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The Evaluation of Amtrak Thick Web Miter Rail Movable Bridge Joint Under HAL Traffic

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Summary

The Transportation Technology Center, Inc. (TTCI) is performing an evaluation of the effects of Heavy Axle Load (HAL) traffic on the long-point thick-web miter rail bridge joint system. This is the third bridge joint tested by TTCI and is designed by Amtrak and manufactured exclusively by Cleveland Track Materials. Results of the Amtrak bridge joints are promising due to their current performance under the 39-kip wheel loads to date with little or no maintenance to this system.

The Association of American Railroads' (AAR) Bridge, Special Trackwork, and Heavy Axle Load Strategic Research Initiatives jointly sponsor the bridge joint test. TTCI is performing the test in section 5 of the Facility for Accelerated Service Testing (FAST) at Pueblo, Colorado. Section 5 contains an open deck bridge of two steel deck plate girder spans.

The bridge joint, installed in February 2004, has accumulated over 140 million gross tons (MGT) to date. The following test observations were made:

- Dynamic performance was very good compared to other special trackwork.
 - The joints are safe for 39-kip wheel load operation.
 - Measured dynamic loads were low; with maximum average vertical loads less than 50 kips (on a 39-kip static wheel load car). The joint had lower dynamic vertical loads than a typical mechanical rail joint from 20 to 40 mph.
 - The measured lateral loads were higher than open tangent track (lateral loads on tangent track are typically much less than on curved track), but not much different than those measured on mechanical joints on the bridge.
- Track and bridge maintenance was low.
 - No activity of existing cracks in the bridge girder and bracing was noted since the installation of the new joint. The lack of crack activity was determined through visual inspection of the cracks.
 - Maintenance on the joint was limited to light grinding of the points and guardrails at 3.1 MGT, 48 MGT, and 131 MGT. The resetting of several shims under the plates and tightening a bolt on a strap that protects a rail weld also occurred. There was no hook bolt maintenance at the bridge joint location since installation.
- Signal system interface components are failing at a high rate under 39- kip wheel loads.
 - Proximity switch brackets have been a problem for the railroads. Three sets of brackets were fabricated by the Amtrak signal department and welded onto the joint points by TTCI. All three brackets have fractured, due to fatigue, within 5 MGT.

This is the third bridge joint that has been tested at TTCI and is designed for a swing bridge type of application although the design is also adaptable to a vertical lift or bascule bridge. The swing bridge type long-point thick-web miter rail system with its lift rails is the longest version of this design miter rail system. The evaluation consists of measuring the performance of the joints themselves, their effects on dynamic loading, bridge component performance, and the performance of the signal system interface used to indicate the position of the bridge and track.



INTRODUCTION

Rail joints for movable bridges allow bridges to open for water traffic while supporting trains when the bridge is closed. They also absorb the forces of thermal rail expansion or contraction and may allow rail joint movement. These joints are located on the ends of the bridge spans and allow for either vertical or horizontal (swing) rail movement. Dynamic loading on bridge joints often causes rail end batter requiring frequent maintenance. Rolling stock ride quality may also be affected.

TTCI is currently testing a long-point thick-web miter rail joint system. This particular type of bridge joint is designed for a swing bridge type application. This design is also adaptable to lift or bascule bridges. This patented joint is presently used on several Amtrak bridges and has been in track for a number of years; Amtrak currently holds a patent on this design.

The swing bridge type long-point thick-web miter rail system with its lift rails is the longest version of this system. It consists of five sets of bedplates covering a bedplate distance of approximately 45 feet.

The approach and lift rails are made of 136-RE thick-web rail material and the rail ends are flash butt welded to standard 136-RE rail. The lift rails have no hinges and therefore the lift rails have no discontinuity in rail surface. The miter points are long and by design make the transition from approach rail to lift rail virtually seamless. The thick web rail allows for additional web material at this critical long point transition area. Figure 1 shows the bridge joint.



Figure 1: Amtrak Long-Point Thick-Web Bridge with Joints Installed

TEST AND RESULTS

The Amtrak thick-web bridge joint is being tested on the High Tonnage Loop (HTL) at FAST. The FAST train typically has 70 cars with 39-ton axle loads. HAL traffic

occurs in two directions with the number of cycles and tonnage documented. Typical train operating speed over the joint is 40 mph. The FAST train typically does not have any flat wheels and it is operated under ideal lubrication conditions. The bridge joints accumulate approximately 4 MGT per week. The Amtrak bridge joints were installed in section 5 on an open deck test bridge with two steel deck plate girders spans. The longest span has a length of 65 feet and a depth of 69.25 inches. The other span has a length of 55 foot 6 inches and a depth of 63 inches. The bridge lies in the middle of a 210-foot long tangent of section 5. There are spirals and curves at each end of section 5.

The ongoing testing is largely observational as general performance was monitored with minimal test specific measurements. The typical measurements at FAST include track geometry, instrumented wheel sets, and rail flaw detection. Rail wear at the points and profile measurements are taken at specific intervals. All maintenance work is also documented.

The Amtrak joint is installed between spans on the bridge. The fixed side of the joint is on the longer bridge span and the lift side of the joint is on the shorter bridge span.

All rail sections were welded providing a smooth transition over the bridge. The joints have accumulated over 140 MGT and are performing well. To date, the only maintenance issues have been a loose bolt on a weld strap and grinding of the flow on the point and guardrail of the joint (Figure 2).



Figure 2: Location of the Flow for Point and Guardrail

Maintenance grinding was done at approximately 3.1 MGT to remove initial flow from both the points and the guardrails. The points and guardrails were ground again at 48 MGT and 131 MGT to remove flow.

To reproduce the downward force that is applied to the lifting portion of the joint, two channels were welded together with drilled holes for the lifting rods. The lifting rods are attached to the rails and are secured to the bottom of the spans by the two channel sections, see Figure 3.

There are two nuts holding a spring against the channels compressing the springs to a specified length. The spring was attached by putting a steel plate over the spring end and double nuts on the rod. The springs were then tightened to hold the points down with approximately the same force used in revenue service. Insulated bushings are used to isolate the bridge from the signal system. The hold down fixture was designed in conjunction with Amtrak engineers. Figure 3 shows the fabricated hold down device.



Figure 3: Hold Down for Lifting Rails

No new cracks in the bridge under the joints were discovered on either 65-foot span or the 55-foot span near or under the bridge joint. The cracks that developed with the previous bridge joint have not propagated any further since the installation of this new joint.

The hook bolts holding the timber deck in place under the bridge joint are still performing well with no maintenance performed at this time. With the previous bridge joint, the hook bolts were rotating and breaking off. There are hook bolts with locking clips in each deck timber under the points.

Figure 4 shows one of the three proximity switch brackets Amtrak donated for testing on their bridge joint. Specific welding instructions were also supplied with these brackets. To date two sets failed within one-night of running with approximately 1 MGT, and the third set lasted about four-nights of running with approximately 5 MGT. The welds on the brackets did not fail. The length and weight of the brackets and the vertical movement caused the fracture about an inch away from the welds and the points. TTCI will continue to test brackets of other designs.

The Amtrak joint has lower vertical dynamic loads than a typical mechanical rail joint. Figure 5 shows dynamic vertical loads from instrumented wheel set (IWS) data for the Amtrak joint, a typical mechanical joint, the other two bridge joints tested, and various other track components for comparison. The Amtrak joint had average maximum vertical dynamic loads approximately 1.1 times the static wheel load at 40 mph. In comparison a number 20 turnout frog had average maximum vertical dynamic loads 2 times the static wheel load, and a crossing diamond frog had average maximum vertical dynamic loads 3 times the static wheel load at 40 mph. The previous joints had an average of about 1.5 times the static wheel load at 40 mph. Vertical loads are nearly as low as those for open track.



Figure 4: The Second Set of Proximity Switch Brackets

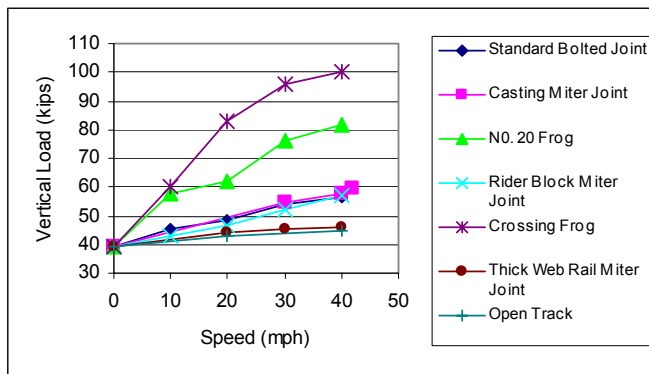


Figure 5: Average Maximum Vertical Dynamic Wheel Loads

The Amtrak joint had slightly higher lateral dynamic loads of about 1 to 2 kips more than a typical mechanical joint. Figure 6 shows average maximum lateral dynamic loads for the Amtrak bridge joint, the other two bridge joints, and a typical mechanical joint.

The lateral loads do not seem to increase with speed, but stay steady at about 7 kips.

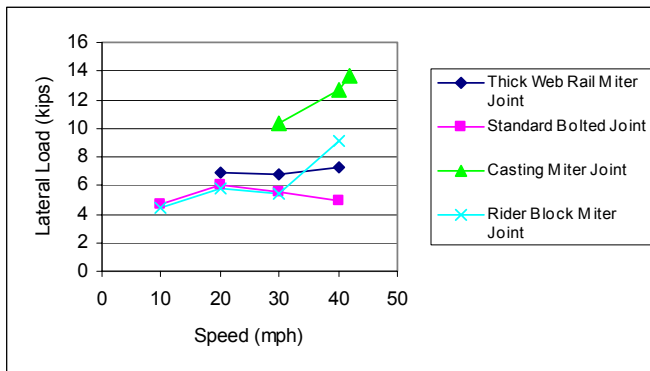


Figure 6: Average Maximum Lateral Dynamic Wheel Loads on the High Rail.

CONCLUSION

The Amtrak thick-web long-point bridge joints have performed well under the 39-kip wheel loads to date. Little or no maintenance was done to this system. The bridge joints to date have accumulated 140 MGT.

The proximity switch brackets are the only problem so far. TTCI plans to try other designs for the brackets when the train resumes operation.

Both the bridge joint and the proximity switches will continue to be tested.

FUTURE WORK

TTCI plans to continue track and bridge effects monitoring and to evaluate signal system fixes.

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