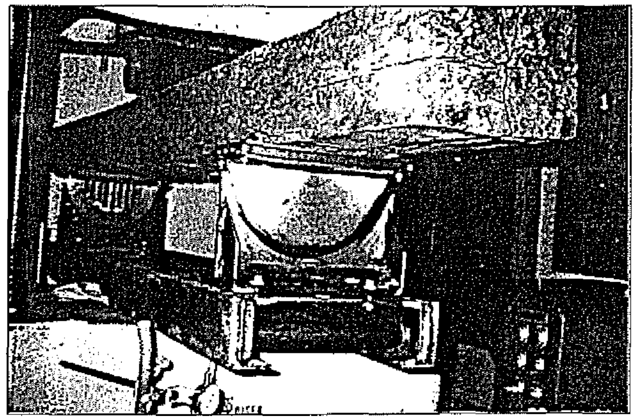
Proposed Strength Properties Tests For Wood Crossties



The static bending test indicates the structural capacity or the breakage of the tie and is important for track load capacity, deformation and surfacing.

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Since 1984, the Association of American Railroads. Chicago. and the Wood Engineering Laboratory in the Department of Forestry at the University of Illinois, Urbana-Champaign Campus, have developed test procedures to evaluate the mechanical performance of wood crossties. These tests are considered to be important to crosstie performance.

Objectives

These methods cover tests on full-size (7" x 9" x 9') specimens and/or 7" x 9" x 18" pieces from each tie specimen of wood that are made to afford:

A. Data for comparing the mechanical properties of various species, chemical or preservative treatments, drying methods, sources of supply, location and length of service in track,

13. Data for engineering design and for developing allowable stresses, and

C. Data for specific use in specifications for procurement and acceptance testing of new wood crosstie products.

Test Methods

The principal mechanical tests are static bending, compression perpendicularto grain, surface hardness, lateral spike resistance, and direct spike withdrawal.

A. Conditioning of Specimens (18" section):

The physical and mechanical properties of wood depend on the moisture content at time of test. It is essential to condition the test specimen to constant weight so it is in moisture equilibrium under the desired outdoor track environmental condition prior to various tests. Therefore, 18" long tie specimens shall be conditioned to constant weight and moisture content in a conditioningchamber maintained at a relative humidity of 90 +5 percent and a temperature of 68 + 5F. If there is any departure from this recommended condition, it shall be so stated in the report.

B. Moisture Content and Density:

These two properties' determinations are required on each static bending test tie specimen. The moisture content shall be determined I inch below the surface near the tie-plate area using a resistance type of electronic moisture meter. Needle type electrodes shall be driven into the wood to 1 inch depth. A more accurate moisture content can be obtained from an increment bored wood sample or a coupon cut from each specimen.

The density shall be computed from the measurement of the length, width, thickness and weight of the tie specimen at time of test.

C. Static bending test (Center Point Flexure Test).

It indicates the structural capacity or the breakage of the tie and is important for track load capacity, deformation and surfacing.

1. Specimen: Each test specimen shall he full-size (from 8 to 9 feet long).

2. Loading Span and Supports: Center loading and a span length of 60 inches shall be used to simulate a "center-bound ¯ tie. Both supporting knife edges shall be provided with bearing plates (6" x 12") and rollers which are free to move in a horizontal direction. The knife edges (12" wide, a rocker type) shall he adjustable laterally to permit adjustment for light twist or warp in the tie specimen. The tie specimen shall be supported by two bearing plates (6" x 12") to prevent damage to the tie at the point of contact between tie and reaction support.

3. Loading Bearing: A 12" long steel pipe (6" diameter) shall he used for applying the load.

4. Speed of Testing: The load shall he applied continuously throughout the test at a rate of motion of the movable crosshead of 0.10 inch per minute.

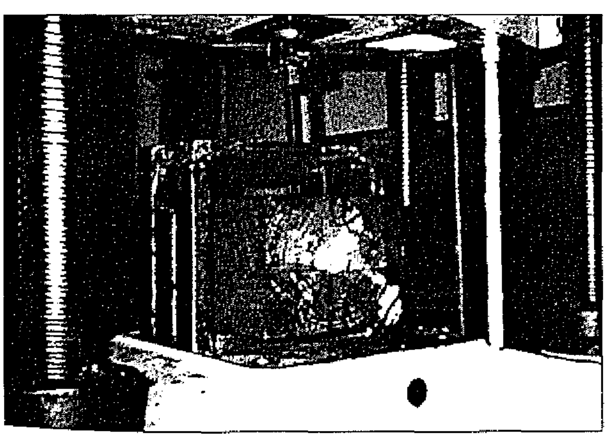
5. Load-Deflection Curve: After a 200 pounds pre-loading, load-deflection curve shall be taken to the maximum load. Deflections of the neutral plane at the center of the length shall be taken.

6. Calculations.

a. Calculate the maximum bending stress or the modulus of rupture (MOR) for each specimen by the following equation:

MOR (Psi) = $3\,PL/2bd^2$

b. Calculate the modulus of elasticity (MOE) for each specimen by the following equation:



Spike resistance tests are used to indicate the rail gage and rollover restraint capacity of the tie spike drive-in force. the lateral spike resistance and spike withdrawal force.

MOE (Psik 1 $L^3/4bd^3y$

where

b = width of specimen, inches;

d = thickness (depth) of specimen, inches;

L = length of span, inches;

P = maximum load, pounds;

P1 = load at proportional limit, pounds;

y I = center deflection at proportional limit load, inches.

D. Compression perpendicular to grain load (24,000 lbs.).

This test determines the crushing capacity of the wood in the critical plate areas. This is the area of the tie that is prone to failure in severe service environments.

1. Specimen Size: The test shall be made on the tie-plate area of the 18" long specimens.

2. Loading: A 24,000 lbs. load shall be applied through a movable crosshead and carried through a short section of 115 RE rail to a 7.75 by 13-inch tic plate and in turn to the upper surface of the crosstie specimen at equal distances from the ends and at right angles to the length.

3. Speed of Testing: The load shall be applied continuously throughout the test at a rate of motion of the movable crosshead of 0.024-inch per minute.

4. Load-Compression Curves: It shall be taken for all specimens up to 24,000 lbs. load. After which the test shall be discontinued.

5. Calculation: The modulus of elasticity in compression (MOE) shall be calculated using. the following equation:

E(psi) = Compressive stress (PSI)/ Strain (in/in)

Compressive Stress (Psi) = P I /A

Compressive Strain (in/in) = y 1/d

where

load at proportional limit, pounds;

A = net plate area, square inches;

y 1 = compressionat proportional limit, inches;

d = thickness or depth of tie specimens, inches.

E. Surface Hardness Test.

This test defines the plate cutting resistance and surface hardness of the tie specimen in the critical plate areas.

1. Specimen Size: The test shall be made on the tie-plate area of the 18" long specimens.

2. Loading: Use a steel ball "2-inch" in diameter as a loading head. A ball holding jig shall be made to restrain the ball from lateral movement.

3. Speed of Testing: The test shall be conducted at a speed of 0.25 inches of crosshead deflection per minute.

4. Load-Penetration Curve: It shall be

Test Results of 94 Newly Treated (Creosote) Oak Crossties (1985-1991)

University of Illinois and Association of American Railroads

				MOE		Bending		Spike Resistance		
Tie Specimen	Year	M.C.	Density	Compression	Hardness	MOR	MOE	Drive-in	Out	Lateral
		%	(lb./cult.)	(psi)	(lbs.)	(psi)	(psi)	(lbs.)	(lbs.)	(lbs.)
"	1985	20	34	39,155	6 4.60		—	—	—	—
			(3)[2]	(28)	(13)					
2. Vapor dried (8)[1]	1985	55	44	33,605	3,495	—	—	—	—	—
			(5)	(10)	(13)					
3. Boulton dried (8)[1]	1986	50	44	44,648	4,270	—	—	—	—	—
			(3)	(10)	(23)					
4. Boulton dried (8)[1]	1987	45	47	31,365	3,520	—	—	—	—	—
			(5)	(18)	(14)					
5. Boulton dried (8)[1]	1987	40	47	32,837	3,530	—	—	9,800	9,100	3,100
			(4)	(19)	(23)			(7)	(	
*Ail dried (5)-[1]	1988	37	47	33,165	4,130	7,450	967,000	9,895	9.060	3,160
			(3)	(26)	(11)	(7)	(12)	(6)	(12)	(18)
7. [3]	1988	37	47	32,830	4,400	7,660	920,000	9,650		
			(4)	(21)	(12)	(7)	(15)	(10)		
8. Air dried (10)[1]	1988	28	44	42,730	4,455	—	—	7,525	8.485	2,895
			(4)	(17)	(25)			(13)	(16)	(12)
9. E3oultou dried (4)[3]	1989	60	58	38,485	3,930	7,215	1,327,300	7415	7,990	-3,300
			(3)	(8)	a.	(	3	)	(8)	(16)
10. Air dried (I0)	1991	22	60	32,520	3,650	8,630	1,043,770	10.660	8.540	3,460
			(2)	(13)	(12)	(14)	(13)	(9)	(7)	(9)
				560-	'-		842,820	8,715	7,405	
						...,c	"	i: (14)		(18)
12. Boulton dried (10)[3]	1991	42		30,170	4,490	8,145	638,860	9.335	7.865	2,970
			(2)	(14)	(18)	(12)	(11)	(6)	(8)	(19)

I Number of specimens (7" x 9" x 18")

[2] Coefficient of Variation (%) + $\frac{\text{Standard Deviation}}{\text{Average}}$ x 100

[3] Number of specimens (7" x 9" x 9')

"The principal mechanical tests are static bending, compression perpendicular to grain, surface hardness, lateral spike resistance and direct spike withdrawal."

recorded for all specimens until the steel ball being imbedded 0.25 inches into the surface of the tie specimen.

5. Calculations: The maximum load required to embed the "ball" to 0.25 inches into the specimen shall be the measure of surface hardness (lbs.). The slope of the straight-hen portion of the load-penetration curve in pounds per inch shall be the hardness modulus (lbs./inch).

Hardness Modulus (lbslinch) \Pi/Y

where P1 = load at proportional limit, pounds,

Y1 = penetration at proportional limit.

F. Spike Resistance Tests.

These tests are used to indicate the rail gage and rollover restraint capacity of the tie spike drive-in force, the lateral spike resistance and spike withdrawal force shall be reported in this test.

A new 5/8" square and 6-1/2" long cut-spike shall first be inserted into the un-bored plate area of the tie specimen, so the resistance to withdrawal in plane normal to the tie surface can be measured.

I. Specimen Size: The test shall be made on the tie-plate area of the 18" long specimens.

2. Speed of Testing: (a) A cut spike shall be driven into the tie plate surface at a speed of 2 inches per minute. (b) The lateral spike resistance test shall be made at the speed of 0.1 inches per minute. (c) The direct withdrawal test shall be made at a speed of 0.3 inches per minute.

3. Load-Deflection Curve: (a) It shall be recorded for all tests as the spike head is being bent or displaced 0.2 inches laterally in the lateral spike resistance test, (b) It shall be recorded throughout the spike withdrawal perpendicular to the plane movement in the direct withdrawal resistance test.

4. Report: The following test results shall be recorded: (1) Maximum spike insertion load, (2) Maximum load produced a 0.20 inches lateral displacement of the spike head, (3) Maximum direct spike withdrawal force. 4*