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Preliminary Performance Evaluation of Crosstie and Improved Fastener Systems at FAST

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Summary

Crosstie and fastener tests recently completed on the High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST) at the Transportation Technology Center, Inc. (TTCI) indicated that, compared to the standard 14-inch tie plate and cut spike system, the 16-inch rolled-steel tie plate, screw spike, and elastic rail clip fastener system tested extended the gage life of low density wood tie species from 200 MGT to beyond 600 MGT.

The elastic fasteners also reduced tie plate cutting in Douglas fir ties by about 43 percent and provided higher gage-spreading strength than cut spikes in both higher and lower density species. The test results also indicated, however, that improvements in elastic fastener plate and plate fastener screw spike durability were needed.

In an effort to identify more robust components capable of withstanding the HAL load environment, in 2004 TTCI installed two new elastic fastening system test zones and two control zones, consisting of 100 solid-sawn Southern Yellow pine ties each. The Pandrol Victor[®] system installed consists of a 16-inch steel tie plate fitted with two swaged shoulders that accept the standard e-clip[®] elastic rail fasteners. The NorFast[™] system is a 16-inch cast tie plate with cleated bottom and NorFast[™] rail clips. Southern Yellow pine ties are being used to accelerate results. TTCI also installed an additional plastic composite tie test zone and wood ties with alternative treatments.

The preliminary results follow:

- The elastic fastener system test zones and the plastic composite tie test zone have been able to withstand over 180 MGT under HAL traffic and the alternative-treatment ties over 152 MGT.
- Tie plate cutting on the field side of the high rail was measured in all the test zones after about 160 MGT. There is less than 0.10-inch under the elastic fastener system plates and less than 0.15-inch under the cut spiked plates on the alternative-treatment ties.
- The gage-spreading strength (low delta gage under load) measured in the Southern Yellow pine ties with elastic fasteners has remained high compared to the wood ties and plastic composite ties with cut spikes.

Fasteners:

- Two of the swaged shoulders separated from their plates during installation (before traffic) in the Pandrol Victor[®] fastener test zone. None of these separated while in service and there have been no rail clip problems.
- Three of the NorFast[™] rail clips that did not meet the steel hardness specifications of the manufacturer lost toe load after 11 MGT and one fractured after 27 MGT. There have been no additional rail clip problems.
- During 180 MGT, less than 0.1 percent of the screw spikes (15 high strength and 13 No. 5760s) in the elastic fastening system test zone have required maintenance for uplifting. None has fractured.
- None of the Pandrol Victor[®], NorFast[™], or 16-inch rolled-steel tie plates fractured in the elastic fastening test zones.

Materials:

- Dimensional variations from swollen surfaces that prevented flat seating of the tie plates resulted in the rejection of 18 percent of the Recycle Technologies International (RTI) plastic composite ties.
- No maintenance has been required and there has been no cracking in the RTI ties.
- Ties that were “over-treated” with borates (i.e., treated to high concentrations) caused signal system problems. (Field tests and in-service use of ties dual treated with borates and subsequently with creosote to recommended retentions have not exhibited similar problems.)

More reliable elastic-system components, with resulting benefits in terms of lower tie-plate cutting/plate-area compression, higher gage strength, and less gage widening, result in a lower stress state and extended wood tie life.



Introduction

The in-track performance evaluations of wood ties and fastening systems that had been in service at the Facility for Accelerated Service Testing (FAST) at the Transportation Technology Center, Inc. (TTCI) for more than 1,000 million gross tons (MGT) were concluded in 2004. The results indicated that the fastening system had a significant effect on the performance of the low density species relative to gage life, gage-spreading strength, and tie plate cutting characteristics under 315,000 pound cars with standard three-piece trucks.

Compared to the standard 14-inch tie plate and cut spike system, the 16-inch rolled-steel tie plate, screw spike, and elastic rail clip fastener system tested extended the gage life of the low density species from 200 MGT to beyond 600 MGT. The elastic fasteners also reduced tie plate cutting in Douglas fir ties by about 43 percent and provided higher gage-spreading strength than cut spikes in both the high and lower density species.

The test results also indicated that improvements in elastic fastener plate and plate fastener screw spike durability were needed. While the rolled plate, elastic rail clip, and screw spike fastener system tested provided significant benefits, it experienced higher failure rates than conventional plates and cut spikes. Two components of the elastic system, the No. 5760 screw spikes and the 16-inch rolled-steel tie plates had significantly shorter service lives than the standard cut spikes and AREMA 14-inch tie plates. There was no loss of toe load or fracture problems with the e-clip rail fasteners.

Background

The Crosstie and Fastener Test is conducted with the objective of evaluating the performance of ties and fastening systems under 315,000-pound heavy axle load (HAL) car traffic and scanning the industry for new and improved components.

In keeping with the test objectives, TTCI surveyed suppliers of ties and fastening systems in 2003 to identify more robust components capable of withstanding the HAL load environment. Suppliers were asked to submit to TTCI their proposal to participate in the FAST/HAL Crosstie and Fastener Test Program, which is jointly funded by the Association of American Railroads (AAR) and the Federal Railroad Administration (FRA).

TTCI's Track Engineering Group reviewed and compiled the proposals, which included technical drawings and laboratory test results. The Crosstie and Fastener Test Technical Advisory Group (TAG) then reviewed the submittals and made the preliminary recommendations.

The Heavy Axle Load Research Committee (HALRC), whose members include senior officials of the Class I railroads and the FRA, made the final selection of test components at the fall meeting of 2003. The HALRC is charged with steering the testing and research that is conducted under the FAST/HAL program.

New Test Zones

The newly selected tie and fastener components were installed in test zones located in the 6 degree, 5 inch superelevation curve of the High Tonnage Loop (HTL) at FAST in 2004. The three new major test component groups being evaluated are: 1) elastic fastening systems, 2) plastic composite ties, and 3) alternative-treatment wood ties.

Elastic Fastening System Tests

Two elastic fastening system test zones and two control zones, consisting of 100 ties each, were installed on solid-sawn Southern Yellow pine ties. The Pandrol Victor[®] system consists of a 16-inch steel tie plate fitted with two swaged shoulders that accept the standard e-clip elastic rail fasteners. The NorFast[™] system is a 16-inch cast tie plate with cleated bottom (designed for increased gage retention) and NorFast[™] rail clips. Both tie plate types were fastened to the ties with screw spikes. The NorFast[™] test zone was fastened with No. 5760 screw spikes while the Pandrol Victor[®] zone was fastened with Lewis Bolt & Nut Company[™] (LB&N) high strength screw spikes. Spring washers were used with the screw spikes in half of the Pandrol Victor[®] test zone; the other half had no washers. Southern Yellow pine ties were used in this test to accelerate results.

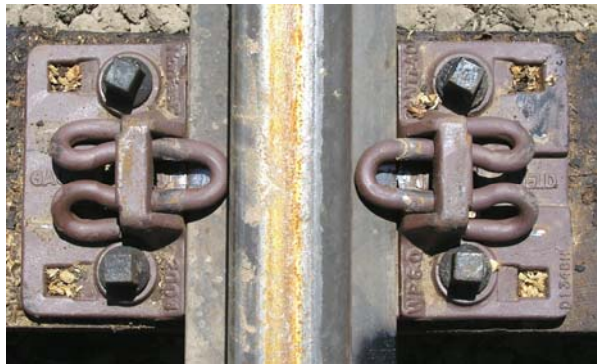
NorFast[™] does not recommend making partial-curve installations where track fitted with their fasteners is immediately adjacent to track fitted with a different type of fastener. A 10-tie transition zone, where every other tie was fitted with Pandrol Victor[®] 16-inch rolled-steel plates and e-clips, was required at each approach to the test zone. Figures 1a and 1b show the top and bottom views of the Pandrol Victor[®] system. Figures 2a and 2b show the NorFast[™] system.



Figure 1a. Top View of the Pandrol Victor[®] Elastic Fastening System and LB&N High Strength Screw Spikes



Figures 1b. Bottom View of the Pandrol Victor® Elastic Fastening System



Figures 2a. Top View of the NorFast™ Elastic Fastening System with No. 5760 Screw Spikes

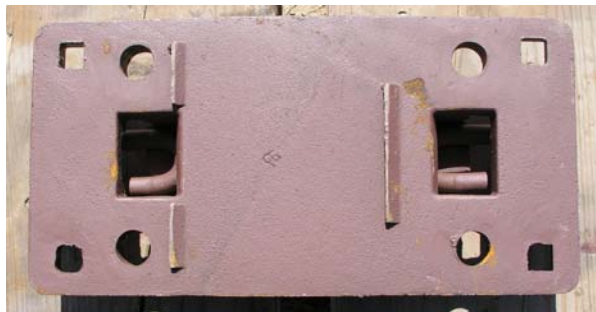


Figure 2b. Bottom View of the NorFast™ Elastic Fastening System with Cleated Plate Bottom

The control consists of two zones fitted with 16-inch rolled-steel tie plates and e-clip rail fasteners where one zone uses No. 5760 screw spikes and the other LB&N high strength screw spikes. These zones were designed for comparison with the new swaged tie plates and the high strength screw spikes to determine if they can withstand HAL loads and reduce maintenance.

The performance of the NorFast™ rail clip and the Pandrol Victor® swaged shoulders is also being evaluated. Table 1 shows the fastening system test zone configuration.

Table 1. New Fastening System Test Configuration

Fastening System 100-Tie Test Zones	Complementary Components	
Pandrol Victor® Plate/e-Clip System ¹	LB & N High Strength Screw Spikes with and without Spring Washers	Solid-Sawn Southern Yellow Pine Ties ²
Control Zone No. 1: Standard 16-inch Rolled-Steel Plate/e-Clip System ¹	LB & N High Strength Screw Spikes	
NorFast™ Plate/Rail-Clip System	Standard No. 5760 Screw Spikes	
Control Zone No. 2: Standard 16-inch Rolled-Steel Plate/e-Clip System		

¹ Donated by the suppliers.

² Donated by BNSF through Railway Tie Association

Plastic Composite Ties

A standard full-size, 100-tie test zone of Recycle Technologies International™ (RTI) plastic composite ties was installed using 14-inch tie plates and cut spikes in 0.5 inch diameter by 3 inch pilot holes. The RTI ties have roughened sides and bottom designed to enhance the tie interaction with the ballast.

A second plastic composite test zone is scheduled to be installed in the fall of 2005. The Performance Rail Tie™, which has successfully completed all the prerequisite laboratory tests, will be installed with 14-inch tie plates and cut spikes.

Alternative-Treatment Wood Ties

Test zones of wood ties treated with alternative preservatives were also installed. The semi-arid climate of Pueblo, Colorado, will not facilitate the evaluation of the treatments relative to protection against warm/wet conditions or insect damage. The ties will, however, be monitored to quantify maintenance requirements, gage-spreading strength, tie plate cutting, fastener retention, and general performance under HAL traffic.

Parallel strand lumber ties made of Yellow Poplar and Douglas fir stock and solid-sawn Southern Yellow pine ties treated with copper naphthenate were installed. Also installed were parallel strand lumber ties made of Douglas fir and Southern Yellow pine stock and treated with creosote. The copper naphthenate and creosote treated ties were installed with 14-inch tie plates and cut spikes.

A 100-tie zone of solid-sawn Southern Yellow pine ties treated with borate only was installed and quickly removed due to low rail-to-rail electrical impedance. An analysis performed on tie samples indicated the low

electrical impedance was likely a result of over treatment. (Field tests and in-service use of ties dual treated with borates and subsequently with creosote to recommended retentions have not exhibited similar problems.)

Preliminary Performance

The fastening system test zones and the RTI plastic composite test zone have been in service under HAL traffic over 180 MGT and the alternative-treatment ties over 152 MGT.

The test fastener systems are performing well in the initial 180 MGT of HAL operations; less than 0.1 percent (28 of 3,200) of the screw spikes (15 high strength and 13 No. 5760) have uplifted 2 inches or more and have required maintenance. There have been no screw spike or tie plate fractures.

However, there were some installation and initial performance issues. During installation of the Pandrol Victor® fastening system test zone, two of the swaged shoulders separated from two different tie plates. None of the swaged shoulders have separated while in service and there have been no rail clip problems. Half of the test zone has spring washers under the screw spikes; the other half has no washers. The spring washers don't appear to have a major effect, thus far, on the performance of the screw spikes.

After 11 MGT, three NorFast™ rail clips lost toe load and after 27 MGT one fractured. The three rail clips were from a batch that did not meet the steel hardness specification of the manufacturer. There are currently 148 of the softer rail clips still in track; the rest are reportedly of the proper hardness. There have been no additional rail clip problems.

The 100-tie RTI installation with cut spikes has also been in service for over 180 MGT. Seventeen ties from the original shipment were rejected due to swelled surfaces that did not allow flat seating of the tie plates; one was rejected due to 1.5-inch center bowing. RTI replaced the rejected ties and the full test zone was installed. Single tie push tests were performed on the RTI ties when they were newly installed and again after consolidation by 10 MGT of traffic. The average single-tie lateral resistance of the RTI ties was the same as the average wood ties, about 1.4 kips. The lateral resistance after consolidation was less than that of wood ties – RTI was about 1.8 kips and wood is about 2.5 kips. The RTI ties have a less aggressive surface-roughening pattern than the other plastic composite ties currently in track at FAST. No track buckling or alignment problems have occurred in the RTI test zone. Although there has been some minor cut spike uplift, no maintenance has been required. There have been no cracks in the RTI ties.

The parallel strand lumber ties and the solid-sawn Southern Yellow pine ties treated with copper naphthenate have not required maintenance during 152 MGT.

Tie plate cutting on the field side of the high rail was measured in all the test zones after about 160 MGT. There is less than 0.10-inch under the elastic fastener system plates and less than 0.15-inch under the cut spiked plates on the alternative-treatment ties.

Measurements of change in gage under static 9 kip gage-spreading loads were taken in all the new test zones using a lateral track loading fixture (LTLF). Figure 3 shows that the Southern Yellow pine ties fitted with elastic fasteners have maintained high gage-spreading strength (low delta gage). During 160 MGT, delta gage has remained below 0.1 inch. The wood-tie and the plastic composite test zones, where the ties are fitted with cut spikes, are experiencing reduced gage-spreading strength. After 160 MGT, delta gage in the three cut spiked zones is between 0.25 inch and 0.45 inch.

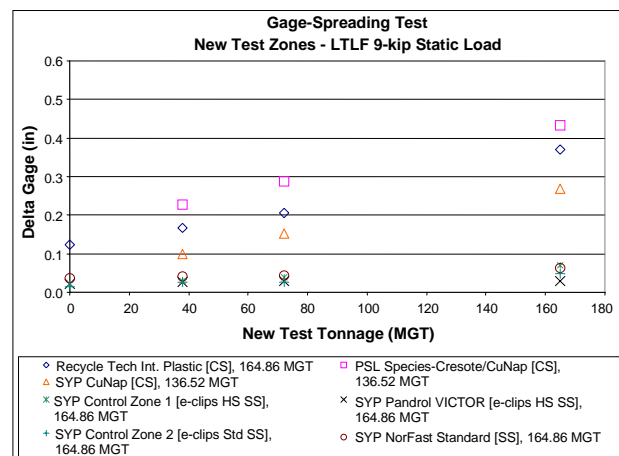


Figure 3. Gage-Spreading Strength as Determined by Change in Gage under Load. The Southern Yellow Pine Test Zones Fitted with Elastic Fasteners are Maintaining High Gage-Spreading Strength While the Cut Spiked Zones are Experiencing Reduced Strength

Acknowledgements

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