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PERFORMANCE OF ELASTIC FASTENERS ON AN 8-DEGREE CURVE IN REVENUE SERVICE

SUMMARY

A test of elastic rail fastening systems was conducted on an 8-degree curve in the Norfolk Southern (NS) Mega Site as part of the Revenue Service Test Program, which is jointly sponsored by the Association of American Railroads and the Federal Railroad Administration (FRA). From June 2005 to January 2010, two types of elastic fasteners (AirBoss and NorFast) were tested and subjected to 260 million gross tons of mostly heavy axle load (HAL) traffic. Their performances were compared with an NS-standard cut-spike fastening system. Figure 1 shows the three types of fasteners.

The elastic fastening systems tested outperformed the cut-spike system based on the gage strength test results:

- The two sections of wood-tie track fitted with the elastic fastening systems and screw spikes provided three times higher gage strength than the track fitted with the NS-standard cut-spike system.
- The elastic fastener test zones did not use additional gage restraint hardware; however, two gage rods were installed in the cut-spike control zone in May 2009.

The lateral rail restraint measured in the elastic fastener zones was over three times higher than in the cut-spike control zone.

The lateral deflection on the low rail measured throughout the cut-spike control zone, under HAL cars operating at track-speed, was almost twice that measured on the same rail in the elastic fastening system zones. Eleven of the 360 NorFast rail clips were fractured under the rail clip keeper portion of the tie plates. The results of the laboratory test on NorFast rail clip samples from the installations at the Facility for Accelerated Service Testing and the mega site showed that these fractures were incidental, and removal was not necessary.

Cut-spike uplift of more than 1 inch occurred in almost 4 percent of the spikes in the cut-spike control zone (five spikes per tie plate). In the elastic fastener zones (four screw spikes per tie plate), none of the Lewis Bolt & Nut screw spikes significantly uplifted or fractured during the test.

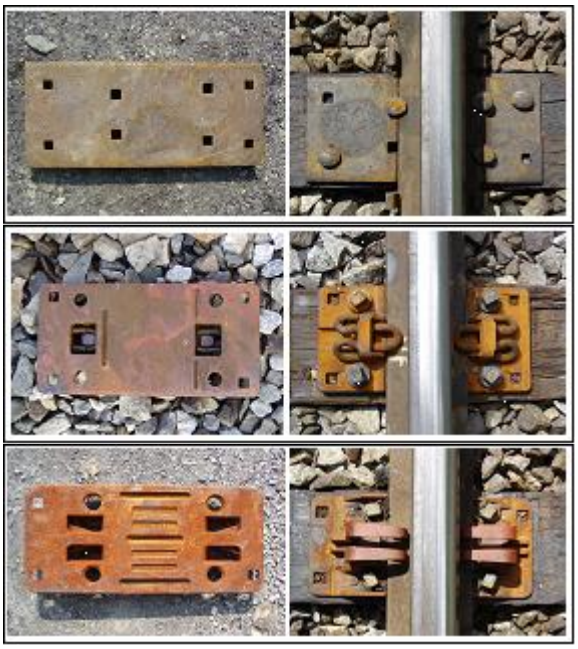

Figure 1. AirBoss (bottom), NorFast (middle), and NS Standard Cut Spikes (top)

BACKGROUND

Before being installed into revenue service, both elastic fastener types had been successfully subjected to heavy axle load (HAL) traffic on the High Tonnage Loop at the Facility for Accelerated Service Testing (FAST) in Pueblo, CO.

OBJECTIVES

The elastic fastener test was installed in June 2005 near Roanoke, VA, to compare the performance of the two elastic fastening systems with that of the Norfolk Southern (NS) standard cut-spike system under HAL traffic.

METHODS

The test zone was in the body of an 8-degree curve at Milepost V238.5 near Roanoke. It consisted of three subzones: (1) 100 consecutive ties with AirBoss 16-inch tie plates and rail clips; (2) 90 ties with NorFast 16-inch tie plates and rail clips: 82 of the 90 ties with the NorFast system were consecutive, and at each of the two approach transitions, four were intermixed with Pandrol 16-inch tie plates and rail clips; and (3) 90 consecutive ties with NS-standard 18-inch tie plates and cut spikes (control zone). All the plates were installed on existing ties.

The test zones were monitored for the following performance: gage strength using a portable track loading fixture (PTLF); in-motion, track gage degradation as a function of accumulated tonnage using FRA's T-18 test vehicle; lateral rail restraint using a static apparatus; and lateral railhead deflection under HAL traffic using Linear Variable Differential Transformers.

RESULTS

The gage strength degradation test results for the three zones using the PTLF showed that after 250 million gross tons (MGT), the gage strength of the two elastic fastener test zones was more than three times stronger (less gage widening) than that of the control zone with the NS-standard 18-inch plate and cut-spike system. The PTLF test, which applies the gage spreading load near the neutral axis of the rail, indicated that the cleats may provide some increased resistance to lateral tie plate translation.

Figure 2 shows a sequence of in-motion, unloaded track gage measurements taken in the elastic fastener and the cut-spiked test zones using FRA's T-18 gage restraint measurement system (GRMS) test vehicle. Portions of the control zone reached 57 inches, 1/2 inch over standard track gage, compared with the test zones fitted with elastic fasteners. Two gage rods were installed in the cut-spiked control zone prior to the May 2009 inspection when the test zone had accumulated 223 MGT. The test zones fitted with elastic fasteners did not require gage maintenance or additional gage restraint hardware.

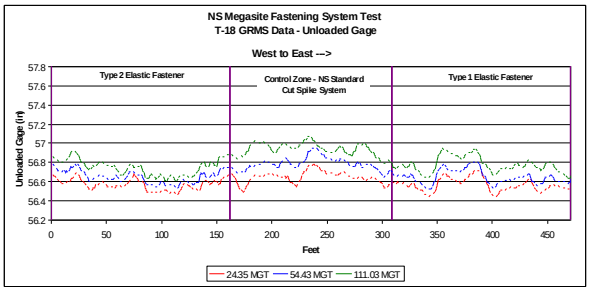

Figure 2. Sequence of In-Motion, Unloaded Track Gage Measurements Taken with FRA's T-18 GRMS Test Vehicle

The Static Lateral Rail Restraint Test was performed at 55 MGT to quantify the resistance that each fastening system provides. Figure 3 shows the lateral rail restraint of the two elastic fasteners and the cut spikes. Linear Variable Differential Transformers data indicated the force required to deflect the high railhead 0.02 inch in the gage-spreading mode was about three times higher (stronger) in the track fitted with the NorFast elastic fastener than the track fitted with the cut-spike system. In the AirBoss elastic fastener track, the 6.2-kilopound force required to deflect the railhead 0.02 inch was about six times higher (stronger) than that required in the cut-spiked track. To deflect the railhead 0.04 inch in the elastic fastener zones, the NorFast elastic fastener provided about three times more resistance, and the AirBoss elastic fastener provided about four times more resistance than the cut-spiked track.

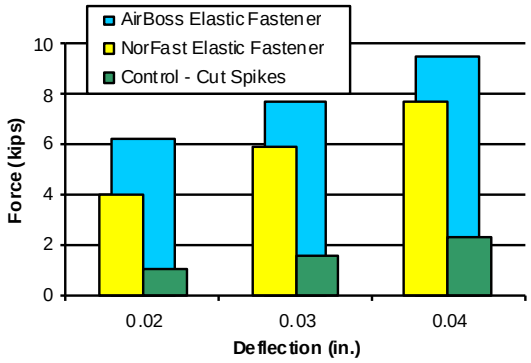

Figure 3. Results of the Static Lateral Rail Restraint Test

Lateral railhead deflections resulting from the dynamic loading introduced by passing HAL coal cars were measured early in the test. Each subzone was fitted with a pair of transducers to capture the high and low railhead deflections.

Given that the test zone was exposed to underbalance train operating conditions, higher loading, and therefore larger deflections, were expected on the low rail. Such was the case in the cut-spiked subzone, where the deflection measured on the low rail was almost twice that measured on the low rail of the elastic fastening system zones. Figure 4 shows that the two elastic fastening systems provided similar resistance to the dynamic gage-spreading forces at both rails where measured deflections ranged between 0.06 and 0.08 inch.

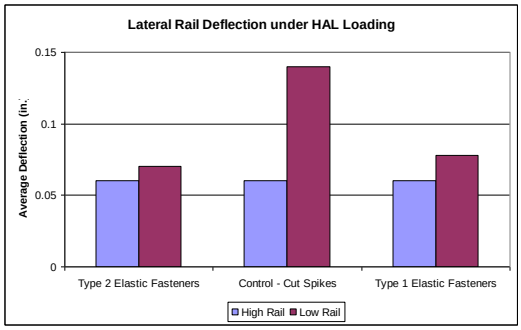

Figure 4. Lateral Railhead Dynamic Deflection under HAL Coal Car Loading

Component Performance

After 70 MGT of service, 2 of the 360 NorFast rail clips installed were found broken. The fractures occurred under the rail clip keeper portion of the tie plate, where it was difficult to detect by typical visual inspection, as Figure 5 shows.

Because of similar rail clip breakage (9 of 260), after 455 MGT at FAST, a laboratory study was conducted on samples taken from the two ongoing in-track tests at the eastern mega site and at FAST to determine whether this type of clip should be removed from service testing.

The results of the laboratory study indicated that no such action was necessary. In total, 11 rail clips in the NorFast elastic fastener test zone broke or fell out during the mega site test. Four of the 11 clips broke at a low rail load station

installation where the ties were not properly tamped resulting in severe vertical displacement (pumping) under traffic. The average lateral load on the low rail resulting from traffic was about 20,000 pounds according to load station data. In the AirBoss zone, four rail clips were bent as a result of being struck by track maintenance machinery.

Cut-spike uplift of more than 1 inch occurred in almost 4 percent of the spikes in the control zone where the NS-standard 18-inch plate system (five spikes per tie plate) was installed. In the elastic fastener zones (four screw spikes per tie plate), none of the Lewis Bolt & Nut screw spikes significantly uplifted or fractured during the test.

Figure 5. Parts of a NorFast Rail Clip Broke at 70 MGT

CONCLUSIONS

The elastic fastening systems tested outperformed the standard cut-spike system, based on the gage strength, the lateral rail restraint, and the dynamic (under HAL traffic) railhead deflection tests conducted during the period of performance.

ACKNOWLEDGMENTS

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KEYWORDS

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