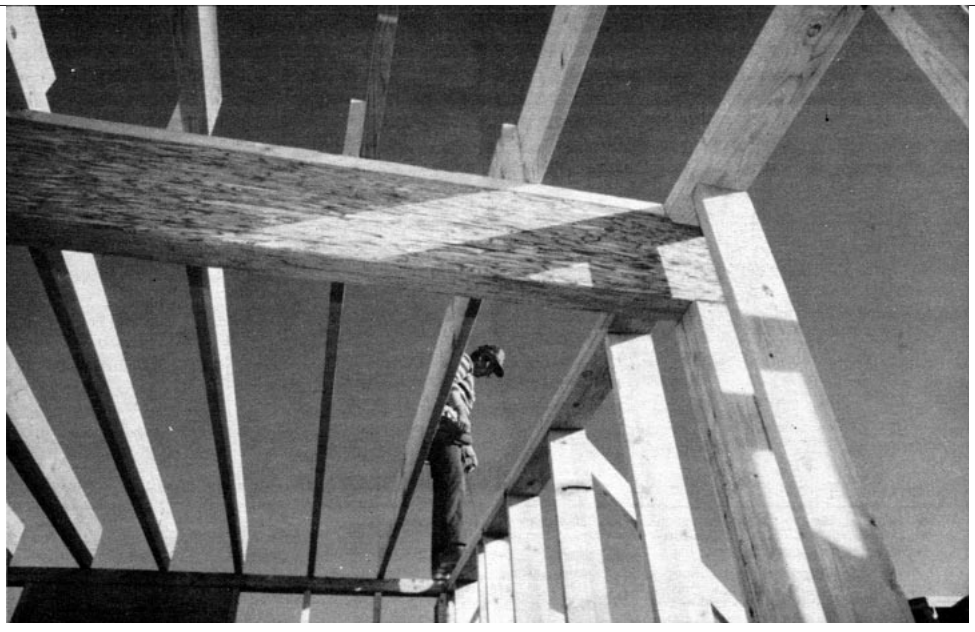


MacMillan —Bloedel

Engineered Beams & Headers

by Clayton DeKorne

Engineered lumber can support greater loads and longer spans, but good performance requires proper handling and detailing

Many new homes boast wide open floor plans and all sorts of architectural bric-a-brac — cantilevered decks, wild roofs, lofts, balconies, popout dormers. These features create complex loading conditions that are often difficult to support with solid-sawn timbers or beams built up from dimensional lumber. As a result, more builders are turning to the higher strength and stiffness of engineered structural wood products, including glulams, laminated veneer lumber, Parallam, and Arrowood.

Practically all the manufacturers of engineered lumber products provide technical support to both the distributor and the guy on site. This support includes span charts and installation details, computer software for sizing beams, and a staff of on-line engineers and technical field reps.

To use these materials successfully, however, requires more than just the right engineering specs. It also requires knowledge of ordering, storage, handling, and connections. Each material is managed very differently on site. Here's a look at several beam materials, based on the recommendations of the manufacturers and the experiences of a number of builders.

Glue-Laminated Timber

Glulams seem to fall into two categories for residential builders — exposed and enclosed members. Many builders think of glulams primarily as replacements for solid-sawn timbers in exposed applications, such as ridge beams, purlins, and headers. But according to Jim Walsh of Bohemia, 85% of the glulams they sell to residential contractors are used for concealed floor girders and garage door headers.

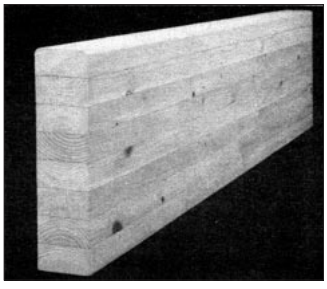
Glulam grades. Glulams come in three appearance grades — industrial, architectural, and premium. Builders often confuse these grades with structural grades of lumber, but they have nothing to do with the strength of a glulam, only its finished appearance.

Industrial-grade glulams are planed to a uniform dimension after coming off the press, but are otherwise left unfinished. This grade is sometimes referred to as a "non-appearance grade." The wood has checks, knot holes, and press marks, and some may have one resawn face.

Architectural-grade glulams have been sanded on all four sides, the edges have been eased over, and large blemishes have been filled with putty. These beams have been sanded, but they may need touching up with a belt sander to take out dings and banding marks. If the member is used as a column or is at eye level, you can go over it with an orbital sander to eliminate sanding marks.

Premium-grade is something of a misnomer, because it is easily confused with premium-grade lumber. In glulams, "premium" signifies that every defect down to the smallest check has been filled with putty. If you expect a clear, unblemished, unputtied finish, you'll need to custom-order the stock from the manufacturer and pay a substantial premium.

Appearance-grade glulams are delivered in a watertight wrapper to protect the finish. Most manufactur-



Bohemia

***Glulams** are made from carefully selected lumber glued face to face with a rigid, exterior glue. The laminations are finger-jointed to just about any length, and stacked to just about any height — making big beams that will carry almost any load.*

ers recommend slitting the underside of the wrapper to allow condensation and any water that gets in to escape, but otherwise leaving the wrapper on until the building is closed in.

But builder Dennis Hunt of Argyle, N.Y., cautions against leaving the wrapper on at all. He explains that any water that leaks in will be held by capillary action against the wood. This will raise the grain and stain the surface. He also warns that the wrappers are slippery to climb around on.

Glulams are manufactured with lumber dried to a 12% to 16% moisture content, which is where wood in buildings usually equalizes. As a result, glulams are dimensionally very stable. Some seasoning checks may open up on the ends, or parallel to the grain on the sides of beams, after finishing. Seasoning checks won't compromise a beam's structural performance, but they might not look too good. Manufacturers offer these suggestions to reduce checking and preserve the finished surface:

- Keep beams covered but allow the wood to breathe.
- Keep the beam off the ground, even if the wrapper is still on.
- Keep beams out of direct sunlight to prevent tanning.
- Keep beams from extreme or rapid drying. This may mean protecting them from strong drying winds and not storing them near heaters or on hot paved surfaces.
- Avoid sudden humidity changes. This may mean you have to dehumidify a space when plaster or joint compound is drying.
- Seal the beams as soon as possible after unwrapping, and seal any new cuts immediately.
- If possible, condition the beams by allowing them to slowly acclimate to the interior of the building. This may take weeks or even months, depending on the size of the beam.

Residential size glulams. Recently, manufacturers have been marketing glulams designed to replace conventional header stock. At least two manufacturers, Bohemia (PO Box 277, Saginaw, OR 97472; 503/942-4473) and Weyerhaeuser (Tacoma, WA 98477; 800/525-5440) make glulams sized to fit standard framing widths ($3\frac{1}{2}$ and $5\frac{1}{2}$ inches) and carry residential loads. (Design values are set at about Fb = 1,700 psi and E = 1,800,000 psi.) These beams are available in standard lengths up to about 24 feet.

By contrast, stock glulams have a higher stress rating (Fb = 2,400 psi and E = 2,000,000 psi) and come in sizes that are narrower ($3\frac{1}{8}$ and $5\frac{1}{8}$ inches) than 2x4 and 2x6 wall framing.

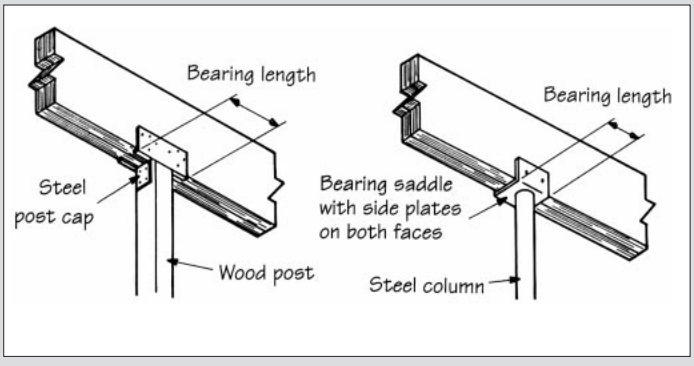
Camber. Most big glulams other than residential headers are built

Making Connections

Trus Joist Corp.

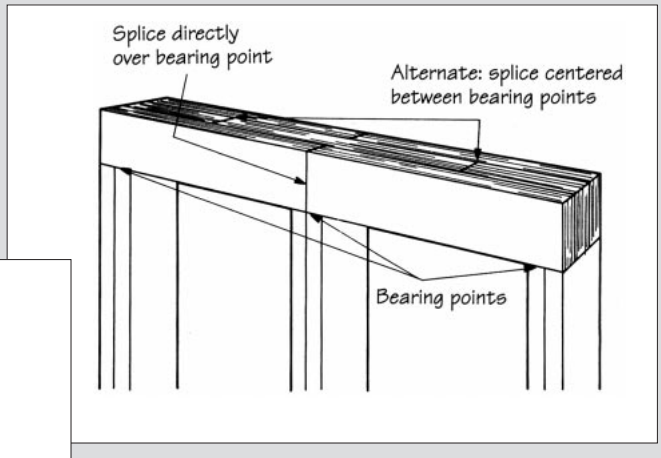
◀ ***Beam pockets.*** Codes require you to protect untreated foundation beams from concrete. They specify either a $\frac{1}{2}$-inch separation from all concrete surfaces or some kind of vapor retarder between the wood and the concrete. Bill Smith of Great Barrington, Mass., uses a piece of foam sill seal on the concrete and sets the girder on a pressure-treated block. Dennis Hunt of Argyle, N.Y., saves scrap pieces of Ice and Water Shield from previous roofing jobs, and uses these to wrap the beam end. Bill Bolduc of MacMillan-Bloedel recommends building a box out of pressure-treated ply to use to form the pocket. The bottom of the box can be made from pressure-treated 2x.

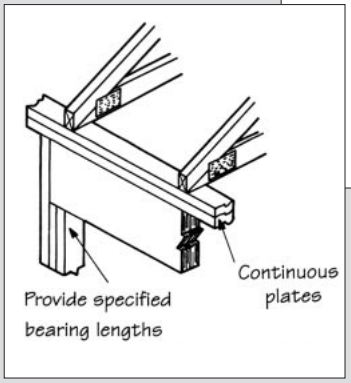
Beams should never be grouted into the pocket. If there is good bearing on the foundation, a floor girder will be held securely in place by the compressive load. Rotational forces are resisted by continuous bracing along the top edge. In most cases, this bracing is joists that either lap over the beam and are toenailed to the top edge, or, in a flush beam, butt each face of the beam. In areas with severe wind loading or seismic conditions, a steel anchor strap may need to be buried in the concrete and secured to the beam ends.



◀ ***Post caps.*** Load-carrying beams must have a minimum bearing length at each support. For this reason, most manufacturers of engineered lumber recommend steel post caps for wood posts or a steel post with a bearing saddle for full support. At the very least, wood posts should be toenailed and should support the entire width of the beam.

Splices. Splices between ▶ plies should be staggered and should fall within the supported bearing length of a post. If this isn't possible, the splice should fall in the middle between supports. Too often the splice is placed just slightly off bearing where it can shift, causing the beam to sag.





◀ ***Header connections.*** Headers should be supported by enough trimmers on each side to provide the correct bearing length. In addition, the top plates should run continuously over the header if possible, and lap the wall by at least 32 inches to tie the header and wall together.

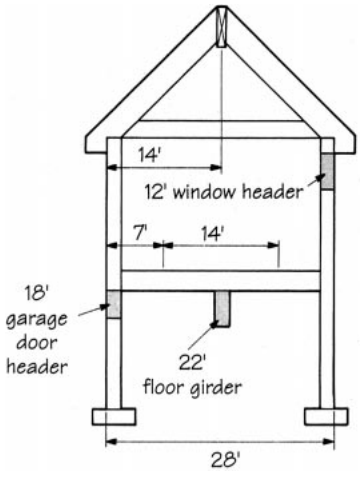
—*CD*

Sizing Up Beams

The chart below shows three typical beam applications in residential construction — a window header, a garage door header, and a floor girder. For each load condition, we've compared four options — dimensional lumber, glulam, LVL, and Parallam.

For clear spans up to 12 feet long under roof loads up to about 420 pounds/linear foot, built-up lumber beams are a reasonable choice. For the longer *clear* spans, engineered lumber is the only option, since dimensional–lumber beams require a center post.

The costs in the chart do not include the labor for laminating multiple lumber pieces, or for shimming thin pieces.



Roof load: LL = 20psf DL = 10psf
Floor load: LL = 40psf DL = 10psf

12' Window Header (420 plf)

	Beam Size	*Cost/LF**	*Remarks*
Doug fir (1,200F, 1.3E)	triple 2x12	$3.75	Clear span
Glulam (2,400F, 1.8E)	3 1/8 x 10 1/2	$4.00	Industrial-grade, clear span
LVL (2,800F, 2.0E)	double 1 3/4 x 9 1/2	$4.40	Clear span
Parallam 269 (3,100F, 2.1E)	2 11/16 x 9 1/4	$3.45	Clear span

18' Garage Door Header (770 plf)

	Beam Size	*Cost/LF**	*Remarks*
Doug fir (1,200F, 1.3E)	quadruple 2x12	$5.20	Requires two 10-foot lengths with center post
Glulam (2,400F, 1.8E)	3 1/8 x 16 1/2	$8.00	Industrial-grade, clear span
LVL (3,100F, 2.0E)	double 1 3/4 x 18	$12.20	Clear span
Parallam (2,900F, 2.0E)	3 1/2 x 18	$8.70	Clear span

22' Floor Girder (700 plf)

	Beam Size	*Cost/LF**	*Remarks*
Doug fir (1,200F, 1.3E)	quadruple 2x12	$5.00	Requires two 11-foot lengths with center post
Glulam (2,400F, 1.8E)	5 1/8 x 18	$11.00	Industrial-grade, clear span
LVL (3,100F, 2.0E)	triple 1 3/4 x 16	$15.70	Clear span
Parallam (2,900F, 2.0E)	5 1/4 x 16	$11.50	Clear span

*Material cost only. Average national pricing, no minimum order

with a *camber*, or slight upward bow, for strength. It's usually a very slight curve with about a 10,000-foot radius. On long members it's only as noticeable as a small crown on a rafter. For most applications, the camber requires no special alterations to the rest of the framing.

It is important, however, to pay attention to which side is up. A glulam manufacturer will often put a premium structural grade of lumber for added strength on the tension side of a cambered glulam. The top is usually well labeled on the outside of the wrapper or stamped on the top edge of the beam.

Connection details. Most connections for engineered lumber beams aren't much different than conventional framing connections. The difference lies primarily in the size of the connector and the strength of the steel. But because the loads are often much greater in an engineered-lumber beam, the need to get the details right is more important (see "Making Connections," page 25).

Glulam connections are usually made with through-bolted steel gussets and brackets, or off-the-shelf nail-on clips and hangers.

Nail-on connectors are most common for enclosed framing, while exposed beam connectors are often custom-made. In either case, it's worth sketching out your plans with a technical rep for help with hardware specifications.

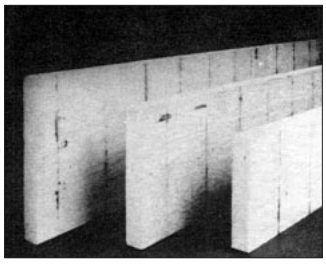
Hunt points out that distributors can sometimes offer hardware at prices way below a custom metal shop. A few hangers for a simple roof might easily cost $35 to $40 apiece from a metal shop. But a retailer ordering in bulk can get the same hangers made for $3 or $4 each, and he'll probably pass some of the savings on to you if you buy his beam stock, says Hunt. In addition, distributors might also offer a pre-cut package, including pre-drilled holes and hardware.

When concealed connections are needed, *splice plates* or *split-ring connectors* are often used. Toenailed lag screws are not recommended. Lags are not strong enough in the end-grain, or diagonal to the grain, to hold the loads a carrying beam usually sees. Lags, however, are sometimes used with face-plates screwed straight into the face grain.

Heavy members. Large glulams are heavy. Hunt claims a 5-inch-thick, 12-inch-deep beam that's 25 feet long is the most his crew can maneuver by hand. Above this size, a backhoe or crane is needed to set the beams into place. To avoid this complication, more and more builders are turning to thinner material.

Laminated Veneer Lumber

On most residential job-sites, laminated veneer lumber (LVL) has displaced both steel and glue-laminated timbers in "big span" applications. The advantages are obvious. You don't need a crane or a welder. The most common material comes in thin, 1 3/4-inch plies that are lightweight and easy to handle. The clips, hangers, and other connectors are readily available and behave much like conventional lumber hardware. And, as demand increases, more lumberyards are stocking LVL.



Trus Joist Corp.

***Laminated veneer lumber**, such as these Micro-Lams, is made from 1/8-inch-thick veneer plies glued together. The grain of each ply runs absolutely parallel along the length of the beam, giving the wood higher strength values than dimensional lumber.*

Specific sizing. But while LVL handles a lot like conventional lumber, manufacturers are quick to caution that it's not the same stuff. First, it must be sized for specific load conditions. It can't be easily substituted on site or used as a standardized material. "If changes or substitutions are made, a builder has to keep going back to the span charts, or, better still, come back to the distributor for engineering support," says John Dawick of Louisiana Pacific's Gang-Lam division.

That recommendation might disappoint builders who want a material they can develop a "framer's intuition" for. But at least the manufacturer isn't asking builders to "consult an engineer" with the expectation that they will have to bear an additional cost. That service is readily available from the distributor and has already been covered in the cost of the material.

Moreover, as Mike Baker of Alpine Structures Inc. cautions, "LVL isn't the 'super wood' it's sometimes made out to be." According to Baker, overspanning can be a problem, and he claims to have seen numerous installations where the load carrying capacity was greatly exaggerated in the field.

At this point, most of the LVL products on the market have similar design values (Fb = 2,800 psi and E = 2,000,000 psi). Gang-Lam brand LVL has slightly higher values (Fb = 3,100 psi and E = 2,100,000 psi). In the future, Baker claims, manufacturers will be offering LVL with lower values as they "fine tune the resource base." As this happens, it will become increasingly important to know what you've got.

Laminating on site. According to several manufacturers, the most

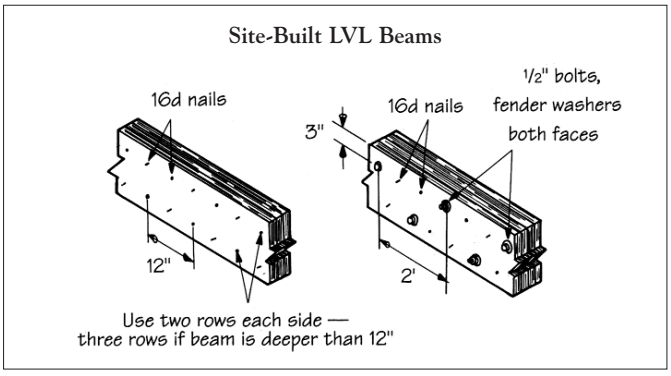


Figure 1. ***Nailing schedule for laminating LVL.*** *For laminating up to three 12-inch-deep plies (left), nail two rows of 16d nails spaced 12 inches on-center. The rows should be nailed from both sides with the spacing staggered. For 14-inch or deeper plies, use three rows of 16d nails spaced 12 inches on-center. For laminating four or more plies (right), use through bolts staggered every 2-feet, in addition to the regular nailing.*

overlooked LVL connection is between plies. Manufacturers are very specific about the nailing schedules for fastening plies (see Figure 1).

Note that the nailing between plies doesn't rely on any glue. Manufacturers are reluctant to recommend on-site glue bonds because it's too difficult to control the quality with structural glues, such as resorcinol or phenolic resin. And elastomeric adhesives, such as PL 400, will deform under heavy loads.

The manufacturers I surveyed all claim that the most common error they see with LVL is insufficient nailing when the beam is *sideloaded*. Sideloading occurs when joists are hung on only one side of the beam. If the plies are not well-connected, most of the load will be carried by only one ply. When the recommended nailing schedule is followed, this isn't a problem.

Another common error is drilling and notching beams. LVL should never be drilled or notched for electrical and plumbing pass-throughs. For that matter, neither should any girder, header, or other single-member beam. Compared with repetitive members such as joists and rafters, the shear forces are more concentrated in a single-member beam. As a result, the center portion of the beam section is extremely important.

Dimensional stability. As manufacturers are quick to claim, LVL has greater dimensional stability than common framing lumber. But while this is true in a general sense, the most common complaint I heard from builders had to do with cupping. Of the builders I spoke with who had used LVL, seven out of ten reported some incidence of cupping.

LVL cups most often when it is stored on the ground and picks up moisture from the soil (see Figure 2). Therefore, manufacturers stress that LVL must be stored on blocks and covered from weather. Builder Bill Smith of Great Barrington, Mass., recommends ordering a roll of house wrap to use as a material cover before it goes on the house. Smith recommends leaving the ends of the pile open to allow any wet material to dry out.

Smith and others have reported that LVL is often received wet. In this case, the material starts to cup as soon as the sun comes out and one face begins to dry and shrink. Even though manufacturers send out wrapped pallets of material, these get opened by distributors. Stocking yards, in particular, are notorious for delivering wet material.

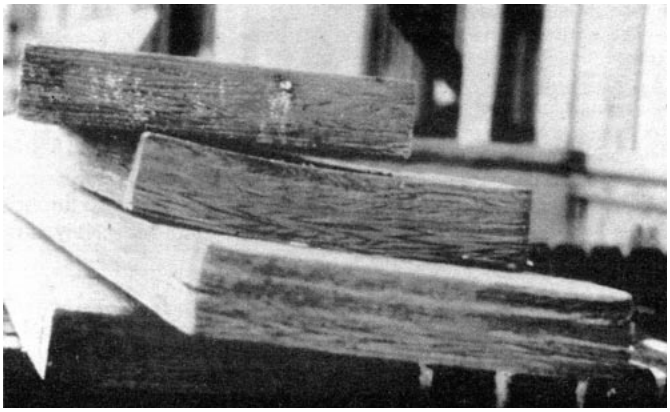


Figure 2. *LVL is manufactured at a low moisture content and is prone to cupping if one face gets significantly wetter than the other. To prevent this requires careful storage in the yard and on site.*

Smith recommends that if your supplier is careless about covering material, you should insist on selecting your own beam stock and should pull sticks from the middle of the bundle. But, he points out, this defeats the purpose: One of the reasons he likes using engineered lumber is that its consistent quality is supposed to eliminate this time-consuming trip to the yard.

Cupped LVL is especially troublesome when nailing together multiple plies. John Dawick of L-P's Gang-Lam division insists that the worst thing you can do is try to draw cupped pieces together with clamps or through-bolts. He recommends waiting several days until the wood has a chance to dry out and come back to its original shape before you wall it in. Dawick says LVL is fairly forgiving stuff, and a few rain showers before the building is enclosed won't be a problem.

Several LVL manufacturers are now making a more stable, 3 1/2-inch-thick material. Manufacturers include Boise-Cascade (PO Box 2400, White City, OR 97503; 800/232-0788), Louisiana-Pacific (111 SW Fifth Ave., Portland, OR 97204-3600;800/999-9105), and Truss Joist Corporation (PO Box 60, Boise, ID 83707; 800/338-0515). Meanwhile, still other manufacturers have turned to entirely different technologies to produce dimensionally stable beam stock.

Parallam

Parallam (MacMillan-Bloedel Ltd., 436 E. Dougherty St., Athens, GA 30601; 800/552-4775) is available in thicknesses from 1 3/4 to 7 inches, so depending on which size you spec, it's handled either like LVL or glulams.

Parallam seems to solve several problems associated with the other materials. Builders report it comes off the truck more dimensionally consistent than glulams and LVL, and remains much more stable than LVL. Out of eight builders I surveyed who had used Parallam, no one reported any evidence of cupping or twisting. And because it comes in thick, solid sections, sideloading can be avoided.

Distributors I called unanimously agreed that they don't worry about callbacks with Parallam the way they do with LVL. Those who sell other engineered products in addition to Parallam report that Parallam sales are now outnumbering LVL sales by as much as four to one.

Parallam has recently introduced a 2 11/16-inch-thick member, dubbed "Parallam 269," with higher design values (Fb = 3,100 psi, E = 2,100,000 psi). This thickness fits well in conventional framing. Two plies match 5 1/2-inch walls. One ply is easily shimmed with 1x2s or 3/4-inch plywood to fit 3 1/2-inch walls. Parallam 269 seems to fit residential budgets, too (see "Sizing Up Beams," previous page).

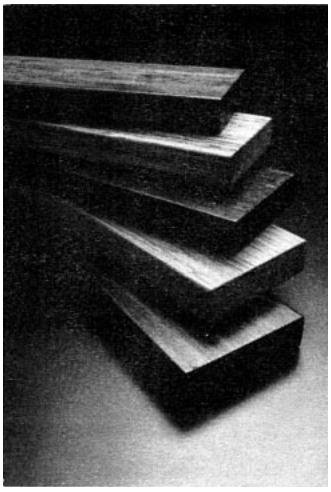
I had to really press builders to find anything wrong with Parallam, and turned up only two minor gripes. First, cutting Parallam dulls steel blades faster. Carbide blades are recommended. Second, builders say that large Parallam beams are heavier than equal size glulam or solid-sawn timbers. The manufacturer responds to this complaint by offering Parallam in a variety of sizes, so builders have the option to use several thinner plies. But, as with dimensional lumber and LVL, multiple-ply beams are usually fastened together on the deck and lifted into place in one piece. If this is the case, it makes sense to use a solid dimension material.

Arrowood

Arrowood (Fibreboard Technologies, 1000 Arrowood Dr., Roxboro, NC 27573; 800/331-8039) isn't quite as versatile for big-span beams as glulams, LVL, and Parallam. The 1 1/2-inch material is used most often for repetitive members, such as joists and rafters, but it deserves a mention as an up-and-coming beam material.

Arrowood handles like dimensional framing material, so it's easy to substitute for conventional lumber. Arrowood is slightly stronger than dimensional lumber, but not enough to drastically increase header spans (Fb for single members 1,950, E = 1,600,000 psi). Fibreboard Technologies has recently added a one-piece, double-web header with 3 1/2-inch flanges that can be used for single-piece window and door headers spanning up to about 12 feet.

The key advantage to Arrowood, according to Bill Smith, is its consistent quality. On a recent project he



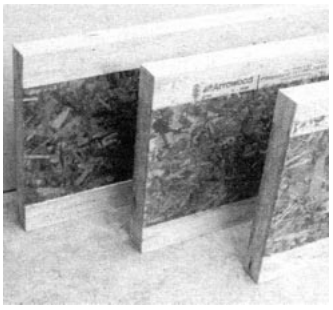
MacMillan—Bloedel

Parallam *is made from hundreds of matchstick-like strands of Douglas fir and southern yellow pine that are covered in glue and then pressed into a huge "parallel strand" billet. The billet is then sawn into different dimension beams. Pressure-treated Parallam is also available for exterior applications.*

used Arrowood for a flush floor girder. On the same project, Smith used 2x12 Micro-Lam brand LVL, which he claimed varied in height from 12 to 12 3/16 inches (it's sold as 11 7/8 inches). The 2x10 Arrowood pieces were consistent in height to within 1/16 inch.

Arrowood is a bit heavier than conventional lumber — about as heavy as a comparable-size piece of wet Doug fir, says Smith. The only criticism he voiced is that his crew had to wear gloves to protect from splinters from the LVL flanges. ■

Clayton DeKorne is an associate editor with The Journal of Light Construction.



***Arrowood** was developed in the 1970s by the U.S. Forest Service to use lumber resources efficiently. Arrowood functions much like a wood I-joist, but it has a solid 1 1/2-inch OSB web with LVL flanges.*

For More Information

In addition to the manufacturers mentioned in this article, there are numerous glulam and LVL manufacturers that distribute on a local or regional basis through lumberyards. The American Institute of Timber Construction (AITC, 11818 S.E. Mill Plain Blvd., Suite 415, Vancouver, WA 98684-5092; 800/525-1625) and the American Wood Systems, an affiliate of the American Plywood Association (AWS, PO Box 11700, Tacoma, WA; 206/565-6600) serve as trade associations to the glulam industry. At present there is no trade organization for the LVL industry.

Hardware sources. The following companies make off-the-shelf hangers, clips, tie-downs, and plate connectors for connections to conventional timbers, glulams, LVL, and other engineered wood products.

Cleveland Steel Specialty Co.
14430 South Industrial Ave.
Cleveland, OH 44137
800/251-8351
800/686-8351 (in Ohio)

Simpson Strong-Tie Company Inc.
PO Box 1568
San Leandro, CA 94577
800/227-1562
800/492-3922 (in S. Calif.)

Teco
Colliers Way
Colliers, WV 26035
800/438-8326 (for eastern U.S.)
800/221-7905 (for western U.S.)
800/221-7906 (in Calif.)

United Steel Products (Kant Sag)
703 Rogers Dr.
Montgomery, MN 56069
800/328-5934