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# Wayside-Based Top of Rail Friction Control: 95 MGT Update

By Richard Reiff

## Summary

Extended monitoring of rail performance over two track segments, one with and one without wayside-based top of rail (TOR) friction control, was conducted by the Transportation Technology Center, Inc., Pueblo, Colorado, with project funding provided by Federal Railroad Administration. Testing was conducted on a segment of the Union Pacific mainline in California. Data confirms that the introduction of TOR friction control, in addition to previous reports of reduced curving forces, reduced rail wear rates and improved rail surface performance.

The previous report of this site deployment presented data showing improved performance of low rail vertical head wear, while this recent extension confirms this benefit extends to the high rail as well; both in vertical and gage face (GF) wear.[1]

Measured wear rates include the implementation of optimized GF lubrication in both areas. Six profile sites were monitored on each of eight 10-degree curves over an 80 million gross ton (MGT) period. The effect of TOR friction control reduced average wear rates by:

Low rail vertical – 57 percent
High rail vertical – 25 percent
High rail GF and gage corner – 61 percent

GF lubrication was optimized throughout the entire area prior to this period and was maintained as uniform as feasible in both segments. This has been reported in TD-05-018.[1]

No indications of rail surface fatigue or spalling were noted during the initial inspection conducted approximately 5 months (38 MGT) after rail was installed. After an additional 9 months of operation (~57 MGT), the low rail in both zones indicated initiation of surface cracking; however, the extent and size of cracks in the area with no TOR friction control was significantly greater. Additional measurements are planned to monitor rail metal removal during production grinding when rail is maintained in the near future.

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## BACKGROUND AND OBJECTIVES

Benefits from controlling TOR friction have been demonstrated in numerous trials using wayside, hi-rail, and locomotive-based applicator systems. Primary benefits provided by TOR friction control systems have included:

- Reduced curving forces
- Reduced rail wear rates

This report summarizes results from implementing wayside-based TOR systems over two segments of nearly identical track to determine the effect of TOR on rail performance.

## TEST SITE

*Technology Digest* TD-05-018 provides a detailed description of the test site near Walong, California.[1] Key parameters of the curves monitored for this test include:

- All curves located on 2-percent grades
- All curves at 10 degrees
- All rail of the same type: Nippon Head Hardened 141AB, installed in August 2005
- All locations optimized with wayside-based GF lubrication
- Same trains, speeds, and general cant deficiency were used in Zone 1 (TOR and GF) and Zone 2 (control with GF only)

Figure 1 shows the track layout in the test area and the two control zones. Within each zone, eight curves were selected that had reasonably the same superelevation and curvature. With one exception, all were located on single track. One curve, located on the mainline portion of the Walong Siding near the load monitoring station, was the only curve not on single track. Load station wear data is not included as the tonnage was not identical to the other curves.

The GF lubrication systems in both zones were upgraded with Portec Protector IV™ solar-electric wayside gage-face applicators utilizing Lithium-based grease. Zone 1 had an identical layout of the GF lubricators but was also equipped with seven wayside TOR applicators.

## KEY RESULTS

### Curving Forces

Curving forces were collected at mile post (MP) 352 to monitor long-term performance of the TOR system. By comparing forces to baseline (GF only) data, which was accomplished whenever TOR friction control units were deactivated for track work, the effectiveness of the system was monitored. Results were similar to that reported in TD-05-018 with data indicating when the wayside TOR units were activated. Curving forces produced by loaded cars for southbound trains were reduced by 31 to 58 percent.[1] The effect on northbound trains was not as beneficial, with reductions of about 10 percent.

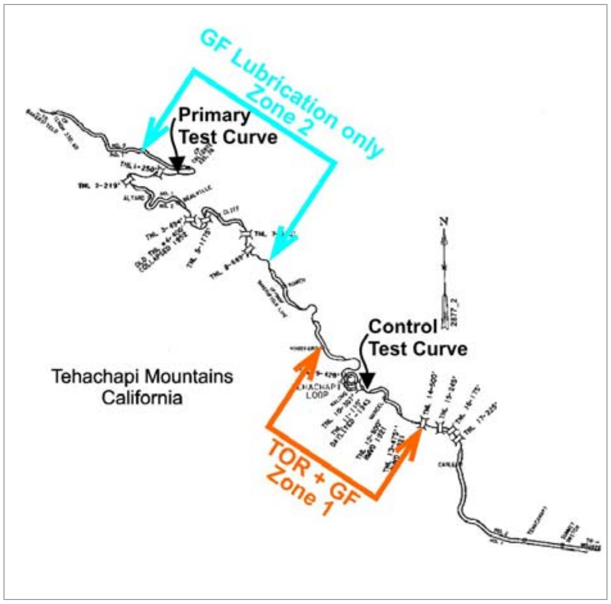

Figure 1. Site Layout showing Curves and Positions of Wayside TOR and GF Applicators

### Rail Wear

Rail wear data was collected on a periodic basis during the demonstration using MiniProf™ measurements. At each site, each subsequent profile was compared to the initial data for each curve to compute wear rates for each of the two zones. Four measurements were collected during 2006. To allow for rail wear in TOR/GF optimization and superelevation changes, these rail wear measurements were initially obtained:

- January – 38 MGT traffic
- March – 65 MGT
- August – 83 MGT
- End of October – 95 MGT

Tables 1 and 2 show the curvature and location of Zones 1 and 2 rail wear.

**Table 1. Zone 1, TOR and GF**

| ID | MP | Curvature |
|---|---|---|
| A | 355.25 | 9° 25” |
| B | 355.2 | 10° 16” |
| C | 354.7 | 10° 05” |
| D | 352.6 | 10° 24” |
| E | 352.4 | 10° 02” |
| F | 352.0 | 9° 32” |
| G | 350.8 | 10° 01” |
| H | 350.5 | 9° 59” |

*Note: Load station site, only curve on double track, not included in wear rate averages*

**Table 2. Zone 2, GF Only**

| ID | MP | Curvature |
|---|---|---|
| M | 344.8 | 10° 05” |
| N | 344.6 | 10° 00” |
| O | 344.3 | 10° 06” |
| P | 343.4 | 9° 27” |
| R | 341.5 | 9° 25” |
| S | 341.0 | 10° 39” |
| T | 337.7 | 10° 02” |
| U | 336.8 | 10° 00” |

Rail wear was tracked for each curve ID (letter code) by changes in head dimension (dimensional wear) for each inspection. Figure 2 shows GF wear for each of the eight curves in Zone 2.

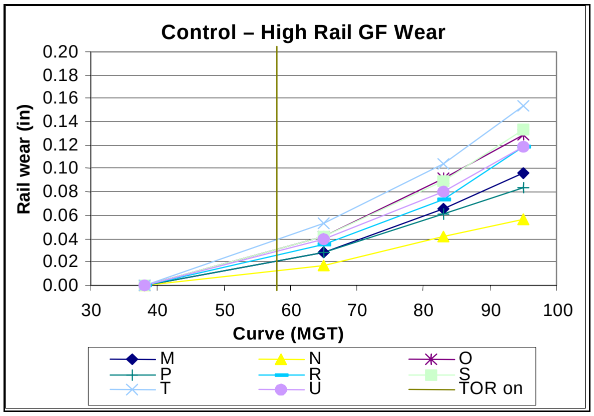

**Figure 2. Wear Rate for Zone 2, All Curves**

For this site, an average wear was determined because all curves being monitored on single track were exposed to the same trains and tonnage which allowed total wear to be compared between zones. Figure 3 shows the average total wear for top of the low and high rails, high rail GF and high rail gage corner (GC) for each of the seven curves in Zone 1, and for the eight curves in Zone 2. Figure 4 shows total area loss for each zone.

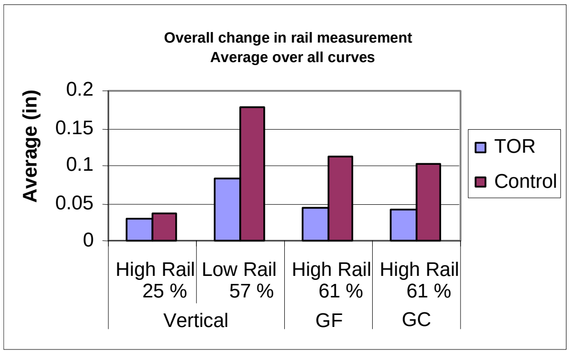

**Figure 3. Total Wear during the Test Period**

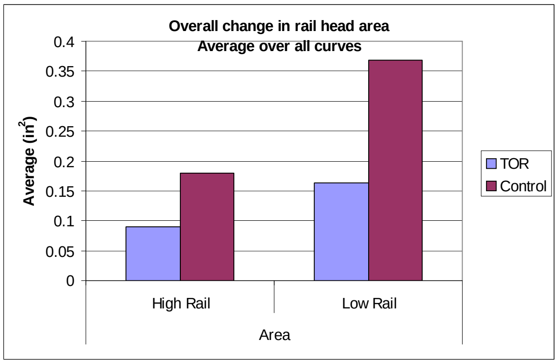

**Figure 4. Rail Head Area Loss (inch$^2$), Zones 1 and 2**

## RAIL FATIGUE/SURFACE PERFORMANCE

Recent results at another location suggest TOR reduces rolling contact fatigue (RCF) and improves overall rail surface performance on low-degree curves.[2] To document the effect of TOR friction control on RCF performance, where higher degrees of curvature are encountered, such as at this site, rail surface condition was documented after 38 MGT and 95 MGT of traffic.

Dye penetrant techniques were used for this inspection. Results suggest TOR had a significant effect in reducing RCF on high and low rails for each of the seven curves in Zone 1 when compared to Zone 2. Figures 5a through 5d show typical low rail photos after 95 MGT of traffic from the low rail in both zones. Figures 5a and 5b show Zone 1 and Figures 5c and 5d show Zone 2.

Inspections conducted on all curves for each zone show similar trends on all but one curve (curve U, where the low rail in Zone 2 exhibited less RCF and surface damage than low rails in Zone 1). As with rail wear, RCF performance on individual curves varied somewhat within each zone.

## OTHER PERFORMANCE ISSUES

Visual examination of rail fastener components (tie pads, rail clips, and insulators) located in the control zone indicated more instances of breakage, movement, and displacement than identical components located in Zone 1.

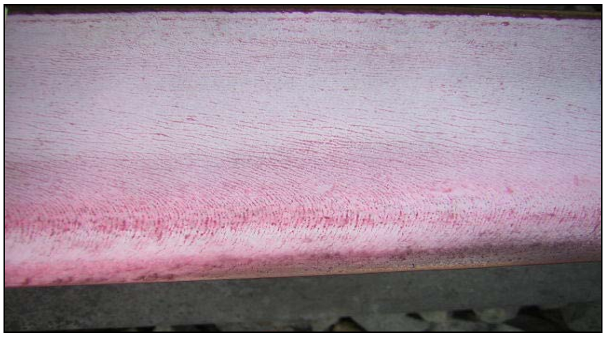

**Figure 5a. Zone 1, Typical Low Rail after 95 MGT of Traffic**

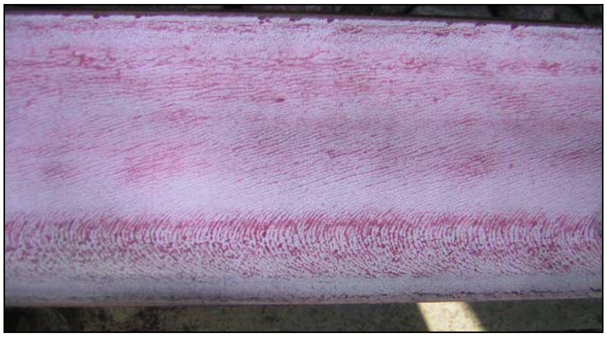

**Figure 5b. Zone 1, Typical Low Rail after 95 MGT of Traffic**

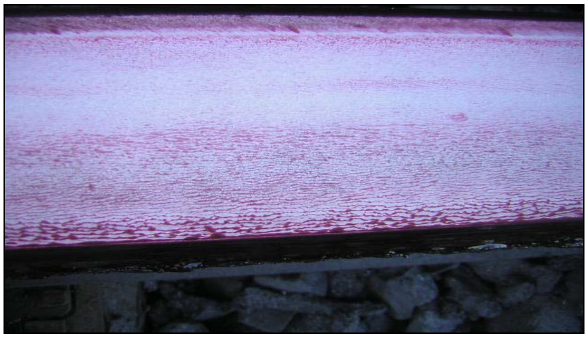

**Figure 5c. Zone 2, Typical Low Rail after 95 MGT of Traffic**

**Figure 5d. Zone 2, Typical Low Rail after 95 MGT of Traffic**

## SUMMARY AND DISCUSSION

This site produced measurable results for rail wear and rail surface performance indicating significant benefits when TOR friction control systems were activated. Data shows that after 95 MGT on both segments (exposed to the same trains and approximate speeds), application of TOR friction control produced benefits of increased rail life.

## FUTURE PLANS AND RECOMMENDATIONS

Results of rail wear rates will be incorporated into a revised cost benefit analysis (CBA) being conducted on wayside application of friction control. Additional information and performance to be monitored over the next 6 to 9 months include:

- Longer-term rail wear
- Long-term rail surface performance
- Metal removed during production rail grinding
- Fastener/clip performance

These additional items will also be included in the CBA.

## ACKNOWLEDGMENTS

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Special acknowledgement also goes to TTCI employees Beatrice Rael, Steve Bretzke, and Rachel Anaya for their invaluable assistance.

## REFERENCES

1. Reiff, Richard, Tony Makowski, and Marty Gearheart. July 2005. “Implementation Demonstration of Wayside-Based TOR Friction Control, Union Pacific Railroad–Waylong, California.” *Technology Digest*, TD-05-018, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colorado.
2. Reiff, Richard, Steve Renfrow, Beatrice Rael, and Rachel Anaya. 2007. “Broken Rail Detection using Acoustic-Based Sensors Deployment Demonstration on FAST.” Federal Railroad Administration, Washington, DC.