TechLine

Forest Products Laboratory

Structural Products Offer Opportunities for Lower Value Hardwoods

Figure 1—Bridge with oak machine stress rated lumber decking.

Background

Structural lumber markets have traditionally been dominated by softwood species. However, hardwood species have been used extensively for certain structural applications such as timbers for railroad bridges, crossties, and mine timbers.

The "soft" hardwoods are often thought of as being inferior because they are less suitable for traditional applications such as furniture, flooring, and cabinetry. For structural applications, these species may be entirely suitable and have properties that rival those of traditional softwood species (Table 1).

Table 1. Properties of clear wood at 12% moisture content

Species	Specific gravity	Bending properties[a]	
		MOR	MOE
Red maple	0.48	13.4	1.64
Yellow-poplar	0.42	10.1	1.58
Sweetgum	0.52	12.5	1.64
Black tupelo	0.50	9.6	1.20
Yellow birch	0.62	16.6	2.00
Loblolly pine	0.51	12.8	1.79
Douglas-fir	0.48	12.4	1.95

[a]MOR, modulus of rupture in bending, $\times 10^3$ lb/in^2;
MOE, modulus of elasticity in bending, $\times 10^6$ lb/in^2.

Past forestry practices have sometimes resulted in an overabundance of low-value hardwood species. However, engineered wood products, such as visually or mechanically graded structural lumber, metal-plate wooden trusses, glue-laminated beams, and wood I-joists, are potential markets for such material.

What We Have Learned

Research at the Forest Products Laboratory (FPL) has shown that good yields of 2-inch- (25-mm-) thick, visually graded structural lumber may be obtained from a variety of hardwood species, using either logs or heart-centered cants. Shorter, cost-effective drying schedules have also been developed for hardwood lumber for structural applications where drying degrade is of less concern, and target moisture content levels are often greater than those for traditional products.

Machine stress rated lumber (MSR) lumber has been produced commercially from softwood species since the 1960s. Research at FPL first established that the MSR process used for softwoods is also applicable to hardwoods. Cooperative studies with faculty at West Virginia University evaluated the potential yield of MSR lumber from a variety of hardwood species. A demonstration project with industrial cooperators resulted in the first commercial certification of hardwood MSR lumber and its use in a laminated-deck wooden bridge in Jackson County, West Virginia (Fig. 1).

Researchers at FPL, Michigan Technical University, and the Natural Resources Research Institute of the University of Minnesota in Duluth are working to improve the economics of forest restoration by developing value-added structural uses for red maple, sugar (hard) maple, and yellow birch. This research is focused on the use of hardwood lumber in structural components, such as metal-plate wooden trusses and wooden I-joists.

Initial studies focused on development of engineered designs for trusses and assessment of fastener performance. Industrial cooperators then manufactured both pitched and parallel cord trusses. Tests showed that hard maple trusses had 29% more strength and 10% more stiffness than equivalent Spruce–Pine–Fir trusses.

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Figure 2—Metal plate trusses constructed with red maple webs.

Figure 3—Shear tests of I-joist with hard maple flanges.

With the cooperation of the Duluth chapter of Habitat for Humanity, two houses with attached garages were built as demonstration projects during the summer of 2001. To minimize concerns related to lumber length and species, the house trusses were manufactured using red maple webs with Spruce–Pine–Fir cords (Fig. 2). Red maple was used for both the webs and the cords in the attached garages. No specific problems were identified when using hardwood trusses, except it was difficult to nail siding by hand to the gable end of the hard maple trusses.

Mechanically graded nominal 2 by 6 (38- by 140-mm) hard maple, red maple, yellow birch, and aspen lumber was used to manufacture I-joists at a commercial facility. Shear and bending tests indicated that I-joists manufactured with red maple and aspen flanges were equivalent to those produced with Spruce–Pine–Fir (Fig. 3). Sugar maple and yellow birch I-joists exhibited marginal bonding between the lumber and the oriented strandboard webs. It is not clear whether the poor bonding was caused by lack of intimate contact, insufficient temperatures during glue-bond curing, or some other factor. We recommend that a larger study be undertaken using red maple and that additional research be conducted to improve the glue-bond strength of hard maple and yellow birch.