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Top of Rail Friction Control – Friction Control Materials

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Summary

Under a program funded by the Association of American Railroads, Transportation Technology Center, Inc. evaluated a number of alternative friction control materials at the Facility for Accelerated Service Testing in November 2007 for use in wayside based top of rail (TOR) application systems.

Results suggest alternative materials can produce similar benefits to the baseline product in the form of reduced curving forces. However, while one product could do so at a lower application rate, all others evaluated required a higher application rate to attain the same reduction in curving forces. The cost of materials and subsequent applicator spacing to obtain similar benefits requires additional investigation. Long-term benefits to rail wear were not determined; extended evaluations are required.

Five prototype friction modifiers were tested, along with KELTRACK® Trackside Freight, the current friction modifier being used.

Cooperative efforts were provided by Kelsan Technologies and Portec Rail Products to conduct this investigation, with the intention of providing performance information on potentially lower cost friction control materials for use in TOR application systems.

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BACKGROUND

Implementation of TOR friction control has shown significant benefits in the form of reduced rail wear, reduced curving forces, and improved rail surface performance. [1,2,3] However a major issue limiting widespread deployment is the additional capital cost of applicators, along with cost of consumables in the form of friction control materials. Feedback provided by railroad users during a one-day workshop held in March 2006 suggested more railroads would deploy TOR friction control, if the consumable cost could be reduced.

OBJECTIVES

Existing and proven application systems are being evaluated to determine if alternative friction control materials can provide the same or better benefits at a lower overall cost. Results of this evaluation are limited to reviewing performance benefits of various materials and effective application rates. As some materials may provide better results, over a shorter distance or with different application amounts, the exact benefit is difficult to determine. Suppliers and users must determine total system cost based on combined fixed investment and material usage.

APPROACH

The High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST) was used for this investigation. The HTL is configured to test track components such as rails, rail fasteners, and crossties by operating heavy axle load equipment over a closed loop and to monitor performance during increasing accumulated traffic, simulating a revenue-service railroad environment.

By keeping variables (such as train speed and direction) constant, the effect of altering rail friction can be assessed. Tests were conducted from December 3 to December 6, 2007. Two or three friction modifiers were tested daily.

A fixed load station at Section 25 (Figure 1) of the HTL recorded track lateral forces for each pass of the test train at FAST. Data collection began when train speed reached 40 mph. Force levels for each train pass were collected for a number of friction modifiers and application rates.

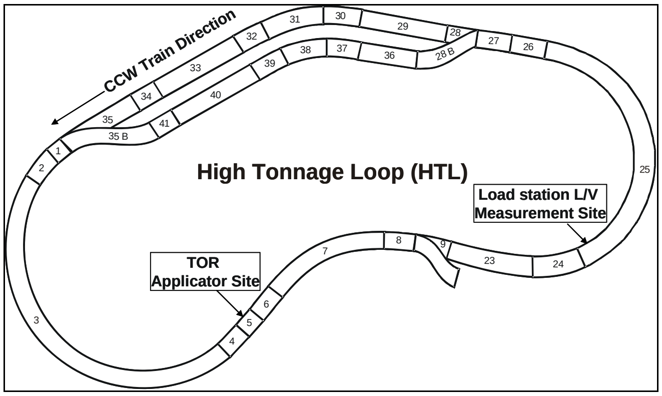

Figure 1: Map of FAST showing Location of TOR Applicator (Sec. 5), Load Measuring Station (Sec. 25) and Train Direction

Two TOR Portec Rail Protector™ IV applicators were installed at Section 5 of the HTL. Application rates were adjusted at the applicators during different portions of the test. Monitoring curving force performance allows assessment of effectiveness of each friction modifier and application rate.

At the beginning of each friction modifier/application series, track personnel confirmed that rail was dry. After reaching a steady speed of 40 mph, the TOR application system was activated at the prescribed friction modifier rate. Data collection continued until enough data was recorded to confirm data integrity. Generally, this was considered adequate if curving forces varied less than 10 percent for five consecutive laps.

For this evaluation, the baseline product KTF (Keltrack Trackside Freight) was compared to five alternative formulations:

1. AFM-1 (Alternate Chemistry “A,” variant 1, lower material cost vs. KTF)
2. AFM-2 (Alternate Chemistry “B,” variant 1, lower material cost vs. KTF)
3. AFM-3 (Alternate Chemistry “B,” variant 2, lower material cost vs. KTF)
4. AFM-4 (Alternate Chemistry “A,” variant 2, lower material cost vs. KTF)
5. K-ER (Improved Formulation derived from Standard KELTRACK Chemistry)

During evaluations, the following information was monitored to create the database for analysis:

1. Rail Lateral Forces
2. Application Rate – Friction Modifier
3. Tribometer – Rail Friction
4. Ambient Temperature

RESULTS/DATA INTERPRETATION

Results are shown for low rail curving forces only. However, both high and low rails behaved in a similar fashion.

Baseline Product Results

KTF is typically used for freight operations. Figures 2 and 3 show two sequences of its use. Figure 2 shows the curving force performance for a 30-lap test sequence, starting with dry rail, using a standard revenue service application rate of 0.25-second pump activation every 16 axles. As Figure 2 shows, this sequence includes 15 laps of dry operation to establish dry rail performance. After implementing TOR on lap 15, lateral curving forces indicated an average reduction of about 7.1 kips (from 16 kips to 8.9 kips) on the low rail, starting with lap 19. After six laps, the TOR system was deactivated, and curving forces returned to nearly the same dry-rail performance.

Figure 3 shows the same product, but at a reduced application rate (0.25 sec/28 axles). As shown, the overall reduction (e.g., benefit) in curving forces was only about 3 kips (16 kips to 13 kips) compared to that obtained from the higher application rate shown in Figure 2.

A dry, TOR activated, TOR steady state, and TOR deactivated sequence was conducted for all products and for a variety of application rates.

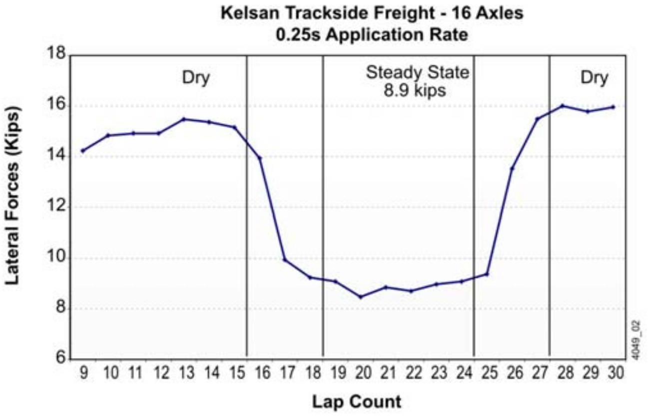

Figure 2: KTF Performance
Baseline Application Rate of 0.25 sec/16 Axles

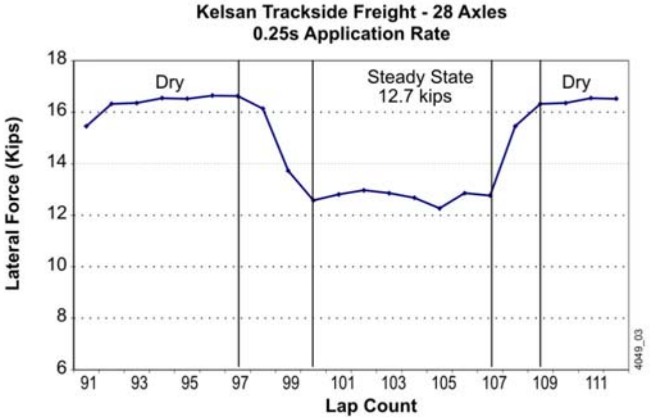

Figure 3: KTF Performance
Decreased Application Rate of 0.25 sec/28 Axles

For purposes of this evaluation, only the amount of curving force reduction generated by different application rates is used to compare product performance. The steady state level used is based on the average of the first 8-10 laps. Because the HTL is a closed loop (2.7 miles), data collected during preliminary tests indicated that after 15 or more laps of operation, product tends to saturate the entire loop; and with sufficient operations, all products approach the same effectiveness. Thus, in order to cull out performance differences in products, only the steady-state curving force observed in the first 8-10 laps is used for comparisons.

Figure 4 shows the relationship of curving force reductions obtained with a wide range of application rates for the baseline product, illustrating that the less product applied, the less benefit obtained. The 16-axle count rate is used as the baseline performance number.

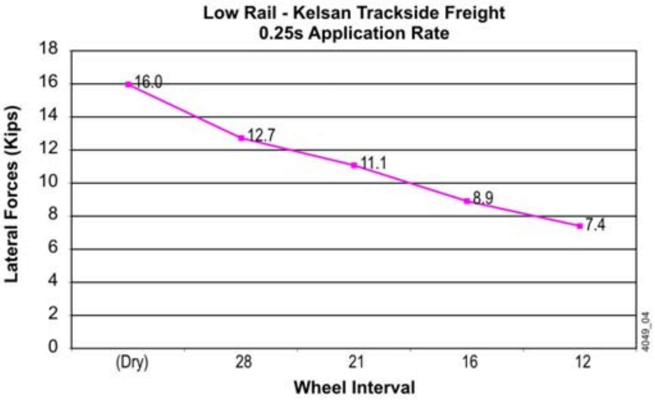

Figure 4: Relationship of Steady-State Curving Forces for the Baseline Product, for Varying Application Rates

This same matrix was repeated for all the prototype FC materials under a variety of application rates. Figure 5 shows data for low-rail performance, combining all products. To highlight the baseline product performance, this line is shown in bold, and the results from Figures 2 and 3 are highlighted in a box. The horizontal scale is in relative application rates, with the normal 0.25-sec/16-axle rate set as 1. Thus, a relative application rate of 0.5 indicates 50 percent of the baseline.

Performance depicted in Figure 5 can be used to optimize costs/benefits of a particular material. By comparing lateral curving forces generated as a function of application rates for each product, overall effectiveness of different application rates and products can be compared.

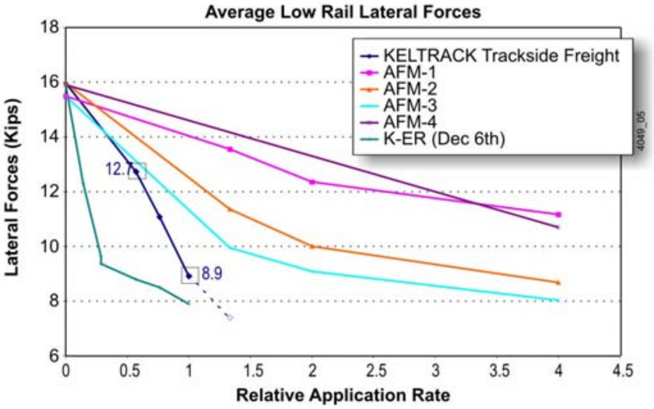

Figure 5: Low Rail - Lateral Force vs. Application Rate

Due to the closed loop nature at FAST, several performance parameters cannot be viably evaluated. As the continued operation of the same train over the same loop has been shown to build up material, the effects of applicator spacing, time to obtain steady state, and effectiveness remaining after application is ceased and cannot be readily differentiated. Further evaluations, outside a closed loop environment is desired to fully benchmark additional performance characteristics such as:

- **Durability** – time product remains effective after application is ceased
- **Carry distance** – maximum applicator spacing to generate steady-state reductions at a specific distance
- **Rail wear savings** – effectiveness in reducing rail wear at different application rates (long-term evaluation: 25-50 MGT)
- **Initial effectiveness** – time (number of trains) needed to carry from applicator to distant point after initiating application.

SUMMARY/FUTURE

Data suggests that K-ER provided reduced rail lateral forces at a lower application rate than KTF. All other products required more material to be applied to obtain the same reductions in curving forces (materials AFM-1 and AFM-4 did not reach equivalent performance levels to standard KTF, even at 4 times the nominal/baseline application rate). Further work is needed to determine overall cost benefits of these different products and to ensure field performance over a variety of track conditions is similar to that observed in closed loop tests.

Acknowledgements

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