

### "Preliminary Analysis of Wood Tie Gage Widening Performance in a Heavy Axle Load Environment,"

by M. Carmen Trevizo

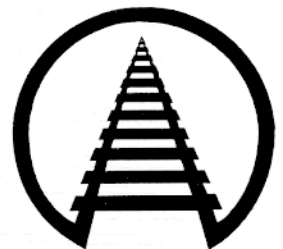
TD 95-018

#### Summary

Test results from the jointly sponsored Association of American Railroad's/Federal Railroad Administration Heavy Axle Load (HAL) Wood Tie and Fastener Experiment at the Transportation Technology Center, Pueblo, Colorado, indicate that the amount of gage widening varies with wood species. The experiment, which has been in place on the High Tonnage Loop (HTL) at the Facility for Accelerated Service (FAST) since the beginning of the HAL program(August 1988), is evaluating the effects of HAL traffic on wood tie and fastener performance.

Ties and fasteners are in test in three curves and one tangent section on the HTL. New wood species were added at the start of the second phase of HAL testing to evaluate underutilized tie resources, which may be used in future HAL revenue service. Gage widening data on different types of wood tie species equipped with cut spikes are covered in this report. Results indicate the following:

- The amount of gage widening varied with wood species.
- Oak ties exhibited less gage widening than any other hardwood or softwood specie in test.
- Douglas fir ties, a softwood specie, retained gage to FRA Class 4 limits about 50 percent longer than other softwood species tested.
- The lateral load environment greatly influences gage widening.



**Suggested Distribution:**  
Operating/Engineering Dept.  
 Maintenance of Way  
 Maintenance Planning  
 Track Maintenance

Association of American Railroads  
Research and Test Department

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## INTRODUCTION AND CONCLUSIONS

The Association of American Railroad's (AAR) Heavy Axle Load (HAL) program is evaluating the behavior and performance of various types of wood tie species and rail fasteners under 39-ton axle load traffic.

Different configurations of oak and Douglas fir ties were installed on two curves of the High Tonnage Loop (HTL) as part of the Wood Tie and Fastener experiment at the start of the HAL program (August 1988.) The ties in Section 25 (6-degree curve) were installed using cut spikes, and the ties in Section 07 (5-degree curve) were installed with cut spikes and different types of direct fixation fastening systems. During the first 160 MGT of HAL traffic, none of the wood tie test zones showed significant track degradation.<sup>1</sup>

In order to test additional track components, which had not been evaluated under HAL traffic, a number of new experiments and components were introduced during the second phase of the HAL program. Additional wood tie species, the majority equipped with cut spikes, were installed primarily in Section 25. They consisted of red oak, hemlock fir, southern yellow pine, red maple, and reconstituted ties.

The data presented in this digest covers the gage widening performance of the various soft and hardwood tie species installed in Sections 07 and 25 of the HTL. Additional fastener and tie data will be reported at a later date.

### Lateral Load Environment

Due to the Transportation Technology Center's semi-arid climate, the majority of the ties exhibit minimal tie plate cutting, thus having little impact on tie performance.

However, most of the tie degradation that does occur is attributed to gage widening.

In spite of the numerous rail changes on the HTL, which required re-spiking, the lateral load environment appears to be the largest contributor to gage widening. Ties located in the higher lateral load environments were more susceptible to gage widening. Exhibit 1 shows a distribution of the lead axle lateral loads measured on two curves of the HTL. As shown, the lateral load environment for Section 25 is much higher

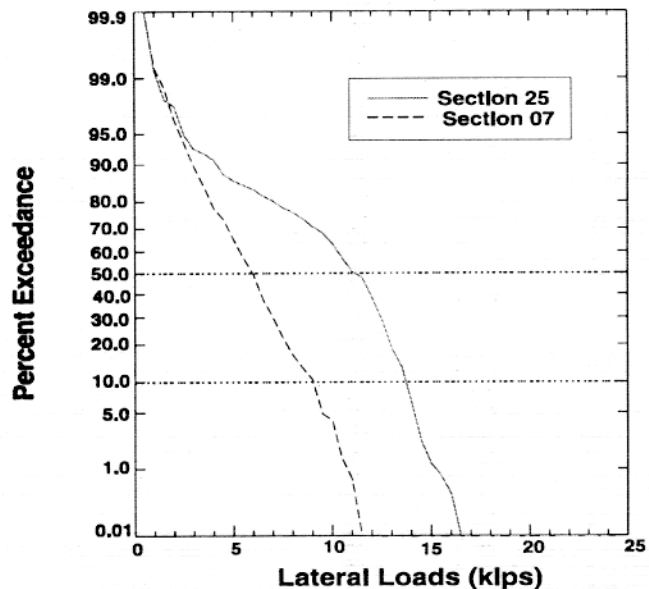


Exhibit 1. Distribution of Typical Lateral Load Environment on the HTL

than for Section 07. The increase is due to sharper curvature, differences in grinding profile, lubrication practices, and operating conditions on this section.

### Track Gage Degradation

At the end of the first 160 MGT, there was no significant degradation in track geometry in the wood tie test zones; however, during the second phase of testing, which involved an additional 300 MGT of HAL traffic, track degradation was evident in several wood tie species.



Exhibit 2 shows the widest track gage measured using the EM80 geometry throughout Section 25. The horizontal line shows that all of the softwood species have gage widened more rapidly than the hardwoods. The reconstituted ties at the end of the section did not gage widen as rapidly as the other ties installed at the same time. However, because of other failure modes, they were removed from track.

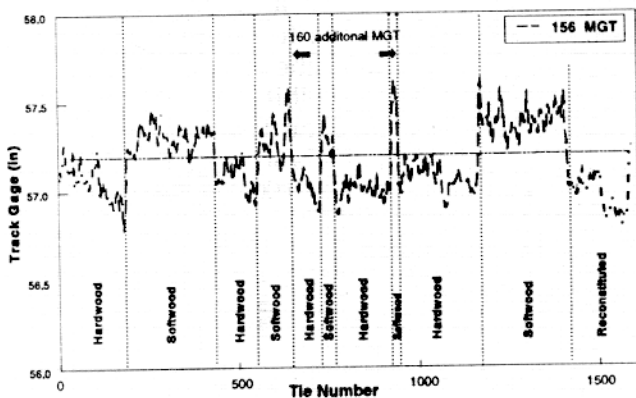


Exhibit 2. Widest Measured Track Gage In Section 25.

With an additional 160 MGT of HAL traffic, the Douglas fir and oak ties shown in the center of the exhibit show less or about the same gage widening as the other hard and softwood species. The Douglas fir in this section required re-gaging after 360 MGT of HAL traffic. However, the Douglas fir ties in

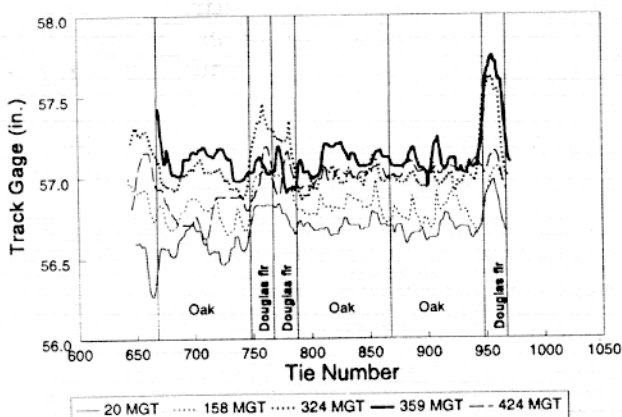


Exhibit 3. Gage In Section 25 - Douglas Fir and Oak Ties Test Areas.

Section 07, which had accumulated the same amount of tonnage, required no maintenance.

Exhibit 3 shows track gage measured on the Douglas fir and oak ties only. The data shown reflects 424 MGT of accumulated HAL traffic. The two middle sections of Douglas fir ties, which are shown as a solid line on the plot, were re-gaged after 359 MGT of HAL traffic and retrofitted with Pandrol plates and coach screws. The Douglas fir tie section on the far right was re-gaged at 375 MGT and the cut spikes were retained. No change in gage widening between the two sections was noticeable at 424 MGT.

Exhibit 4 shows the measured track gage on the Douglas fir and oak ties in Section 07. The highest measured gage is about the same for both Sections 07 and 25, however, about 1/2 inch of the measured gage in Section 07 is due to rail wear. When comparing measurements at 352 and 359 MGT, the extent of rail wear in Section 07 is noticeable. The rail was changed just prior to the 359 MGT measurement. Because the installation of new

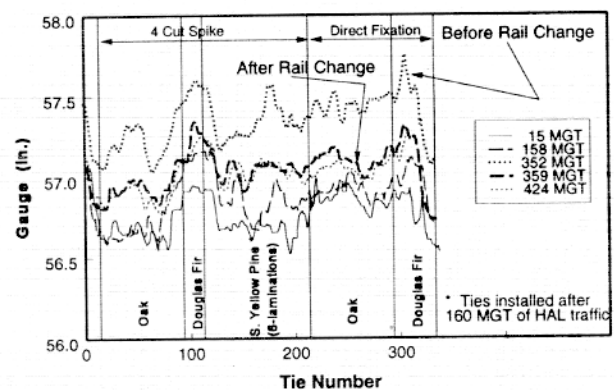
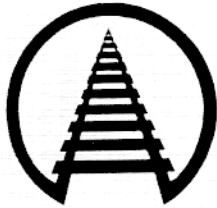


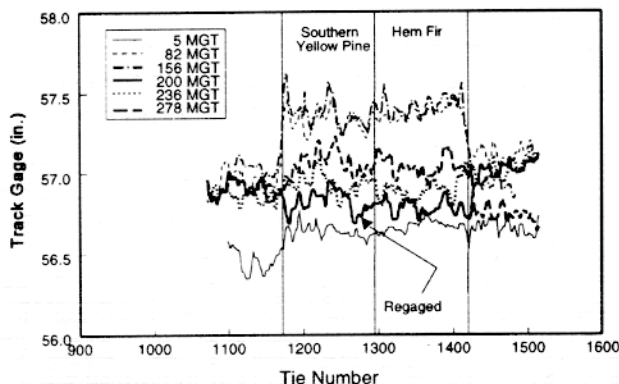
Exhibit 4. Gage In Section 07 - Douglas Fir and Oak Tie Test Areas.

rail was performed without re-gaging the plates, the measured track gage in both the cut spike and direct fixation fastening system zones can be attributed to long term degradation.



In Section 25, track gage degradation was also significant in the hem fir and southern yellow pine ties installed at the start of the second phase of the HAL program. After 200 MGT of HAL traffic, the ties gage widened significantly and required re-gaging. In fact gage widening was so severe the track supervisor felt that re-plugging and re-gaging the ties with the existing cut spike system would bring about gage widening in a short time period. Thus, the ties were re-gaged and equipped with Pandrol plates, fasteners, and coach screws in an attempt to lengthen the re-gaging maintenance cycle.

Exhibit 5 shows the measured track gage for the hem fir and Southern yellow pine. The change in track gage between 156 and 200 MGT of accumulated HAL traffic once again was due to re-gaging prior to the 200 MGT measurement.



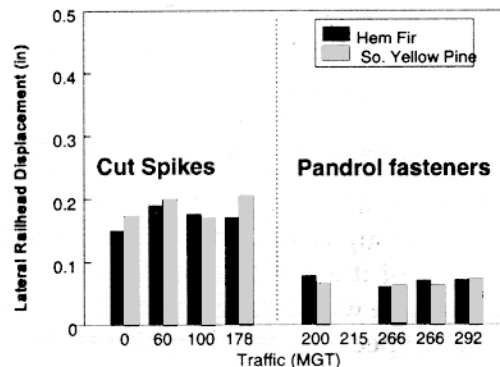
**Exhibit 5. Accumulated Track Gage on the Southern Yellow Pine and Hem Fir Tie Test Sections.**

While Pandrol plates and coach screws improved gage retention of the ties, the coach screws were continually working out of the ties under traffic. In an attempt to remedy the problem, threaded coil inserts were used in the hold down hole. However the screws continued to work out wherever a split was

present in the hold down hole. Tie splitting may have been too severe for this type of repair. The severe tie condition was accelerated by rail plugs installed during a period when rail fatigue caused numerous breaks.

The use of direct fixation fasteners in these softwood ties appeared to have improved track strength. However, gage continues to widen and may soon require maintenance or tie replacement.

Track strength, a measurement used to monitor tie and fastener degradation, is determined by statically applying known vertical and lateral loads to the rails, while measuring the lateral railhead and rail base displacement. In Exhibit 6, railhead displacement measured on the hem fir and Southern yellow pine ties is shown. The data, under 40,000 vertical and 20,000 pounds static



**Exhibit 6. Lateral Railhead Displacement.**

loads, indicates that gage restraint increased after the installation of the Pandrol fastening system. The measured average lateral railhead displacement was about 50 percent less.

Contact M. Carmen Trevizo (719) 584-0560 with questions or comments about this document.

1. Read, David M. "FAST/HAL Wood Tie and Fastener Experiment," *Proceeding -- Workshop on Heavy Axle Loads, Pueblo, Colorado, October 14 - 17, 1990.*

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