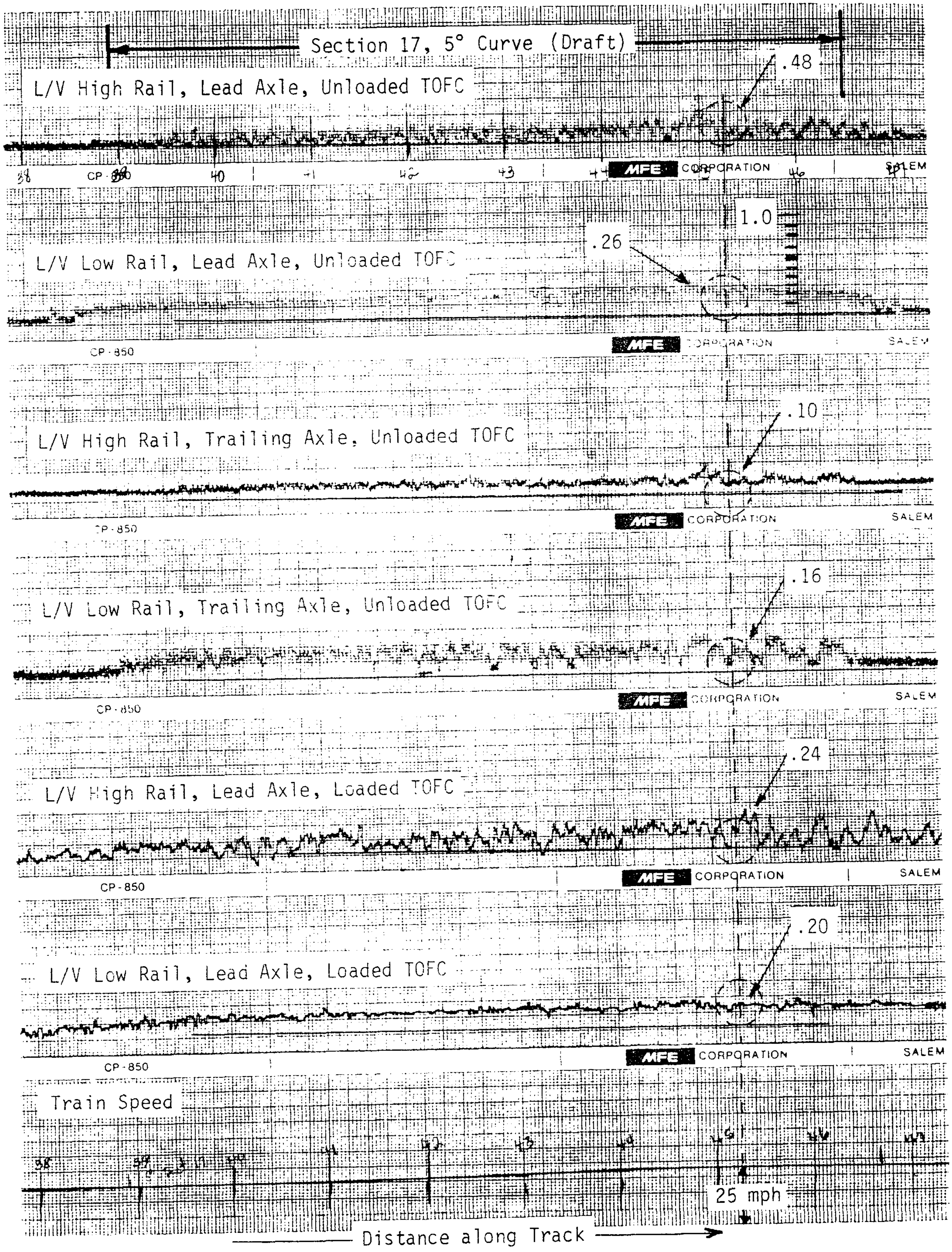


FIGURE 3. TYPICAL TEST RUN STRIP CHART.

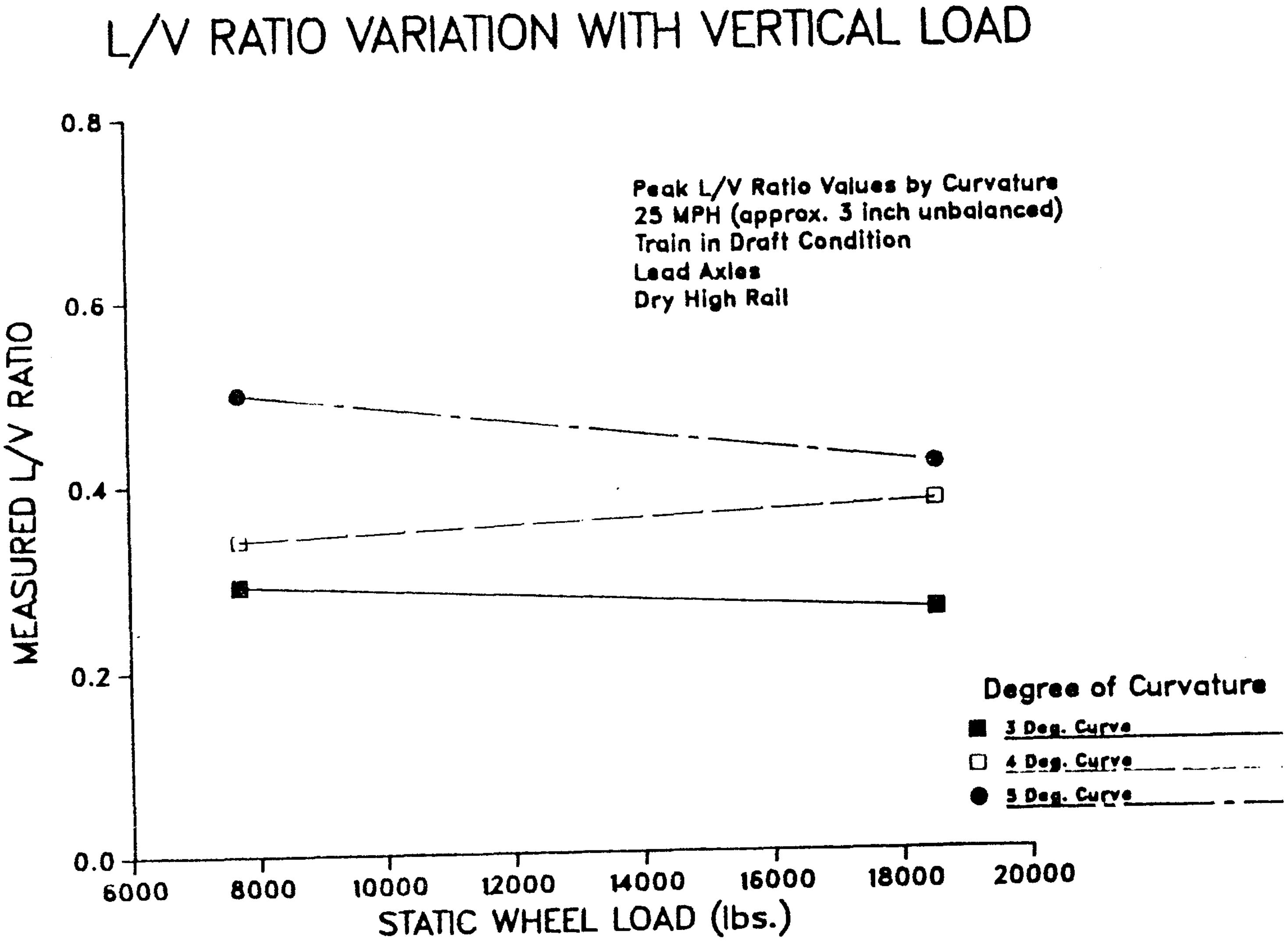


FIGURE 4. PEAK L/V VALUES AT 25 MPH (DRAFT CONDITION) FOR 3-, 4-, AND 5-DEGREE CURVES.

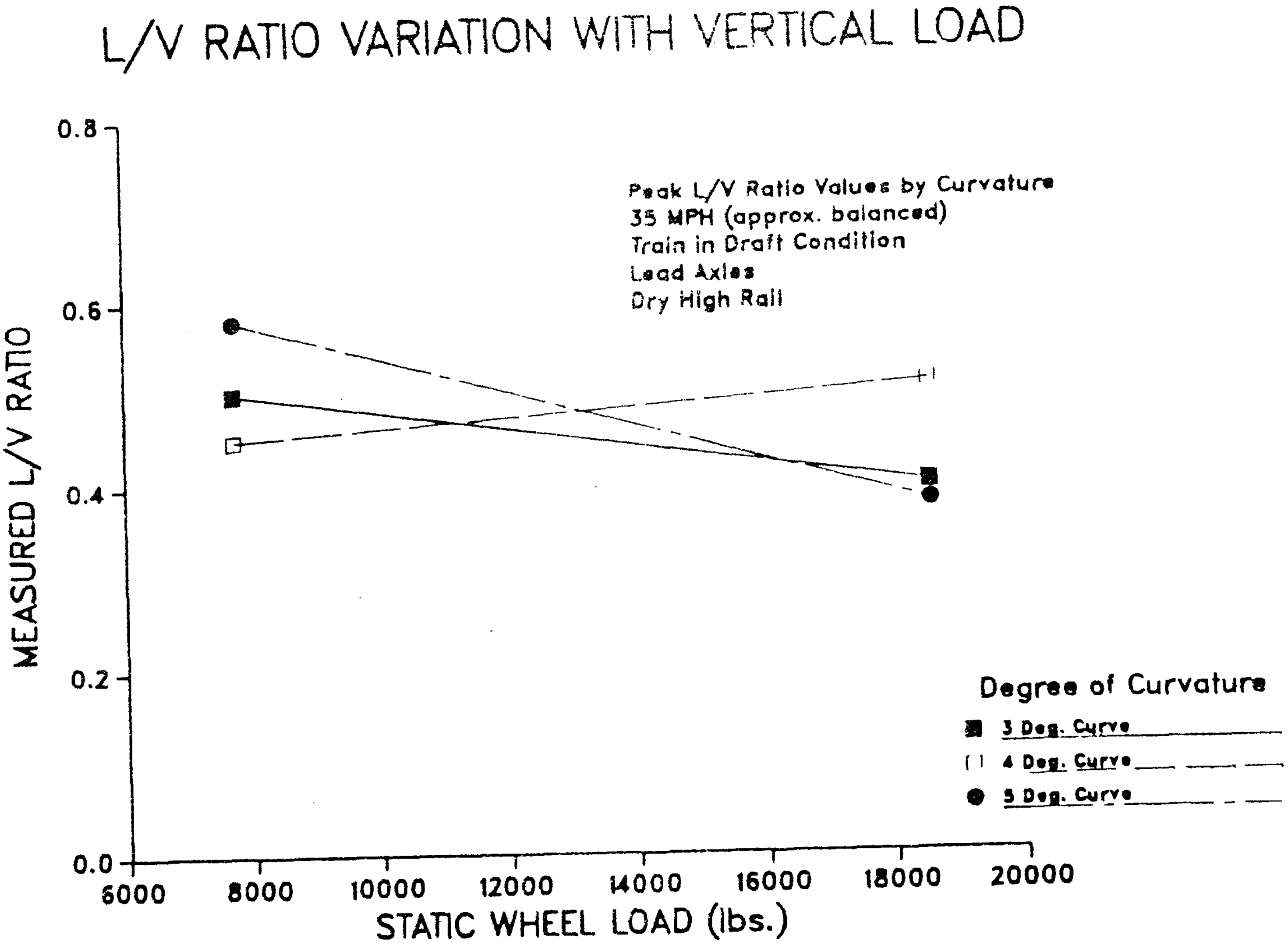


FIGURE 5. PEAK L/V VALUES AT 35 MPH (DRAFT CONDITION) FOR 3-, 4-, AND 5-DEGREE CURVES.

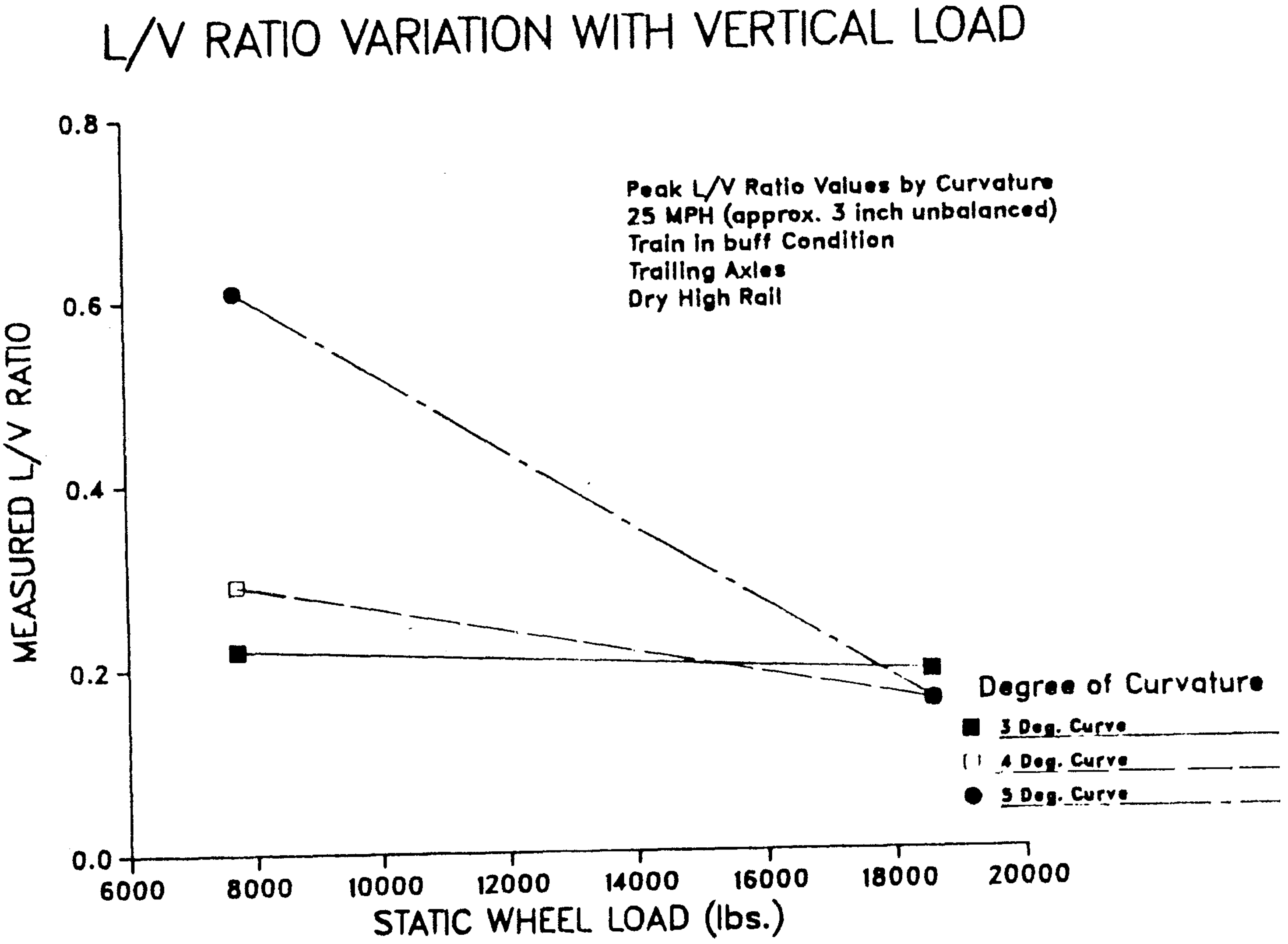


FIGURE 6. PEAK L/V VALUES AT 25 MPH (BUFF CONDITION) FOR 3-, 4-, AND 5-DEGREE CURVES.

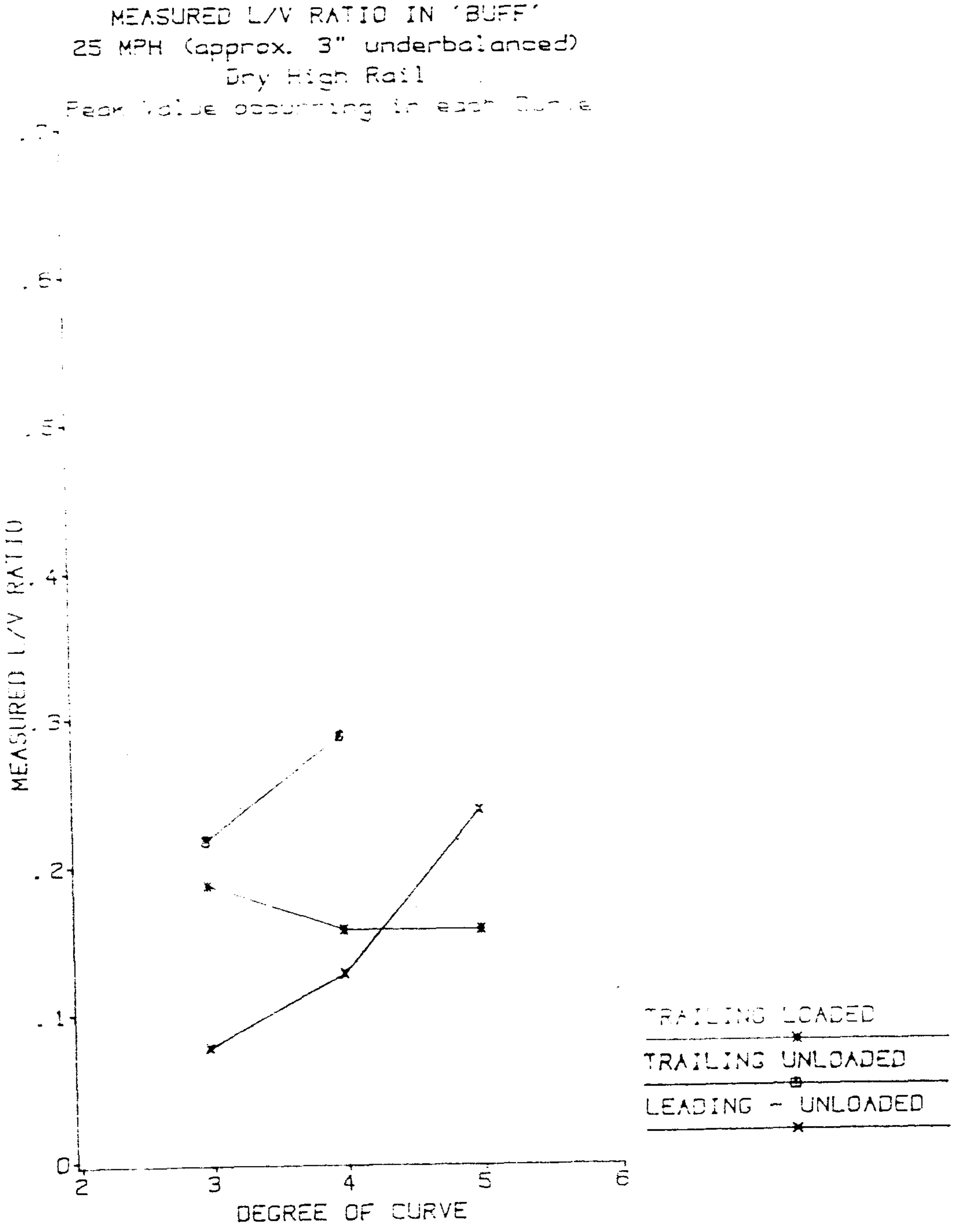


FIGURE 7. PEAK L/V VALUES AT 25 MPH (BUFF CONDITION) AS MEASURED FOR TRAILING AXLE (LOADED/UNLOADED) AND LEAD AXLE (UNLOADED).

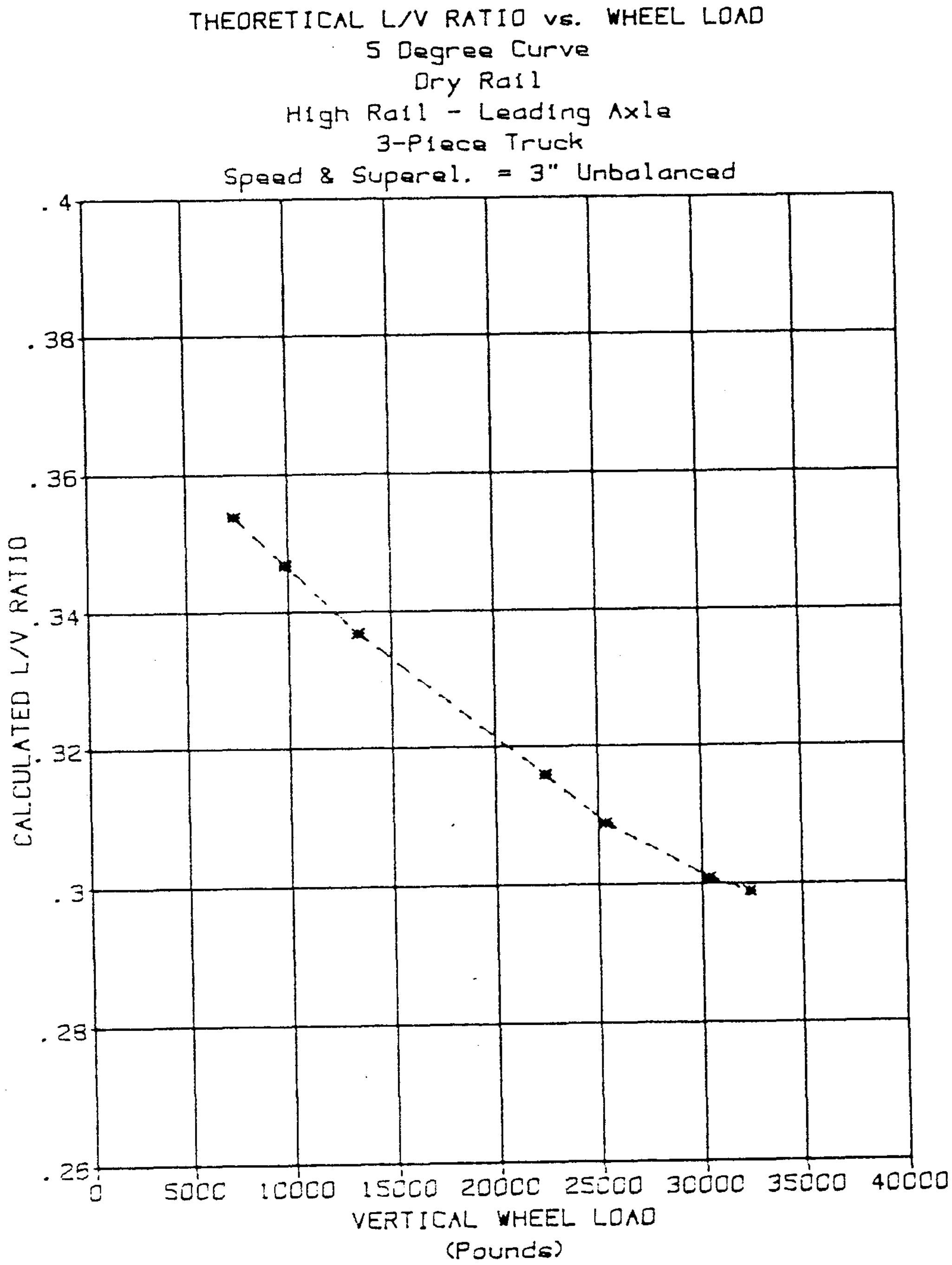


FIGURE 8. THEORETICAL L/V RATIO VS WHEEL LOAD, 5-DEGREE CURVE.

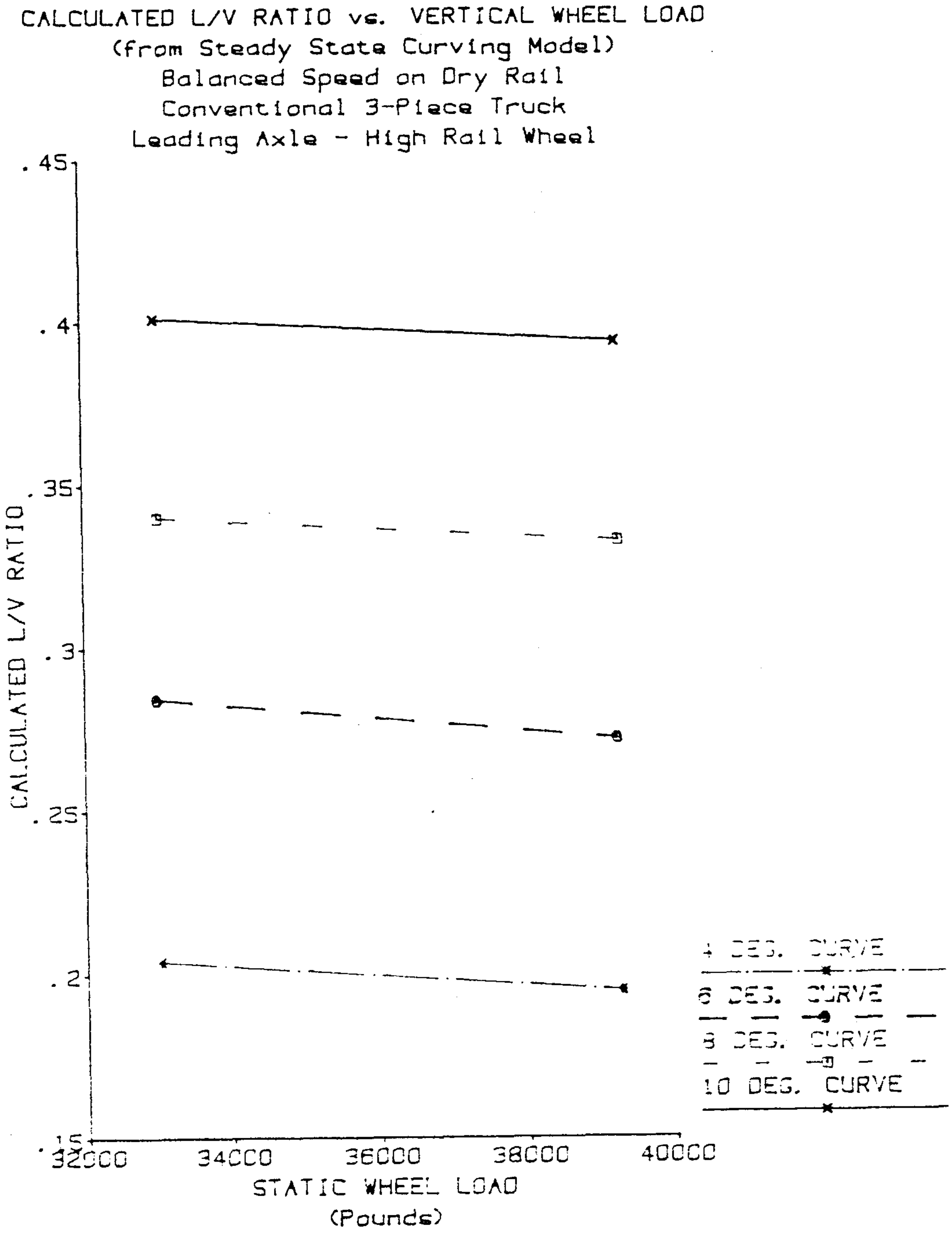


FIGURE 9. CALCULATED L/V RATIO VS VERTICAL WHEEL LOAD, CURVES OF 4-, 6-, 8-, AND 10-DEGREE CURVATURE.

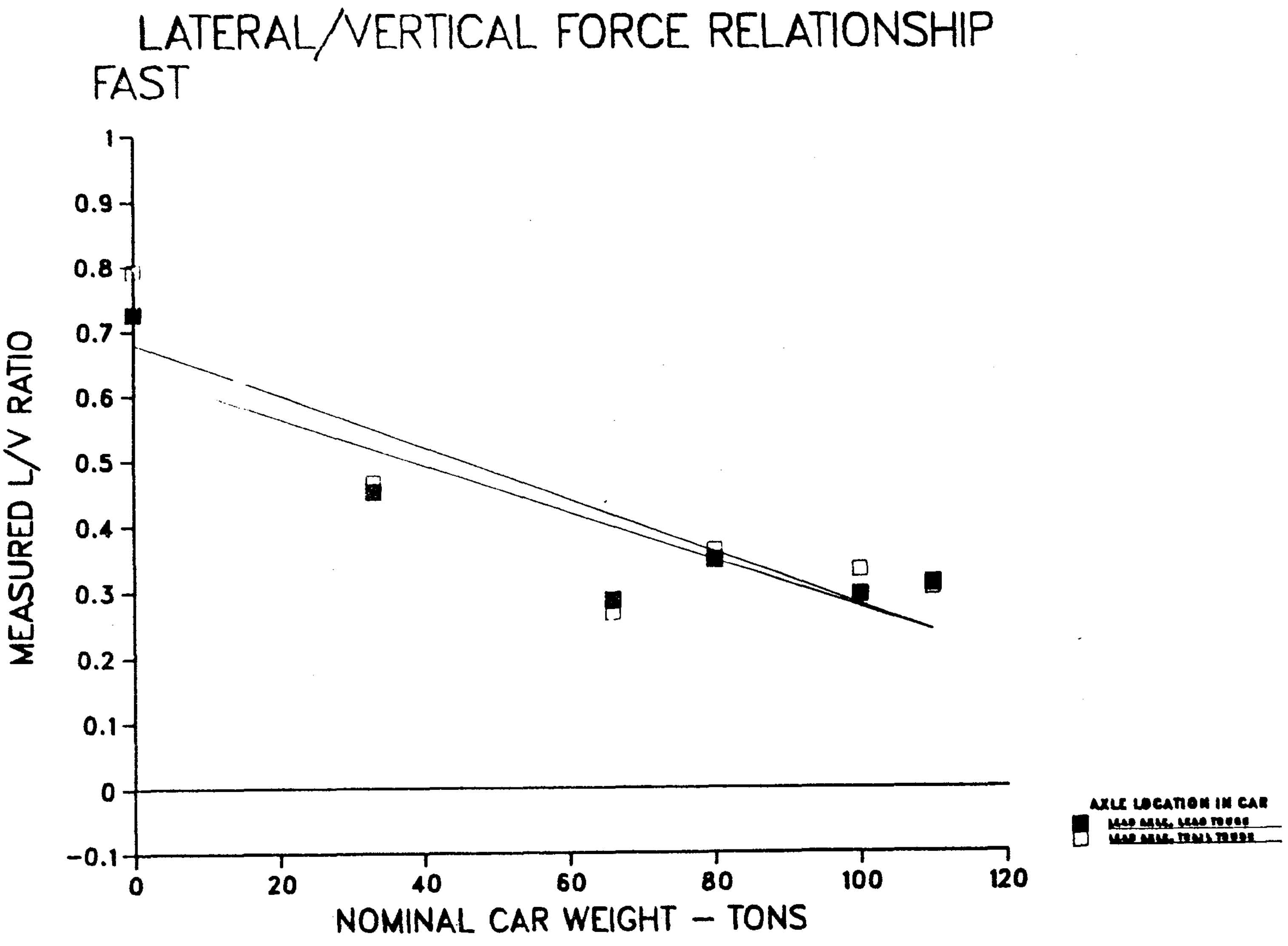


FIGURE 10. LATERAL/VERTICAL FORCE RELATIONSHIP, SECTION 17, INSIDE RAIL.

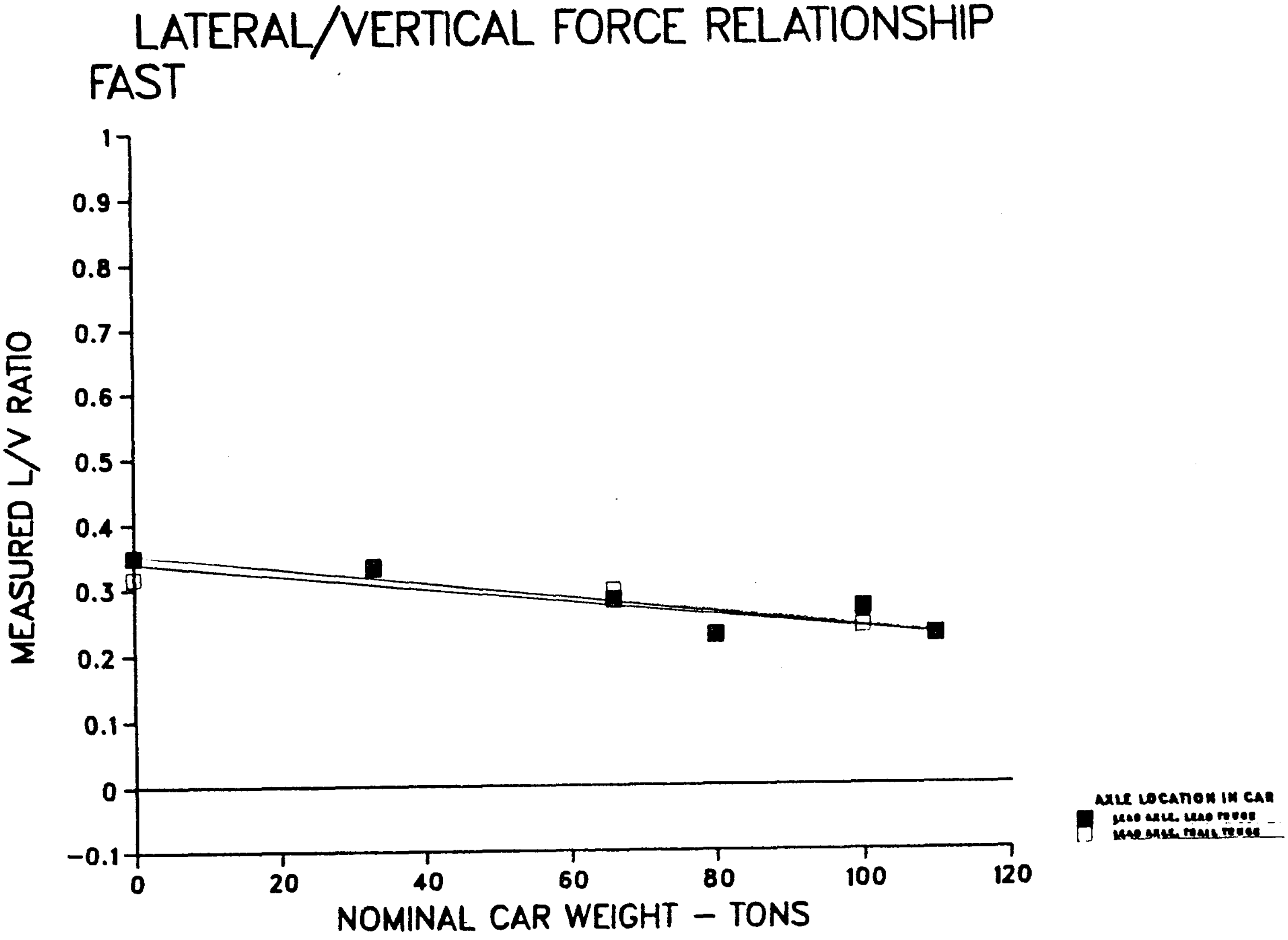


FIGURE 11. LATERAL/VERTICAL FORCE RELATIONSHIP, SECTION 7, INSIDE RAIL.

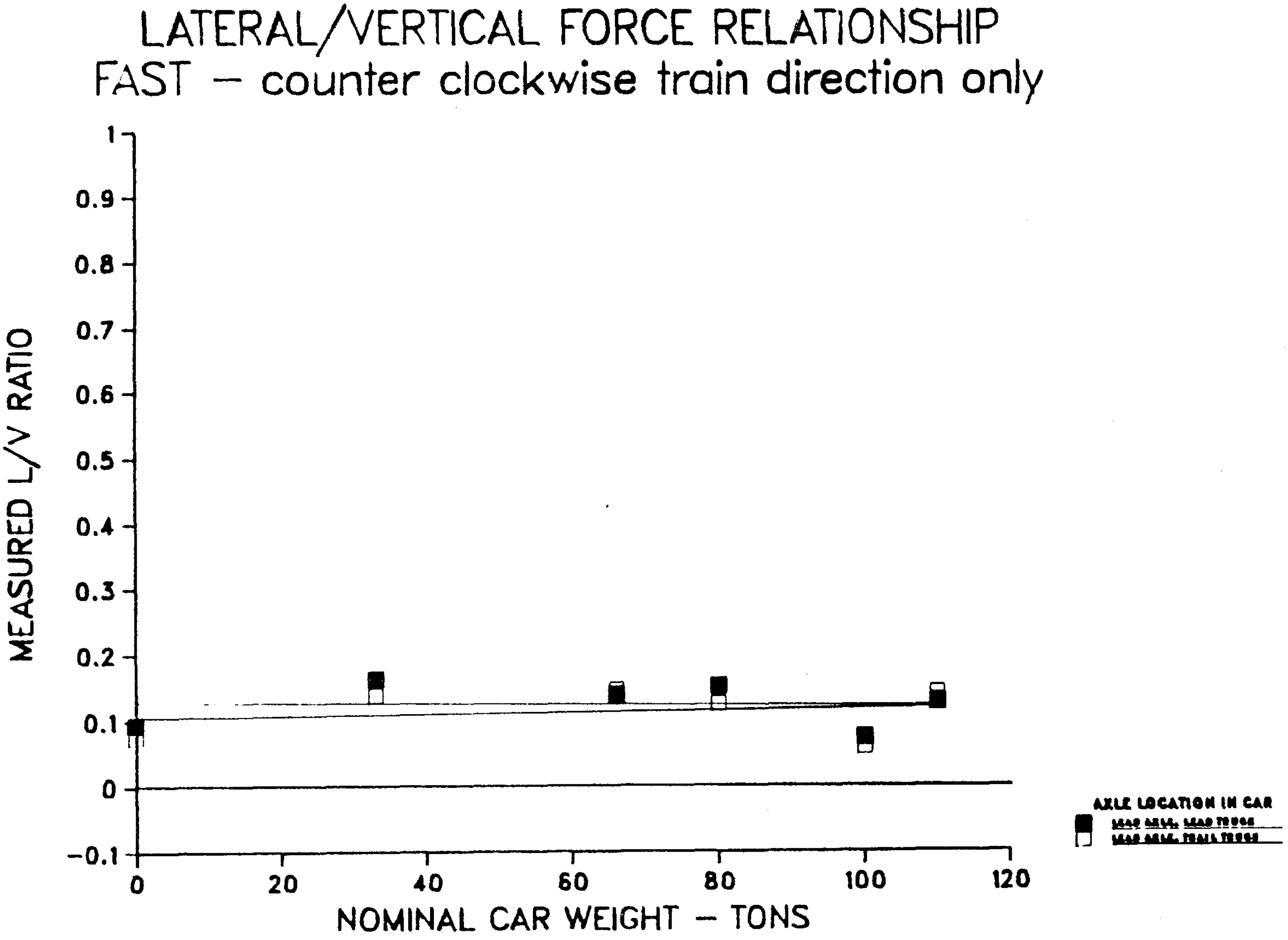
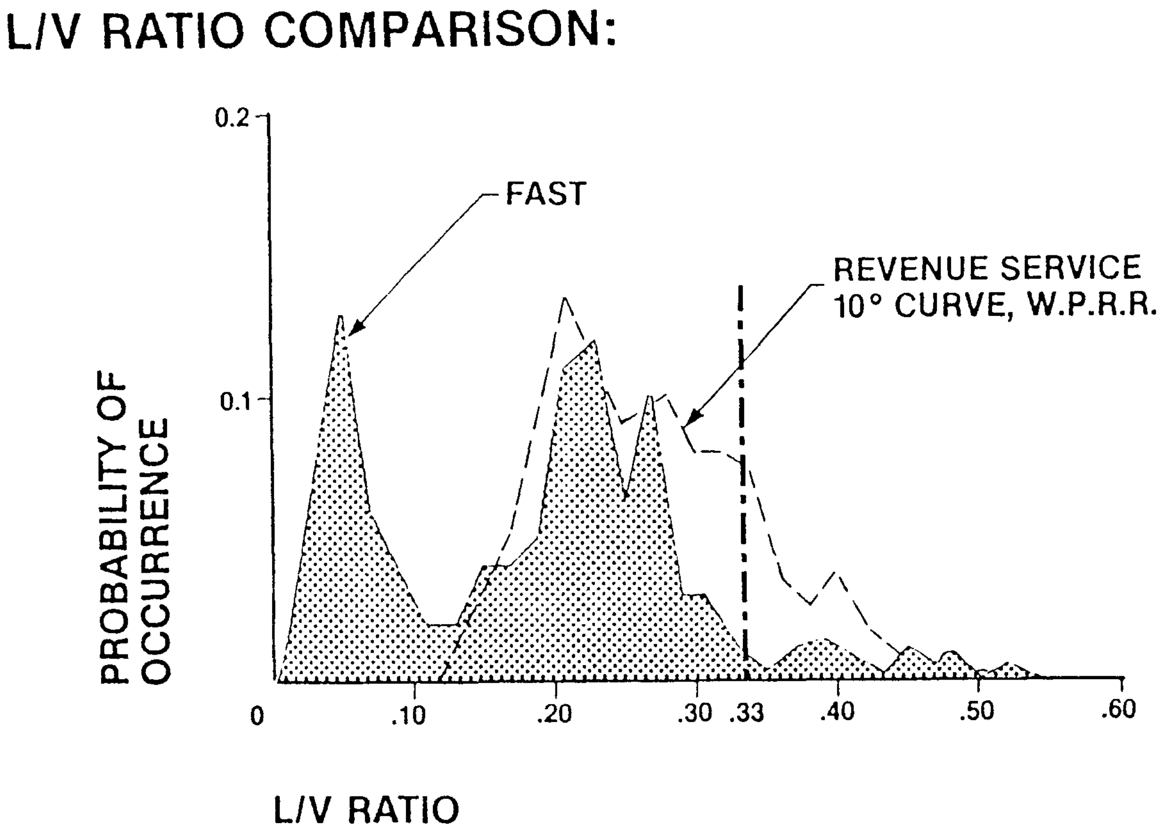
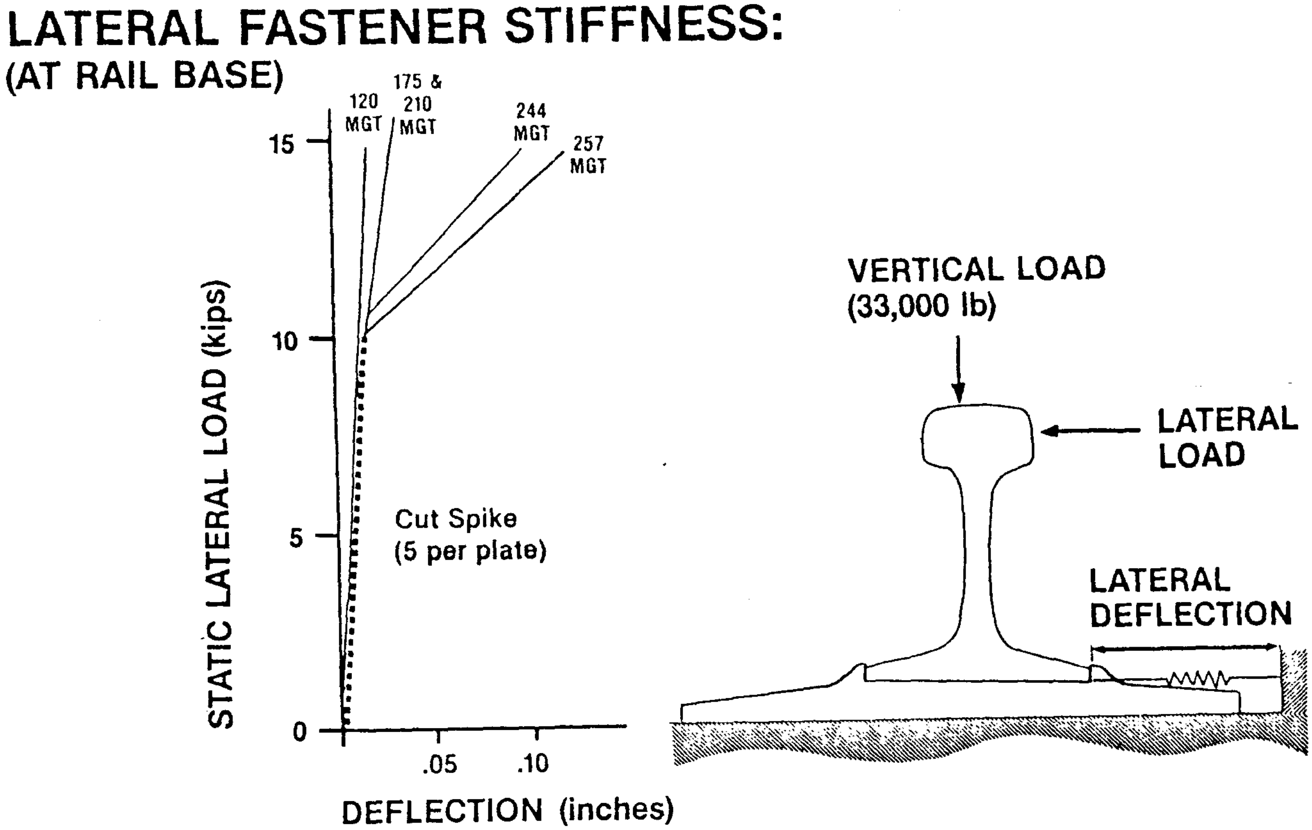


FIGURE 12. LATERAL/VERTICAL FORCE RELATIONSHIP, SECTION 7, OUTSIDE RAIL.



Source: Proceedings, FAST Engineering Conference, 1981, (page 65).

FIGURE 13. COMPARISON, L/V PROBABILITY OF OCCURRENCE, FAST VS SINGLE REVENUE CASE.



Adapted from <u>Proceedings, FAST Engineering Conference, 1981, (page 69)</u>

FIGURE 14. VARIATIONS, WITH MGT, IN LATERAL FASTENER STIFFNESS AT THE RAIL BASE.