TECHNOLOGY DIGEST

Timely Technology Transfer — 99-005

FAST Steel-Tie Test Update

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Summary

Performance evaluations by Transportation Technology Center, Inc., indicate that while newly installed NARSTCO and T&TS steel crossties provided greater lateral track-panel strength and single-tie lateral resistance than wood ties, thus far they require more track-surface maintenance under heavy-axle-load (HAL) operations. The steel-tie test is in its second series at the Federal Railroad Administration's Transportation Technology Center near Pueblo, Colorado. The ties are installed on the High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST) to quantify their performance under 39-ton HAL traffic.

Major findings from these tests include:

- The T&TS and NARSTCO ties, in their out-of-face configuration, and the interspersed UniP ties performed well in gage-widening strength, gage retention, and track alignment.
- Once the track was consolidated after 10 million gross tons (MGT), the lateral track-panel strength of the NARSTCO and T&TS steel ties was comparable to that of wood ties. When newly installed, however, the two steel-tie zones provided greater lateral track-panel strength than the wood-tie zone.
- Maintenance was required approximately every 3 MGT when there were rail joints and a slightly mismatched field weld in the 50-tie out-of-face test zones. After the joints were removed by welding and the mismatched field weld replaced, track-surface maintenance decreased to approximately every 15 MGT. The majority of track-surface maintenance was required within the first 15 steel ties at each end of the out-of-face test zones. Typical out-of-face surface maintenance interval required on the 6-degree, continuously welded rail, wood tie curve of the HTL at FAST is approximately 100 MGT.

Series I of the steel tie test logged 270 MGT over the 50-tie test zones along the HTL. Fifty Tie & Track System (T&TS) steel ties were installed in Section 24; 50 BHP Ltd. steel ties (later replaced with NARSTCO steel ties) were installed in Section 26; and 50 UniP steel ties, interspersed such that every third wood tie was replaced, were installed in Section 39. To isolate transitions and find ways to minimize their effects on track surface, the additional objective of Series II testing, currently in progress, is to study transition designs. Series II of the steel tie test consists of 100 T&TS steel ties and 100 NARSTCO ties installed consecutively, with a 20 elastic-fastened wood-tie transition zone at each approach. Thus far, the current transition has been observed as contributing to better track-surface performance. A 100-tie wood-tie zone will be used for comparison.

Suggested Distribution:

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

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INTRODUCTION

Transportation Technology Center, Inc. (TTCI) is evaluating steel ties at the Federal Railroad Administration's Transportation Technology Center (TTC). The ties are installed on the High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST) to quantify their performance under 39-ton heavy-axle-load (HAL) traffic. Series I of the steel-tie test logged 270 million gross tons (MGT) over the 50-tie test zones along the HTL. Fifty Tie & Track System (T&TS) steel ties were installed in Section 24; 50 BHP Ltd. steel ties (later replaced with NARSTCO steel ties) were installed in Section 26; and 50 UniP steel ties, interspersed such that every third wood tie is replaced, were installed in Section 39. Series II testing is in progress and includes 100 T&TS steel ties and 100 NARSTCO steel ties installed consecutively, with a wood-tie transition zone of 20 ties at each approach. A zone of 100 wood ties will be used for comparison. Series II's additional objective is to study transition designs. The longer test sections will provide a better evaluation of each tie's performance in out-of-face applications. Additionally, the performance of a transition zone commonly used in revenue service will be evaluated under HAL traffic.

SERIES I

Lateral track-panel strength, single-tie lateral resistance, resistance to gage widening under static load, gage retention, and maintenance requirements were studied in Series 1.

Installation

Exhibit 1 shows the location of the three test zones on the HTL during Series I of testing. The T&TS ties with the Safelok fastening system and the NARSTCO ties with Pandrol e-clips were

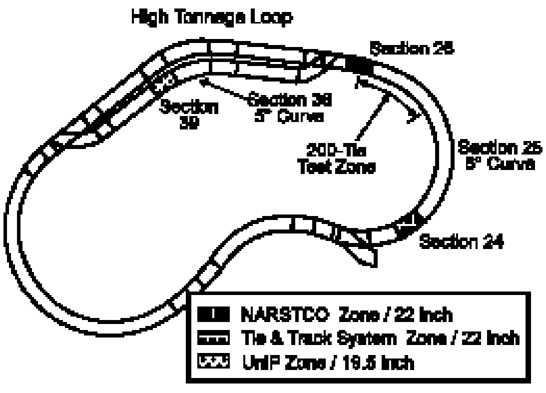

Exhibit 1. Test Zone Locations

installed in Sections 24 and 26, respectively. Fifty ties each were installed consecutively at a 22-inch spacing. Sections 24 and 26 are spirals of a 6-degree, 5-inch superelevation curve. Since the HTL rails are canted at 1:40 and the T&TS ties tested were manufactured with a 1:30 cant, a five-tie cant transition at each end of the T&TS test zone, with cut-spike 1:30 cant wood-tie plates was used to avoid a transition over the steel ties. NARSTCO's 1:40 canted ties did not require transition. New AREMA Grade 4A 2" – 3/4" granite ballast was used to replace the old ballast in both test zones. The Unip interspersed installation, where every third existing wood tie was replaced with a Unip steel tie, was made in Section 39, the spiral of a 5-degree, 4-inch superelevation curve on the HTL siding. Tie spacing remained at the existing 19.5 inches. Because a 1:30 cant is provided with the Unip system at the rail-seat pad, a five-tie transition at each end of this zone was used in the same manner as that used in the T&TS zone of Section 24. In addition, the interspersed wood ties in the zone were installed with 1:30 cant plates.

Tamping Procedure

In addition to being tamped under the rail seats, NARSTCO recommended that their ties be center tamped at installation and after any surfacing maintenance. Comparatively, T&TS for Series I recommended tamping the center of the ties and under the rail seats only at initial installation. T&TS recommended tamping only under the rail seats after surfacing maintenance.

Measurements

Static measurements of gage spreading under a 0.6 L/V (24-kip lateral/40-kip vertical) load using the 605 Rail Force Calibration Car were taken at five locations in each zone. Track alignment and gage were monitored using the EM-80 Track Geometry Car. Single-tie push tests (STPTs) were made on four ties in each zone to determine the average single-tie lateral resistance of each tie type. This test is conducted using the STPT fixture, which consists of a hydraulic cylinder mounted on the top surface of the tie. As the cylinder reacts on the low rail and pushes the tie to the high side of the curve, the resistance and tie displacement are plotted. The peak resistance within the first inch of displacement is used to define the single-tie lateral resistance.

Dynamic track-panel push measurements were taken using the Track Loading Vehicle (TLV) to characterize lateral track-panel strength. In this test, a single in-motion run was made with the TLV over each zone while applying a constant 0.8 L/V load ratio (16-kip lateral/20-kip vertical) at 2 to 3 mph. Peak lateral displacement of the track panel is measured at 12 locations using linear voltage-displacement transducers (LVDTs). The average peak displacement of each zone is plotted in Exhibit 2.

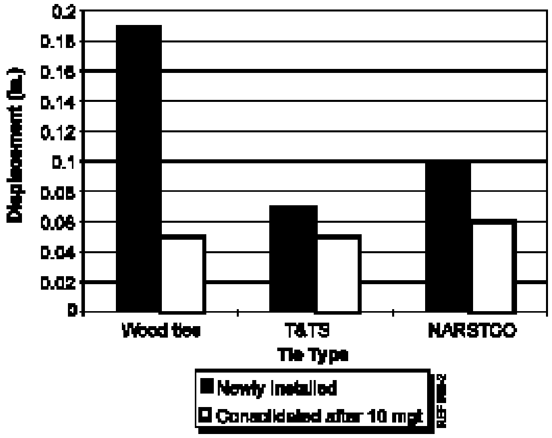

Exhibit 2. Dynamic Track Panel Push Test[1]

SERIES I RESULTS

The results of the Dynamic Track-Panel Push tests shown in Exhibit 2 indicate that once the track was consolidated after 10 MGT, the lateral track-panel strength of the NARSTCO and T&TS steel ties was comparable to that of wood ties. When newly installed, however, the two steel-tie zones provided greater lateral track-panel strength than the wood-tie zone. The results of the single tie push tests from Series I, shown in Exhibit 3, indicate that the lateral resistance of newly installed single steel ties (under wider spacing) was greater than that of wood ties. After 10 MGT of traffic, the lateral resistance of the T&TS ties was about 44 percent greater than that of wood ties, while the lateral resistance of the NARSTCO and wood ties was comparable. Track-surface and ballast migration to the low side of the curve required considerable maintenance. Exhibit 4 shows that maintenance was required approximately every 3 MGT when there were mechanical joints and a slightly mismatched field weld in the 50-tie out-of-face test zones. After the joints were removed by welding and the mismatched field weld replaced, the need for track-surface maintenance decreased to about every 15 MGT. The majority of track-surface maintenance was required within the first 15 steel ties at each end of the out-of-face test zones. Results of the 605 Rail Force Calibration Car Test indicated that the resistance to gage-widening of the T&TS ties with Safelok fasteners and the NARSTCO ties with Pandrol e-clips was comparable to that of oak ties with Pandrol e-clips under the static 0.6 L/V load. Track gage and alignment, as monitored using the EM-80 Track Geometry car, did not exceed FRA Class 4 specifications in the T&TS and NARSTCO out-of-face test zones. The UniP interspersed test zone, where every third wood tie with UniP fastening system was a UniP steel tie, also performed well in gage-widening strength, gage retention, and track-alignment retention. Track-surface maintenance was not required in the UniP interspersed test zone.

	Resistance (kips) Newly Installed	Resistance (kips) Consolidated/10MGT
NARSTCO/22 inch	1.9	2.6
T&T/ 22 inch	2.8	3.6
Wood ties/19.5 inch[2]	1.4	2.5

Exhibit 3. Results of Single-Tie Push Tests

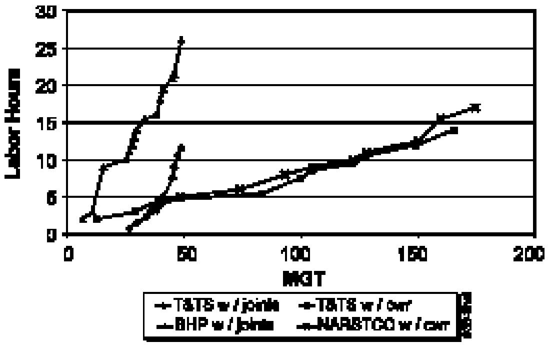

Exhibit 4. Track Surface Maintenance

SERIES II

Due to the frequency of track-surface maintenance required within the first 15 steel ties at each end of the short 50-tie test zones during Series I testing, a 200-tie out-of-face test zone has been installed in an effort to isolate the transitions and study ways to minimize their effects.

Installation

The steel-tie zone for Series II, shown in Exhibit 1, includes 200 consecutively installed ties: 100 T&TS and 100 NARSTCOs, of the same design as those tested during Series I, placed adjacent to each other. A 20-tie transition zone is at each approach and an existing zone of 100 wood ties will be used for comparison. The two 20-tie transition zones consist of the existing 8.5-foot wood ties fitted with elastic fasteners instead of cut spikes. The steel ties, spaced at 22-inch centers, use the same fastening system that was used in Series I. The transition zones were left at 19.5-inch center tie spacing. The test extends from the 6-degree, 5-inch superelevation curve of Section 25 to the spiral of the same curve in Section 26.

Tamping Procedure

For Series II testing, T&TS recommended only tamping under the rail seats at installation and after surfacing maintenance, except for the first 10 ties adjacent to the NARSTCO ties, where center tamping was recommended only at installation. As in Series I, the NARSTCO ties are to be tamped under the rail seats and in the center at installation and after maintenance.

Measurements

Top-of-rail elevations, using an automatic level, are taken over every third tie at scheduled intervals to provide a profile view of each zone as a means of monitoring track settlement. Track alignment and track gage are monitored using the EM-80 Geometry car.

SERIES II PRELIMINARY RESULTS

After 31 MGT, the 200-tie steel test zone has not required spot surfacing within the first 15 ties inside the zone, as was the case during Series I when the wood-tie transition zones were not used. All spot-surfacing maintenance performed thus far in the steel zone has been on the T&TS ties; none has been required on the NARSTCO ties. The majority of surfacing performed on the T&TS ties has been in the first 10 to 20 T&TS ties adjacent to the NARSTCO ties.

CONCLUSIONS

The installation of a transition zone of 20 elastic-fastened wood-ties at each approach to the steel-tie zone has been observed as contributing to better track-surface performance within the first 15 ties inside the zone. In addition, the overall reduction in maintenance frequency thus far during Series II testing indicates that tamping to the proper depth (manufacturers recommend inserting the tamping tools so that the top of the blades are 5/8 " to 3/4 " below the bottom of the ties), and keeping the tie cribs full of ballast may be contributing factors. The difference in tamping procedure, where the NARSTCO ties are tamped in the center, as well as under the rail seats, and the T&TSs are tamped only under the rail seats, may be the cause of surface degradation in that zone.

FUTURE WORK

The test plan has been modified to reflect a change in the tamping procedure of the T&TS ties where tamping after surfacing maintenance will include tie centers in addition to rail seats. The effect of the change will be documented. TTCI will use track-stiffness modeling in continuing investigations into methods to reduce maintenance frequency of steel-track surface.

TEST ENVIRONMENT

Due to the climatic, geologic, and operating conditions under which tests are conducted at FAST, including the use of improved-suspension trucks which significantly reduce the lateral load environment, the performance of these ties in revenue service may differ.

REFERENCES

1. Li, D.; Cooke, J., and Shust, W., "Preliminary Assessment of the Effects of Track Maintenance on Lateral Strength," Technology Digest, TD 97-025, Association of American Railroads, July 1997.
2. Samavedam, G. and Kish, A., "CWR Track Buckling Safety Assurance Through Field Measurements of Track Resistance and Rail Force," Transportation Research Board and American Railway Engineering Association Joint Conference, St. Louis, Missouri, May 1990.

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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.