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Research Results

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Update of Experiments at the Revenue Service Mega Sites

SUMMARY

Revenue service testing by Transportation Technology Center, Inc. at the eastern and western mega sites (Figure 1) continues to determine the effects of heavy axle loads (HAL) on track infrastructure and to monitor performance of new technologies and designs intended to improve train operation safety and to mitigate detrimental effects of HAL on the track structure. The Federal Railroad Administration and the Association of American Railroads co-sponsor this research.

These two mega test sites were established in 2004 and every year a number of experiments are conducted to address various HAL operation issues. Some experiments are long term, taking a few years to complete and may be conducted in phases. This paper is a summary of findings from experiments conducted in 2008 and the first quarter of 2009. These include experiments on premium rails, wide-gap welds (WGW), insulated joints (IJ), rail anchors on concrete ties, plastic ties, elastic fasteners, and bridge approach remedies.

Premium test rails at both mega sites continue to show excellent wear performance. The eastern mega site premium test rails have been subjected to 210 million gross tons (MGT) of HAL traffic and the western mega site premium test rails have endured 880 MGT. At the eastern mega site, gage face lubrication and top-of-rail (TOR) friction control have effectively reduced rail wear and rolling contact fatigue (RCF). At the western mega site, TOR friction control or preventive grinding have been started as measures to extend rail life and prevent or delay the onset of RCF.

At the eastern mega site, WGWs have been under testing as an alternative repair process to the conventional plug and weld procedure as a single weld to repair welds and railhead defects up to 2.75 inches in length. Also at the eastern mega site, performance monitoring of plastic ties and elastic fasteners continues. At the western mega site, two tests have concluded: one regarding IJs with an improved design and the other regarding the effectiveness of rail anchors designed for concrete ties at IJ locations.

Bridge approach remedy tests include those for open deck bridges located in sharp curves and concrete tie ballasted deck bridges.

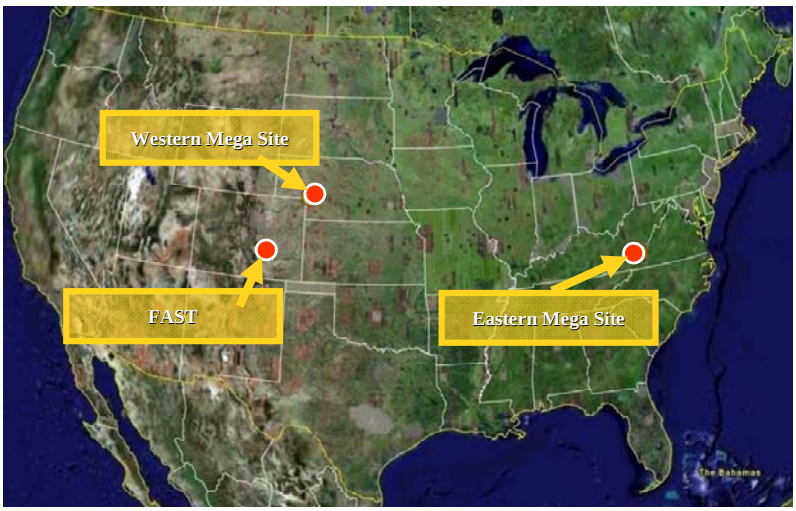

Figure 1. Location of Mega Sites and FAST Test Site

INTRODUCTION

Two mega test sites were established in late 2004 to consolidate some of the heavy axle load (HAL) revenue service experiments. The eastern mega site is located near Bluefield, WV, on a heavy haul track of Norfolk Southern (NS) Railway. The western mega site is located near Ogallala, NE, on a heavy haul track of Union Pacific Railroad. In 2008 and during the first quarter of 2009, numerous experiments, most of which started before 2008, continued or were concluded. This *Research Results* gives a summary of findings from this revenue service test program.

PREMIUM RAILS, RAIL LIFE EXTENSION

Several premium rails have been tested in HAL operating environments at both mega sites since September 2005 [1]. The eastern mega site has four test curves with curvatures ranging from 6.8° to 10°. All premium test rails continue to show excellent performance after approximately 210 MGT of traffic, with less than 4 percent rail head area loss from natural wear. There has been no rolling contact fatigue (RCF), and no internal defects have been identified. For all four test curves, excellent gage face (GF) lubrication and TOR friction control implemented by NS have contributed to rail performance. No preventive grinding, which is normally done every 30 MGT in this area, has been allowed on any of these test curves.

At the eastern mega site, rails with mixed ages and mixed types in two groups of curves (six curves in each group) were monitored for TOR friction control performance effects on rail life. One group of curves has both GF lubrication and TOR friction control, whereas the other group has only GF lubrication. Measurements to date (150 MGT) have shown that implementation of TOR friction control reduced vertical wear by approximately 30 percent. In addition, TOR friction control reduced loss of rail metal from rail-grinding operations, suggesting that TOR friction control reduced the occurrence of RCF. Figure 2 shows a comparison of average vertical wear on low rails between these two groups of curves; one having TOR-friction control and the other without. Vertical wear shown in Figure 2 included both natural wear and loss of metal from rail grinding.

At the western mega site, where the annual HAL traffic is roughly 250 MGT, several premium rails have been under test since September 2005. The western mega site has three rail test curves with curvatures in the 1- to 2-degree range. All test rails have shown excellent wear performance with projected minimum wear lives of 2,800 MGT [1]. But RCF became a problem for the 2-degree test curves, which required corrective grinding on the low rails at 375 MGT and then again at 690 MGT (see Figure 3). The high rails also required corrective grinding to remove RCF at 690 MGT.

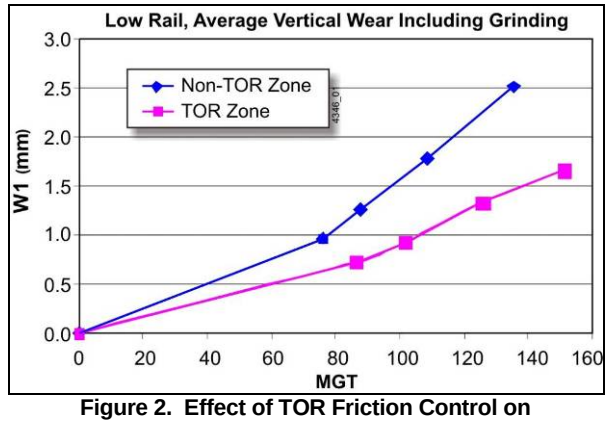

Figure 2. Effect of TOR Friction Control on Low Rail Vertical Wear

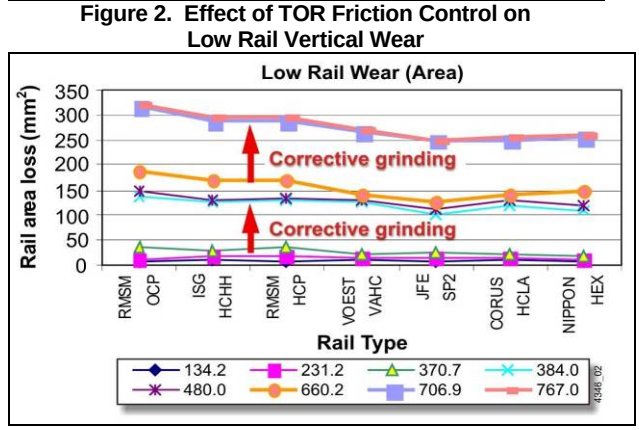

Figure 3. Loss of Rail Metal Due to Natural Wear and Corrective Grinding at Western Mega Site

Starting in September 2008, the focus of the premium rail test at the western mega site was shifted to rail life extension by using TOR friction control or preventive grinding. To accomplish this, one 2-degree test curve was set up with a TOR friction control unit, while a regimen of one-pass preventive grinding every 60–90 MGT was implemented on the other 2-degree curve. Because of little RCF on the 1-degree curve to date (880 MGT), no TOR friction control or preventive grinding has been implemented on this curve.

WIDE-GAP WELDS

A report was recently published [3] summarizing the test results for 32 wide-gap test welds (from two different suppliers) installed at the eastern mega site. In general, these welds have performed well for approximately 200 MGT for one of the products, and 144 MGT for another product that was installed 1 year later. However, the majority of the test welds (70 percent) have some moderate plastic flow or

gage corner spalling. Because the welds were located in the premium rail test curves, they have not received any grinding, which would normally be done on a regular basis to mitigate these surface issues. To prevent these surface condition issues from growing into defects, hand grinding was done in May 2009.

INSULATED JOINTS (IJs), RAIL ANCHORS

Eight test IJs were installed at the western mega site in the summer of 2004 [5]. Seven IJs had an improved design, whereas, one, which failed at 330 MGT in 2006, used a traditional design. This test was concluded in 2007 in terms of measuring load environment data of these test IJs, but monitoring of their long-term performance continued. After approximately 1,000 MGT, two of the seven test IJs failed from cracked joint bars, resulting in a life at least three times as long as the conventional design. Figure 4 shows a failed IJ due to a cracked joint bar. Notice the rough running surface that generated high wheel impact forces and contributed to the breakage of the joint bar.

Figure 4. IJ Failed Due to Cracked Bar at 1,090 MGT

In 2007, three different IJ locations at the western mega site (two locations with older IJs and one location with new IJs) were selected to test the performance of rail anchors designed for concrete tie track. A report was recently published describing this test and its results [4]. The test anchors installed at the IJ locations did not provide additional benefits in terms of reducing changes in rail neutral temperature (RNT) nor in preventing a drop in RNT when the joint bars cracked at the old IJ test location.

PLASTIC TIES, ELASTIC FASTENERS

At the eastern mega site, performance monitoring of two types of plastic ties installed on a 6.8-degree curve has been ongoing since November 2004. After 250 MGT, these plastic ties continue to perform well. Figure 5 shows gage strength degradation test results by using a lightweight track loading fixture for two types of plastic ties and for wood ties located in the same curve. Although showing slightly higher gage spreadings, these plastic ties have exhibited gage strength degradation trends similar to the wood ties.

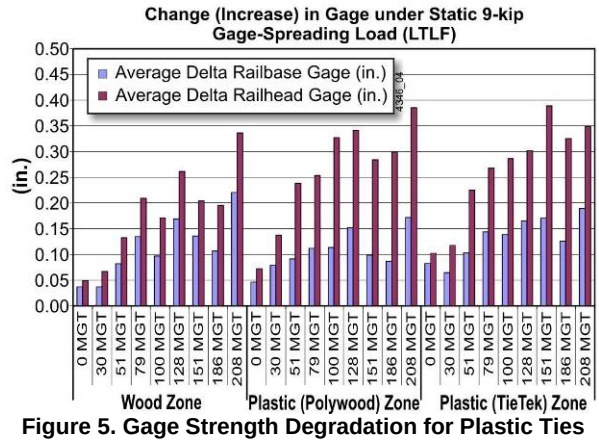

Figure 5. Gage Strength Degradation for Plastic Ties

In April 2009, the entire test curve was regaged due to wide gage issues in the adjacent spirals (equipped with wood ties) of the same curve. The regaging operation for plastic ties followed the same procedure used for wood ties in terms of spike removal, spike hole filling using a synthetic material, and respiking the tie plates. Predrilling was done only for the spikes next to the side edges of the plastic ties. Except for a small crack on two ties, respiking did not cause cracking problems for plastic ties.

At the eastern mega site, performance monitoring of two types of elastic fastening systems installed in an 8-degree curve has been ongoing since June 2005. No major performance issues have been noticed to date after approximately 225 MGT of HAL traffic.

BRIDGE APPROACHES

The bridge approach test has been a major component of the HAL revenue service monitoring program at both the eastern and western mega sites, although the causes of bridge approach problems were very different at the two sites. The objective of the early phase of the test was to determine the root causes of the problems [2, 6]. In the past 2 years, the focus of the testing has been to select, design, install, and monitor remedies.

At the eastern mega site, the problems are associated with open-deck steel bridges located in sharp curves, which tend to have track alignment and cross-level problems, mainly because of inconsistent lateral track strength (at both the rail tie

and tie-ballast/bridge girder interfaces), skewed bridge abutment, and, in some cases, subgrade issues. One effective remedy is to replace the open deck with a ballasted deck, which essentially addresses the lateral track strength and cross-level support issues. Two bridges located in 10- to 11-degree curves, which had required track geometry maintenance on a monthly basis in the past, have not had any track geometry issues since deck replacement

Figure 6 shows the improvement in the lateral alignment problem (in terms of roughness, which is a mean square calculation based on actual track geometry car alignment data) for the two bridge approaches to an open deck steel bridge located in a sharp curve. As shown, alignment roughness was significantly higher before the remedy (deck replacement) than after the remedy.

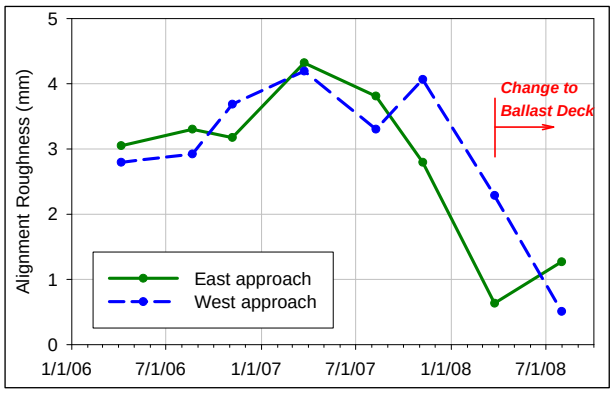

Figure 6. Improvement in Alignment due to Deck Change

Changing from an open deck to a ballasted deck, although effective, is an expensive remedy and will not address bridge approach problems caused by subgrade issues. Currently, TTCI is investigating alternative remediation methods, which can be less expensive or can address subgrade problems.

At the western mega site, bridge approach problems are associated with ballasted-deck bridges (both concrete and steel) with standard concrete ties. Past measurements have shown that the tracks on these bridges have very high track stiffness and very low damping, which is detrimental to dynamic vehicle/track interaction. High impact forces are often generated on these bridges and cause rapid track component and track geometry degradation as well as mud pumping.

In September 2007, standard concrete ties were changed to ones fitted with rubber pads underneath a test bridge at the western mega site to address track stiffness and damping issues. It had experienced significant mud pumping and tie cracking problems (a broken rail had occurred in the approach of this bridge). Track drainage conditions were improved to drain rainwater from the track. This bridge and its approaches continue to show good performance after approximately 400 MGT.

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