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Dynamic Gage Widening Inspection of an Eastern U.S. Main Line

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Summary

A typical mainline track in the eastern part of the United States was experiencing recurring gage-widening after introducing 286,000-pound gross rail load heavy axle load (HAL) traffic. To determine any track strength changes that may have occurred over the year, Transportation Technology Center, Inc. (TTCI) in September 2001 and again in August 2002 used its Track Loading Vehicle (TLV) to perform an inspection of approximately 170 miles of track.

Inspections, observations, and information from the host railroad provided the following:

- There was a significant 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 track maintenance efforts.
- Most of the TLV wide gage locations were found in curves.
- Widened gage locations were found on several approaches to bridges and road crossings.
- Sections of track with elastic fasteners installed on older, used wood ties were not performing well, as evidenced by several widened gage paint locations.
- On recent flood damaged track mostly remedial maintenance was done until a tie and surfacing program could be scheduled.
- Evidence of gage widening modes included tie plate cutting (field side), high rail negative cant, lifted spikes (pull-outs), tie splitting, and tie plate wear.
- Broken spikes were not found to be a major cause of the wide gage exceptions.

The main line chosen for this study is owned and maintained by one railroad. It is comprised of three separate lines, each averaging 50 MGT per year of traffic. A loaded wide gage paint limit of 57.50 inches and a dynamic wide gage (loaded gage – unloaded gage) paint limit of 1.00 inch was used for this investigation.

This investigation was a cooperative effort by the Federal Railroad Administration (FRA) and the Association of American Railroads (AAR) to study the track degradation and load relationship of normal to heavy traffic (number of trains/day) in revenue service. Various tie and fastener combinations were examined under various types of traffic, primarily heavy haul conditions (286,000-pound gross rail load) on mainline track.

Suggested Distribution:
- ❑ Safety
- ❑ Maintenance-of-Way
- ❑ Track Maintenance
- ❑ Planning & Analysis

TTCI
Transportation Technology Center, Inc.

INTRODUCTION AND CONCLUSIONS

An inspection for dynamic gage widening conditions was performed by TTCI on a typical mainline track that operates normal (263,000-pound gross rail load) and heavy axle load (HAL - 286,000-pound gross rail load for 4-axle car) traffic in the eastern United States. The inspection was part of an FRA/AAR cooperative effort in HAL research to study the track degradation and load relationship in revenue service. This investigation was conducted concurrently with another wide gage study on a western U.S. main line that is also under the same HAL research program.[1]

Three different tracks were tested for wide gage conditions in this study. They are all owned and maintained by one railroad and cross through three different districts. The three lines were tested over sections of track 95, 46, and 40 miles long. The 95-mile section of the first line is a double track, with only the eastbound side used for loaded train operation being tested. The other two sections are single tracks with two-way traffic.

Overall, the data indicates that there was a significant reduction in TLV wide gage exceptions compared to the previous year's inspection.[2] All of the reduction was seen in the two shorter mainline sections, where wide gage exceptions were reduced by more than 50 percent. Information from the host railroad indicated considerable maintenance was performed in the areas tested over the previous year. Maintenance consisted of a comprehensive tie and surfacing (T & S) program. The 95-mile track section showed no change in the number of wide gage exceptions from the previous year's test, although in most cases areas identified were in different locations. Railroad staff indicated that spot maintenance was conducted over the 95-mile section, and that it is scheduled for a more comprehensive T&S program in 2003.

TEST/INSPECTION PROCEDURE

The initial and follow-up inspections were conducted by TTCI using the TLV. The TLV test train contained a locomotive from the host railroad, the AAR Instrumentation Car, the TLV, and a specially instrumented tank car. The TLV can be configured to evaluate vertical track modulus, panel shift, and gage restraint.

For this test, the TLV was configured to inspect for track gage restraint and in a few locations for vertical track modulus. For loaded gage testing, the TLV applied continuous loads of 33,000 pounds vertically and 18,000 pounds laterally, at track speeds between 15 and 20 mph. In this configuration, an automated paint spray system marks locations where dynamic gage or delta gage under the TLV equals or exceeds a preset value (exception). Multiple spray sites for exceptions through a curve were regarded as one "location." Wide gage paint limit (loaded gage) was set at 57.50 inches, and the delta-gage paint limit (loaded/unloaded) was set at 1.00 inch, the same as for the previous year. (See Figure 1 for typical paint marking.)

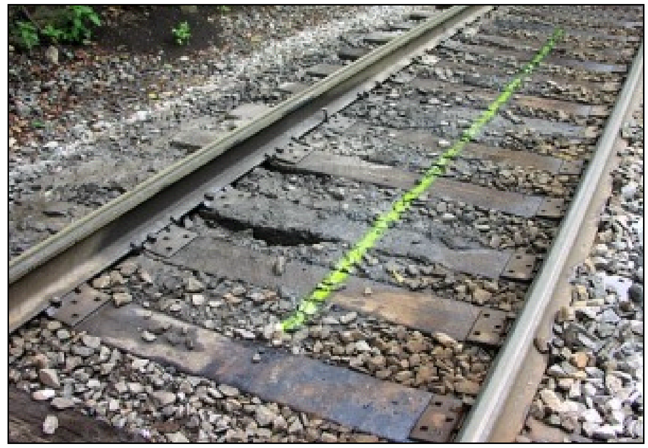

Figure 1. Wide Gage Paint Location at Previous Wash-Out Area in Tangent Track

Two track inspectors from the host railroad and two TTCI engineers followed the TLV in a hi-rail truck. They stopped at a majority of the sites marked with paint to visually inspect and try to determine the cause for dynamic wide 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 painted area, observing tie, fastener, and ballast conditions, measuring unloaded gage, striking fasteners to determine if they were broken or loose, and taking photographs for documentation. At some locations, rail heads were measured with a hand-held rail wear gage to assess wear on the gage face and top of head (head height). The TLV operated one day at each track location. Travel was predominately eastward the first two days, and southward the final day, which was the same as in the initial test.[2]

RESULTS

August 2002 Inspection

The first line was inspected over a 95-mile section of track. There were 72 locations marked because of TLV loaded wide gage exceptions, with no delta gage locations found. This compares to the same number of locations found in the 2001 investigation.[2] On the second line, approximately 46 miles of track were inspected. There were only 17 locations marked for dynamic TLV wide gage on this line, comparing to 72 locations in 2001; a reduction in locations of 76 percent. The third line was tested for a distance of approximately 40 miles. There were 27 locations painted for dynamic wide gage, which compares to 63 in 2001. Refer to Table 1 for details.

Most of the dynamic wide gage exceptions were found in curves of 6 to 9 degrees. The marked locations contained predominantly hardwood ties, cut spikes, 18-inch tie plates, and granite ballast on a filled embankment. Most of the rail was 132-pound per yard rail, with 7-in.x 9-in. x 8.5-ft. long hardwood ties. The exception was the second mainline, which had 136-pound per yard rail. In almost every case, two-tie plate hold-down spikes were used to fasten the tie plates to the ties, in curve and tangent sections; however, 2 cut spikes were also installed in tangent track sections as rail fasteners, and 3 to 4 spikes were installed as rail fasteners in curve sections.

Two locations at bridge approaches had elastic fasteners retro-fitted onto older wood ties. There were visual indications of gage strength problems, probably caused by older wood ties that were not in prime condition when retrofitted with the elastic fasteners (see Figure 2). One 4-mile section of track, at the beginning of the inspection, had concrete ties and was referred to as the "concrete test section" by the host railroad. It was not tested during the 2001 investigation so no comparisons can be made. However, in this test, there were four locations where the TLV identified and marked for wide gage conditions. The wide gage exceptions were in both tangent and curve track. One of the track inspectors reported that the elastic fasteners and concrete ties were periodically being replaced with hardwood ties, 18-inch tie plates, and cut spikes as part of recent T&S programs. Apparently the concrete system has not worked out well for this line because of insulator wear, rail seat abrasion, and tie pad wear problems (see Figure 3).

Figure 2. Elastic Fastening System Installed on Old Ties

Figure 3. Pencil Points to Worn Insulator at Concrete Tie

Specific Causes for Wide Dynamic Gage

Most gage strength problems were found in curves. It has been suggested that damaging effects from lower levels of steering performance in locomotives and heavily loaded freight cars may play a major role in this. Under- and overbalance conditions from HAL traffic through these curves also contribute to degradation of the track gage strength.

Typical conditions observed include rail gage face wear, spike lifting, tie plate cutting, plate to tie lateral sliding, and some rail base to plate seat wear. Spike lifting, tie plate cutting, and rail to plate wear were the three prime causes of rail cant found in this investigation, which corresponds directly to dynamic gage widening. Gage face wear and lateral plate sliding were the main conditions seen that contribute to wide gage under unloaded conditions. Two areas that were marked had recently undergone a T&S operation, but measured wide in the unloaded state. The only explanation offered for this was that the track must have been laid wide initially. Occasional broken spikes were also found, but were not a typical condition seen in this inspection.

The unloaded gage in painted areas typically measured in a range from 56 7/8 inches to 57 1/8 inches, with one location where unloaded gage was 57 3/8 inches.

2002 and 2001 Results Comparison

The 2002 data for the 95-mile section of track on the first main line tested indicates that there is no change in the number of TLV wide gage paint locations from the previous year. However, data from the tested sections on the second and third lines (46- and 40-mile lines, respectively) indicates that there is a significant reduction in the number of TLV wide gage exceptions compared to 2001. The first line had 0.65 identified locations per mile of track for both years tested, but not necessarily in the exact places for both years. The second line had 0.37 identified locations per mile of track in 2002, compared to 1.57 locations in 2001. That is a 76 percent reduction in locations. The third line had 0.68 identified locations in 2002 compared to 1.58 locations in 2001, a 57 percent reduction. Table 1 presents this data as a comparison of results between the two years.

The above results support maintenance information provided by the railroad that much T&S work has been accomplished over the previous year, particularly for the second and third lines tested. Even though the numbers may not indicate it, there had been a lot of repair work done on the first line as well. This includes emergency repairs made to mitigate flooding damage that has occurred over the past year. A T&S program is currently scheduled for this line and should address many of the problem areas in a more comprehensive manner and increase overall track strength.

Table 1. Comparison of Results: 2001 and 2002 Investigations

		Wide Gage Locations		Exceptions Per Mile		
Line	Miles	2001	2002	2001	2002	Percent Reduction
1	95	62	62	0.65	0.65	0
2	46	72	17	1.57	0.37	76
3	40	63	27	1.58	0.68	57

Figure 4 summarizes the number of locations, over the first 50 miles of the first main line, for each of the major conditions determined to cause widened gage. It compares results from the 2002 investigation with those from the previous year.

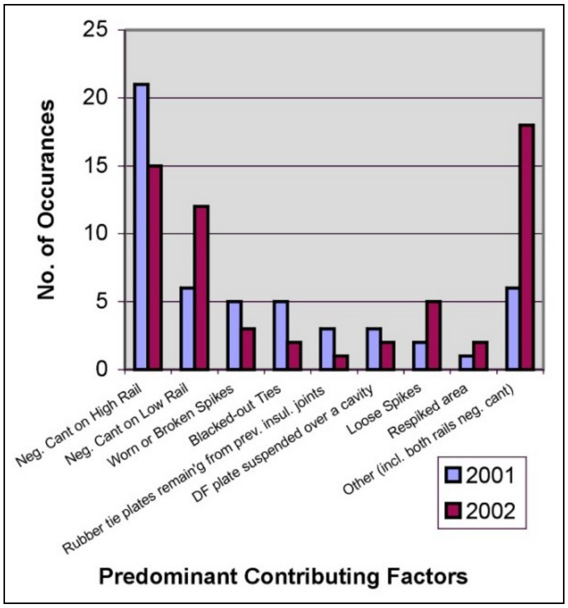

Figure 4. Number of Defect Occurrences

SUMMARY/FUTURE WORK RECOMMENDATIONS

A significant improvement in gage strength was found from 2001 to 2002 on two of the three eastern U.S. lines investigated. Overall, reductions of 57 and 76 percent were found in TLV wide gage locations for those two lines. The third line showed no change in the number of locations, although many exceptions were found in different locations of the track from the previous year.

Future work in the study of conditions leading to gage widening should include an effort to determine the different rates of degradation for the various conditions found in this investigation. Those conditions include:

- Rail wear
- Tie plate cutting
- Tie plate wear
- Spike lifting
- Conditions at approaches to bridges and road crossings resulting in widened gage

References

1. Larson. W., Davis, D. and Thompson, R. "Dynamic Gage Widening inspection of a Western U.S. Main Line under TLV Loading," *Technology Digest* TD02-028, Transportation Technology Center, Inc., Pueblo, Colorado, December 2002.

2. Reiff, R. "Tie Conditions Leading to Dynamic Gage Widening Exceptions Under TLV Loads," *Technology Digest* TD01-029, Transportation Technology Center, Inc., Pueblo, Colorado, December 2001.