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Revenue Service Evaluation of a Continuous Mainline Rail Turnout

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Summary

The first prototype of a continuous mainline rail turnout has performed successfully for 1½ years in a revenue service main line following a brief heavy axle load test at the Facility for Accelerated Service Testing. The prototype has performed successfully in mainline operations of more than 100 MGT of freight and passenger service up to 79 mph. During this period, approximately 2,500 cars have been operated on the diverging route of the turnout. The turnout has performed without any accidents or condition-based speed restrictions.

Transportation Technology Center, Inc. and BNSF Railway have measured the performance of the No. 11 turnout prototype in service on a main line near Clifton, Texas. Turnout performance was assessed by monitoring any component failures, measuring track parameters (such as gage), and measuring running surface wear.

Results show that wear rates on the switch points are significantly higher than those for the mainline stock rails. Thus, the design is best suited to locations with low volumes of diverging route traffic.

There have been no component failures to date. However, there are some areas for improvement. These include reduction in required throw effort, wear in the point lock mechanism, and fatigue in the thin section switch point tips.

The switch configuration of the new design differs from conventional design by having both fixed stock rails on the mainline route, thus its name “continuous mainline rail turnout.” The moveable switch points are both on the diverging route. In the right-handed switch prototype, one switch point is located on the gage side of the left stock rail, whereas the other switch point is located on the field side of the right stock rail.

The continuous mainline rail turnout design is also called a “vertical switch” because it functions by lifting wheels over the mainline rails, instead of providing a gap in the mainline rail for wheel flanges to pass through. This switch is the functional counterpart of the lift frog design that has been successfully implemented by North American freight railways. The design strongly favors the main line in terms of ride quality and allowable speeds. This type of switch has potential applications for set-out tracks and industrial sidings accessed from the main line. The geometry of the diverging route meets all requirements for Federal Railroad Administration track safety standards for low speed track. No waivers are required for use of this turnout.



INTRODUCTION

Progress Rail Services, BNSF Railway, and Transportation Technology Center, Inc. (TTCI) have developed a prototype of a continuous mainline rail turnout for low speed and low volume diverging traffic.¹ The prototype was evaluated under 39-ton axle load traffic at the Facility for Accelerated Service Testing (FAST).² After a proof of concept test and some minor modifications, the same turnout has been installed in revenue service. This *Technology Digest* describes the performance of the prototype turnout during the initial 1½ years in revenue service on BNSF Railway.

Revenue Service Testing

The prototype turnout was installed in a BNSF main line near Clifton, Texas, in April of 2013. Figure 1 shows the turnout lined for the diverging route. The turnout connects the single track main line to an industrial siding that serves a company that receives aggregates in 286,000-gross-rail-load (GRL) hopper cars. Traffic on the main line includes passenger trains at 79 mph and a variety of freight trains at speeds up to 70 mph. Annual tonnage rates on the turnout are approximately 70 and 0.13 MGT/yr on the main line and diverging routes, respectively. The diverging traffic amounts to about 1,500 cars per year. Turnout performance was assessed by monitoring any component failures, measuring track parameters (such as gage), and measuring running surface wear.



Figure 1. Prototype Continuous Mainline Rail Turnout in Service near Clifton, TX

There have been no component failures to date. However, there are some areas for improvement. These include reduction in required throw effort, wear in the point lock mechanism, and fatigue in the thin section switch point tips.

The high effort required to throw the switch is likely due to the additional mass of the points (as compared to conventional designs). Figure 2 shows the right point in the turnout. The additional mass on this point includes the diverging running surface, which overlays the mainline rail, and a lateral guarding surface. Additionally, the original roller design,

which is integral to the plate work, was not successful. Use of conventional rollers should reduce the effort needed to throw the switch.



Figure 2. Right (Field Side) Switch Point (End View)

Lastly, the gage side switch point experienced cracking in the horizontal surface that overlays the mainline running rail. Figure 3 shows an end view of the cracking. As Figure 3 shows, the switch point is made of a milled rail and a replaceable “tip.” The two-piece design allows for some vertical deflection under load. This is beneficial, as the intent of the design is for the load path to be mostly through the switch point to the mainline rail, with some load being carried through the switch point to the plate work.



Figure 3. Left (Gage Side) Switch Point (End View)

Track gage and cross level were monitored on the prototype turnout. The performance has been good with the turnout remaining in railroad maintenance and track safety limits. Figure 4 shows a plot of mainline track gage versus distance from the point of switch (POS). Similar results were measured for the diverging route, as well.

Running surface profiles were taken periodically in the switch of the turnout on both stock rails and both switch points. These measurements were concentrated in the areas where the wheels transition from stock rails to switch points. The profiles were used to calculate wear (in cross section area) on these components. Figure 5 shows a time series of wear

versus distance from POS for the left mainline rail. The two rails show similar wear performance over the 108.7 MGT monitored.

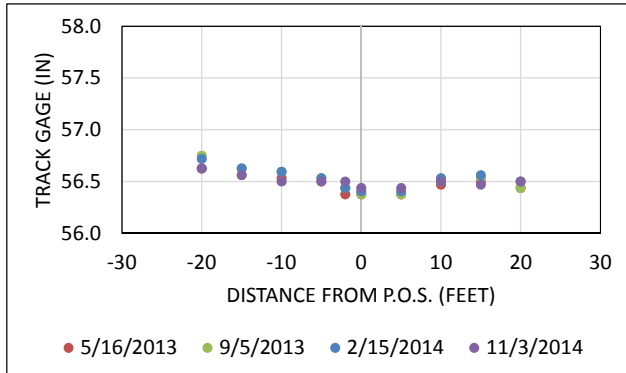


Figure 4. Mainline Route Track Gage vs. Distance from POS

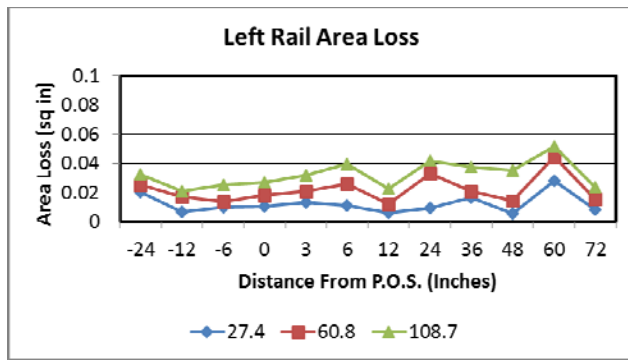


Figure 5. Left Mainline Rail Wear vs. Distance from POS

The same calculations were done for the two diverging route switch points. Figures 6 and 7 show the results for the left (gage side) and right (field side) points, respectively. Note that the wear for the switch points during this period is similar to that of the mainline rails. However, the amount of tonnage carried is approximately 500 times larger for the mainline rails.

Figure 6 shows more wear at the longitudinal ends of the switch point. The end at the POS is unsupported longitudinally, which likely causes more wear and deformation. The other end is at the top of the vertical ramp in the point. This may cause higher loading and/or surface tractions, as the wheel begins negotiating the diverging route curve in facing point moves.

Figure 7 shows a location of higher wear. This location is where wheels come in contact with the vertical guard portion of the switch point. This guard acts like the guard on a self-guarded frog. It helps guide wheel flanges across the right mainline rail in trailing point moves, thus ensuring the wheelset is in the gage of the mainline track before contacting the mainline rail.

Figure 8 shows the wear and metal flow seen at approximately 36 inches from the POS on this guard. The wear accounts for the large spike in switch point wear at 36 inches, as Figure 7 shows.

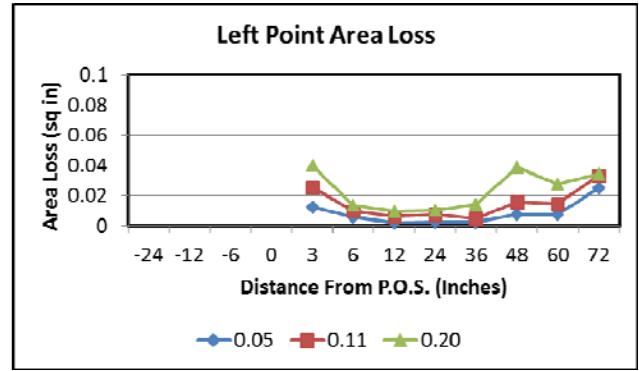


Figure 6. Left Switch Point Wear vs. Distance from POS

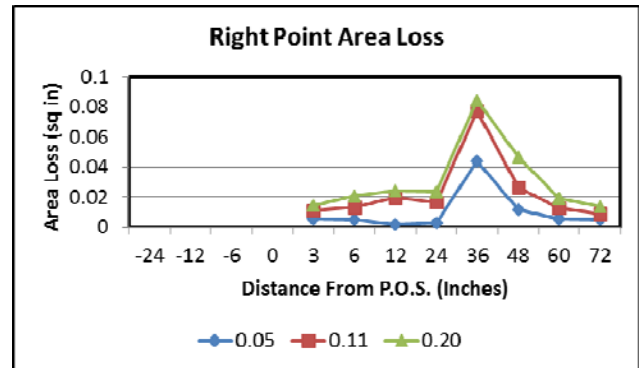


Figure 7. Right Switch Point Wear vs. Distance from POS



Figure 8. Metal Flow and Wear on Lateral Guard of Right Switch Point at 36–42 inches from POS

In comparing the performance of the turnout in revenue service and at FAST, TTCI determined that the running surface wear rates are far lower in revenue service. The current wear rates on the mainline rails are less than 25 percent of the wear rates at FAST. The current wear rates for the switch points are less than 10 percent of the corresponding wear rates at FAST. TTCI attributes these changes to two factors: (1) running surface shape and (2) wheel load. The as-built shapes of the rails and switch points were not conformal to the wheels running over them. This is especially true for the switch points. The flat plate work of the switch also makes the mainline rails less compatible with worn wheels. Thus, the

components wore to more conformal shapes during the 40 MGT test at FAST. The second factor is wheel load. All test cars at FAST had 39-kip wheel loads, whereas cars in revenue service have wheel loads from about 8 kips to 36 kips. Wear is significantly higher with higher wheel loads. Based on the decrease in wear rates during the FAST test period,² TTCI estimates the more conformal shapes account for about half of the decrease in wear rates, with wheel load accounting for the rest.

Continuous Mainline Rail Turnout Concept

The design of the switch configuration differs from conventional design by having both fixed stock rails on the mainline route, thus the name “continuous mainline rail turnout.” The moveable switch points are both on the diverging route. Figure 9 shows the continuous mainline switch configuration. Note that one switch point is located on the gage side of the left stock rail, and the other one is located on the field side of the right stock rail.

Because the new design functions by lifting wheels over the mainline rails, instead of providing a gap in the mainline rail for wheel flanges to pass through, it is also called a vertical switch. This switch is the functional counterpart of the lift frog design that has been successfully implemented by North American freight railways. This design strongly favors the main line in terms of ride quality and allowable speeds. This type of switch has potential applications for set-out tracks and industrial sidings accessed from the main line.



Figure 9. Prototype Continuous Rail Turnout at FAST

Conventional switches have one fixed stock rail and one moveable switch point on each route. The name “split switch” is applied to this design. Figure 10 shows a conventional split switch. Both routes have running surface discontinuities on one rail. Wheels transition from stock rail to switch point on one rail of each route.

The continuous mainline rail concept described here was developed to address the common failure modes of a split switch. These failure modes are related to the thin section

switch point design used.¹ The prototype turnout was evaluated for a period of about 40 MGT of 315,000 GRL mainline route traffic and several hundred cars diverging. During this evaluation, wheel-rail forces and vehicle accelerations were measured. Tests showed that mainline performance was significantly improved, with a small operating penalty in maximum diverging forces.² The continuous mainline rail turnout eliminates any running surface discontinuities for the mainline traffic. As a result, vertical impacts are eliminated and maximum lateral forces are reduced from 10 kips to 3 kips.



Figure 10. Conventional Split Switch Turnout at FAST

CONCLUSIONS

The first prototype has performed successfully for 1½ years in a revenue service main line following a brief heavy axle load test at FAST. The prototype has performed successfully in mainline operations of more than 100 MGT of freight and passenger service up to 79 mph. During this period, approximately 2,500 cars have been operated on the diverging route of the turnout. The turnout has performed without any accidents or condition-based speed restrictions.

Results show that wear rates on the switch points are significantly higher than those for the mainline stock rails. Thus, the design is best suited to locations with low volumes of diverging route traffic.

There have been no component failures to date. However, there are some areas for improvement. These include reduction in required throw effort, wear in the point lock mechanism, and fatigue in the thin section switch point tips.

The project team will be monitoring additional turnouts as they are installed in 2015.

REFERENCES

1. Davis, David D. and Muhammad N. Akhtar, May 2010, “Development of a Vertical Switch Design,” *Technology Digest* TD-10-014, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, CO.
2. Davis, David D. et al. April 2013, “Demonstration of a Continuous Mainline Rail Turnout,” *Technology Digest* TD-13-006, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, CO.

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