Innovative Wood Utilization

BY DAN SEMSAK

What changes are occurring in wood construction that could change the way timber is utilized? Let's look at characteristics of engineered wood products and how the characteristics of timber might affect them. Engineered wood products for structural use must meet minimum strength and stiffness criteria.

Engineered wood covers a broad range of products. The latest buzz centers around mass timber. Mass timber usually refers to CLT (cross-laminated timber) and glue-laminated timber beams and columns (glulam). Other mass timber products of limited production include DLT (dowel laminated timber), NLT (nail laminated timber), and MPP (mass plywood panels).

CLT is made of alternating, perpendicular layers of lumber glued together in massive panels, hence the name "cross-laminated." It is similar to the production of plywood in that sense. The layers are typically 2" x 6" that have been finger-jointed together into long lengths and then laid up side-by-side. The top and bottom layers are parallel. In a 3-ply panel, the alternating layer is perpendicular to those. This could continue into thicker panels of 5-ply or 7-ply. The current ANSI standard allows for #2 grade lumber for the parallel chords, including any parallel layers in the core of 5- or 7-ply CLT. Number 3 grade is allowed in the cross plies. Note that these are visual lumber grades. MSR (machine-stress rated) lumber allows CLT manufacturers to develop new recipes or lay-ups, which could provide more flexibility in the future.

Glulam beams and columns utilize MSR lumber for the lam stock. The highest strength grade of lam stock is tension lam, which is used for the bottom layer or "chord." The top chord is in compression, which also requires a high grade. As you move toward the center, lower grades are used where tension and compression factors are minimized.

CLT and glulam require straight lumber, small knots, square edges, and straight grain. The moisture content must be 12% or lower for proper adhesion. The drier the lumber, timber characteristics like compression wood that can cause warp and twist become more of a factor. Home center customers also want square-edge lumber—they just will not buy lumber with wane. Between mass timber and home centers, wane-free lumber demand will continue to increase.

Knots are a defect. Lumber produced in the Inland US and Interior Canada typically have smaller knots and knot holes than lumber produced on the coast.

LVL (laminated veneer lumber) is another engineered wood product with special needs. LVL is similar to plywood in that thin, typically 4' x 8' veneers are laminated in layers into various thicknesses. However, plywood is made up of alternating 90-degree layers—or cross plies. Veneer used in LVL is laid up unidirectionally with the veneer laid out like a fan of cards. Each veneer sheet is offset from the one below it, longitudinally. The veneers are lapped over the sheet in front. This allows for LVL to be laid up into virtually any length, typically 40' to 80' long, called billets. The billets are sawn into structural beams or high-strength dimension lumber and studs. The strongest veneer comes from the sapwood portion of the logs. Smaller logs have a higher percentage of sapwood. LVL producers, therefore, get most of their veneer from smaller logs.

The suitability of wood fiber for structural purposes is determined by its bending stiffness, bending strength, and density. LVL utilizes veneer that has been tested for strength using sound waves. Veneer testing machines can measure the ultrasonic propagation time (UPT) of veneer. The denser the material, the faster sound waves will travel through the wood fiber. The veneer for LVL is separated into different strength classes by UPT. On average, the veneer laid up into LVL with fastest sound waves of UPT graded veneer is stronger than the slower UPT graded veneer. Newer veneer testing machines can also determine modulus of elasticity (E), specific gravity, and density, helping to more efficiently utilize veneer. One challenge for LVL manufacturers is that very gradually over time, those strength values have been declining, forcing them to occasionally increase the ratio of the higher strength veneers into the recipe.

In recent years, some mills that produce lam stock for glulam beam manufacturers or veneer for LVL mills have been separating logs using stress wave timing/testing or bonking with stress wave tools. This allows for higher density logs to be targeted toward engineered wood products, resulting in higher yields of stronger lam stock or veneer.

Acoustic tools are a non-destructive method of predicting the stiffness of materials. They work by measuring the propagation of stress waves through wood, either by time-of-flight (over a fixed distance) or via resonance (vibration at the wood's natural frequency).

While veneer producers are happy with round logs, the lumber mills would love square logs. The goal of timber producers is to provide logs with straight grain, small to no knots, with no compression wood. Unrealistic? Yes, so what defects can be minimized by forest management?

What if, at the time of thinning a managed forest, the criteria for selecting trees to cut were not based on size? Knot sizes and number, straight grain, and sapwood percentage are more useful criteria. Stress wave tools can determine the soundness of the tree, particularly decay. Is it possible to quickly determine the density of each tree and leave those to gain mass until final harvest? Marketing of higher-value logs toward engineered wood products producers would be the goal. ◆

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LVL beams used in floor framing. PHOTO COURTESY OF PACIFIC WOODTECH