TECHNOLOGY DIGEST

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Dynamic Gage Widening Inspection of a Western U.S. Main Line under TLV Loading

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Summary

To determine the effects of increased axle loads and tonnage on a typical mainline track in the western part of the United States, an inspection using Transportation Technology Center, Inc.'s Track Loading Vehicle (TLV) was performed in April 2001 and again in July 2002. This digest details the follow-up inspection performed in July 2002 and then compares the results with those found in the initial inspection. Test results and observations suggest:

- There is a significant (67 percent) reduction in the number of dynamic wide gage locations (exceeding specific parameters under TLV loading conditions) on this mainline track since the first test in 2001, resulting from effective maintenance efforts.
- Most of these dynamic wide gage locations were in curves.
- Spike lifting, tie splitting, and tie plates cutting into the field side of ties were typically seen at these wide gage locations, but broken spikes were not.
- A section of new concrete ties with elastic fasteners is performing well up to this point, with no TLV loaded wide gage or delta gage exceptions found. Further testing under heavy axle load (HAL) conditions is needed to determine long-term performance.
- Field side tie plate cutting was seen in curves predominantly on high rails, but also on low rails at some locations. This was likely influenced by variations in train speed, load conditions, and grade and would indicate under and overbalance conditions.
- Highest unloaded/loaded TLV wide gage measurements were found through curves in steepest ascent grades, loaded train direction. This may be indicative of strength degradation from high forces of helper locomotives.

The main line chosen for this study has sections that are owned and maintained by two railroads. During the two-day follow-up inspection in July 2002, approximately 14 locations were marked for further inspection of wide gage. This compares with 42 locations marked during the April 2001 inspection.

This evaluation was a cooperative effort by the Federal Railroad Administration and the Association of American Railroads in HAL research to study the rate of track degradation and load relationship in revenue service with various tie/fastener combinations under various types of traffic, primarily heavy haul track (286,000-pound gross rail load) on mainline track.

Suggested Distribution:

- ☐ Maintenance of Way
- ☐ Planning & Analysis
- ☐ Track Maintenance
- ☐ Safety

Work performed by TTCI Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads

INTRODUCTION AND CONCLUSIONS

An inspection for gage widening conditions was performed by TTCI on a typical mainline track that operates normal and heavy axle load (HAL - 286,000 lbs. gross rail load for a 4-axle car) traffic in the western United States. The inspections are a part of an FRA/AAR cooperative effort in HAL research to study the track degradation-load relationship in revenue service locations. The investigation was conducted in concert with another wide gage study, on an eastern main line, under the same program.[1]

The main line chosen for this study has sections that are owned and maintained by two railroads. It typically serves 263,000-pound coal and mixed freight cars with an increasing number of HAL coal and grain trains in recent years. An inspection of the track by TTCI using the Track Loading Vehicle (TLV) was first performed in April 2001 and then repeated in July 2002. This digest details the follow-up inspection performed in July 2002 and compares the results with those found in the initial inspection.

The areas of gage widening found in this project were typically in curve areas and were characterized by classic cases of loss of rail cant and spreading that are typical under HAL traffic. Evidence included tie plates sliding on and cutting into wood ties, leading to rail pumping and consequently to "lifted spikes." Rail wear was observed in some curve areas, including the low rail side where loaded trains traveled below balance speed when ascending steep grades. Split ties were also observed in some curve areas..

Overall, the data shows that there is a significant increase in track gage strength now compared to last year, particularly in the southbound loaded direction on the up-hill grade from MP-12 to MP-50. These results are validated by the track maintenance record, which indicates considerable maintenance has been performed over the previous year in that area. This maintenance consisted of a comprehensive tie and surfacing (T&S) program from MP-12.8 to MP-50, including 12 miles of new concrete ties and fasteners from MP-12.8.

TEST/INSPECTION PROCEDURE

The initial and follow-up inspections were conducted by TTCI using the TLV. The TLV test consist, Figure 1, was composed of a locomotive from the host railroad, the AAR 100 Instrumentation Car, the TLV (AAR 110 Test Car), and a special trailing tank car (AAR 120). The TLV can be configured to evaluate vertical track modulus, panel shift, and gage restraint.

The TLV applied continuous loads of 33,000 pounds vertically and 18,000 pounds laterally at track speeds between 15 and 20 mph for this test. It was configured to inspect for track gage strength only. In this configuration, an automated paint spray system marks locations where dynamic gage and/or delta gage under the TLV equals or exceeds a preset value (exception). Multiple spray sites through a curve were treated as one "location." Wide gage paint limit (loaded gage) was set at 57.00-58.00 inches and delta gage paint limit (loaded–unloaded) was 1.00-1.50 inches. (See Figure 2 for typical paint marking.)

For this test, a track inspector from one of the two host railroads and two TTCI engineers followed the TLV in a hi-rail truck. Each marked site was inspected to determine the cause for the widened gage conditions. The host railroad also had a standby track crew that it dispatched to those locations that warranted immediate repairs. Inspection consisted of walking the suspect area, observing tie and fastener conditions, measuring unloaded gage, striking fasteners to determine if spikes were broken, and taking photographs for documentation.

The TLV was operated for two days, completing the northbound test of the mainline track (normally the unloaded coal train direction) on the first day. The return southbound test of the main line (normally the loaded coal train direction) was done on the following day. The single main track section at midway was inspected both days. (See Figure 3 for a representation of the mainline plan and profile.)

Figure 1. TLV Test Consist

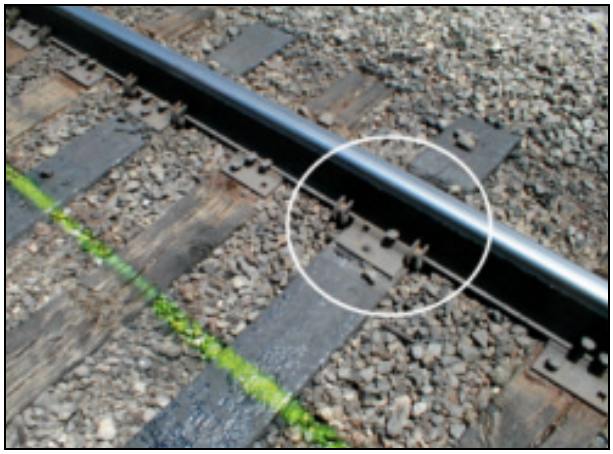

Figure 2. Yellow Paint Stripe at Curve with a Broken Spike, Tie Plate Cutting, and High Spikes

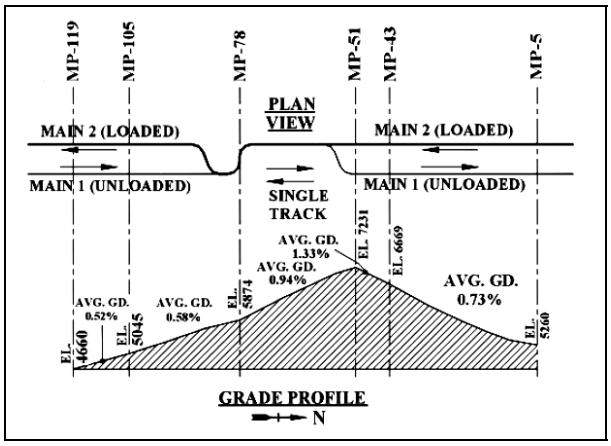

Figure 3. Plan View and Grade Profile for the Western Main Line Inspected

RESULTS

July 2002 Inspection

There were 14 locations marked as a result of TLV wide gage exceptions, with no delta gage locations found. Most of these locations were found in curves of 2 to 6 degrees, with the majority of those being 3 degrees. All marked locations had oak wood ties, cut spikes, 14-inch plates, and granite ballast on a filled embankment. Most ties were 7-in.x 9-in. x 9-ft. long. It was noted that rail clips were installed at some of these locations during scheduled maintenance and, in some locations, cut spikes and conventional tie plates were being replaced with elastic fasteners and plates on wood ties.

A 12-mile section of concrete ties with elastic fasteners in the southbound loaded direction beginning at MP-12.8 was laid only a few months prior to this follow-up test. Reports from the host railroad indicated that they were performing very well up to this point. Test results from the TLV confirmed no exceptions were found. More tonnage under HAL conditions is needed to determine long-term performance.

Some of the painted wide gage locations contained ties initially planned for removal during an upcoming tie replacement program, but were later eliminated from the maintenance program and not replaced.

Specific Causes for Wide Dynamic Gage

Gage widening in curved track constructed of cut spikes and wood ties is typical of conditions caused by HAL traffic. Vehicles with lower levels of curving performance and underbalance speed of slow loaded trains ascending steep grades intensify this effect. This condition was seen as heavy wear on the gage face of either high- or low-rails. Figure 3 is a representation of the mainline plan and depicts grade views for a sense of HAL operations. As can be seen, the loaded coal traffic, using helpers, must negotiate grades averaging about 1.33 percent.

Other conditions seen in the painted curve areas included spike lifting, tie plate cutting, and evidence of plate-to-tie lateral movement at field side of high rail tie plates (see Figure 2). Broken spikes, as seen in the photo, were found in two locations, but this was not a typical circumstance found during inspection.

The unloaded gage in painted areas typically measured in a range of 57.13 inches to 57.50 inches. The TLV measured two locations where unloaded gage was more than 57.50 inches. Those areas had nominal gage restored by repositioning the low-side rail.

2002 and 2001 Results Comparison

Overall, the data indicates that there is a significant reduction in the number of TLV wide gage conditions now compared to last year. During the April 2001 test, 42 gage-widening locations (81 actual TLV exceptions) equal to or greater than 58.00-inch limit were reported. That compares to 14 gage widening locations (32 actual exceptions) reported in the July 2002 test, or a 67 percent reduction from last year's test. In particular, the biggest improvement was seen in the southbound loaded direction on the up-hill grade from MP-12 to MP-50; and in the single-track section between MP-52 and MP-60. These results are validated by the track maintenance record, which indicates considerable maintenance has been performed over the previous year in those areas. Specifically, this maintenance consisted of a comprehensive T&S program from MP-12.8 to MP-50, including 12 miles of new concrete ties and fasteners from MP-12.8. It also included the installation of elastic fasteners on wood ties where rail was being replaced between MP-54 and MP-58.

Figure 4a (unloaded gage) and Figure 4b (loaded gage) support this conclusion. They are overlays of histograms taken from the same section of track in both tests, to make the areas of improved gage strength easily distinguished.

Seven of the 14-milepost sections found in 2002 had TLV wide gage exceptions on the 2001 test as well. In fact, the TLV histograms from both tests of these areas look nearly identical. This lack of change implies that maintenance in these particular sections has been effective in preventing additional deterioration caused by continuing traffic.

Figure 5 summarizes the number of locations for each of the major conditions determined to cause TLV wide gage found in the 2002 inspection. Note that many sites had combinations of causes, especially plate cutting, spike lifting, and ties splitting.

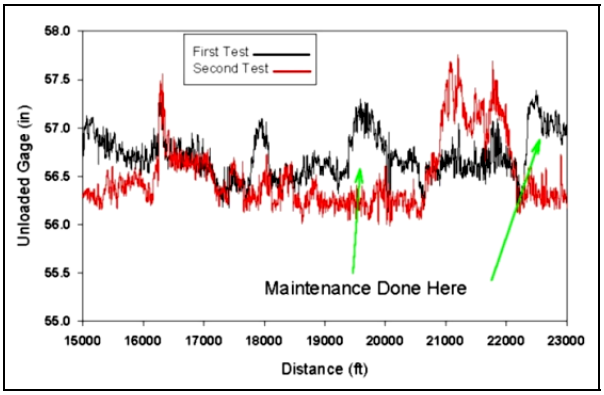

Figure 4a. Histogram showing Unloaded Gage in 2002 vs. 2001 at Same Location

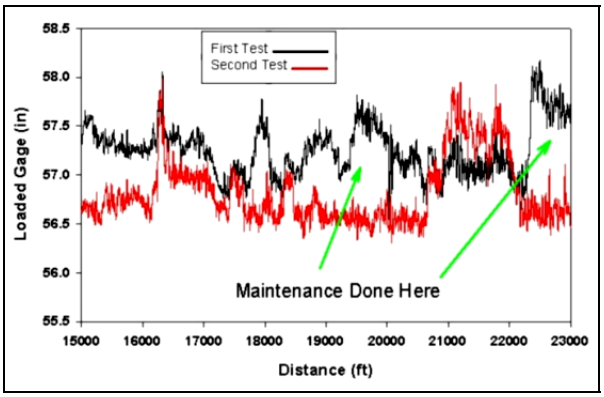

Figure 4b. Histogram showing Loaded Gage in 2002 vs. 2001 at Same Location

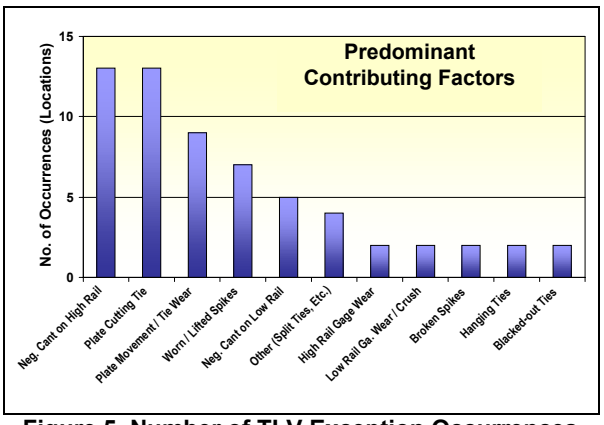

Figure 5. Number of TLV Exception Occurrences

SUMMARY AND FUTURE WORK RECOMMENDATIONS

The TLV track strength data and visual inspections from the July 2002 follow-up test of the western US main line shows a significant improvement in gage strength from the 2001 test. An overall reduction of 67 percent in loaded gage paint locations from the previous year was found. Part of the reduction includes a 12-mile section of track that was recently fitted with new concrete ties and elastic fasteners. Performance of the concrete ties and elastic fasteners, up to this time, has been very good. They should be re-evaluated after one or two years of HAL operations.

The greatest number of loaded TLV wide gage areas, by far, were found in curve sections having hardwood ties and cut spike fasteners, as was expected. In most of these areas, field side tie plate cutting and lateral movement, accompanied by lifted spikes indicated tie plate and rail negative cant. Broken spikes were not found to be a typical problem.

A wayside instrumented site to measure lateral loads could help evaluate current operations in various scenarios — using fewer helpers, using helpers operating at less than full throttle, operating trains at lower speeds, and finding the optimum balance speeds for typical loaded coal and mixed freight trains.

References

1. Reiff, Richard. "Tie Conditions Leading to Dynamic Gage Widening Exceptions Under TLV Loads," *Technology Digest* 01-029, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, CO, December 2001.

Acknowledgement

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