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REPORT ON THE NEW RAIL INTEGRITY AND PERFORMANCE TESTING AT THE MEGA SITES

SUMMARY

Since 2005, the Association of American Railroads (AAR) and the Federal Railroad Administration (FRA) have co-sponsored ongoing rail performance testing under mainline heavy axle load (HAL) operations as part of the jointly funded HAL Revenue Service Program. In 2013, Transportation Technology Center, Inc. (TTCI) and two host railroads started two new experiments at the revenue service mega sites [1] [2] to further investigate rail integrity and the performance of the latest generation of rail steels in the revenue service environment.

Preliminary results have shown the following:

- With 429 million gross tons (MGT) accumulated at the western mega site, it is still too early to differentiate the performance of two 2-degree test curves, one implemented with an optimized strategy (top-of-rail, or TOR, friction modifier plus preventive grinding once every 150–190 MGT) to control rolling contact fatigue (RCF) and rail wear, and the other being the control (no TOR friction, nor preventive grinding).
  - Rail wear has decreased more than 50 percent compared to the earlier round of testing that began in 2005.
  - Significant RCF on the low rails began to appear at 350 MGT, which is comparable with the results of the 2005 test.
- At the eastern mega site, three high-degree test curves (9 to 11 degrees) were set up with TOR friction modifier and gage-face lubrication. Optimized grinding cycles were implemented in one high-strength rail test curve, and the intermediate-strength rail test curve. The other high-strength rail curve is the control with no grinding scheduled until significant RCF develops. With 92 MGT accumulated since November 2016, the results have shown:
  - The intermediate-strength rail test curve needed a more aggressive maintenance grinding schedule to keep up with the higher rate of RCF development.

All three curves received a re-profiling grind after 90 MGT to address the degradation of the wheel/rail contact interface.

BACKGROUND

For more than a decade, rail integrity and performance testing have been an integral part of the HAL Revenue Service Program, giving the industry insight into the effectiveness of new and innovative strategies on the performance of rail in different degrees of curvature. Results from earlier long-term studies of high-strength rail performance with TOR friction modifier and preventative rail grinding have shown the benefits such strategies can have on the

[1] Western mega site is located in western Nebraska, near Ogallala, NE.

[2] Eastern mega site is located in West Virginia, near Bluefield, WV.

performance of rail in curves (Baillargeon, J., Li, D., and Kalay, S., 2015). Among the most influential of these benefits is a reduction in the severity and delay in the development of RCF as well as improved resistance to internal defects and wear.

OBJECTIVES

TTCI, in collaboration with Union Pacific Railroad (UP) and Norfolk Southern Corporation (NS), installed new test curves at both the eastern and western mega sites to: (1) evaluate the latest generation of high-strength rail steels currently available to the industry, comparing their performance against that of the previous generation tested, and (2) optimize rail maintenance strategies for both high-strength and intermediate-strength rails using the results provided by the previous revenue service testing at the mega sites. This research provides information taken from this new phase of testing at both mega sites.

METHODS

New rail testing at the western revenue service location began in fall 2013, with two separate test curves having four grades of high-strength rail from four manufacturers: ArcelorMittal U.S., EVRAZ Rocky Mountain Steel, Nippon Steel & Sumitomo Metal, Mitsui USA/JFE Steel. The test curves themselves include two 2-degree curves, with standard concrete ties and elastic fasteners. This line sees between 180 and 220 MGT of traffic annually from 36-ton axle loads with operating speeds ranging between 40 and 50 mph over near-flat grades. One curve was considered the control in this experiment, which implemented only gage-face lubrication initially. The second curve, also with gage-face lubrication, implemented TOR friction modifier from the beginning, as well as preventive grinding on an optimized schedule of every 150 to 190 MGT (approximately once per year), based on previous studies.

The eastern mega site is a loaded coal route that typically sees between 37 and 54 MGT of 36-ton axle load traffic annually and operates with speeds between 15 and 25 mph over grades as steep as 1.4 percent in some areas. Hardwood ties with mixture of cut spikes and elastic fasteners were used throughout this site. Two 11.3-degree curves were installed in spring 2014, which featured six grades of high-strength rail from five domestic and international manufacturers: ArcelorMittal U.S., EVRAZ Rocky Mountain Steel, Nippon Steel & Sumitomo Metal, Mitsui USA/JFE Steel, and TATA Steel. Given the high degree of curvature in the area, one curve, considered to be the control, began testing with gage-face lubrication and TOR friction modifier. The second curve includes gage-face lubrication and TOR friction control as well, in addition to the benefits of preventive grinding on an optimized schedule of every 35 to 45 MGT (approximately once per year). Finally, a 9.7-degree test curve, featuring intermediate-strength rail from ArcelorMittal U.S.; EVRAZ Rocky Mountain Steel; Lucchini; Steel Dynamics, Inc.; and Třinecké železárny/Moravia Steel Group, is being evaluated with the same optimized grinding strategy to figure out if this approach will effectively control RCF in these rails for this special application.

RESULTS: WESTERN MEGA SITE

At the time of the 2016 spring measurement cycle, the western mega site rail test had accumulated 429 MGT. During inspection and measurements at 271 MGT, minor RCF, in the form of spalling, was seen throughout both curves. Optimized grinding was started at 272 MGT to address the RCF, and to place the test curve with TOR friction modifier on a regular grinding regimen of approximately once per year to address further RCF that may develop. The control curve receives grinding only when necessary. At 350 MGT, both curves developed significant RCF on the low rail, which was similar to the 2005 high-strength rail test. A corrective grinding cycle was performed on both test curve low rails to address the problem.

Figure 1 shows the wear for the test curve compared to the control curve. Rail A was the only rail that statistically showed higher wear than the control rail at all the test locations. The amount of rail wear throughout both curves is very similar despite the presence of TOR friction modifier in the test curve.

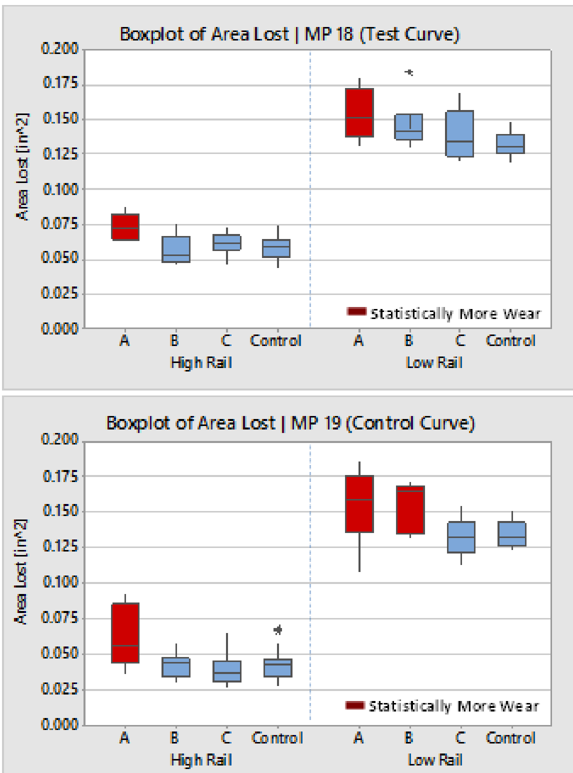


Figure 1. Western mega site interim rail wear results

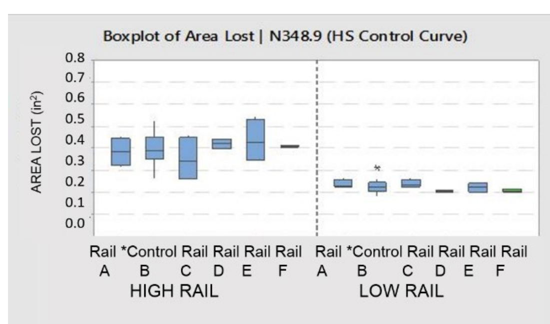
The cause of the equivalent rail wear with and without the presence of friction modifier is under further exploration to account for the minimal effect at this location. Previously, in the 2005 high-strength rail test, rail wear significantly decreased with the presence of friction modifier. It should be noted, however, that the earlier test used two TOR friction modifier units in the same curve (one additional unit for conditioning).

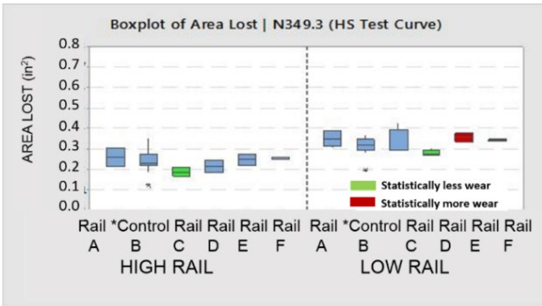
RESULTS: EASTERN MEGA SITE

The eastern mega site accumulated 92 MGT up to the 2016 spring measurement cycle. The optimized grinding cycles were originally proposed for once per year. However, after just 31 MGT on the intermediate-strength rail curve, the team decided to start grinding every 30 MGT. As of November 2016, the intermediate-strength rail curve received three maintenance grinding cycles, including one re-profiling grind. This preventive cycle is identical to the normal grinding maintenance schedule at NS for this area, which is equivalent to two grindings per year. The high-strength test curve did not receive its first grind until 45.5 MGT, and continues to receive preventive grinding every 40-50 MGT. In March 2016, all three test curves received a re-profiling grind to modify the wheel/rail contact interface.

At the time of this report, the high-strength test curve had only received two grinding cycles. The test rail within the 2014 high-strength rail curves appeared in good condition; however, minor spalling toward the field side of the railhead indicated less than optimal wheel/rail contact through the curves. The spring 2016 re-profiling grind of the rail within the curves addressed this issue and restored proper wheel/rail contact.

Post-grind inspection of both curves revealed that the running band returned to the center of the railhead, suggesting better wheel/rail contact with the adjusted railhead profile. The curve using the optimized grinding cycle of once every 40–50 MGT has been performing well, with only minor head checking on both the high and low rails. The average area of rail wear for each high-strength rail curve indicates that the curve with optimized grinding was performing slightly better on the high rail (Figure 2).





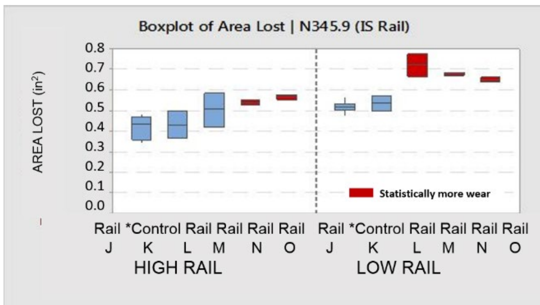


Figure 2. Eastern mega site interim rail wear results

CONCLUSION

It was too early to conclude whether the optimized strategy will in fact reduce or control the development of RCF. Optimized grinding cycles continued once per annum at both mega sites, and corrective grinding when deemed necessary. As of 2017, FRA is no longer funding this project as part of the collaborative HAL Revenue Service program, though the test is still being actively monitored by the AAR. As such, there are plans to present further results in future TTCI/AAR Technology Digests.

REFERENCES

Baillargeon, J., Li, D., and Kalay, S. (2015). Implementation of Rail Life Extension Methods in Heavy Haul Railways. *IHHA Conference.* Perth.

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KEYWORDS

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