Strength Properties of Wood Crossties

A major function of the crosstie is to support the vertical and lateral loads transmitted to the tie through the rails. The ability of crossties to support these loads is defined as the strength of the ties.

One recent research effort attempted to quantify several key strength-related properties of wood crossties, and to relate these properties to the condition of ties in track. This activity, which was carried out as part of the Association of American Railroads' ongoing track-maintenance research program, tested four groups of ties selected from a railroad test site (1). These four groups were defined, based on visual evaluation of their condition, as good, marginal, bad and unusual. (These ties were approximately 20 years old and were subjected to approximately 20 MGT of mainline traffic per year on a northeastern U.S. railroad.) A group of new ties was similarly tested in order to obtain reference values.

In order to quantify the strength of the ties, in a manner representative of their performance in track, a series of bending, surface hardness and other tests were carried out. The tie bending tests, which were performed to simulate a severe loading condition, showed a reduction in both maximum static load and corresponding bending modulus of elasticity.

Tie bending tests

Figure 1 presents the results of the maximum static bending tests (simulating a center-bound tie). As can be seen from these results, the good, marginal and bad ties experienced a loss of approximately one-third of their new bending strength (as defined by this test), while the unusual ties (which were the most severely-failed group) lost more than half of the new-tie bending strength.

Similar results were obtained for the bending modulus of elasticity tests presented in Figure 2. In this case, the bending modulus of the good, marginal and bad ties are all approximately 50% of the new ties. (The lack of variation in these three categories exhibited in both sets of tests is probably due to the subjective nature of the visual inspection.) For the unusual (failed) ties, the bending modulus was approximately one-third of the new ties (or a loss of two-thirds of the new modulus values).

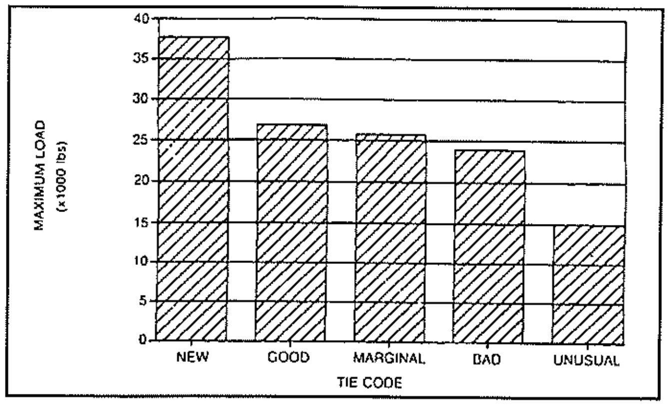

Figure 1 — Maximum static bending load for 20-year-old ties (1).

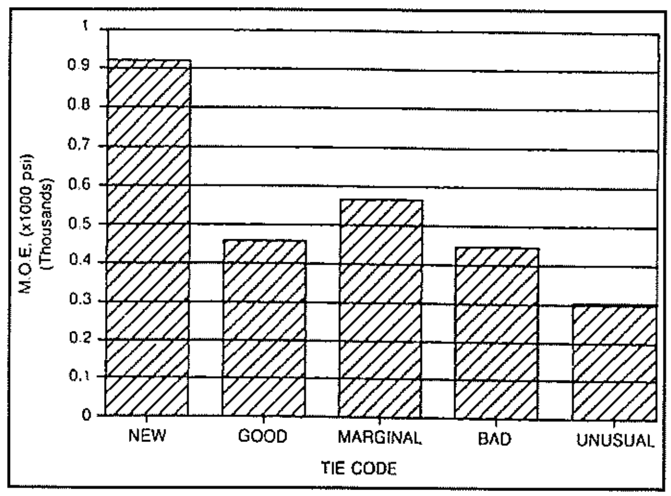

Figure 2 — Bending modulus of elasticity values for 20-year-old ties (2).

This variation in bending modulus was significantly greater than that encountered due to differences in species. This is clearly illustrated in Figure 3, which shows the bending modulus of elasticity (for clear wood samples as opposed to the whole tie values shown in Figure 2) for several different wood species (2). Although the greatest variation in modulus among the species was a factor of two (between cedar and maple), among the most commonly used hardwoods, this variation was of the order of 33%, significantly less than that

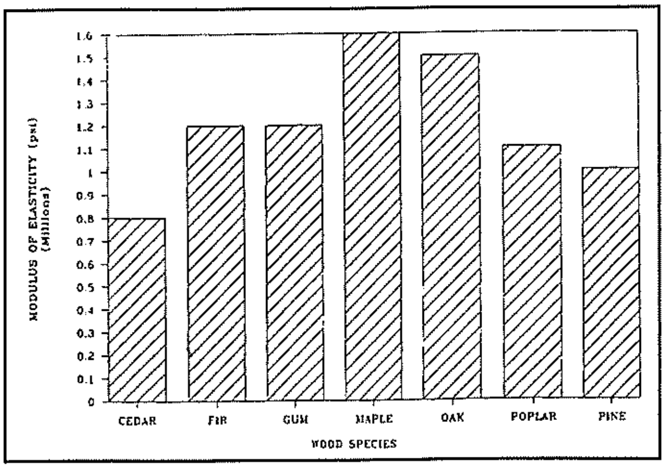

Figure 3 — Modulus of elasticity in bending for clear-wood samples (2).

measured due to deterioration in the field (2,3).

A second class of tests was carried out to determine the deterioration in surface properties of the ties. These tests, which examined the surface hardness and the compressive modulus of the ties, at the center and at the railseat (under the tie plate), showed a similar loss of properties, particularly in the railseat area (2). This is illustrated in Figure 4, where the loss of tie hardness under the tie plate is approximately 50% for good and marginal ties, 60% for bad ties and 75% for unusual ties. The degradation in the center of the tie, away from the area of load application, is significantly less. (Comparable behavior was observed for the compressive modulus tests.)

The remaining tests showed a similar set of behavior, with the overall reduction in strength of the 20-year-old ties being approximately 30% to 50% of the new-tie values (1). Thus, it appears that the actual strength properties of the ties are reduced under actual service conditions. Noting the lack of consistency in the visual assessment of these ties, however, it appears that there remains a need for more objective field-measurement techniques for assessing the actual in-track condition of wood crossties.

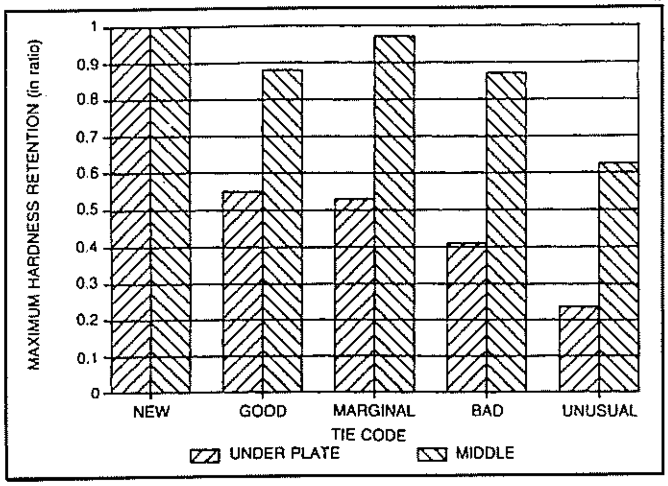

Figure 4 — Maximum hardness retention for 20-year-old ties (1).

References

(1) Davis, D. D. and Chow, P., "Tie Condition Inspection: A Case Study of the Failure Rate, Modes, and Clustering," Bulletin of the American Railway Engineering Association, Bulletin 723, Volume 90, December 1989.

(2) Carmichael, C.. "Kent's Mechanical Engineer's Handbook, Twelfth Edition," John Wiley & Sons, 1950.

(3) Forest Products Laboratory, "Wood Handbook," U. S. Department of Agriculture.