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Testing on the Heavy Axle Load Northern Mega Sites

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Summary

Canadian National Railway Company (CN) and Transportation Technology Center, Inc. (TTCI) as part of the Association of American Railroads' Strategic Research Initiative on Heavy Axle Load (HAL) Implementation, have established a northern mega site to study the effects of cold climates on 286,000-pound car HAL operations. The mega site is located near Winnipeg, Manitoba, Canada, on main lines of the CN system. Results will supplement the HAL research and development work at the Facility for Accelerated Service Testing and the HAL testing at the eastern and western mega sites.

The northern mega site has been divided into two locations: a predominantly tangent track location on the Rivers Subdivision, just west of Winnipeg, and a location with heavier curvature on the Redditt Subdivision near Kenora, Ontario. Tests that have been established at the northern mega site include:

- Premium Rail Performance Test: This test has been installed on a 4.5-degree curve on the Redditt Subdivision, approximately 130 miles east of Winnipeg. It is designed to compare the performance of six premium test rail types with CN's standard rail for the area.
- Premium Insulated Joint (IJ) Performance Test: Eight premium test IJs have been installed on the Rivers Subdivision. Each test IJ was paired with a standard CN joint as an experimental control.
- Seasonal Substructure Evaluation: Instrumentation has been installed on the Rivers Subdivision to investigate the effects of spring thaw on track stiffness and stability.
- Top of Rail (TOR) Friction Control Materials Evaluation: Instrumentation and TOR applicators have been installed on the Redditt Subdivision to investigate performance of various TOR friction modifier products in cold weather.

Rail performance results are predominantly driven by rolling contact fatigue at this site. Visual comparisons at ~60 million gross tons (MGT) since installation indicated that on the high rail, all of the test rail types exhibited less severe rolling contact fatigue (RCF) than the control rail, whereas on the low rail, three of the six test rail types exhibited less severe RCF than the control rail. Measurements of rail wear (including material removed by rail grinding) indicated that on the high rail, all of the test rails exhibited statistically less wear than the control, while on the low rail, only test rail 6 exhibited statistically less wear than the control. Subsequent inspections indicated significantly improved RCF performance of all rails.

The premium IJs are performing comparably to the controls, with the exception of one joint, which began to show signs of rail movement at ~60 MGT since installation (potentially due to improper installation). The substructure and TOR tests are in the preliminary phase and baseline data is being collected.

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INTRODUCTION

Canadian National Railway Company (CN) and Transportation Technology Center, Inc. (TTCI) have established a northern mega site to study the effects of cold climates on 286,000-pound car heavy axle load (HAL) operations. This work is being performed as part of the Association of American Railroads' Strategic Research Initiative on HAL Implementation.[1]

The mega site is located near Winnipeg, Manitoba, Canada, on main lines of the CN system. The mega site has been divided into two locations (Figure 1):

- A predominantly tangent track location on the Rivers Subdivision, beginning on the western edge of Winnipeg and running to the west.
- A location with heavier curvature on the Redditt Subdivision, approximately 130 miles east of Winnipeg, near Kenora, Ontario.

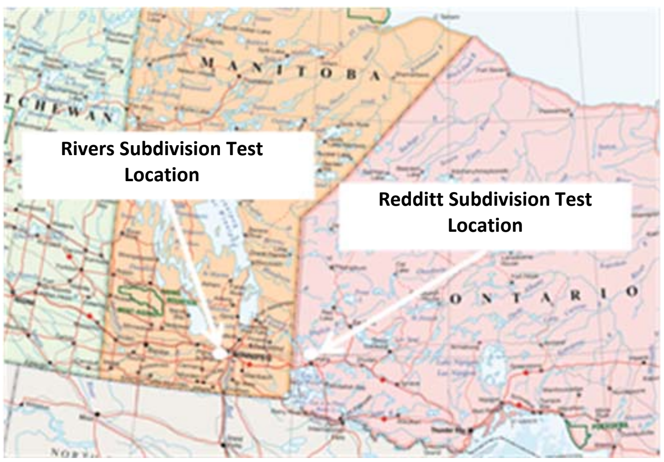

Figure 1. Map showing Northern Mega Site Locations[2]

This project will allow the railroads to objectively evaluate the effects of HAL traffic on track and bridge performance under revenue service cold weather conditions. Mega site experiments have been implemented to investigate premium rail performance, premium insulated joint (IJ) performance, seasonal substructure performance, and performance of top of rail (TOR) friction modifier materials in cold weather.

SITE CHARACTERISTICS

The climate at both locations is typical for midcontinent conditions on the CN main line. Figure 2 shows that both locations experience ~50 days annually with temperatures below -4 °F (-20 °C) and 6 to 12 days annually with minimum temperatures below -22 °F (-30 °C).

The Rivers Subdivision is two main track territory, with premium rail, timber ties, and cut spikes. The first 50 miles west of Winnipeg is over 90 percent tangent track.

The Redditt Subdivision is single track territory with premium rail, concrete ties, and elastic fasteners. Between mile post (MP) 90 and 140, approximately 50 percent of the track consists of curves between 1 and 5 degrees.

Figure 3 summarizes 2015 tonnage at the Rivers and Redditt locations. Figure 4 provides curve distribution for both locations.

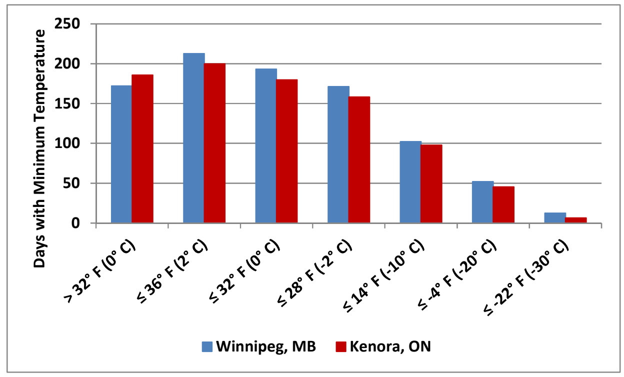

Figure 2. Number of days with Minimum Temperatures for Northern Mega Site Locations[3]

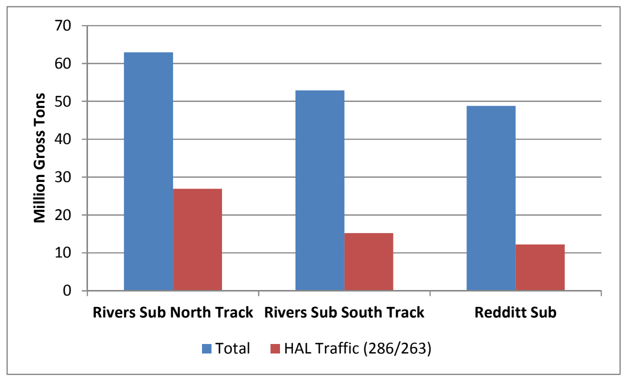

Figure 3. Summary of 2015 Tonnage at Northern Mega Site

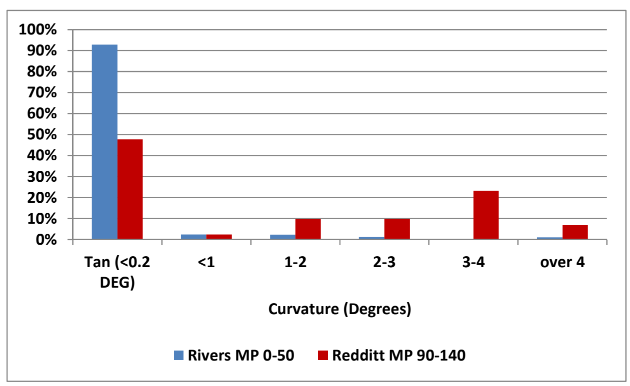

Figure 4. Curve Distribution Northern Mega Site

PREMIUM RAIL PERFORMANCE TEST

In December 2014, an experiment to quantify cold weather performance of premium rails was initiated at MP 111 at the Redditt location. Test rails were installed on a 1000-foot, nominal 5-degree curve with 4 inches of superelevation. Concrete ties with elastic fasteners are installed throughout the curve. Nominal train speed is 35 mph (close to balance speed). The test site is subject to rail grinding twice yearly and has gage face lubricators installed. Figure 5 shows the test site.

Figure 5. Northern Mega Site Premium Rail Test Site near Kenora, Ontario

Rail manufacturers were asked to provide premium rails that would perform well in the cold conditions anticipated on the northern mega site. Table 1 shows the six test rails chosen. Standard CN rail for the area (Nippon DHH400s) was installed as an experimental control.

Table 1. Northern Mega Site Premium Test Rails

Manufacturer	Rail Type
ArcelorMittal	Advanced head hardened (AHH)
British Steel	Maximum head hardened (MHHP)
JFE	Super pearlitic (SPA)
JFE	Super pearlitic (SP3)
Nippon	Hyper Eutectoid (HE-X)
voestalpine	UHC / Super Premium (R400HT)

Test rails were welded at the CN plant in Winnipeg into two 1,000-foot strings for installation. Each string has three repeats of each test rail type distributed evenly in the curve and seven CN control rail positions distributed evenly in the curve. Additional CN rails were installed on the ends of both strings, to facilitate field welding. Each test rail type was positioned at least once on each side of a CN control rail. The same sequence was used for high and low rail. CN installed the rails in December 2014.

As of March 2017, the rail test had accumulated ~110 MGT. TTCI is monitoring rail wear, rail hardness, and surface condition during track inspections before and after each rail grinding event.

During the pre-grind inspection in April 2016, at ~60 MGT since installation (30 MGT since last grinding), significant RCF was noted. Figure 6 shows an example of RCF observed on the low rail.

Figure 6. Example of Low Rail Surface Condition ~30 MGT since Grinding

Because there is no standardized method for measurement of RCF, a qualitative assessment method developed for rail experiments at the Facility for Accelerated Service Testing was employed.[4] RCF condition was rated between zero (no RCF) and three (severe RCF). Figure 7 shows a box plot analysis based on evaluation of photographs of 185 individual locations by three independent observers. Based on 95 percent confidence intervals around the median, all of the test rail types exhibited statistically less severe RCF than the control on the high rail, and test rail types 2, 4, and 6 exhibited statistically less severe RCF than the control on the low rail. The curve was ground after inspection – post grind inspection showed the RCF was largely removed.

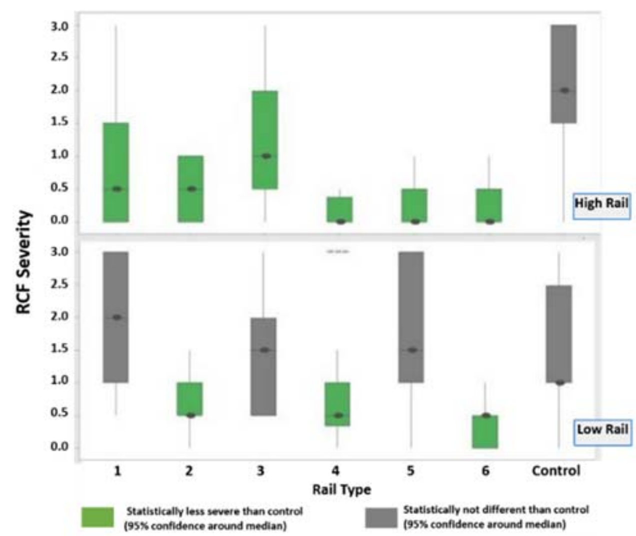

Figure 7. Observed RCF Severity ~30 MGT since Grinding

Rail metal removal due to wear and grinding was monitored from periodic rail profilometer measurements taken at 254 specific locations. Figure 8 compares high rail wear (including material removed by grinding) for each rail type. The majority of material removed is due to grinding. Based upon 95 percent confidence intervals around the mean:

- High rail: All test rails exhibited statistically less wear than the control. This may indicate that more material was removed from the control rail due to RCF.
- Low rail: Test rail 6 exhibited statistically less wear than the control. The remaining rails exhibited wear that was not statistically different than the control.

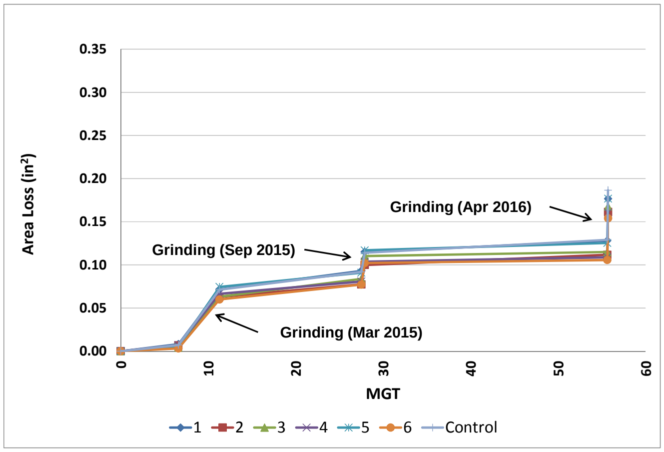

Figure 8. High Rail Wear (Area Loss)

Subsequent inspections in November 2016 and February 2017 indicated significantly improved RCF performance of all rails. The cause of this apparent change in performance is under investigation.

PREMIUM IJ PERFORMANCE

In November 2014, a premium IJ performance test was initiated, with eight premium IJs installed adjacent to standard joints in mainline track.

Test joints include two Koppers Short Angle Projection (SAP™) IJs and six LBFoster Endura-Joint Systems™ provided by the manufacturers (Figures 9 and 10). Each premium joint was paired with a standard CN joint as a control. For blind reporting purposes the IJ types were designated Product A and Product B. The IJs were installed between November 2014 and March 2015. As of March 2017, they had accumulated between 120 and 140 MGT. The premium IJs are generally performing comparably to the controls with mild metal flow. However, one premium joint (Product B) began to show signs of epoxy failure at ~60 MGT since installation (potentially due to the joint being installed with improper support). One premium IJ was removed due to other track maintenance, but it has since been reinstalled.

Figure 9. L. B. Foster Endura-Joint at 75 MGT

Figure 10. Koppers Short Angle Projection Joint at 65 MGT

SEASONAL SUBSTRUCTURE EVALUATION

In June 2016, TTCI and CN installed instrumentation to monitor soil pressure and soil temperatures at various depths on the Rivers Subdivision. The test objective is to characterize seasonal degradation of subgrade support due to cycles of freeze-thaw. Baseline data is being collected.

TOR FRICTION CONTROL MATERIALS EVALUATION

In September 2016, TTCI installed a load station at Redditt, to be used for evaluation of TOR friction modifier performance in cold weather. Baseline data is being collected.

REFERENCES

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