Engineered Lumber

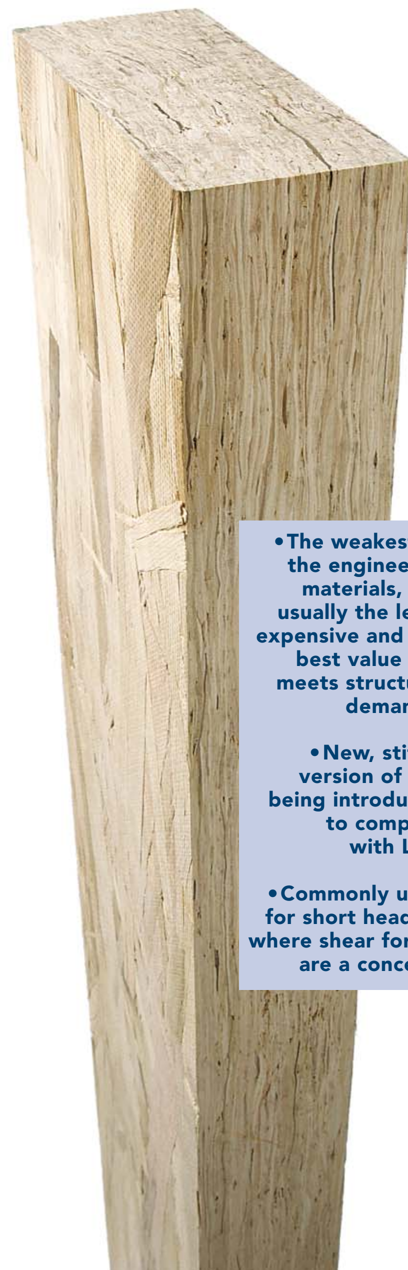
Dramatic strength combined with zero shrinkage puts engineered beams and headers on more and more job sites

BY SCOTT GIBSON

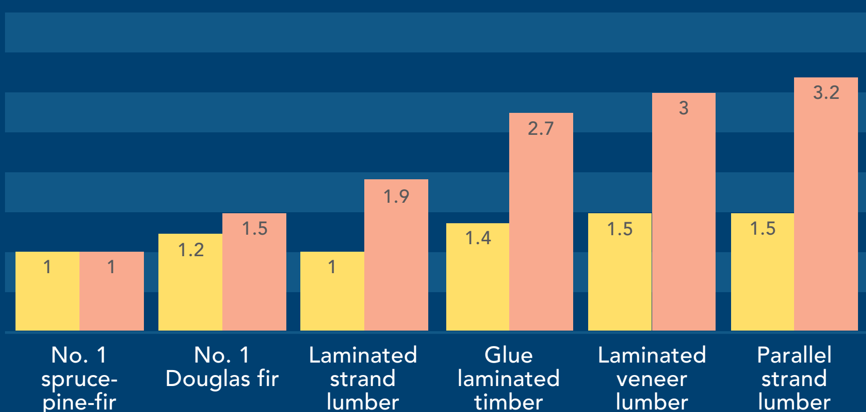
LVL? LSL? PSL? WHAT'S THE DIFFERENCE? A PRIMER ON COMMON ENGINEERED LUMBER

Laminated strand lumber

Resembling oriented strand board, LSL (sold as TimberStrand) is glued-together strips of wood fiber, but its strands are shorter than parallel strand lumber, and not parallel.



- The weakest of the engineered materials, but usually the least expensive and the best value if it meets structural demands.
- New, stiffer version of LSL being introduced to compete with LVL.
- Commonly used for short headers where shear forces are a concern.



Engineered lumber vs. sawn lumber

Given the same dimensions, engineered-wood beams are stronger than sawn lumber. The bar graph compares natural and engineered lumber for strength (load-bearing capacity) and stiffness (resistance to deflection under load) by assigning a value of 1 to No. 1 spruce-pine-fir (SPF). For example, laminated strand lumber is no stiffer than SPF, but it's nearly twice as strong. Compared with the same piece of SPF, parallel strand lumber (Parallam) is 50% stiffer and can carry three times the load. Common applications for engineered lumber include beams and headers that are unusually long, that carry an unusually heavy load or whose depth is constrained by unusual height limitations.

Stiffness (resistance to deflection)

Strength (load-bearing capacity)

Engineered structural beams made their North American debut in 1934 in Peshtigo, Wisconsin, just north of Green Bay. Glue laminated timber (or glulam) had been widely used in Europe for decades, but when Max Hanisch, a German immigrant, suggested glulam for the new gymnasium at Peshtigo High School, building traditionalists balked. The Wisconsin State Industrial Commission demanded steel reinforcements, but Hanisch prevailed. He and his partners supplied arched glulam beams that are still in service nearly 70 years later.

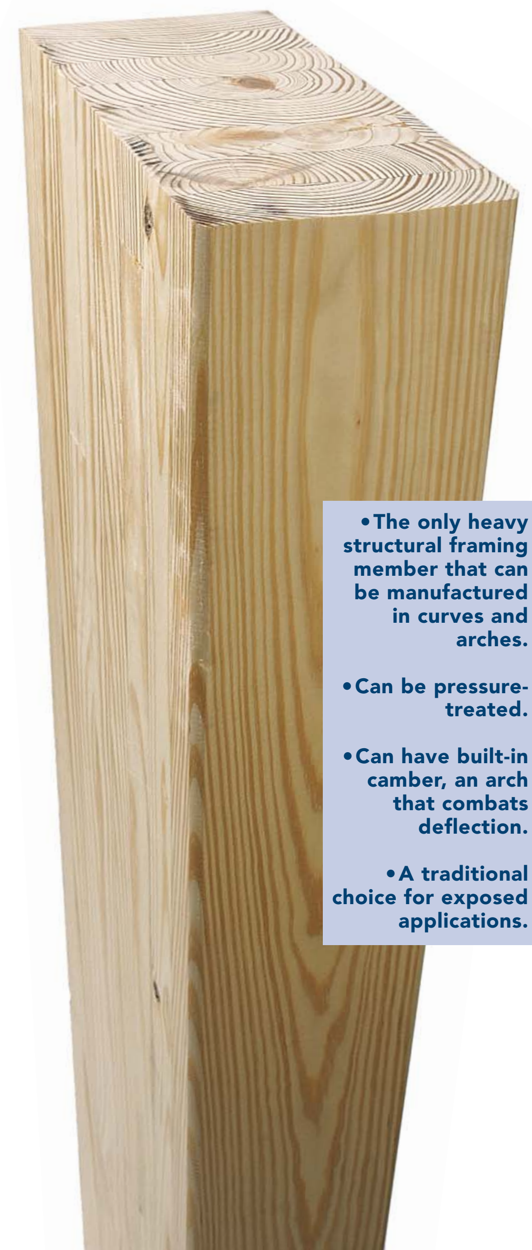
That was then. Now manufacturers combine relatively small pieces of wood with adhesives to form a variety of structural members that can be three times as strong as the sawn timbers they replace (chart facing page). Glulam was followed in 1970 by laminated veneer lumber (LVL). Later, MacMillan Bloedel, the Canadian forest-products giant, invented two other engineered framing materials: parallel strand lumber (PSL), sold as Parallam, and laminated strand lumber (LSL), sold as TimberStrand. On the horizon are structural members that combine wood fiber with more exotic materials such as Kevlar or carbon filament for even better performance (sidebar pp. 60-61).

Despite a higher cost, engineered beams are in demand

Builders and manufacturers both are reaping the rewards of engineered beams and headers. Engineered lumber supports much heavier loads than sawn timbers of the same size. Unlike sawn lumber, engineered lumber shows little if any shrinkage (reducing problems like sagging floors and cracked drywall) and has consistent

Glue laminated timber

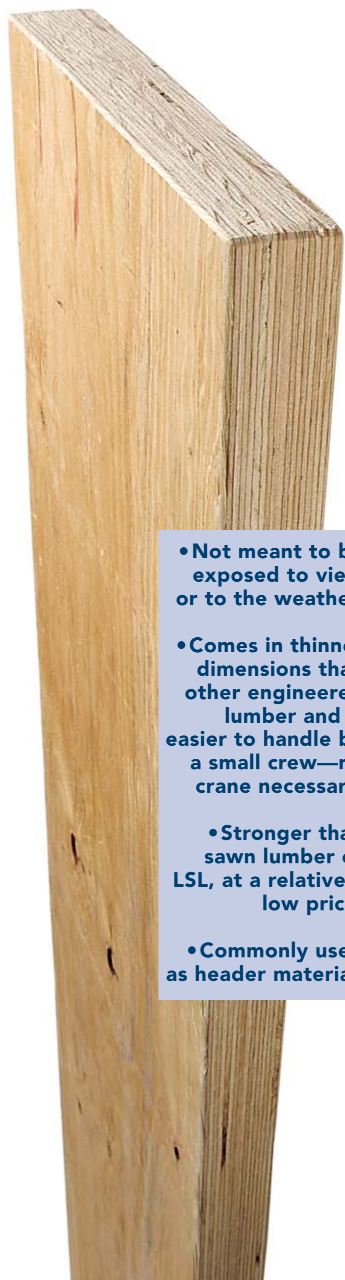
Glulam is stacked, finger-jointed layers of standard lumber. Varying the grade of lumber used and the placement of different grades within the glulam tweaks performance.



- **The only heavy structural framing member that can be manufactured in curves and arches.**
- **Can be pressure-treated.**
- **Can have built-in camber, an arch that combats deflection.**
- **A traditional choice for exposed applications.**

Laminated veneer lumber

Made from thin layers of wood glued together, LVL resembles plywood, except that the laminations all run parallel rather than perpendicular to each other.



- **Not meant to be exposed to view or to the weather.**
- **Comes in thinner dimensions than other engineered lumber and is easier to handle by a small crew—no crane necessary.**
- **Stronger than sawn lumber or LSL, at a relatively low price.**
- **Commonly used as header material.**

Parallel strand lumber

Sold as Parallam, parallel strand lumber is packed with long strips of wood fiber that are parallel to each other and saturated with adhesives.

- **Best combination of strength and stiffness.**
- **Can be pressure-treated.**
- **Can come visually graded and finished for exposed framing.**

Builders praise performance but debate environmental benefits

Rhode Island builder John Spier needed a dozen 20-ft. timbers to carry the second floor of the house he was building. Salvaged timber, while available, was expensive, and new timber might warp and shrink too much. His solution? Glulam.

Spier has used plenty of engineered-wood components. "They all have different strengths and weaknesses," he says. "Glulams are expensive and take quite a while to order, but they can be finished nicely (photo far right). So for anything exposed, a glulam is the obvious choice. LVLs are built up, and I can get them in nice long lengths. They're very strong, and the companies will do the engineering work for me. A Parallam is kind of an ugly thing, but I can get it treated for use on exterior porch applications. It's very heavy but quickly available in my area, and it comes in big sizes."

Hank Fotter, a builder in Litchfield, Connecticut, disagrees with Spier about the looks of Parallam. He chose Parallam for an exposed use in his own dining room because he liked the way it looked (photo above). "I'm a convert," he says of engineered beams. "It's obvious to everyone that lumber is horrible coming off the truck." Fotter adds that its ability to eliminate drywall cracks and similar problems makes engineered lumber easy to sell to his customers.

But not everyone is on the bandwagon. Leo Ojala, a builder in western Massachusetts, uses as little engineered wood as possible. Past employment with a manufacturer of stress-skin panels left him with a chemical sensitivity to resins and adhesives used in

design values. The downside: Engineered beams may cost three times as much as Douglas-fir dimensional lumber.

For manufacturers, engineered lumber represents a market opportunity just as supplies of tight-grained, old-growth timber dwindle and complaints about inferior fast-growth timber increase. Engineered wood turns spindly second- and third-growth timber—the very stuff many builders have learned to hate—into reliable framing material. Although not all green builders embrace the trend (sidebar above), high-tech manufacturing and materials make it possible to conserve timber by using species that are otherwise unsuitable for framing.

A variety of wood species can go into engineered framing lumber. But because it's manufactured with specific design values in mind, the particular species doesn't matter much to the builder. Dan Harris, director of a Trus Joist training center, compares it to buying Kentucky Fried Chicken: "It's like the Colonel. You're buying that piece of chicken, and it better taste the same every time. All the manufacturers test their stuff. Regardless of the species, the strength is there."

Glulam: High strength in a decorative package

Glulam is stacks of dimensional lumber glued together like a wood sandwich. Where boards of one lamination meet end to end, manufacturers use finger joints for added strength. In the eastern United States, glulam usually is made of southern yellow pine, which is stiff, strong and plentiful. In the West, Douglas fir and larch often are used,

Photo this page: Brian Vanden Brink

"Is it a good use of forest products? Maybe, from one point of view."

engineered-wood products. He also worries that offcuts and job-site waste present serious disposal problems.

Although he's impressed with engineered lumber's strength and the fact that these products conserve diminishing natural resources, Ojala isn't swayed. "Is it a good use of forest products? Maybe, from one point of view. But if we're loading them up with glue and chemicals that are going to be omnipresent, are we doing a good thing? I don't know."
—S. G.

Exposed Parallam. *A Connecticut builder liked the look of finished Parallam enough to leave the central girder and ceiling joists exposed in his dining room.*

Glulam is a traditional choice for exposed framing. *Rounded edges and a nice finish leave glulam looking good enough to use as an architectural feature.*

but other species also can be ordered. Glulam is graded for appearance and strength, and it can be pressure-treated for exterior use.

More than three dozen forest-product companies make glulam. (For manufacturers, see the Web sites of the American Institute of Timber Construction at www.aitc-glulam.org and of The Engineered Wood Association at www.apawood.org). Glulam can be ordered in curved shapes to support a serpentine deck or in arches for ceilings. Stock widths run from 3⅛ in. to 6¾ in., including both 3½ in. and 5½ in. to make them compatible with 2x4 and 2x6 framing. Glulam also can be custom-manufactured to just about any width and height.

In a simple span—that is, when a glulam spans an opening with no intermediate supports— it gets much of its strength from the bottom layer, or tension lam. Here, The Engineered Wood Association recommends what the industry calls an "unbalanced" beam. Unbalanced beams use laminations with different bending stresses for the compression (top) and tension (bottom) layers. Unbalanced glulam beams have a definite top. Where either the top or bottom may be stressed in tension, as in a cantilever, manufacturers recommend balanced beams, which are symmetrical in lumber quality.

Glulam is made of visually graded or, less frequently, mechanically stress-tested stock. By carefully selecting individual laminations, manufacturers can tweak design strengths to suit different structural loads. A stock glulam will deflect sooner than either PSL or LVL. However, beefier versions, such as the Power Beam from Anthony Forest

Photo right this page: Courtesy of APA-The Engineered Wood Association

The engineers' job site: inventing a better glulam

Current engineered beams are basically combinations of wood and glue, but more advanced products are on the way. One is a glulam supplemented with a layer of fiber-reinforced polymer.

Habib Dagher, director of the Advanced Engineered Wood Composites Center at the University of Maine, says reinforced beams offer greater span ratings and use less wood fiber than conventional glulam beams. Dagher and his colleagues are among a number of researchers around the country who have been working on these hybrids. The beams have been used on several bridge projects, and Dagher expects the know-how eventually will find its way into the residential-construction market.

Most glulam failures, he says, occur at or near the bottom lamination—the part of the beam under tension—either because a finger joint ruptures or because a defect in the wood weakens it. Replacing that lamination with a fiber-reinforced polymer layer sharply reduces the problem. The research center has experimented with Kevlar and carbon fibers and a variety of resins, epoxies and thermoplastics.

If only 1.5% of the beam's depth is replaced with a polymer layer, the beam's strength roughly doubles. Stiffness goes up by another 15% to 20%. Consequently, a smaller beam can carry the same load as a regular glulam. Because fiber reinforcement is expensive, however, hybrid glulam starts to become cost-effective only at longer spans. Still, Dagher's work points to a new generation of engineered products that will be more sophisticated than a simple combination of wood fiber and glue.

—*S. G.*

Fresh from the lab and headed for market. *This new glulam looks different because it's made of variable-size waste hardwoods instead of stock 2xs.*

Products (800-856-2372; www.anthonyforest.com), have higher design values to compete directly with other types of engineered beams.

LVL: A radical departure for the forest-products industry

Trus Joist wasn't thinking beam or header when it developed laminated veneer lumber in 1970. Originally, Trus Joist designed its trademarked Microllam as flange material for the company's wood I-joists. At the time, LVL was expensive, and the company didn't think it had much potential as a stand-alone product, Trus Joist's Harris says. Later, the company paired LVL beams and I-joists to give builders a fully engineered floor system, and LVL took off. LVL is manufactured by a dozen companies now, and roughly half of it goes into I-joists.

LVL is a lot like plywood. Thin veneers of southern yellow pine, Douglas fir or other species are glued together to form a billet that can be cut to finished lengths and widths. Unlike plywood, though, the grain of the veneer runs in the same direction. Like other engineered-wood products, LVL doesn't shrink appreciably because the wood used to make it is dry when it's manufactured. LVL beams are straight, are essentially defect-free and have consistent design values—all the qualities that dimensional framing material seems to lack.

Stock LVL comes in a variety of thicknesses and heights. The standard thickness is 1¾ in., meaning that two LVL components must be joined in the field to create a single timber compatible with 2x4 framing. That makes them easier to handle but adds to labor costs. Other widths, from 3½ in. to 5½ in., are available. Depths range to 20 in.

Most LVL has a bending strength slightly higher than that of standard glulam. But unlike glulam, LVL is available only as straight timbers and is not designed for exposed or exterior use. On the job site, uncoated LVL is susceptible to cupping when it gets wet.

Strand technology produces two new kinds of engineered beams

By the late 1980s, MacMillan Bloedel was becoming worried about supplies of softwood veneers that could be turned into plywood and

Beyond the breaking point. *A polymer-reinforced glulam gets the ultimate stress test at the Advanced Engineered Wood Composites Center in Orono, Maine. The thin, dark polymer layer near the bottom roughly doubles the beam's overall strength.*

"If only 1.5% of the beam's depth is replaced with a polymer layer, the beam's strength roughly doubles."

LVL. It tinkered with ways of turning strands of wood fiber into lumber and invented two new types of engineered beams: parallel strand lumber (PSL), marketed as Parallam, and laminated strand lumber (LSL), which is sold as TimberStrand. Both still are protected by patents.

Although different in design and intended use, both of these structural components are manufactured by shredding trees into long strands and gluing the strands into larger structural components. Parallam starts with strands 2 ft. to 8 ft. long, arranged with wood fibers parallel to each other. They are bonded with an adhesive and run through a microwave to form beams up to 7 in. wide, 18 in. deep and 66 ft. long. Finished beams have a stiffness similar to that of LVL and high-strength glulam. Unlike LVL, however, Parallam can be pressure-treated with wood preservative for use outside. Untreated versions swell if they become wet.

TimberStrand, Harris says, originally was designed not for structural framing but rather as a replacement for pine molding and millwork. But when door and window manufacturers didn't nibble, MacMillan Bloedel and Trus Joist, which formed a joint venture in 1991, looked for other uses. Manufactured much like oriented strand board (OSB), TimberStrand is made from strands about 1 ft. long glued together to form sheets up to 8 ft. wide, 5½ in. thick and 48 ft. long. It then is milled into timbers in widths of 1¾ in. and 3½ in. and in depths of up to 18 in. Laminated strand lumber is not as strong (or as expensive) as parallel strand lumber.

Choosing an engineered beam: Price, availability and design

Glulam, LVL and PSL all can be manufactured to handle heavy loads and long spans, says Steve Zylkowski of The Engineered Wood Association. As a result, selecting a particular brand or type of beam probably hinges less on strength than it does on price, appearance (if the beam will be visible when the house is finished) and ease of installation.

Builders see a hefty difference in price between dimensional and engineered lumber. TimberStrand and LVL cost a lot less than Parallam or glulam but still more than sawn lumber. Parallam and glulam, which always cost the most, are the only options for high design values and exposed use, but their prices and availability vary too widely by region to offer a general rule for choosing between them.

When an engineered structural component will be visible in the finished structure, architectural-grade glulam is the traditional choice. But Parallam made to be left exposed also is available. Choosing between Parallam and glulam might boil down to local availability, price and the personal taste of the homeowner, engineer or architect who writes the specifications for the job.

Job-site handling is a factor as well. Laminated veneer lumber may never win a beauty contest, but it typically arrives on site in 1¾-in. wide pieces that are nailed together to form larger-capacity beams. That means smaller crews can handle LVL beams. Parallam and glulam, however, arrive as single components, making them heavier and harder to place.

Do you need engineered headers?

Engineered-wood components also are used as headers in door and window openings, especially for long spans. They shrink less than wide dimensional lumber, thus reducing cracks and nail pops in drywall at the corners of windows and doors. And insulated headers now are entering the market ("Tools & Materials," p. 114). But it's difficult to justify the higher cost for small openings unless the added dimensional stability is worth the extra money or unless the header carries an unusual load, such as a column supporting a structural ridge.

"You only want to use it for a larger-span structure, or something with a heavy load on it," says Ed Vanderhoef, a structural engineer in Cheshire, Connecticut. Headers up to 10 ft. long usually can be made less expensively with 2x material, he says. □

Scott Gibson, a contributing editor to *Fine Homebuilding*, lives in Steep Falls, ME. Photos by Scott Phillips, except where noted.

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