Engineered wood for form construction

An alternative to standard sawn lumber for many formwork applications, engineered wood offers greater strength, reliability and value

BY M.K. HURD

When a leading manufacturer switches from conventional 2x6s to laminated veneer lumber 2x4s for prefabricated wood column forms, there must be a good reason. When a Wisconsin distributor saves a customer thousands of dollars by supplying laminated veneer lumber that cuts in half the number of joists needed to form a bridge deck, it's time for contractors to take a look at the advantages of engineered wood.

Dwindling supplies of suitable sawn dimension lumber, as well as the roller-coaster movement of lumber prices, have led some form builders to use other framing materials to support formwork. Structural composite lumber (SCL), a precision-manufactured engineered-wood product, is an alternative that offers some of the same properties of wood along with enhanced strength and reliability. As one manufacturer put it, you get the consistency of aluminum and the workability of wood.

Like ordinary wood, the manufactured beams are workable and easy to handle, but they don't warp or twist, and they're 100% reusable.

Trus Joist MacMillan

Workers set LVL beams into adjustable joist hangers to support deck forms from the girders of a steel bridge.

They reportedly cost less than aluminum and more than sawn lumber. However, they offer a greater return on investment, particularly when you consider that typically 20% or more of sawn lumber is discarded due to defects.

Structural-composite-lumber products

Three SCL products—laminated veneer lumber (LVL), parallel strand lumber (PSL) and laminated strand lumber (LSL)—are composites made of wood veneers or wood strands bonded under heat and pressure with an exterior-grade adhesive. The wood fibers are oriented primarily along the length of the member, and the products are fabricated in large blocks, called *billets*, which are sawn into commercial sizes after they come out of the presses.

Table 1 shows a wide range of available cross sections for SCL products. Most of the sizes of sawn dimension lumber are offered. (The fractional measurements are the actual sizes of nominal 2x4s, 2x6s and so on.) In addition, there are actual beam depths of 4, 5, 6, 8, 10 and 12 inches.

Table 1. Some available engineered-wood cross sections

	Width, in.	Depth, in.*
Laminated veneer lumber (LVL)	1½, 1¾, 2, 2¼, 2½, 3, 3½	3½, 4, 5, 5½, 6, 6½, 7¼, 7½, 8, 8½, 9¼, 10, 11¼, 12
Parallel strand lumber (PSL)	5¼, 7	5¼, 7, 9¼, 9½, 11⅞, 14, 16, 18

*Available with each of the widths shown.

SCL should not be confused with glued-laminated timber, or *glulam*—another engineered-wood product, primarily used for architectural and structural purposes. Glulam is manufactured by gluing together individual pieces of dimension lumber instead of the veneers or strands used for SCL.

Laminated veneer lumber. LVL is manufactured of rotary-peeled veneers from 8-foot-long logs. The ⅛- or ⅒-inch-thick veneers are then clipped to 2- or 4-foot widths. In the United States, typical woods used are Southern yellow pine or Douglas fir. After the veneers are dried and graded, they are coated with an exterior-grade adhesive and sequentially placed into a press. Heat and pressure are applied to cure the thermosetting adhesive resin. The billet created is 1¼ to 3½ inches thick, either 4 or 8 feet wide, and up to 60 feet long.

In LVL, the grain of each layer of veneer runs in the same (long) direction, unlike plywood where the grain of each veneer layer runs at a right angle to the adjacent layer. This parallel lamination produces a material of greater strength when it's edge-loaded as a beam or face-loaded as a plank. When it comes out of the press, LVL is sawn into the lumber sizes shown in Table 1 and can be used for form joists, studs, wales and shoring. Scaffold planks are made from a special grade of LVL, with select-quality outer veneer layers.

Parallel strand lumber. PSL also is manufactured of ⅛- or ⅒-inch veneers rotary peeled from 8-foot logs. The veneers are dried and graded then clipped into strands approximately ¾ inch wide. After the strands are coated with an exterior adhesive, they are pressed into a billet up to 11 inches thick and 19 inches wide. Microwave heat is used to cure the thermosetting resin while the material is under pressure. Once out of the press, the billet is sawn into the sizes shown in Table 1. PSL can be used much the same as LVL but is most economical when used for shoring or heavy formwork beams.

Laminated strand lumber. LSL is manufactured from aspen or yellow poplar logs that have been stranded into 12-inch-long strips only about 1⁄32 inch thick. The manufacturing process resembles that of LVL and PSL, but the resulting product is not as strong. Its primary formwork application is edge forms for slabs on grade or tilt-up concrete panels.

Wood I-joists

More than a dozen companies in North America manufacture wood I-joists, another engineered-wood product. I-joists for use as formwork supports are manufactured from a variety of wood products, including the SCL described above. Generally, LVL is used for the flanges, but solid sawn lumber also is used. The joist web may be plywood or oriented strand board. The flanges, which are routed and filled with adhesive to accept the web, are pressed to the web in a continuous manufacturing process. The I-joists are then placed in an oven to cure the adhesive.

Wood I-joists often are used in prefabricated deck form panels (see cover photo). Typically I-joists used in formwork are 10 to 20 inches deep with flanges up to 3½ inches wide. However, joists up to 38 inches deep also are available. Design data are largely based on load testing and therefore are product-specific. Thus, it's important to review the technical data for the exact product you are considering. For example, one manufacturer's allowable load tables for a 10-inch-deep I-joist show that it can carry as much as 250 pounds per foot on a 10-foot simple span. A similar 20-inch-deep I-joist on the same span can carry more than 500 pounds per foot.

Strength and value of engineered-wood products

As Table 2 shows, LVL and PSL are dramatically stronger than sawn lumber. When compared with select structural lumber—the strongest grade of Douglas fir-larch—bending stresses can be nearly twice as great. Compression stresses also are significantly higher.

LVL and PSL also make better use of a log than is possible with traditional sawn lumber. More than 50% of each log can be used as structural lumber, compared with a 40% conversion rate achieved by traditional sawmilling practices.

Because of the way LVL and PSL are manufactured, the natural defects of the wood can be dispersed or eliminated to yield a product with greater strength and stability. The engineered wood resists warping and splitting and can be reused many times. United Contractors, Johnson, Iowa, began using LVL beams for formwork in 1989 and is still using much of the originally purchased material. Steve Sorenson of Shor-Co Inc., Omaha, Neb., says that using LVL beams allows the company to use less lumber and labor, saving both time and money. The case history on page **843** describes how another contractor benefited by using engineered wood.

Formwork suppliers and builders also find that engineered wood offers added value. One of the pioneers in using LVL members in formwork is Forming Concepts, Gilberts, Ill., which began using the product more than 14 years ago. The company maintains a large inventory of beams for rental, principally the 2¼ x7¼-inch size. According to Forming Concepts president Norton Baum, the company is just now culling out some of the beams from its original stock. Though the beams look worn, they are still structurally sound. Good maintenance and dry storage are the keys to this long service life.

Gates & Sons Inc.

This truckload of column forms was built with 1½ x3½-inch LVL vertical supports. By using them flat, three to a side, the manufacturer was able to cut the unsupported plywood span by almost half compared to an alternate design using dimension lumber.

Gates & Sons Inc., Denver, has been using LVL in lengths of 16 to 48 feet to build wood column forms. LVL's straightness and extra length without splicing save enough time in building the forms to pay for the extra cost of the material. And because of its longevity, LVL has a higher salvage value.

Table 2. Allowable design stresses (base values) for dry use and 100% load duration. Adjustment factors according to NDS (Ref. 1) must be applied.

PROPERTY	Laminated veneer lumber (LVL)*	Parallel strand lumber (PSL)*	Douglas fir-larch**	
			Select structural	No. 2
Bending stress	2750 psi for 12-inch depth; more for shallower members	2900 psi for 12-inch depth; more for shallower members	1500 psi	900 psi
Modulus of elasticity	2,000,000 psi	2,000,000 psi	1,900,000 psi	1,600,000 psi
Compression parallel to grain	2500 psi	2900 psi	1700 psi	1350 psi
Compression perpendicular to grain	750 psi; 880 psi for widths exceeding 1¾ inch	750 psi	625 psi	625 psi
Horizontal shear	285 psi, perpendicular to glue line	290 psi, perpendicular to wide face of strands	95 psi, parallel to grain	95 psi, parallel to grain

* These values were supplied by Trus Joist MacMillan. For products of other manufacturers, ask the local distributor for technical literature, and contact the manufacturer if engineering assistance is required.

** From Reference 1.

LVL joists save contractor time and labor

A new bridge structure on I-94 had to be placed between two existing highway bridges over the St. Croix River in Hudson, Wis. Lunda Construction Co., Black River Falls, Wis., faced a tight deadline for completion of the bridge's 8½-inch-thick concrete deck slab, which rests on steel bridge girders spaced 9 to 11 feet apart. The contractor hoped to achieve early completion by accelerating the deck forming and pouring schedule. The plan was to have crews form the entire 192,000 square feet of deck and pour the whole slab continuously without stopping to strip and reset the forms.


Trus Joist MacMillan

Having to erect bridge deck formwork between existing bridges across the St. Croix River, Lunda Construction Co. was faced with space constraints as well as a tight construction schedule. By using precut LVL joists, crews were able to form the whole deck and place concrete continuously, without interruption for form stripping and resetting.

Lunda already had a supply of custom-made adjustable joist hangers that would allow joists to be set and adjusted to grade easily and would minimize stripping time later. But the hangers could accommodate joists only up to 12 inches deep, and using 2x12 dimension lumber would require the joists to be set 12 inches on center. That meant cutting to length and hand setting more than 14,000 joists.

That's when Lunda consulted with one of its suppliers, Larry Karlson of Karlson Forming Specialties, Amery, Wis. Karlson worked with Lunda's engineering and purchasing departments to design a system using LVL form beams. The strength and stiffness of 12-inch-deep LVL joists made it possible for Lunda to use its custom joist hangers but space the joists 24 inches on center, cutting in half the number of pieces to be set. Karlson took it one step further by supplying all the joists precut to the exact lengths needed and delivering them in bundles, according to length, to keep pace with steel erection. Lunda saved on the number of joists required while cutting in half the labor costs for setting and stripping. After the job was completed, the contractor had 7,000 reusable joists ready to use for another bridge deck project.

The need for industry-wide standards

Although engineered wood appears to be the wave of the future for lumber in North America, designers have been deterred by the lack of information on how to use it. Many engineered-wood products are proprietary, and it may not be possible to substitute LVL from one manufacturer with a product of the same dimensions made by another manufacturer.

Industry-wide standards will likely be developed over time, as they have been for plywood and oriented strand board. Meanwhile, formwork designers must rely on information from manufacturers. Fortunately, a new source of information on engineered wood is available to bridge the gap (see Reference 2).

For more information about engineered-wood products, circle **101** *on the reader service card in the back of this issue.*

References

1. "National Design Specification (NDS) for Wood Construction," ANSI/AF & PA NDS-1997, American Forest and Paper Association, Washington, D.C., 1997.

2. *Engineered Wood Products: A Guide for Specifiers, Designers and Users,* edited by Stephen Smulski, PFS Research Foundation, Madison, Wis., 1997.

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