APA Technical Topics
TT-011C JULY 2015

Connections for Built-up Glulam Beams

When a pair of glulam beams must be combined to carry a specific load, it is essential that the two glulam elements be connected in a manner that will permit the load to be shared equally by both beams. The 2015 International Building Code (IBC) provides guidance for lumber framing in Table 2304.10.1, Item 27, "Built-up girder and beams." Developed for nominal 2x framing, the attachment recommendations listed are not appropriate for members wider than 1-1/2 inches. The 2015 International Residential Code (IRC) also provides guidance for built-up girders and beams in Table R602.3(1), Item 27. This *Technical Topic* provides nailed connection information for 1-3/4-inch-wide glulam beams and bolted or lag-screw connection information for 3-inch and wider glulam. The guidance in this publication is based on the 2015 *National Design Specification for Wood Construction* (NDS) for loads applied perpendicular to the grain of the glulam members. For fasteners, loads, and directions of loading that are not covered herein, the designer should reference the NDS for guidance.

For the purpose of this publication, both glulam beams are assumed to be full length; have adequate lateral bracing to avoid buckling; have the same width, stiffness, and bending capacity; and have adequate bearing at supports to carry the applied load. The fastener edge distance is based on potential for reversed loading from wind or seismic loads.

Top-Loaded Applications: In a top-loaded application, load is applied perpendicular to the span of the built-up beam and parallel to the depth of the beams—e.g., a wall or post resting on the top of a built-up beam (Figure 1). Theoretically, if the load is bearing equally on both elements of the built-up beam and the elements are identical in strength and stiffness, the load should be equally distributed between both beams without any beam-to-beam connections. In reality, because the bearing and actual positioning of loads are seldom exactly as planned, and due to the natural variability in any manufactured product, a minimum connection between the glulam beams is necessary. This minimum attachment is provided in Table 1. It is important to note that this also serves as the **minimum** attachment requirement between a pair of beams for any loading conditions.

Figure 1. Top-loaded built-up glulam beams

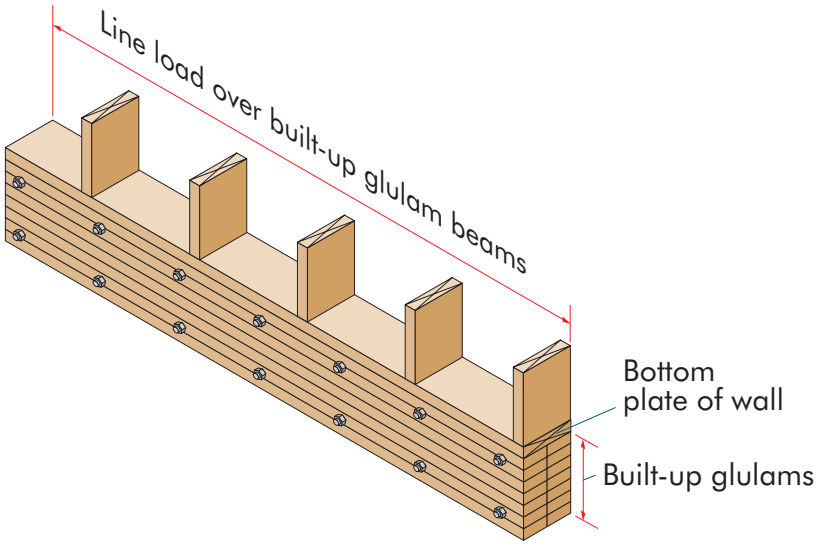


Table 1. Minimum connection requirements for top-loaded applications

Fastener	Two rows spaced at:
1/2-inch-diameter lag screws[a][f]	24 inches on center
1/2-inch-diameter bolts[b][f]	
12d common nails (0.148 x 3-1/4 inches)[c][d]	24 inches on center[e]

(a) Lag screws shall conform to ASTM A307 and have a minimum yield strength of 45,000 psi. Lag screws shall be of sufficient length to fully penetrate both glulam beams. For example, for two glulam beams of 3 inches wide, the lag screws shall be at least 6 inches long. Lag screws shall be equipped with cut washers and placed with a wrench via a **3/8-inch lead hole.** Lag screws **shall not** be driven into the beam with a hammer.

(b) Bolts shall conform to ASTM A307 and have a minimum yield strength of 45,000 psi. Bolt holes are recommended to be not more than 1/32 inch greater than the bolt diameter. Standard cut washers shall be used between head and nut of the bolt and the glulam.

(c) Nails shall conform to ASTM F1667 and have a minimum yield strength of 90,000 psi.

(d) 12d common nails (0.148 x 3-1/4 inches) are permitted for glulam beams not exceeding 1-3/4 inches in thickness. Nails may all be driven from one side.

(e) Spacing is derived from the 2015 IBC Table 2304.10.1 and the 2015 IRC Table R602.3(1).

(f) Bolts and lag screws shall be located a minimum of 4 times the fastener diameter (D) away from the glulam ends. In addition, bolts and lag screws shall be located a minimum of 4D away from the glulam edges, 5 percent of the glulam depth, or 1-1/2 inches (1-3/8 inches for southern pine glulams), whichever is larger. The distance between the outermost rows of bolts and lag screws shall not exceed 10 inches and 6 inches on center, respectively.

Side-Loaded Applications: When a load is applied to one side of a built-up glulam (Figure 2) or an unbalanced load is applied to both sides, the elements of the built-up beam shall be attached such that the applied load is distributed equally to all elements of the built-up glulam beam. Like the minimum attachment shown in Table 1, this connection is most often made with lag screws or bolts but may be made with nails for glulam beams 1-3/4 inches wide. The uniform load capacities of 1/2-inch-diameter bolts and 5/8-inch-diameter lag screws are given in Table 2 for a built-up beam composed of two beam elements, each 3 inches wide and wider. Table 3 gives the uniform load capacities of 12d (0.148 x 3-1/4 inches) common nails for built-up beams composed of two beam elements of 1-3/4 inches wide each. Connections for more than two beam elements are beyond the scope of this publication.

Figure 2. Side-loaded built-up glulam beams

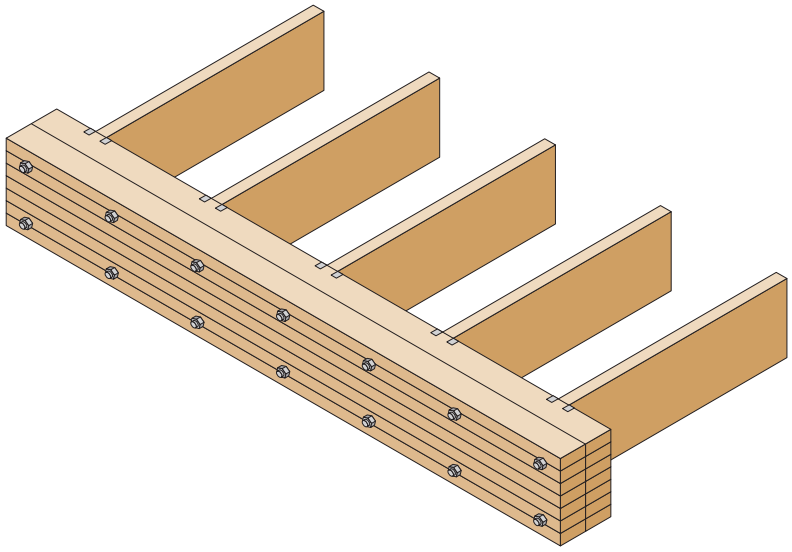


Table 2. Uniform load capacities of two-beam connections (side- or eccentrically-loaded) for 3-inch-wide and wider glulam (plf)[a]

	Two rows spaced at:[c]					
	24 inches on center			12 inches on center		
	Glulam species[d]					
Fastener[b]	SP	DF	SPF	SP	DF	SPF
1/2-inch diameter lag screws[e][g]	510	475	420	1,020	950	835
1/2-inch diameter bolts[f][g]	925	860	675	1,850	1,720	1,350
5/8-inch-diameter lag screws[e][g]	775	720	570	1,550	1,435	1,145
5/8-inch-diameter bolts[f][g]	1,120	965	760	2,245	1,930	1,520

(a) Capacities given are for two-beam (single-shear) connections under normal (10-year) load duration. The minimum width for each glulam beam element is assumed to be 3 inches. Increases for other load durations are permitted. For connections with more than two beam elements (e.g. double-shear), consult with an engineer/architect qualified in wood design.

(b) Use 5/8-inch-diameter bolts or lag screws when each glulam beam element is wider than 3-1/2 inches.

(c) Offset bolt or lag screw spacing so that protruding fasteners do not interfere with intersecting side members.

(d) The symbols used for species are DF=Douglas-fir-larch, SP=Southern pine and SPF=Spruce-pine-fir.

(e) Lag screws shall conform to ASTM A307 and have a minimum yield strength of 45,000 psi. Lag screws shall be of sufficient length to fully penetrate both glulam beams. For example, for two glulam beams 3 inches wide, the lag screw shall be at least 6 inches long. Lag screws shall be equipped with cut washers and placed with a wrench via a 3/8-inch lead hole for the 1/2-inch-diameter lag screws and a 15/32-inch lead hole for 5/8-inch-diameter lag screws. Lag screws shall not be driven into the beam with a hammer.

(f) Bolts shall conform to ASTM A307 and have a minimum yield strength of 45,000 psi. Bolt holes are recommended to be not more than 1/32 inch greater than the bolt diameter. Standard cut washers shall be used between head and nut of the bolt and the glulam.

(g) Bolts and lag screws shall be located a minimum of 4 times the fastener diameter (D) away from the glulam ends. In addition, bolts and lag screws shall be located a minimum of 4D away from the glulam edges, 5 percent of the glulam depth, or 1-1/2 inches (1-3/8 inches for southern pine glulams), whichever is larger. The distance between the outermost rows of bolts and lag screws shall not exceed 10 inches and 6 inches on center, respectively.

Table 3. Uniform load capacities of two-beam connections (side- or eccentrically-loaded) for 1-3/4-inch wide glulams (plf)[a]

	Two rows spaced at:											
	24 inches on center			12 inches on center			6 inches on center			3 inches on center		
	Glulam Species[b]											
Fastener	SP	DF	SPF	SP	DF	SPF	SP	DF	SPF	SP	DF	SPF
12d common nails (0.148 x 3-1/4 inches)[c]	255	235	200	510	470	400	1,025	945	800	2,050	1,890	1,600

(a) Capacities given are for two-beam (single-shear) connections under normal (10-year) load duration. The width for each glulam beam element is assumed to be 1-3/4 inches. Increases for other load durations are permitted. For connections with more than two beam elements (e.g. double-shear) or for beams of other widths, consult with an engineer/architect qualified in wood design.

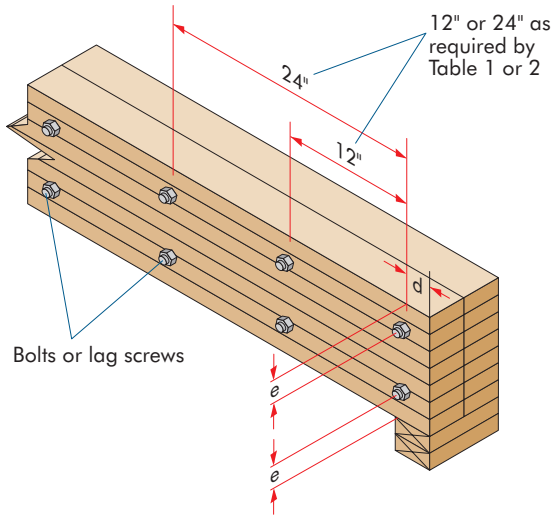
(b) The symbols used for species are DF=Douglas fir-larch, SP=Southern pine and SPF=Spruce-pine-fir.

(c) Nails shall conform to ASTM F1667 and have a minimum yield strength of 90,000 psi.

DESIGN PROCEDURE FOR SIDE-LOADED APPLICATIONS:

- Determine maximum uniform load (plf) on built-up beam by summing all uniform loads acting on the beam. Concentrated loads require special consideration. Consult with an engineer/architect qualified in wood design.
- Select glulam to carry this load based on manufacturer's recommendations.
- If two glulam members are required for a built-up beam, select an attachment schedule from Table 2 or 3 with sufficient capacity to carry applied loads.
- Bolts and lag screws shall be located a minimum of 4 times the fastener diameter (D) away from the glulam ends. In addition, bolts and lag screws shall be located a minimum of 4D away from the glulam edges, 5 percent of the glulam depth, or 1-1/2 inches (1-3/8 inches for southern pine glulams), whichever is larger. The distance between the outermost rows of bolts and lag screws shall not exceed 10 inches and 6 inches on center, respectively.
- If nails are used, place nails with sufficient end distance so as to not split the glulam beam (15 nail diameters recommended by the 2015 NDS Commentary for a 12d common nail = 15 x 0.148 = 2-1/4 inches.)

Figure 3. Bolt or lag screw installation details for built-up glulam beams



d = Minimum End Distance
For bolts or lag screws: 4 x bolt or lag screw diameter (2 inches for 1/2-inch-diameter bolt or lag screw and 2-1/2 inches for 5/8-inch-diameter bolt or lag screw)
For nails: 15 x nail diameter (2-1/4 inches for 12d common nails)

e = Minimum Edge Distance
For bolts or lag screws: 4 x bolt or lag screw diameter, 5 percent of glulam beam depth, or 1-1/2 inches (1-3/8 inches for southern pine glulam beams), whichever is larger
For nails: 15 x nail diameter (2-1/4 inches for 12d common nails)

Note: The minimum edge distance of 5 percent of glulam beam depth or 1-1/2 inches (1-3/8 inches for southern pine glulam beams) is intended to prevent the installation of bolts or lag screws in the outermost tension and compression laminations.

The distance between the outermost rows of bolts and lag screws shall not exceed 10 inches and 6 inches on center, respectively.

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Form No. TT-011C
Revised July 2015