Building With Glulams

by Eliot W. Goldstein


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For long spans and heavy loads, stock and custom glued laminated timbers are an attractive alternative to steel

Higher lumber prices and labor costs for stick framing have led me, like many architects, to specify engineered lumber in more and more structures. Though wood I-joists and laminated veneer lumber (LVL) will do for many applications, glued laminated timbers, or glulams, are the only substitute for large, exposed solid timbers. In this article, I'll share some of what I've learned from ten years of using glulams for headers, joists, cathedral ceiling rafters, and exposed trusses.

Why Glulams?

Glued laminated timbers are made by face-laminating dry lumber of 1- or 2-inch nominal thickness under controlled temperatures and pressures. Glulams can be made to nearly any width, length, depth, or strength. And because their laminations are oriented horizontally, the fabricator can make them with nearly any curve or camber. As with any beam, most of the stresses on a glulam are concentrated along its top, or compression edge, and its bottom, or tension edge. (There's little stress along the beam's centerline.) But unlike I-beams, which derive their strength from their wide top and bottom flanges, glulams derive their strength from the higher-quality lumber used in the top and bottom laminations.

A glulam is a good choice when you can't get sawn lumber or an LVL in the size needed for a given span; when the structure doesn't give you enough depth for a solid sawn beam or girder; when you need a high-quality finished appearance; or when you have to support concentrated loads at midspan (a task that requires special engineering).

Ordering Glulams

I buy glulams only from manufacturers who belong to the American Institute of Timber Construction (AITC), since members must comply with stringent manufacturing standards. Beams from these companies are stamped with a label that outlines their structural characteristics. Glulams made by nonmember firms may or may not comply with these standards, so it may be impossible to determine their true strength.

Grades and materials. Several "appearance" grades are available. (Appearance is unrelated to strength.) From worst to best (and from least to most expensive), these are Industrial, Architectural, and Premium Grade. To save money, use the most economical appearance grade acceptable in each location, and prefinish only those members that will be exposed in the completed building (see Figure 1).


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Figure 1. *Use Architectural or Premium Grade glulams for exposed beams (left), and less expensive Industrial Grade for concealed beams (right).*

Douglas fir is the standard glulam material in the western United States. Southern pine is the most popular species in the East, though other species, including Doug fir, may also be available. Some fabricators make pressure-treated members for exterior use.

Stock glulams. On most residential jobs, the builder estimates the headers and beams needed as if they were sawn beams, then orders stock glulams of equivalent strength from the lumberyard. You can't go wrong by using an equivalent size, but since glulams are stronger than solid wood, you can probably use a smaller member. Consult a glulam span table, available from AITC (see "For More Information," at end of article). Straight stock glulams come in widths of 2 1/2 inches, 3 1/8 inches, 5 1/8 inches, 6 3/4 inches, 8 3/4 inches, and 10 3/4 inches. Depths are multiples of the lamination thickness. Thus, a member with eight 1 1/2-inch laminations (typical of straight beams) will have a total depth of 12 inches.

On a big job that requires a lot of glulams, it's a good idea to use the same size throughout whenever practical. If the plans show several glulams with slightly different sizes, ask the architect or engineer if you can use the largest size everywhere. This will raise material costs somewhat, but I've found that it saves money and time because it makes things a lot easier for the workers on the site.

Custom glulams. Stock glulams are fine for most simple headers and joists. But if you need beams that will span long distances or shoulder heavy loads (a heavily stressed girder, for example, or a set of flat roof joists that will carry a heavy snow load), it's better to send your plans to the fabricator, whose engineers can determine if you need a custom member. Unlike stock glulams, which are cut from perfectly straight, 60-foot lengths, custom members are made with a subtle camber. The camber approximates the anticipated long-term deflection, so that the beam will straighten, rather than sag, over time. Another advantage to getting a beam custom made is that the fabricator can make any custom connectors, and can predrill bolt holes and precut birdsmouths for rafters. Glulam hip rafters can even have their top edges beveled to receive roof decking — the shop will do a better job than you could on site. (Even if you would rather bevel the rafter yourself, it's a good idea to tell the fabricator what you're doing. They can place some additional high-strength laminations on the top of the beam so that you can bevel it without weakening it.)

Before making custom glulams, the fabricator will send you a set of shop drawings showing the overall size and shape of each member, as well as any cuts, bolt holes, or hardware. The drawings will also list the appearance grade and species, the glulam's design values, the adhesive used, and the finish or treatment.

The disadvantage of ordering custom is that you'll pay more and wait longer to get your beams. (I've seen lead times of up to three months.) It's best to get quotes from different suppliers, and to place your order before digging the foundation hole.


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Figure 2. *Unless your delivery truck has a boom, you'll need a crane to unload and place large glulams. Use slings to protect the beams.*

Handling and Assembly

Putting up one or two headers is no big deal. But if you're building a complex roof or a glulam addition (a solarium, for example), then good planning is crucial.

Make sure that the delivery truck can access the site, and find out whether it's a boom truck. If not, you'll need to schedule a crane to unload the beams. When lifting a glulam with a crane, always use slings to keep from scratching it (Figure 2).

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Figure 3. *Glulams come to the job site wrapped in protective paper. To prevent uneven weathering and stains, it's best to unwrap the whole beam at one time.*

Glulams normally come wrapped in a housewraplike material (Figure 3). Take the wrapping off of the whole beam before assembly. Otherwise, sunshine and moisture may cause uneven weathering between covered and uncovered areas. A partially open package also invites moisture to get inside. At the job site, all glulams should be stored on blocks and separated from one another with wood stickers. Of course, it's best to schedule the job so as to keep the beams out of the weather completely, which means the best time for a set of glulam rafters to arrive is the day you're ready to install them. The roof should be sheathed and papered immediately after the glulams are placed.

On complex jobs, carefully check all anchor bolt, column, and base plate layouts, making sure that everything will fit together the way it's supposed to. And make sure you understand the proper assembly sequence. On some glulam trusses, for example, the hardware used makes it necessary to assemble the small web pieces before finishing the chords. Make sure that the designations in the drawings match the marks on the glulams themselves. (These marks should be located so that they'll be concealed in the finished building.) Each connector and glulam should also be given the same mark as in the shop drawings.

Glulam frames must be braced during assembly and until the structural system, including the decking, is complete. Arrange temporary braces so that their fasteners don't mar the glulams' exposed faces. If there will be a lot of traffic during construction, protect the corners of posts and headers by taping on temporary guards made from wood strips or heavy cardboard.

When sheathing glulam rafters or joists, snap the centerline of each glulam on the sheathing before installation and keep your fasteners on these lines. This will keep the fasteners from splitting the edges of the glulam. When the job is finished, remove dirt and dust from exposed surfaces with a detergent that's appropriate for the particular finish (check with the fabricator).

Making Connections

Part of a successful glulam job is knowing what connections to make where. Glulams can be fastened to each other and to other parts of the structure in a variety of ways. Connector manufacturers make joist and beam hangers, column caps and bases, and saddle hangers specifically for glulams. Most of these fall into one or more of the following categories:

- ***Direct bearing connections,*** the most common type, are those in which one structural member bears directly on another — a beam on a column, for example (Figure 4). Fasteners merely hold the members together until the walls, floors, and roofs are framed and sheathed. Direct bearing connections are inappropriate for joints that must resist lateral loads or uplift, such as the eaves of a roof (T-plates at beam-column intersections are often used for this purpose).
- ***Indirect bearing connections*** are those in which a steel connector supports one member and transmits the load to the other member. These include joist hangers, saddle hangers, and column caps where the plate supporting the beam is larger than the top of the column. An oversized column cap is useful where a heavily

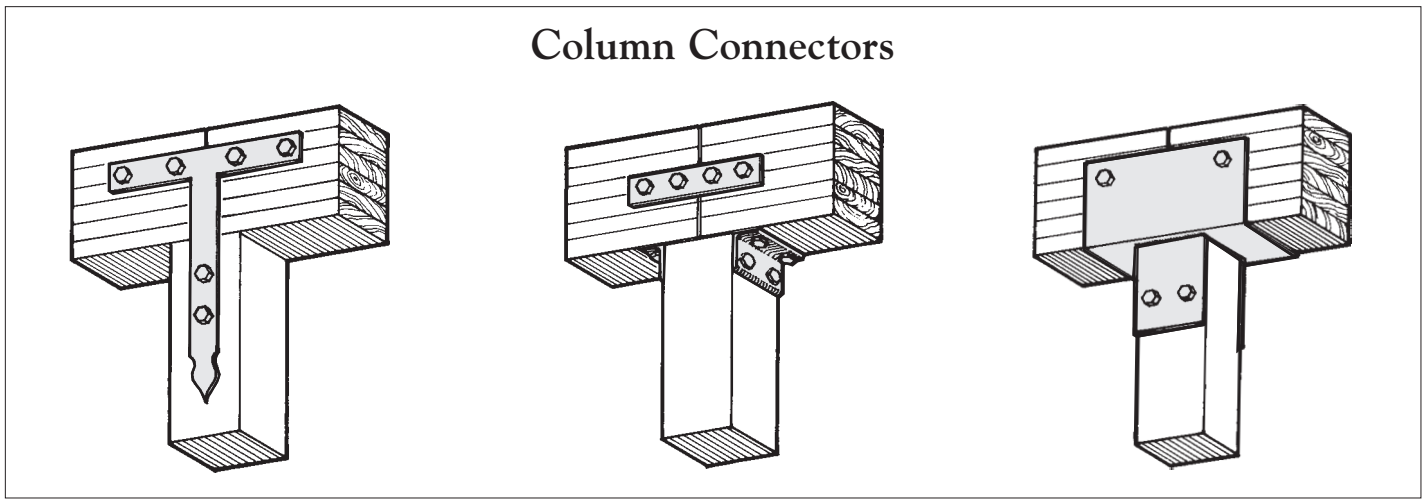

Figure 4. *T-plate connectors (left) provide alignment and resistance to uplift. Where two heavily loaded beams meet over a column, steel angles provide extra bearing while straps tie the ends together (center). Where a heavily loaded beam sits on a post, a welded steel U-plate spreads the load and prevents the beam's wood fibers from crushing (right).*

Figure 5. *In metal side plate connections, such as the ones at the top of this glulam post (left), the bolts must be adequately sized to transfer the loads to the metal plates. Cantilever connectors (right) are commonly used to join glulams end to end.*

loaded floor beam sitting on a 6x6 column might get crushed at the point of bearing. The column cap's plate prevents this by spreading the load over a wider area.

- ***Layered connections with wood side plates*** are those in which overlapping wood members are fastened through the zone of overlap — for example, where a jack rafter meets a hip. With large members like glulams, these connections should be fastened with through-bolts or lag screws, not nails. When the loads get very high, consider using split rings or shear plates. These spread the loads over a larger area than bolts alone. These connections must be engineered; they're made by the glulam fabricator using precision cutting tools.
- ***Layered connections with metal side plates*** are very common (Figure 5). The side plates are bolted in place through the glulam, and transfer loads from one glulam to another. Metal side plates are generally 1/4 inch or 1/2 inch thick, which makes the overall assembly relatively slim. This type of connection is particularly useful when a number of glulams converge at a single joint.
- ***Timber joinery*** is seldom used with glulams, because of the additional labor and engineering required (see "Nuts and Bolts of Timber Framing," 1/92). Besides, the loads that dictated that you use glulams in the first place are generally too high to be handled by traditional mortise-and-tenon construction.

Always use galvanized fasteners with glulams. Even an interior fastener could see excessive moisture during construction; if it rusts, it may stain the glulam.

Detailing for Moisture

Glulams are subject to many of the same moisture problems as sawn lumber. Here are some tips on how to compensate for them.

Moisture-related expansion. While glulams won't twist like solid timbers when exposed to moisture, they will expand, especially in width. Therefore, the pockets provided for them in steel connectors should be slightly oversized. An extra 1/8 inch to 1/4 inch is usually enough. This doesn't weaken the connection, since the bolt, not the plate, is what provides the connection's strength.

Never overtighten a bolt, or else it will crush the side grain of the member when the wood expands with moisture changes. Unless steel side plates are present, use washers on all bolts to prevent the bolt head and nut from crushing the wood fiber.

Drying-related checking. Most glulams pick up some moisture during construction. As they dry, they have a tendency to check; the bigger the member, the worse the checking. To minimize this, dry the building out as slowly as possible, especially if you have large exposed members. You might want to turn the heat up gradually by a few degrees each day, starting around 30°F.

Moisture absorption. Like sawn lumber, glulams will wick moisture from any damp surface they touch. Always leave at least 1/2 inch between a glulam (particularly its cut end) and any masonry or concrete. Steel shoes, column bases, and other connectors that might collect water during or after construction should have weep holes drilled in them.

When you cut a glulam, you should immediately seal the end grain with a water repellent. To prevent mistakes here, it's best to have as much of the drilling, cutting, and sealing as possible done in the shop. ■

Eliot W. Goldstein is a partner in the Goldstein Partnership in West Orange, N.J. He is the only architect on the American Forest and Paper Association committee that writes guidelines for engineered wood structures.

For More Information

The following organizations publish technical information on glued laminated timbers.

APA — The Engineered Wood Assn.
P.O. Box 11700
Tacoma, WA 98411
206/565-6600

American Forest and Paper Association
1111 19th St. NW
Washington, DC 20036
202/463-2766

Southern Pine Council
P.O. Box 641700
Kenner, LA 70064
504/443-4464

American Institute of Timber Construction
7012 S. Revere Pkwy., Suite 140
Englewood, CO 80112
303/792-9559

Western Wood Products Assn.
Yeon Bldg.
522 S.W. 5th Ave.
Portland, OR 97204
503/224-3930