TECHNOLOGY DIGEST

Timely Technology Transfer — 99-003

Testing of Dynamic Ballast Stabilization upon Newly Maintained Railroad Track

by William C. Shust, Dingqing Li, and Randy Bowman*

Summary

Two series of lateral track-strength tests on revenue track indicate that post-tamped use of a dynamic track stabilizer improves lateral track strength. Engineers from Transportation Technology Center, Inc., used the Track Loading Vehicle (TLV) to measure the variability in stabilizer effectiveness under different operating parameters on two Norfolk Southern (NS) mainline routes. The new TLV moving-load test method was employed, as detailed in TD98-013. NS's Plasser PTS-62 Dynamic Track Stabilizer was used during testing.

In-motion data from tests conducted near Pell City, Alabama, was consistent with TLV stationary test results. This was shown by significant reductions of lateral track deflections (under a constant axle load) in the stabilized zones as compared to the deflections generated for the newly tamped zones. Stabilizer operation using vibrating frequency from 30 Hz to 35 Hz and downward pressure between 70 and 90 bar (a relative measure used by the operator, 1 bar = 14.5 psi) generated more consistent strength improvements, and should be targeted for daily operation. These settings are within the manufacturers recommended operating practices. However, wider operating ranges (from 25 to 40 Hz and from 50 to 90 bar) were sometimes as effective.

On revenue track near Poplarville, Mississippi, dynamic ballast stabilization was examined in conjunction with (nominally 25 percent) new crosstie replacement. Test results showed that after tie-and-surfacing (T&S) gang maintenance, the stabilization technique improved track strength. The post-maintenance stabilized strength was measured to be 85 percent of original strength, significantly greater than the average non-stabilized strength (63 percent of baseline). Prior to these tests, effects of dynamic stabilization over new ties has been debated within certain railroads, given the non-dimpled bottom surfaces of new wood ties, and the additional ballast disturbance involved in tie replacement.

The TLV tests were partly funded by the Federal Railroad Administration (FRA) under the auspices of the joint Association of American Railroads/FRA Vehicle Track Systems Program.

*Norfolk Southern Corporation

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

January 1999©

INTRODUCTION AND CONCLUSIONS

In 1998 strength tests using the Track Loading Vehicle (TLV), Transportation Technology Center, Inc. (TTCI), engineers determined that improvements in lateral track strength can be obtained by post-tamping use of a dynamic track stabilizer. The tests were conducted on the Norfolk Southern (NS) railroad mainline tracks in Alabama and Mississippi in hopes of finding better methods — with respect to both rail-network efficiency and safety — to maintain railroad track. During 1997, stationary TLV lateral track-strength tests in West Virginia showed that timber-and-surfacing (T&S) operations reduced the stationary lateral track strength by approximately 50 percent, and that subsequent stabilization immediately returned the strength to approximately 65 percent of the original (TD97-047). At that time, the TLV in-motion lateral measurement system was not yet functional. Since then, a continuous TLV in-motion capability has been developed by TTCI (TD98-013). Norfolk Southern requested these moving-load revenue-track tests in order to measure the variability in stabilizer effectiveness under different operating parameters. NS's Plasser PTS-62 Dynamic Track Stabilizer, shown in Exhibit 1, was used during testing.

These tests were performed on NS Class 4 mainline track in the vicinities of Pell City, Alabama, (45 million gross tons [MGT] annually, 136 lb/yard rail) and Poplarville, Mississippi (22 MGT annually, 132 lb/yard rail). During the scheduled maintenance, new granite ballast was added to the existing (mostly) granite. The ties are mixed hardwood with cut spikes.

Exhibit 1. Norfolk Southern's Dynamic Track Stabilizer

The conclusions from these tests are summarized as follows:

- NS's dynamic track stabilizer worked as expected over a frequency range of 30 to 35 Hz and a vertical pressure range of 70 to 90 bar. Properly used, the dynamic ballast stabilizer improves lateral track strength even when 25 percent of ties have been replaced. The few occasions where the stabilizer did not work as effectively were associated with lower vibrating frequency (25 Hz), and lower vertical pressure (50 bar).
- After surfacing near Pell City, Alabama, the stationary strength measured by the TLV was reduced to approximately 62 percent of the premaintenance condition. Dynamic track stabilization returned this to 74 percent of the original strength. After T&S operations near Poplarville, Mississippi, the baseline track strength was reduced to 65 percent (range from 57 to 69 percent). Dynamic track stabilization returned this to 81 percent (range from 73 to 88 percent) of the original value.
- Tie replacement percentages appear to have a minor effect on post-maintenance strength over a replacement range of 20 to 30 percent. Slightly larger average track deflections (and hence lower strength) result from greater density of replaced ties .

TLV IN-MOTION TEST TECHNIQUE

This examination of track involves in-motion TLV application of constant vertical and lateral forces to the track. During these trials the TLV vertical test axle load was 20 kips, and various lateral test loads were used including 14, 16, and 18 kips. The TLV traveled at 5 to 8 mph. Both loaded and unloaded track lateral profiles are measured during the one-pass test. Using this test, a small change between the initial alignment and the loaded alignment chordal offsets indicates a strong track (for example 0.04 inch). A greater change between the two cases indicates weaker track restraint (for example greater than 0.1 inch). However, track *strength* is generally defined as the force required during a stationary test to move track laterally by a defined distance (often 0.1 inch). Since the TLV in-motion method does not measure strength directly, limited stationary strength tests were performed as well.

STABILIZER SETTING VARIATIONS

NS tracks near Pell City, Alabama, were tested to examine the various operating adjustments that could be made with a dynamic track stabilizer. In these tests, the operating frequency and the steady downward pressure exerted by the stabilizer were varied. Typically, the operating frequency on such a unit can be varied from 25 to 45 cycles per second (Hz). Also, the pressure in the stabilizer's steady downward actuators can be varied from 50 to 100 bar.

Exhibit 2 shows example data over seven test zones during an in-motion test with 18-kip lateral load. In these cases, the stabilizer vertical pressure was set to 90 bar, but the operating frequency was varied between 25 Hz and 39 Hz. Also, two zones without dynamic track stabilization (no DTS) were tested. Lateral deflections were significantly larger in zones without any stabilization, indicating laterally weaker track. Among the stabilized zones, the 30, 35, and 39 Hz operating frequencies all yielded similar deflection results. The lowest frequency zone (25 Hz

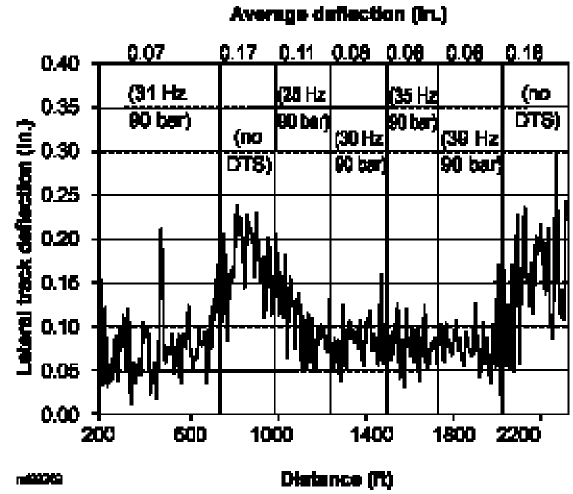

Exhibit 2. Track Lateral Deflections during In-Motion TLV Tests at Various Stabilizer Operating Frequency Settings

stabilization) exhibits somewhat larger deflections, indicating somewhat lower effectiveness.

Exhibit 3 shows another example of an in-motion TLV test across four track zones. In this test, the dynamic stabilizer operating frequency was kept constant at 35 Hz, and the vertical pressure was varied from 50 to 90 bar. The first zone shows non-stabilized track, and again the lateral deflection resulting from the TLV forces are larger than for any stabi-

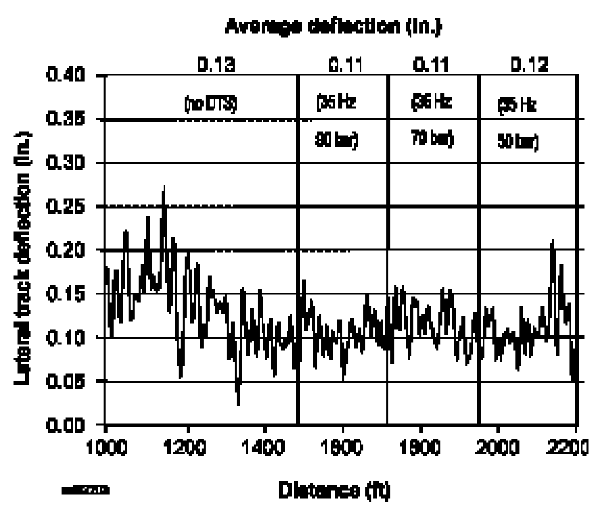

Exhibit 3. Track Lateral Deflections during In-Motion TLV Tests at Various Stabilizer Operating Pressure Settings

lized zone. Also, the fourth zone (50 bar) shows larger deflections, indicating less effective stabilization.

To examine stabilization results in terms of lateral track strength (rather than deflection) Exhibit 4 shows various TLV stationary strength data defined at 0.1-inch track deflection. This plot shows combined results from various tests conducted at three ballast conditions: as-is condition prior to tie / rail replacement, newly tamped condition, and after dynamic ballast stabilization (all operating variations grouped into one data set). As shown, the average strength for the mainline tracks was 31.8 kips. Tamping caused an average strength reduction to 19.8 kips, or approximately 62 percent of the original. Use of the stabilizer following tamping improved track lateral strength to 23.4 kips on average, or 74 percent of original.

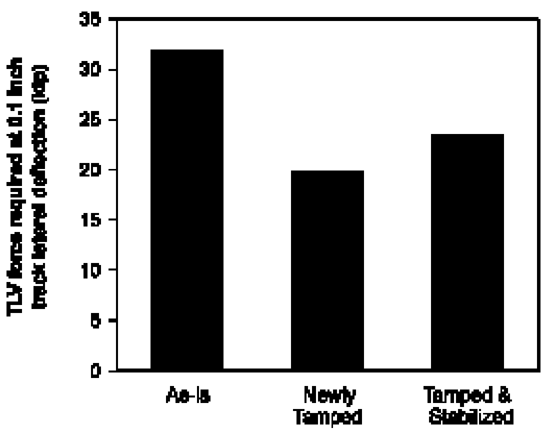

Exhibit 4. Mean Track Strengths Found using TLV Stationary Tests near Pell City, Alabama

STABILIZATION ON TRACK WITH NEW TIES

TTCI engineers conducted a second series of TLV tests near Poplarville, Mississippi, to examine stabilization effects on ties without dimpled bottom surfaces. This was done in conjunction with a timber-and- surfacing (T&S) gang which replaced approximately 25 percent of the crossties. Several in-motion

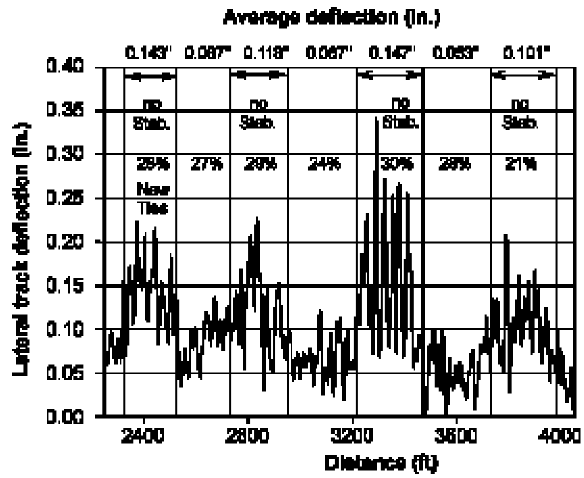

Exhibit 5. TLV In-Motion Lateral Shift Test Over Seven Track Zones after Scheduled Crosstie Replacement and Surfacing

tests were performed, all at nominal stabilizer settings (30 Hz, 90 bar). Exhibit 5 shows another set of TLV measurements over three stabilized zones, and four non-stabilized zones.

Given a nominal tie replacement rate of 26 percent, mean TLV-deflections on non-stabilized track were approximately 75 percent larger than for stabilized track. Again, this increase in deflection (in response to a moving load) tends to exaggerate strength differences. Therefore, several stationary tests were performed in the first three zones to document the track-strength differences. These showed that the stabilized strength was measured to be 23.4 kips (approximately 85 percent of baseline). The average non-stabilized strength was measured to be 17.3 kips (63 percent of baseline). Thus, even after tie-and-surfacing gang replacement of 25 percent of crossties, the dynamic stabilization technique improves lateral track strength.

Note: Contact William Shust at (719) 584-0765 with questions or comments about this document.
E-mail: william_shust@aar.com
Web site: www.ttci.aar.com

A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH AAR/TTCI, PUBLICATIONS, P.O. Box 79780, BALTIMORE, MD, 21279-0780.