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Update of Experiments at Eastern Mega Site

Dingqing Li and Russell McDaniel

SUMMARY

In 2006, six track experiments were in progress at the eastern mega site located on a Norfolk Southern (NS) heavy haul coal line near Princeton, West Virginia, and another satellite location near Niagara, Virginia. These experiments included a plastic tie test, bridge approach test, premium rail performance test, wide gap weld test, elastic fastener test, and monitoring of top of rail friction control. A summary of the main findings and achievements at the end of 2006 are as follows:

- Although plastic ties are not as good as hardwood ties in terms of performance measures (such as gage strength), they have been capable of supporting heavy axle load (HAL) traffic to date (112 million gross tons or MGT).
- The causes of track maintenance problems associated with open deck bridges and their approaches were determined and have been incorporated in the design of effective remedies.
- All premium rails have performed well to date (74 MGT) with only minor wear and surface checks.
- Wide gap welds have performed well to date: one product accumulated 65 MGT, the other accumulated 10 MGT (due to later installation).
- Use of top-of-rail friction control reduces lateral wheel force significantly (up to 30 percent). Monitoring is in progress to determine its effect on rail surface performance.
- Elastic fasteners on wood ties have performed well, out performing cut spikes to date (89 MGT).

The Mega Site Test Program was established in 2004, under joint funding by the Association of American Railroads and Federal Railroad Administration, to consolidate various revenue service test activities into two mega sites: one in the east with NS and the other in the west with Union Pacific. Each mega site is 10 to 30 miles, located in the heavy haul coal lines.

The objectives of the revenue service mega site programs are to evaluate the effects of HAL on track infrastructure and to monitor the performance of new technologies, new materials, and improved design and maintenance practices first tested at Facility for Accelerated Service Testing to mitigate the effects of HAL traffic.

Please contact **Dingqing Li (719) 584-0740** with questions or concerns regarding this *Technology Digest.* E-mail: Dingqing_Li@ttci.aar.com.

INTRODUCTION

At the eastern mega site on a NS heavy haul coal line located near Princeton, West Virginia, and another satellite location near Niagara, Virginia, six experiments were in progress in 2006, including:

- Plastic tie test
- Bridge approach test
- Premium rail performance test
- Wide gap weld (WGW) test
- Monitoring of top-of-rail (TOR) friction control
- Elastic fastener test (at the satellite location)

The eastern mega test site was established in 2004 under a joint research program funded by the AAR and Federal Railroad Administration (FRA). The objectives of this program are to determine the effects of HAL on track infrastructure and monitor performance of new technologies, new materials, and improved design and maintenance practices intended to mitigate the effects of HAL traffic.

The annual tonnage at the eastern mega site (also at the satellite location) is approximately 60 MGT per year, with 50 percent being 286,000-pound capacity unit coal trains running at 20 to 40 mph. The track has many sharp curves (with the maximum 10 to 12 degrees) and primarily uses wood ties.

These experiments are ongoing. This *Technology Digest* summarizes the results and preliminary conclusions to-date.

PLASTIC TIE TEST

The plastic tie test began in November 2004. Two types of plastic ties (Polywood and TieTek, 75 ties each) were installed in a 6.8-degree curve (2.5-inch superelevation), with NS's 18-inch tie plates and cut spikes. A control section of 75 mixed hardwood ties was installed between the two plastic tie sections.

At the end of 2006, approximately 112 MGT was accumulated in the test zone. *Technology Digest* TD06-005 describes this experiment. The following is a summary of the main conclusions to date:[1]

- Plastic ties have been capable of supporting HAL operations to date, although their performance was generally not as good as that of hardwood ties in terms of the measurements conducted (e.g., gage strength).
- Initial cracks in plastic ties, caused by spiking without pilot holes, have not grown, and no fracture has developed due to initial cracks to date.

Figures 1 and 2 give additional test results that were not published in TD06-005.[1] Figure 1 shows a comparison of gage strength (delta gage) test results among three test sections, obtained at two MGT levels (FRA's T18 test vehicle). As indicated, the wood tie section showed higher gage strength (lower delta gage) than both plastic tie test sections.

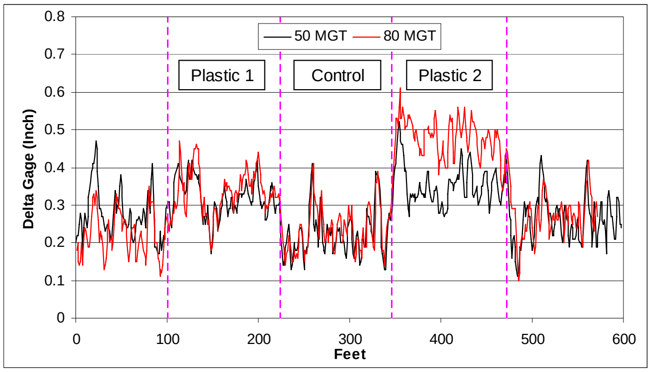

Figure 1. Gage Strength Comparison – Plastic Tie Test

Figure 2 shows a comparison of maximum vertical displacement (average of five ties for each tie type) recorded under a HAL car. As shown, one plastic tie type had vertical downward movement significantly higher at both ends of the ties than the wood ties.

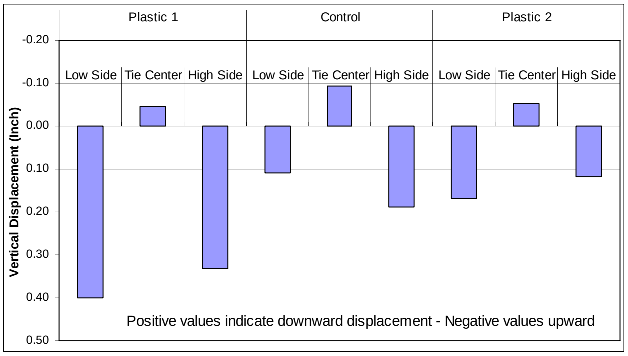

Figure 2. Vertical Displacement – Plastic Tie Test

BRIDGE APPROACH TEST

The bridge approach test began in 2005. The objectives of this test include: (1) determining the factors that cause track maintenance problems associated with open deck steel bridges located at this mega site, and (2) selecting and installing remedies and monitoring their long-term performance. The first objective has been achieved, and a *Technology Digest* (TD06-022) summarized the investigations conducted and the main conclusions drawn.[2] In short, problems of rough surface and alignment conditions, broken spikes/fasteners, plate cutting, and broken rails were attributed to a combination of several factors: differential track support between two rails due to skewed back wall (abutment), rapid change of track stiffness in both lateral and vertical directions, weak subgrade, and severe load environment due to rough track geometry and location in a sharp curves or adjacent spiral.

Several remedies have been considered, including the following two:

- Change from open deck to ballast deck to address lateral track stiffness change and to a secondary degree vertical track stiffness change between approach and bridge. Consistent fastening, tie spacing, and ballast support between bridge and approach will also make the track consistent in transitions.

- Install an approach slab or hot mixed asphalt track foundation in approaches to address differential track support issues as well as vertical stiffness issues.

PREMIUM RAIL PERFORMANCE TEST

The premium rail performance test started in August 2005. Eight premium rail types from four suppliers (Nippon, Rocky Mountain Steel Mill, Mittal, and Corus) were installed in four different curves (two 6.8-degree curves, and two 10-degree curves) to monitor their long-term performance under HAL train operation.

In order to determine performance of eight rail types objectively, one rail type was used as the control test rail, and in each curve, each of other seven rail types was welded together (flash butt weld) with the control rail. Rail performance is evaluated in terms of the ratio of test rail/control rail. In other words, the control rail is used to normalize possible condition variations from location to location, even in the same curve. The performance of test rails is being monitored in terms of rail wear resistance and resistance to rolling contact fatigue. Measurements of rail surface hardness have shown that all rails have hardness above 400 Brinell hardness number (BHN) after about 65 MGT of traffic.

At the end of 2006, approximately 74 MGT of traffic had accumulated on these test rails. To date, all test rails have performed well, with only minor wear (see Figure 3 for the average head area loss for the high rail in a 10-degree curve).

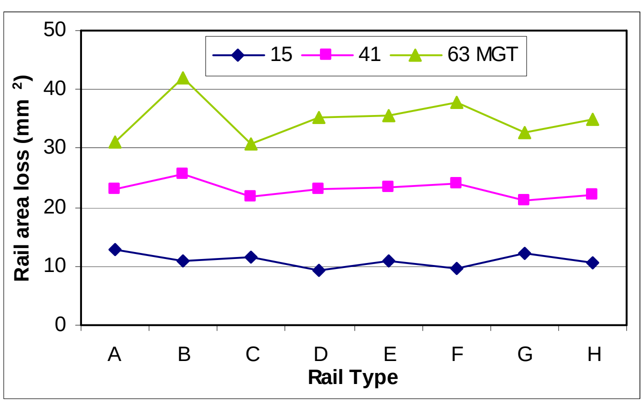

Figure 3. Average Rail Wear (High Rail in 10-Degree Curve)

WIDE GAP WELD TEST

Two types of WGWs were included under the WGW test: One, an Orgo Thermit product, was installed in October 2005, and the other, a Railtech Boutet product, was installed in October 2006. As compared to 1-inch standard welds, WGWs (2.75 inches) can prevent use of two welds when a rail defect needs to be removed or can reduce the large change of neutral rail temperature when a broken rail can be welded without heating or pulling.

For each product, 16 welds were installed in eight different spirals (both low and high rails, 141RE) in the field. At the end of 2006, 65 MGT had accumulated on Orgo WGWs, whereas only 10 MGT had accumulated on Boutet WGWs. Performance monitoring has included hardness measurement, longitudinal surface profile, and integrity of weld using hand-held ultrasonic tester.

To date, all welds have performed well. No defects have been found, and no surface irregularities have developed between welds and rails, although surface hardness had varied due to the effect heat had on the rails caused by the welding.

Figure 4 shows hardness results that were taken at the center of each weld, 12 inches away on the rail in either direction of the weld, and near the ends of the rails that were affected by heat of welding (heat affected zones or HAZ). As shown, rails have higher hardness than the welds, but the rails that were affected by heat of welding have lower hardness than the welds.

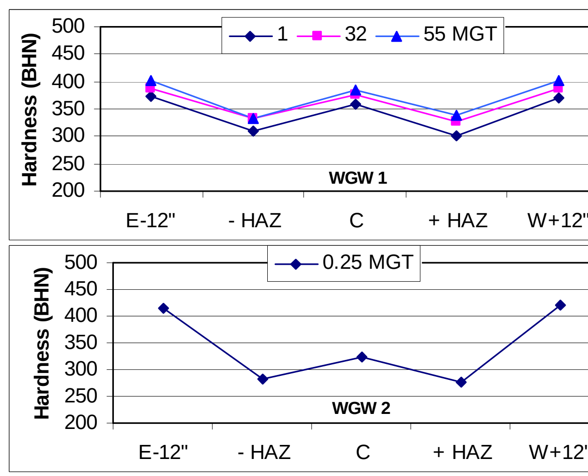

Figure 4. Rail Hardness Test Results (High Rail Average)

Monitoring of TOR Friction Control

TOR friction control monitoring started in 2004. Fourteen pairs of wayside-based TOR applicators were installed by NS in late 2003 at intervals of 1 to 2 miles. The objective of this test is to monitor how effective TOR friction control is in terms of improvement in track performance and determine the long-term reliability of the systems.

Technology Digest TD06-006 describes the experiment and summarizes earlier findings.[3] In short, use of TOR friction control reduced lateral wheel force significantly (up to 30 percent) and reduced gage widening of the track as a result of reduced lateral force. The issue, however, has been the reliability of the wayside systems. As reported in TD06-006, these wayside systems (specifically the application bars on the rails) have not been capable of handling removal and re-installation several times a year due to various track maintenance activities (such as tie replacement and rail grinding) in the area.[3]

Another earlier objective of this experiment was to determine an optimized TOR friction modifier application rate based on the amount of lateral force reduction. For the direction of loaded train traffic (east bound), for example, an optimized rate was settled at 0.25:8 (i.e., 0.25 second of pumping at every 8th axle).

Currently, the focus of this experiment has shifted from monitoring lateral wheel forces to monitoring rail surface performance due to use of a friction modifier. Two groups of curves (one with friction modifier, the other without) were selected in the summer of 2006. Their initial surface conditions were documented (via means such as dye penetrant and photographs). Field inspections will be conducted every six months to compare rail surface performance between these two groups of curves.

ELASTIC FASTENER TEST

The elastic fastener test started in June 2005. Two types of elastic fastening systems (NorFast and AirBoss) were installed in an 8-degree curve, with high strength screws (Lewis Nut & Bolt). Each fastening system was used on 100 consecutive wood ties. A control section was installed between the two fastening systems and consists of NS's 18-inch tie plates with cut spikes. The objective of this test is to monitor long-term performance of the new generation elastic fasteners under HAL operations.

At the end of 2006, 89 MGT of traffic had accumulated in the test zone and both elastic fastening systems had performed well. Figures 5 and 6 give examples of test results concerning performance of the test zone. Figure 5 shows gage strength test results via FRA's T18 test vehicle. As expected, the track with elastic fasteners provided higher gage strength (lower unloaded and loaded gage as well as lower delta gage) than the track with cut spikes. Note that the track outside of the test zone also uses NS's tie plates with cut spikes.

Figure 6 shows the rail roll restraint test results (required force to roll the rail to a certain amount). As shown, the rail with either elastic fastener is more resistant to rail roll than the rail with cut spike (control). However, two clips of one fastening system broke at about 70 MGT. Broken clips of the same system were also observed in the experiment at FAST. Investigation is in progress and further monitoring will reveal if these were an isolated problem.

CONCLUDING REMARKS

Findings from the TOR friction control experiment have been incorporated into another AAR research project for developing the guidelines of implementing TOR friction control. Preliminary performance results of premium rails, plastic ties, elastic fasteners, and wide gap welds are similar

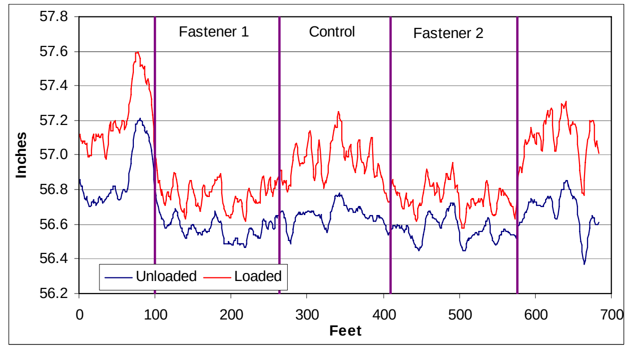

Figure 5. Gage Strength Test Results

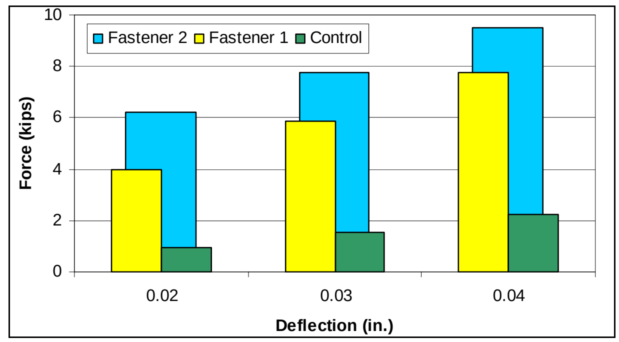

Figure 6. Rail Roll Restrain Test Results (High Rail)

to those observed under the FAST Experiment Program, although it is still too early to correlate the revenue service test results to the results obtained from the experiments at FAST. In 2007, all experiments will continue. For the bridge approach test, the focus in 2007 is to install remedies and start monitoring effectiveness.

ACKNOWLEDGMENTS

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