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Top-of-Rail Friction Control on Rail Surface Performance and Grinding

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Summary

An ongoing project under the Association of American Railroads' Strategic Research Initiatives Program monitors implementation issues and benefits associated with wayside based top-of-rail (TOR) friction control. Recent measurements and inspections conducted before and after rail grinding suggest curves in the TOR zones received fewer grinding passes, had less metal removed, and produced rail with overall better surface conditions than the identical rail located in a gage face (GF) only lubrication zone. To date, observations and measurements at this field site, located on the Union Pacific railroad, have shown that wayside based TOR friction control reduced rail wear rates from 23 percent to 60 percent.

Visual examination showed that this site produced less rail surface cracking after 140 MGT of traffic in areas where TOR was applied than in GF only areas. Although the GF only zone received 14 percent more grinding passes, the difference in amount of metal removed was not conclusive.∗ However, the rail surface condition remaining after grinding was noticeably better in the TOR zone than in the control (GF only) zone, suggesting that additional grinding passes would have been required over most curves where TOR was not being applied to obtain similar rail surface conditions in both zones.

This *Technology Digest* summarizes observations and measurements that suggest TOR friction control resulted in improved rail surface conditions, and reduced rail grinding demand. This is based on data collected within two 10-mile segments separated by approximately 5 miles. Both zones were optimized with identical (and improved) wayside based gage face lubrication. One zone has been further modified by implementing TOR systems. Data is based on almost 2 years of traffic.

Additional information and performance will be monitored over the next 6 to 9 months. If feasible, measurements will be taken closer to the actual grinding dates. Results will be incorporated into a revised cost benefit analysis as well as updating recommended practices and TOR implementation guidelines.

∗The small number of curves in each zone limited the statistical significance of the results.

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INTRODUCTION

Benefits from controlling TOR friction have been demonstrated in numerous trials with emphasis on documenting improved rail wear rates.[1] Field inspections have suggested that rail surface conditions and rail grinding may also benefit from the application of TOR friction control.

This TD summarizes rail surface performance after 140 MGT of traffic and rail grinding demand. Data was collected from 10-degree curves located in two zones. Both zones were optimized for GF lubrication, and the TOR zone was further enhanced by implementing wayside-based TOR friction control systems.

TEST SITE

Key parameters include:

- 10-degree test curves on 2-percent grades
- Nippon Steel Corp. Head Hardened rail, 141AB, installed in August 2005
- Trains traveling at the same speed and general cant deficiency in both zones

Figure 1 shows the track layout in the TOR plus GF and control (GF only) zones.

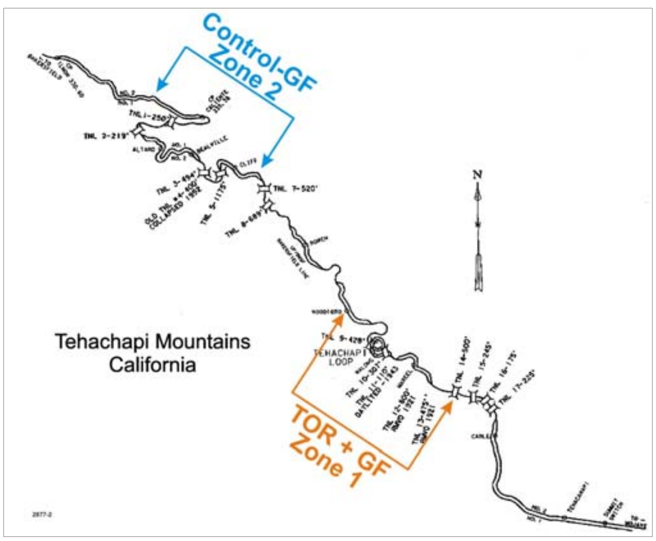

Figure 1. Site Layout showing Test Zones

Optimized GF lubrication in both zones is provided by Portec Protector IV™ wayside systems using Lithium-based grease. The TOR zone is equipped with eight wayside Portec TOR applicators, applying Keltrack™ freight friction modifier.

RAIL GRINDING

The entire section was ground in late November 2005. TOR and GF applicator optimization was still being conducted, thus rail wear monitoring was not initiated until early 2006. Rail has been measured six times at various intervals, including just before and after an April 2007 rail grind.

During April 2007, a rail grinder (96 stone, 18-22 HP per stone) operated over the control and TOR zones. At this site, grinding effort and number of passes were dictated by inspections and observations of the grinding contractor, along with available track time.

Grinding passes were summarized in 0.1 mile segments. This data was superimposed over track chart information to allow comparison between the grinding efforts of the two zones. Figure 2 shows results between MP 343.3 and MP 345.2, along with the location of Control zone test curves M-P. This analysis was conducted on all Control and TOR zone test curves located on single-track segments of this route. Table 1 summarizes the results.

Table 1. Grinding Pass Summary
Curve F is on a Double Track Segment

UP Tehachapi Grind Pass Summary (April 2007)
Test Curves Only

TOR Zone		Control Zone	
A	2	M	4
B	3	N	4
C	5	O	4
D	4	P	4
E	4	R	4
G	3	S	4
H	4	T	5
		U	4
TOR Zone Average Pass	3.57	Control Zone Average Pass	4.13
Pass Range	2 – 5	Pass Range	4 - 5

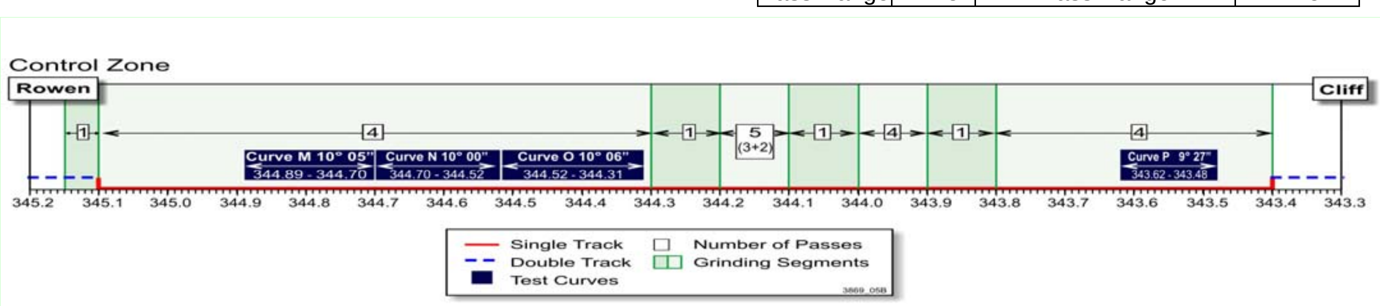

Figure 2. Grinding Passes shown Against Control Zone Test Curve Locations, MP 343.3 to MP 345.2

Table 1 shows that the test curves in the TOR zone received fewer grinding passes than test curves located in the control (GF only) zone. Figure 3 shows the progression of low rail head area loss for each inspection from the start of monitoring (38 MGT - January 2006) to the present (140 MGT - May 2007), based on rail profile data for curves in the TOR zone. Similar plots have been generated for high and low rails in both zones and for other wear parameters.

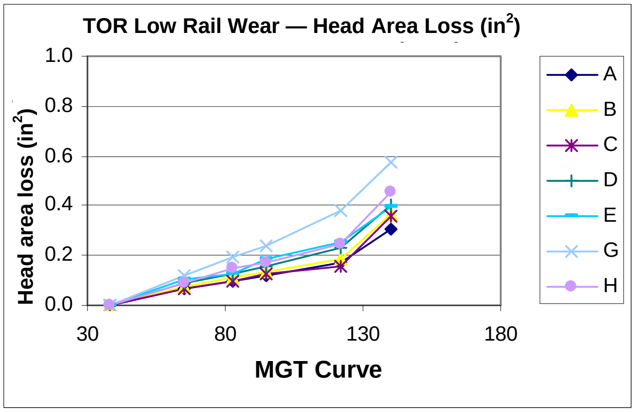

Figure 3. Historical Low Rail Head Area Wear —TOR Zone

The jump in the amount of wear between 122 and 140 MGT shows the effect of rail grinding between pre- and post-grind measurements. The wear between these two measurements includes total from both train traffic and the amount removed from grinding. Figure 4 shows the total head area loss for each curve in the TOR and the control zones between 122 MGT and 140 MGT, from both grinding and train wear.

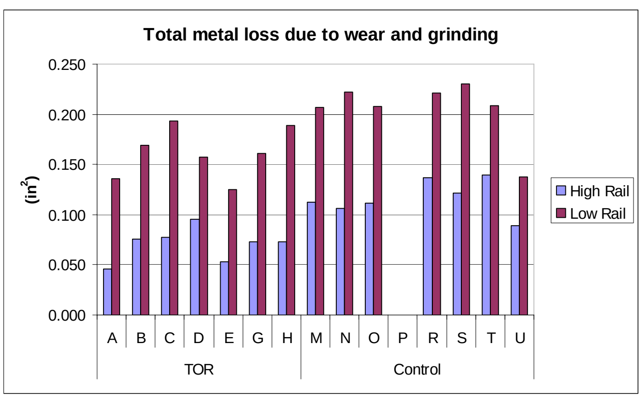

Figure 4. Total Wear Head Area Loss (train and grinding) between Pre- and Post-Grinding Measurements
Curve P could not be accessed for wear measurements.

It was not feasible to schedule measurement crews to be on site during grinding, thus the wear data was adjusted to remove estimated amounts from train traffic. For this TD, rail wear rates for the 18 MGT period during which grinding occurred were assumed to be the same rates as during the previous period (95 – 122 MGT). By reducing the amount of area lost by this projected wear rate from train action (by curve), the amount of metal removed by grinding alone was estimated and is summarized in Figure 5.

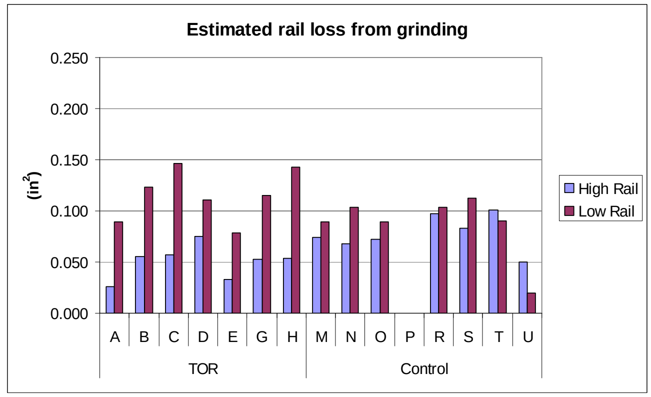

Figure 5. Projected Head Area Loss from Grinding
Curve P could not be accessed for wear measurements.

SUMMARY OF GRINDING – HEAD AREA LOSS

Table 2 shows average metal removed between the measurements was greater for both high and low rails, when wear and grinding are considered. When the amount of metal from train traffic estimated wear rates for the period is removed from the total, the TOR zone shows a larger amount of metal removed through grinding for the low rail only.

Table 2. Average Head Area Loss 18 MGT Period
Total (Train + Grinding) and Projected for Grinding Only

	High Rail in^2	Low Rail in^2
TOR zone Total average wear (train +grinding)	0.070	0.161
Control zone Total average wear (train +grinding)	0.117	0.205
TOR zone Grinding only	0.050	0.115
Control zone Grinding only	0.078	0.087

RAIL SURFACE APPEARANCE PRE/POST GRINDING

Dye penetrant techniques were used for this inspection to document rail surface conditions and crack appearance. Results show reduced levels and amounts of cracking on both high and low rails in the TOR zone when compared to the GF only zone. Figures 6a and b show typical low rail photos after 95 MGT of traffic, before grinding, from the low rail in both zones. Figures 7a and b show the same sites after grinding. Similar results have been documented at most of the curves in the TOR and control zones.

Figure 6a. Pre-Grinding, TOR and Optimized Gage Face Lubrication (Low Rail — Curve G, Site 5L)

Figure 6b. Pre-Grinding, Optimized Gage Face Lubrication Only (Low Rail — Curve R, Site 1L)

Figure 7a. Post-Grind Rail Surface Conditions, TOR Zone (Low Rail — Curve G, Site 5L)

Figure 7b. Post-Grind Rail Surface Conditions Control Zone (Low Rail — Curve R, Site 1L)

SUMMARY AND DISCUSSION

This site produced less rail surface cracking after 140 MGT of traffic in areas where TOR was applied than in the GF only areas. Although the GF only zone received more grinding passes, the difference in amount of metal removed between zones was not conclusive (limited statistical significance). This may be due to the uncertainty of projected rail wear in the 18 MGT period that was used to determine the amount of rail ground. However, the rail surface condition remaining after grinding was noticeably better in the TOR zone than in the control (GF only) zone, suggesting that additional grinding passes/metal removal over most curves where TOR was not being applied would have been required to obtain similar rail surface conditions in both zones.

FUTURE PLANS AND RECOMMENDATIONS

Additional information and performance will be monitored over the next 6 to 9 months. If feasible, measurements will be taken closer to actual grinding dates. Results will be incorporated into a revised cost benefit analysis as well as updating recommended practices and TOR implementation guidelines.

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REFERENCES

1. Reiff, Richard, Tony Makowsky, and Marty Gearheart. July 2005. "Implementation Demonstration of Wayside-Based TOR Friction Control, Union Pacific Railroad – Walong, CA." *Technology Digest*, TD-05-018, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, CO.