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Preliminary Placement Guidelines Top of Rail Friction Control Application Systems

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Summary

An assessment of wayside-based top of rail (TOR) friction control near Lytton, BC was conducted under a cooperative program with the Association of American Railroads (AAR), CN, Kelsan Technologies Corporation, Portec Rail Products, and Transportation Technology Center, Inc. (TTCI). The program's initial goal was to generate a TOR friction control cost benefit analysis based on the trial's rail wear results. The project scope was expanded to investigate issues related to rail surface fatigue. The test site was on the Ashcroft Subdivision near Lytton, British Columbia, and experiences 98 percent unidirectional westbound traffic with a mixture of intermodal trains.

Rail wear data collected via the hand held profilometer and vehicle mounted optical rail systems demonstrated vertical rail wear reductions from 0 to 60 percent with TOR friction control. Due to uncontrolled and variable side gage face lubrication, additional data will be required to determine TOR friction control effectiveness on gage face wear rates. This trial has been expanded to a multi-unit TOR applicator configuration to increase the test area and generate more rail wear data.

Key guidelines for placing a wayside TOR applicator include rail surface inspection within 200 feet of the TOR unit for the presence of surface cracks, grinding field side metal flow to allow fitting of applicator bars, installing on straight (tangent) track to prevent FM runoff, not installing applicators closer than 100 feet to the beginning or end of a spiral, and maintaining at least 100 feet distance from gage face lubrications to avoid cross contamination of products.

Initially, the wayside TOR applicator system was located in the entrance spiral of an 8 degree curve. However, localized spalling developed up to 40 feet downstream of application. This issue was addressed by relocating the TOR applicator unit to tangent track. Close monitoring of rail conditions near and downstream from the relocated applicator for over 1 year, indicated no significant changes in rail surface condition. The results were used to prepare guidelines for placing wayside TOR applicators.

Tribometer (a hand operated device that measures coefficient of friction, COF) measurements indicated no significant changes between baseline and the TOR treated areas. Experience at some trials has shown that wayside-based TOR friction control systems achieved lateral force reduction despite little or no change in TOR COF. This suggests a FM picks up and conditions train wheels.

The future expansion to a multi-unit wayside TOR application trial at this site will incorporate a lateral load measuring station. Lateral force data will be collected to evaluate effectiveness at different TOR application unit spacing and FM application rates.

TTCI Transportation Technology Center, Inc.

Background

A single wayside-based top of rail (TOR) friction modifier (FM) demonstration near Lytton, British Columbia, was conducted by CN, Kelsan Technologies Corporation, Portec Rail Products, and Transportation Technology Center, Inc. (TTCI). The primary goal was to determine the impact of TOR friction control on rail wear. Rail wear, rail surface condition, coefficient of friction (COF), and FM consumption were monitored.

Test Site Location and Details

The test site is located on the CN, Ashcroft subdivision, which transports CN and Canadian Pacific unidirectional trains west to Vancouver, Canada. At the time of the test, yearly traffic tonnage was 80 MGT, with up to 40 trains daily. Approximately 98 percent of traffic is westbound with a mixture of coal, grain, sulfur, intermodal, and mixed freight trains. This subdivision exhibits a wide range of curvatures including a significant number of 8-degree curves.

The site experiences variable Pacific weather where changes alternate between hot, humid, or dry summers to freezing winters. Summers can reach a high of 90+^{o} F and winters to a low of -20^{o} ◆F.

Spalling was observed and attributed to hydro-pressurization of KELTRACK® Trackside Freight FM in liquid form. The single Portec Protector IV unit was moved to a location on tangent track, 250 feet upstream of a 5 degree curve. A gage face lubricator is located at Mile Post (MP) 93, 4 miles east of the TOR installation site. Figure 1 provides the test site schematic.

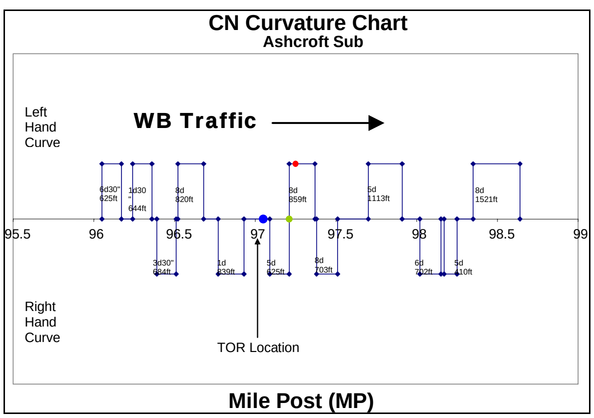

Figure 1. Location of TOR System on Ashcroft Subdivision Showing Initial, then Relocated Site

Rail Wear Results

Curves with similar severity (degree of curvature) were selected upstream and downstream of the TOR applicator bars (located at MP 92) and monitored for rail wear. A hand held rail profilometer (Lazerail EZ-2) was supplemented by the vehicle mounted ARM optical rail profile system. The latter system collects rail profile information every 5 feet and can accommodate a large area of track. As an example, approximately 100 profiles could be collected from a 500 foot long curve.

The rail wear analysis utilized 26 different curves. Baseline (non-TOR treated) curve wear was compared to comparable curves treated with TOR FM material. High rail vertical wear rates are summarized in Figure 2. Examination of results shows that at most locations the wear rate of the TOR treated curves were less than that of non-treated curves; however, the data scatter is high.

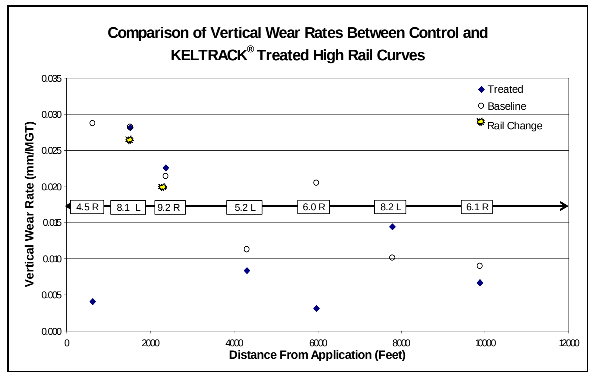

Figure 2. High Rail Vertical Wear Rates for Curves within 10,000 feet Downstream of TOR Applicator

Referencing Figure 2, specific results for a pair of 5-degree and a pair of 8-degree curves were selected for comparison based on similar curvature and rail wear rate during no FM application, shown in Figures 3 and 4. Figure 3 illustrates the similarity inherent in each set of curves, indicating a valid comparability. For each set, one curve was then treated with FM and re-compared (Figure 4).

The curves treated with FM demonstrated lower rail wear rates by 62 to 63 percent, where the reduction passed as statistically significant.

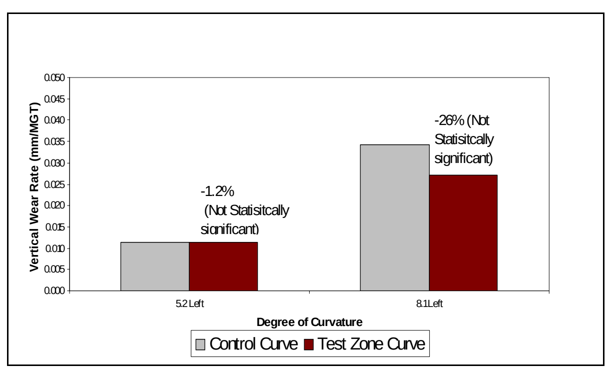

Figure 3. Control Zone and TOR Zone Curve Wear Rates Prior to TOR Activation

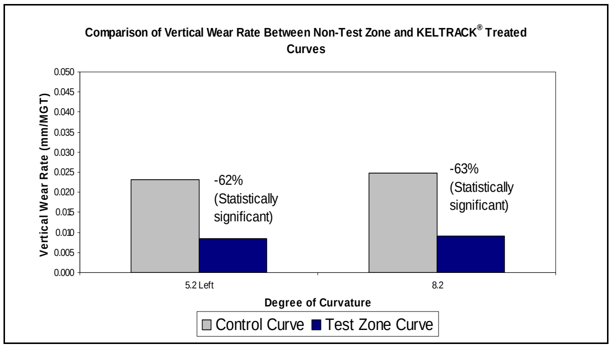

Figure 4. Control Zone and TOR Zone Curve Wear Rate after TOR Activation

Rail Surface Condition

Between July 17, 2002 and August 2, 2002, the TOR applicator was originally located in the entrance spiral of the 8-degree curve just west of a bridge. The initial installation site location was selected, in part, to be near commercial power to avoid the use of solar power. Within 19 days of TOR applicator commissioning, spalling developed at the applicator bars and was noted for 40 feet downstream of the TOR system on the low rail and about 19 feet on the high rail.

Severe spalling occurred primarily on the low rail near the gage corner with minor spalling on the high rail near the gage corner. Through discussions with Dr. Joe Kalousek of the National Research Council of Canada Centre for Surface Transportation, it was suggested that the FM material, which is water based, remained in a liquid phase for up to 50 feet downstream of the TOR system. This created a situation where FM material (still in its liquid phase) could seep into existing cracks in the rail head, which is characteristic of curves in this area, allowing hydraulic dynamics to propagate crack growth, resulting in top of rail spalls. No spalling was found beyond 40 feet, which suggests that the FM material in a dry phase does not cause spalling.

Subsequent investigation of other curves in the area indicated that rail surface cracks (virtually invisible to the eye) were likely present on the top running surface of the rail prior to installation of the TOR system. A section of rail at the applicator site was removed for examination in the laboratory. The evaluation verified that cracks existed ahead of, at the location of the TOR applicator bars, and downstream from the applicator site.

Figure 5 shows details of the rail and cross section analyses. These samples are representative of the rail just ahead of the spalling and at the spalling site. The evaluation agrees with the theory that a water-based FM entered the cracks and acted as a hydraulic ram, accelerating the development of spalls.

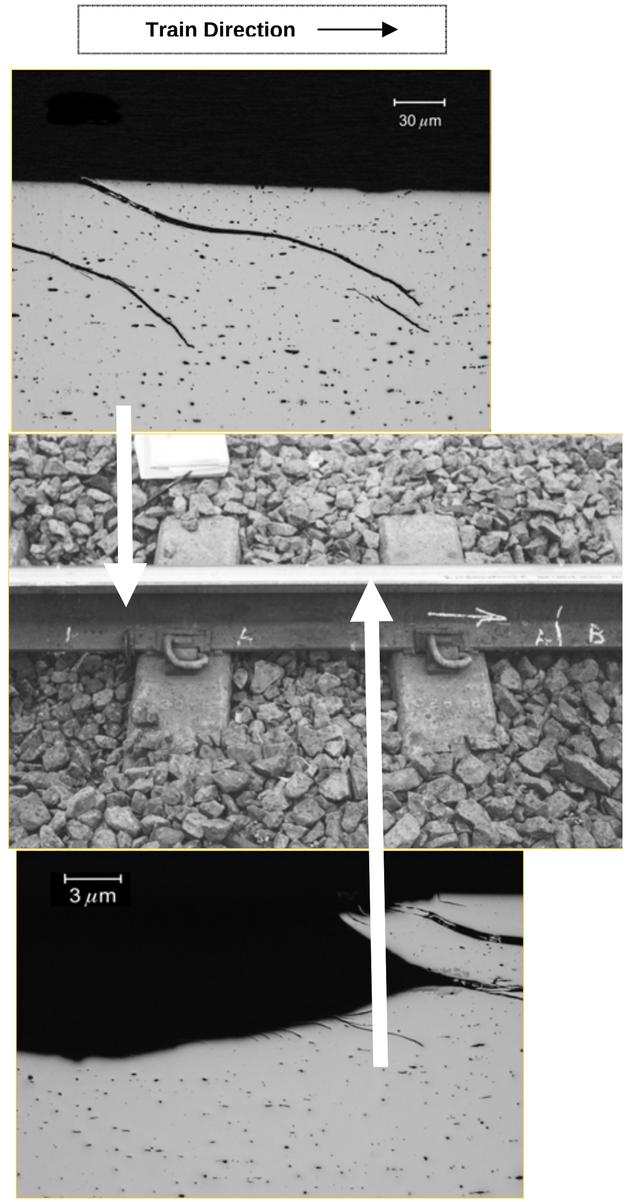

Figure 5. TOR Running Surface Showing Spalling Starting at Center (middle photo). Cross-Section of Rail before Spalled Site (top detail), in the Spalled Area (bottom detail)

This situation was addressed by relocating the TOR system approximately 1,200 feet eastward, on tangent track, west of the 5-degree right hand curve. Dye penetrant inspection of the tangent section at the new location confirmed that the rail, at and near the relocated applicator site, did not contain surface cracks. After more than 1 year of operation, no spalling was noted at or near the relocated applicator. This also includes nearby curves that contained pre-existing rail surface cracking similar in nature to the original site.

Implementation and Placement Guidelines

Results from this evaluation have been used to develop implementation and applicator placement guidelines for wayside-based TOR systems. These guidelines are also being incorporated into the AREMA Recommended Practices, Chapter 4, Lubrication and Friction Control.

Key guidelines for placing a wayside TOR applicator include:

1. Inspect rail surface within 200 feet of the TOR unit for the presence of surface cracks.
   - If no cracks are present, no installation issues related to location
   - If cracks are present, then:

     – Select another location, or:

     – Grind the rail surface to remove cracks
2. Grind field side metal flow to allow fitting of applicator bars.
3. Install on level (tangent) track to prevent FM runoff.
4. Do not install applicators closer than 100 feet to the beginning or end of a spiral.
5. Maintain at least 100 feet distance from gage face lubrications to avoid cross contamination of products.

Coefficient of Friction

Tribometer readings were taken up to 1,600 feet west of the unit encompassing the 5-degree and the following 8-degree curves. The top of the north rail friction measurements (Figure 6, red series) during the FM treated phase indicated a reduction in friction from 0.6 μ dry to about 0.3 μ at the applicator site and a return to dry COF about 600 feet from the applicator. The south rail did not exhibit this change in friction.

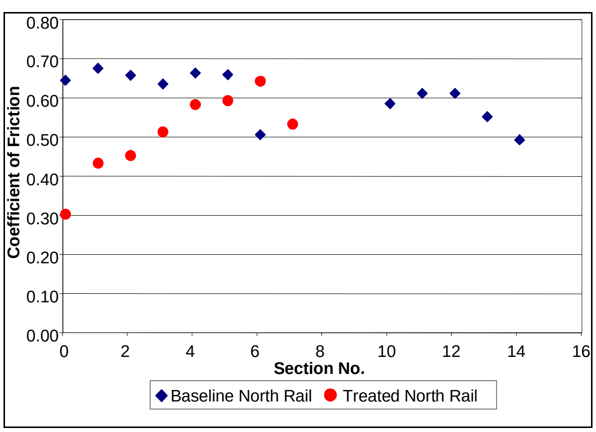

Figure 6. Friction Measurements for North Rail

Experience at some trials has indicated that FM materials applied via trackside units can demonstrate high COF levels yet still result in a reduction of lateral curving forces. One possibility is that train wheels pick up and are conditioned by the FM modifier material. Thus, the use of tribometer data is still being evaluated for use in inspecting and adjusting TOR systems applying FM materials.

Conclusion and Future Evaluations

Analysis of limited rail wear data suggests that wayside-based TOR friction control systems reduced vertical rail wear rates. However, rail wear rate results were highly variable. Some curves exhibited no change while other curves indicated up to 60 percent reduction.

Originally, the wayside TOR system was located in the entrance spiral of an 8 degree curve. This resulted in propagation of existing cracks attributed to hydraulic dynamics of KELTRACK® in liquid form. This was addressed by relocating the TOR unit on tangent track where no existing cracks were present. After one year of application, no significant changes in rail surface condition were observed (no new cracks developed). Experience gained from this trial emphasizes that TOR systems on high axle load systems should preferably be installed on tangent track that does not exhibit pre-existing cracks.

A further expansion of this trial will incorporate a multi-unit TOR strategy to study spacing and application rates. A load measuring station addition will allow for lateral curving force monitoring and will be the main parameter for evaluating different TOR configurations.

Continued evaluation and development of implementation and deployment guideless is being sponsored by AAR, CN, Portec Rail Products, and Kelsan Technologies Corporation.

Acknowledgments

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