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Revenue Service Test of Rail Anchors on Concrete Tie Track at Western Mega Site

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Summary

In August 2007, the Transportation Technology Center, Inc. (TTCI) and Union Pacific Railroad (UP) initiated a revenue service test to monitor the performance of rail anchors designed for concrete ties. This test was conducted at three locations with insulated joints (IJs) at the western mega test site on UP's heavy haul coal route near Ogallala, Nebraska.

Test results showed that the anchors did not provide additional benefits in reducing the short- and long-term changes in rail neutral temperature (RNT), nor did they prevent a large drop in RNT when the joint bars cracked at one of the test locations. In other words, the anchors installed on the concrete ties at IJ locations did not provide additional longitudinal resistance when no apparent longitudinal rail movement was observed. In addition, measurements of fastener toe load indicated little difference in the magnitude of toe load or changes in toe load over time between the rail with anchors and the rail without anchors.

At each test location, the rail on one side of the track was anchored for 120 consecutive ties in either direction from the joint, whereas the rail on the other side of the track was not anchored. As such, each test location provided a direct comparison of performance between the anchored and unanchored rails.

The anchors are designed for use with concrete ties at critical track locations, such as IJs, turnouts, crossovers, open-deck bridges, or any heavy axle load (HAL) track where longitudinal rail movement needs to be controlled. The anchors are essentially regular rail anchors for use with wood ties, but have a plastic cover intended to provide isolation between the rail and the concrete tie, and to prevent damage to the concrete tie from the metal anchor.

The western mega site is subjected to approximately 250 million gross tons of HAL coal traffic per year. A number of experiments are currently conducted by TTCI at this site to address track component degradation and performance issues under HAL operations, as part of a research project funded jointly by the Association of American Railroads and the Federal Railroad Administration.

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INTRODUCTION

A rail anchor is a device that is applied to the base of a rail with a friction grip and bears against the tie. It is used to restrain longitudinal movement of rail due to thermal changes and longitudinal wheel forces. Traditionally, anchors have been applied mainly to track constructed with wood ties and cut spikes. Where elastic fasteners are used instead of spikes, rail anchors are considered unnecessary. Rail anchors have rarely been used on track constructed with concrete ties, because the clip force that fastens the rail to the ties (toe load) provides sufficient longitudinal resistance.

In the past several years, loss of toe load due to pad degradation and rail seat abrasion has become a problem for tracks constructed with concrete ties in HAL operating environments, especially those tracks with high annual tonnage. Loss of toe load leads to reduced restraint of rails in both the longitudinal and lateral directions. To address this problem, a modified rail anchor (Figure 1) was developed by the supply industry for application to concrete ties. As shown, it consists of a regular anchor designed for wood ties and a plastic cover. The plastic cover serves two purposes: it provides electrical isolation between the rail and the concrete tie, and it protects the concrete tie against damage from the metal anchor.

In August 2007, TTCI and UP initiated a revenue service test at the western mega site located on a coal route near Ogallala, Nebraska, to monitor the performance of this type of anchor. This *Technology Digest* summarizes the test results.

Figure 1. Rail Anchor for Concrete Tie Track

TEST SITE AND INSTRUMENTATION

Three locations at the western mega site were selected for the test. Each location included bonded IJs. Two locations, milepost (MP) 61.3 and MP 65.7, had IJs that appeared to be in poor condition (old), and one location (MP 69.1) had IJs that were just installed (new). At each test location, the rail on one side of the track was box-anchored for 120 consecutive ties in either direction from the joint (Figure 2) whereas the rail on the other side of the track was not anchored. As such, each test location provided a direct comparison of performance between the anchored and unanchored rails.

Figure 2. Box Anchors of Rail at Test Site

The test monitored the following performance parameters between the anchored and unanchored rails:

- Change of rail neutral temperature (RNT) over time, which gave a direct indication of changes in longitudinal rail resistance due to daily and seasonal temperature changes and possible cracks in the joint bars at the locations with old IJs.
- Toe load and its reduction (degradation) over time, which provided another measure of the rail restraint between the anchored and unanchored rails.
- Monitoring of potential rail movement relative to the ties.

The western mega site is one of the revenue service testing sites that consolidate a number of experiments jointly funded by the Association of American Railroads and the Federal Railroad Administration. The annual tonnage at this site is very high, approximately 250 million gross tons (MGT) a year on the track that transports coal with 36-ton axle load unit trains. Loaded unit trains operate at 40-50 mph from west to east. All three test locations are located in tangent track segments, and the maximum grade is 0.5 percent (downhill from west to east).

TEST RESULTS AND DISCUSSION

Rail Neutral Temperature Change

RNT sensors were installed at two locations to monitor changes in RNT over time. Figure 3 shows the actual layout of four RNT sensors installed at one test location. As shown, two sensors were installed on the anchored rail and the other two were installed on the unanchored rail. Each sensor was approximately 6 feet from the joint bars.

Figure 3. RNT Sensors Installed at Test Site

Monitoring the change in RNT over time at these locations indicated no apparent difference between the anchored and unanchored rails. Figure 4 shows the results from two sensors installed at the location with the new IJs. For illustration purposes, the data shows one month (summer) of operation. As expected, RNT fluctuated on a daily basis and drifted lower over time. Comparison between the anchored and unanchored rails indicates no obvious difference in the short- and long-term changes in RNT; i.e., no additional longitudinal resistance from the anchors was present under normal operating and weather conditions.

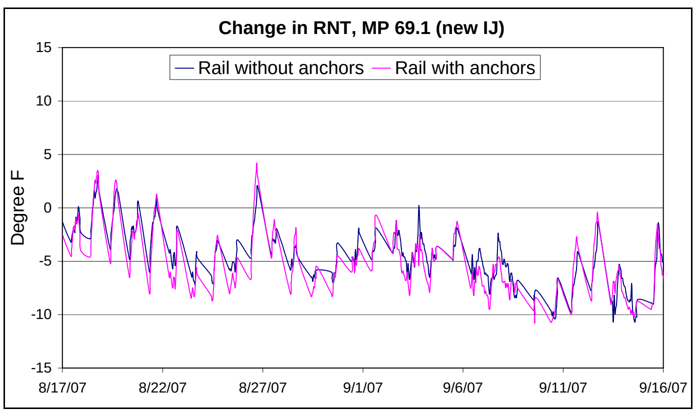

Figure 4. Change of RNT at New IJ Location

Figure 5 shows the results from two sensors installed at the location with the old IJs. Again, the data shown is only for one month (winter) of operation. As expected, RNT fluctuated on a daily basis and also drifted downward over time. Comparison between the anchored and unanchored rails also indicates no obvious difference in the short- and long-term changes in RNT; i.e., no additional longitudinal resistance from the anchors was present under normal operating and weather conditions.

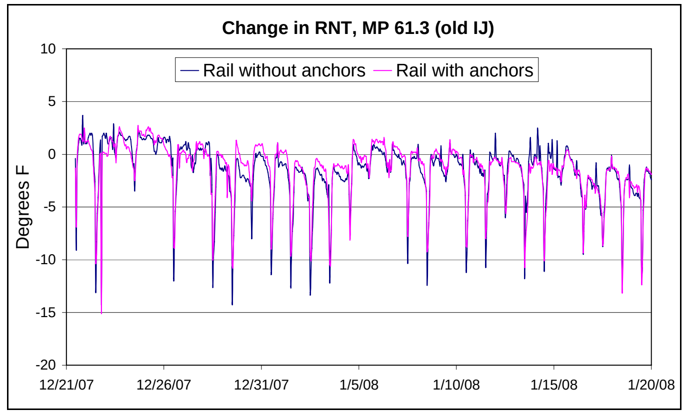

Figure 5. Change of RNT at Old IJ Location

On November 8, 2008, at one of the test locations with the old IJs (MP 61.3), the joint bars on the rail with anchors cracked. Figure 6 shows the actual rail section that was replaced due to cracked bars. As shown, the joint bar on the field side of the rail broke. The joint bar on the gage side of the rail also cracked, although the crack did not extend across the entire bar (not shown in Figure 6).

Figure 6. Cracked and Replaced Joint

Figure 7 shows the drop in RNT due to cracking of the joint bars. Daily RNT reflects temperature changes after the joint bars cracked. In this figure, data is shown from the two RNT sensors installed on the anchored rail. As illustrated, there was a large drop in RNT (by approximately 60 degrees F) due to cracking of the joint bars. In other words, the anchors did not provide any significant longitudinal resistance that would have reduced the amount of drop in RNT.

Note that the failed joint section was replaced on November 17, 2008. Between November 8 and November 17, 2008, the change in RNT essentially reflected the change in rail temperature, which generally can vary over a much wider range than RNT.

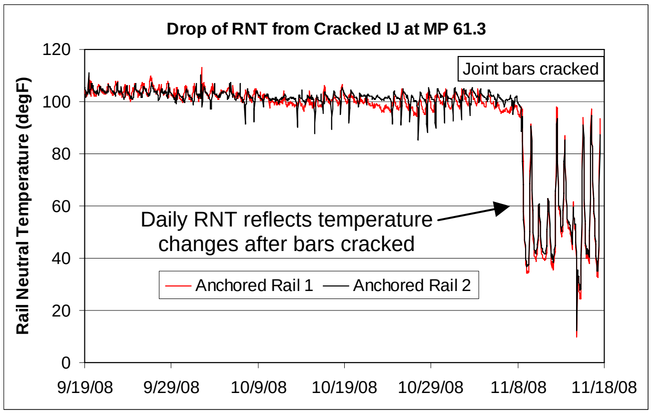

Figure 7. Drop of RNT from Cracked Bars

Toe Load and its Change over Time

Toe load is the hold-down force provided by a spring clip on the base of rail. In theory, it is equal to the force required to just lift a clip from the base of the rail. As part of this test, TTCI used the device shown in Figure 8 to measure toe load. The device is used to lift the spring clip from the rail base via a hydraulic cylinder, while recording the force required to lift the clip at different displacement levels.

At each test location, measurements were taken every tenth tie, on both rails for the clips on both the gage and field sides of the rails. Measurements were taken at different times (MGT) in order to monitor potential degradation in toe load over time.

Figure 8. Toe Load Measuring Device

Figure 9 provides a summary of test results for all three test locations obtained on three different dates. This figure shows the forces required to lift up the clips to four displacement levels (0.02, 0.05, 0.08, and 0.11 inch). The force corresponding to 0.05 inch may be considered as the toe load, because this displacement roughly corresponds to the point at which the clip just loses contact with the rail base.

The top graph in Figure 9 shows a summary of the data for the anchored rail. The bottom graph shows a summary of the data for the unanchored rail. As illustrated, there were no significant differences between the anchored and unanchored rails in toe load or the required forces to lift clips at the four deflection levels. In addition, the change (or degradation) in toe load over time was insignificant.

On November 18, 2008, toe load measurements were taken at MP 61.3 where the joint bars had cracked on November 8, 2008. No significant difference in toe load was measured between the anchored and unanchored rails at this location.

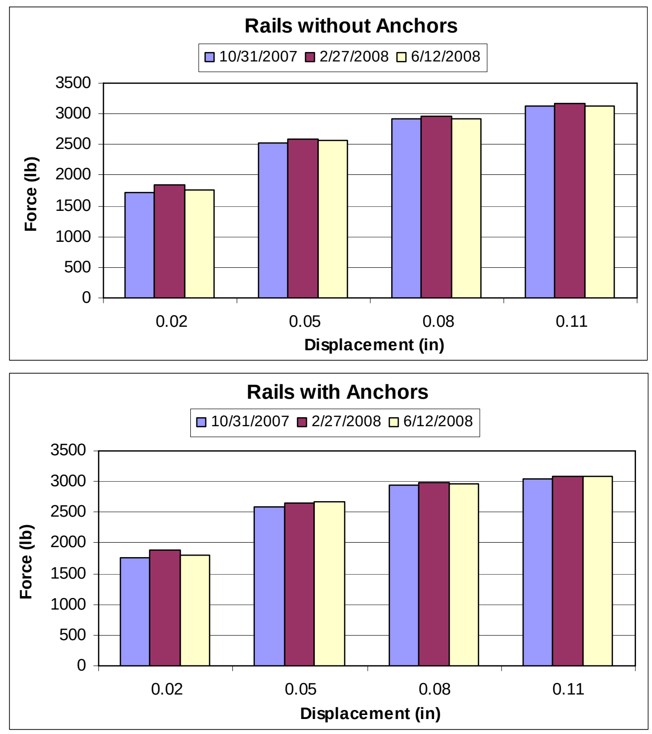

Figure 9. Summary of Toe Load Measurements

CONCLUSION

Rail anchors installed at three IJ locations with concrete ties did not provide additional benefits in reducing the short- and long-term changes in RNT, nor did they prevent a large drop in RNT when the joint bars cracked at one of the test locations. In other words, the anchors installed on the concrete tie track at IJ locations did not provide additional longitudinal resistance when no apparent longitudinal rail movement was observed. In addition, measurements of fastener toe load between the anchored and unanchored rails indicated little difference in the magnitude of the toe load or changes in toe load over time.