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Timber Bridge Information Resource Center

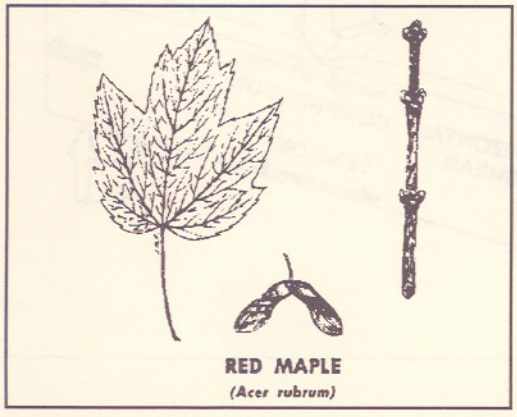
CROSSINGS

NEWSLETTER OF THE NATIONAL TIMBER BRIDGE INITIATIVE

Editor - Tinathan Coger *Issue 17* *August 1994*

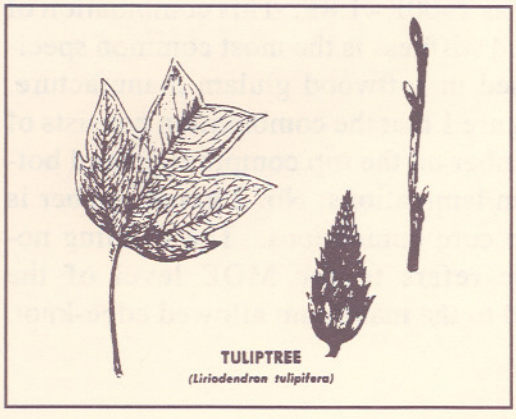
Red Maple and Yellow Poplar Glulam Timber Beams

Red Maple and Yellow Poplar are rapidly becoming predominant hardwood species in the forests of the northeastern United States.



RED MAPLE
(Acer rubrum)

Because these two species have not been considered for structural applications, there has been little interest in development of red maple or yellow poplar lumber products.



TULIPTREE
(Liriodendron tulipifera)

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Second National Timber Bridge Design Competition

The winners of the 1994 National Timber Bridge Design Competition Awards have been selected. This is the second national student competition organized by the Southwest Mississippi Resource Conservation and Development Incorporation's Executive Board.

The award selections were made by a panel of judges which included N. Montgomery Dodson, Consulting Engineer; James Brohaw, Engineer - Applied Research Associates; and Stephen C. Quintana, Program Director of the Timber Bridge Information Resource Center.

The Timber Bridge Student Design Competition is intended to familiarize engineering and forestry students with the structural capabilities of wood and its potential as a principal material for highway bridges and related transportation structures. The competition is open to students of civil engineering, agricultural engineering, and forestry throughout the United States.

The 1994 national student competition received favorable responses from various colleges and forest products groups. A total of twenty colleges sent notices of intent to participate. Fourteen submitted design and test results for final competition. Many other colleges were unable to participate.

The Southwest Mississippi Resource Conservation and Development, Inc., with assistance from the Department of Civil Engineering at Mississippi State University (the host university), coordinated the competition.

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Recently, two separate research programs were carried out that studied the performance of glued-laminated (glulam) timber beams manufactured with red maple and yellow poplar lumber *(see note at the end of this article for references)*.

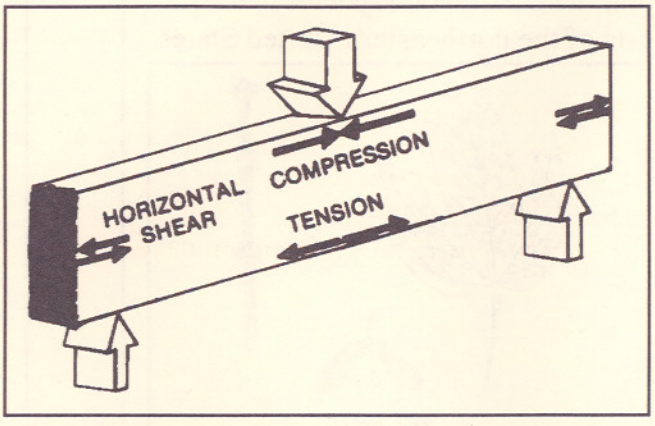
The objective of these studies was to develop hardwood lamination combinations with design strength and stiffness properties comparable to those of the more commonly used softwood combinations.

Tabulated design values for strength and stiffness of several species of hardwood glulam members and for several lamination layup combinations are published in AITC 119-85 (AITC, 1985).

Current hardwood glulam specifications are published only for layup combinations of uniform grade laminations and for selected species. For the more commonly used softwood glulam timber, tabulated design values are published in AITC 117-87 for several softwood species and for a wide variety of lamination combinations (AITC, 1987). Because the performance of glulam timber manufactured with softwood lamination lumber is better understood than hardwood glulam, a wider variety of efficient combinations of softwood glulam timber are found in the AITC 117 standard.

In developing the new combinations of hardwood glulam timber, existing standards were followed. The tabulated design values for glulam timbers were calculated using the industry standard ASTM D3737 procedures (ASTM, 1992). The calculation procedures require that the grade and species of all the laminations in the layup be specified and known.

The ASTM D3737 calculation procedures are well established and verified for softwood glulam timbers, and are used to predict the tabulated design values for the softwood lamination layup combinations published in AITC 117. The ASTM D3737 procedures have not been used to generate design values for strength and stiffness of practical hardwood lamination layup combinations. To determine the lamination lumber information for the hardwood species, preliminary tests were conducted on several lumber specimens to obtain information needed by the ASTM D3737 procedures.



Using the information on the hardwood species of lumber, and the ASTM D3737 procedures, it was determined that the layup combination shown in Figure 1 could achieve a design bending strength (F_b) of 2400 lb/in^2 and a design modulus of elasticity (MOE) of 1.8 (10)^6 lb/in^2; commonly referred to as 2400F - 1.8E. This combination of strength and stiffness is the most common specification used in softwood glulam manufacture. Note in Figure 1 that the combination consists of E-rated lumber on the top compression and bottom tension laminations; No. 2 grade lumber is used in the core laminations. The E-rating nomenclature refers to the MOE level of the lumber and to the maximum allowed edge-knot.

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For example, the 2.0-1/6 grade shown in Figure 1 indicates that the lamination grade must have an average MOE of 2.0 $(10)^6$ lb/in^2 and edge-knot characteristics cannot exceed 1/6 the area of the cross-section. Another important note is that 15% of the combination is made from 1/6 edge-knot lumber, and the remaining 85% of the combination is made from 1/3 edge-knot and No. 2 grade lumber. Thus, a 2400F - 1.8E hardwood glulam combination was designed while utilizing a large percentage of low-quality lumber.

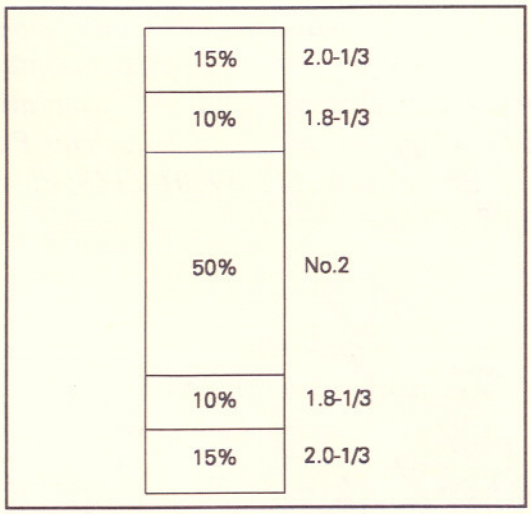

Figure 1. Layup configuration for 2400F - 1.8E hardwood glulam timber.

For each of the studies (red maple and yellow poplar), approximately 45 beams were manufactured in 3 different sizes (15 beams in each size group). The varying sizes allowed the researchers to study the decrease in calculated bending stress as beam size increased; commonly referred to as the volume effect.

All beams were tested to failure to determine the ultimate modulus of rupture, and the MOE was determined using the load-deflection information up to the design load (the applied load that corresponds to the 2400 lb/in^2 design bending stress).

The results of these two studies showed that efficient combinations of hardwood glulam timber can be manufactured to achieve the common design specification of 2400F - 1.8E. It was also determined that the ASTM D3737 calculation procedures, which have historically been based on softwood timber, are applicable for the design of hardwood glulam timber. Finally, it was observed that the volume effect in hardwood glulam timber was similar to that observed in past research for softwood glulam timber.

NOTE: *The two research studies discussed in this article are the Forest Products Laboratory Research Paper No. 519 (FPL-RP-519) for the red maple glulam timber research, and FPL-RP-520 for the yellow poplar glulam timber research. For copies of these papers, contact USDA Forest Service, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705-2398.*

SUBMITTING ARTICLES FOR CROSSINGS

This newsletter is published to share information about modern technology used in constructing timber bridges and other timber structures related to transportation systems. The topics address specific areas, and articles are typically prepared by specialists.

If you, or someone you know, would like to suggest a topic or prepare an article for "Crossings", please feel free to contact me at (304) 285-1591, or write to USDA Forest Service, TBIRC, 180 Canfield St., Morgantown, WV 26505.

STEPHEN C. QUINTANA
Program Director, TBIRC

Second National Competition ...

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Awards:

First Place and $750.00 - University of Oklahoma — The timber bridge consisted of two stress laminated, double bulb-tee stringers using No. 3 southern pine and utility douglas fir (2X4, 1X12, 1X8) for materials.

Second Place and $500.00 - West Virginia University, Entry A — The timber bridge consisted of 4 box beam stringers using yellow pine and 1/2-inch plywood decking for materials.

Third Place and $250.00 - Mississippi State University — The timber bridge consisted of two main trusses with three secondary stringers using southern pine for materials.

Special Award A and $300.00 - University of Missouri at Kansas City. Most economical and cost-competitive timber bridge.

Special Award B and $200.00 - Princeton University. Most aesthetic timber bridge.

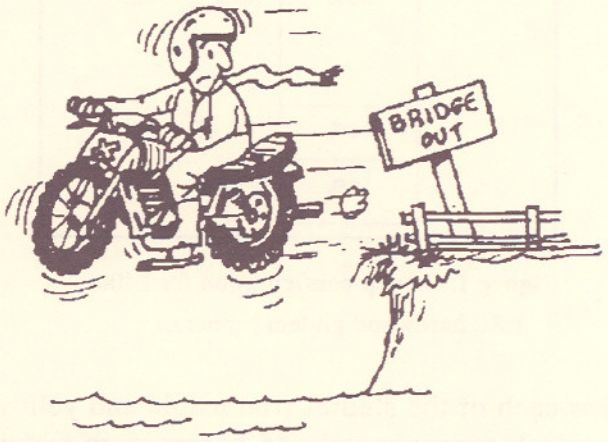
The remaining top ten colleges and universities not selected for awards received $100.00 if their entry passed all the requirements. These colleges included: Oregon State University, Milwaukee School of Engineering, Ohio State University, University of New Hampshire, West Virginia University - Entry B, Washington University, Virginia Polytechnical Institute and State University, and California State University at Fresno.

Also participating was the University of British Columbia, Canada.

National Sponsors

The second National Timber Bridge Design Competition was sponsored by the Southwest Mississippi Resource Conservation and Development, Inc.; Mississippi State University, Department of Civil Engineering; and the USDA Forest Service Timber Bridge Information Resource Center. The competition received the endorsement of the American Forest and Paper Association's Timber Bridge Task Force. The staff of the Southern Forest Products Association provided valuable input in planning the competition.

If you are interested in the 1994 fall competition or wish to be a sponsor, please contact: Southwest Mississippi Resource Conservation and Development, Inc.; 114 Industrial Park Drive; Brookhaven, MS 39601-2148; Phone: (601) 833-5539.



Article contributions, questions or comments may be sent to Stephen C. Quintana, Program Director, P.E. or Ms. Tinathan A. Coger, Information Assistant; USDA Forest Service; 180 Canfield Street; Morgantown, WV 26505; Phone: 304-285-1591 or 304-285-1596; or FAX: 304-285-1505; DG: S24L08A.

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