

Understanding Specifications for Glued-Laminated Timber.

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Specifications are included in most construction documents in order to communicate the standard of quality required for the project. In the Construction Specification Institute numbering, glued-laminated construction (glulam) is in division 06180. Several of the items included in glulam specifications are architectural while others are structural. What follows is a description of the specifications as they are commonly used in construction of new buildings. Material specifications generally include General Specifications, Product Specifications and Execution Specifications. Each section has a general explanation followed by an example. The hyperlinks below will allow you to quickly access individual specification topics. Use Ctrl+click to navigate with the hyperlinks.

General Specifications

[Scope](#)

[Submittals](#)

[Acceptable Manufacturers/Suppliers](#)

Product Specifications

[Manufacturing Standard](#)

[Lumber Species](#)

[Adhesives](#)

[Stress Class/Combination](#)

[Sizes](#)

[FSC Certification](#)

[Camber and Curvature](#)

[Appearance Grade](#)

[Timber Connections](#)

[Fire Resistive Design](#)

[Fabrication](#)

[Finish](#)

[Protection](#)

[Preservative Treatments](#)

Execution

[Jobsite Storage](#)

[Installation](#)

[Field Cutting, Notching and Drilling](#)

General Specifications

Scope:

The scope of the specification will include all of the requirements to be met by the contractor supplying and installing the glulam members. This section also delineates the design responsibility for the glulam construction. If the engineer of record (EOR) has

designed all of the timber members, assemblies and connections, this may be as simple as instructions to supply members as shown on the plans. If the EOR requires the glulam supplier to design some or all of the glulam members and assemblies, the extent of the design responsibility will be described in this section. The scope may also include requirements for the supply of connecting steel and hardware. In complicated structures or assemblies, it is often advisable to have the glulam supplier include the design and/or supply of the steel connection assemblies. By doing so, the responsibility for fit and constructability rests with one entity thus eliminating the question of liability when conflicts between suppliers occur in the field.

Example:

“This section includes the design and supply of the structural glued laminated timber (glulam) on this project, complete with the design and supply of all glulam to glulam connecting steel and hardware. Design of glulam members and their connections shall be performed by a qualified engineer licensed in the state of Oregon.”

[Back to Top](#)

Submittals:

This section specifies requirements for the submittal of shop drawings and/or calculations. Shop drawings provide a means for the glulam supplier to request information that is either omitted from the contract documents or is unclear or conflicting. The answers to these requests can be written directly on the shop drawings and become a permanent record in the building contract documents. For the EOR, the shop drawings confirm that the supplier will provide the size, grade and shape of the members conforming to the structural drawings as well as fabrication for the connections. If the glulam supplier is supplying calculations as part of his contract, the requirements for these are also included in this section. The qualifications of the person preparing the calculations usually include licensure as a professional and/or structural engineer. In some cases, a minimum experience in the type of work is required.

Often a representative sample of a glulam member is required. This sample will provide an indication of color variation, surfacing, distribution of growth characteristics such as knots, etc that will be supplied. The sample becomes a standard for the material delivered to the jobsite.

Example:

“Shop Drawings: Show layout of glulam system and full dimensions of each member. Indicate species, laminating combination, size and shop performed fabrication of each member.

Calculations: Provide structural calculations for each member and connection showing conformance to the design criteria signed and sealed by a professional engineer licensed in the state of Oregon

Samples: Submit a sample a minimum of 3 1/8" x 12" x 2'-0" showing the range of variation to be expected in appearance of the glulam timber."

[Back to Top](#)

Acceptable Manufacturers/ Suppliers:

The specifier may wish to include minimum qualifications for the glulam manufacturer or material supplier. This may include a minimum time that the manufacturer has been in operation or successful involvement in similar projects. The specification can list known suppliers who meet the qualifications and the process to become approved if not listed.

Example:

"Glulam manufacturer shall be a firm with at least 5 years of continuous operation and be licensed by AITC or APA-EWS or approved."

[Back to Top](#)

Product Specifications

Manufacturing Standard:

ANSI/AITC A190.1 is the current manufacturing standard for structural glued-laminated timber. This is the consensus document referenced in the building codes for glued laminated timber manufacturing. All glulam members should conform to this standard. The standard includes the requirements for manufacturing glulam materials including requirements for the laminating lumber and adhesives. The standard lists the allowable tolerances of the finished product for size, length, camber or straightness, and squareness of the cross section. The requirements for plant qualification testing, quality control testing, inspection, marking, and certificates of conformance are also included in this document.

The design standards used for glulam construction are the "Standard Specification for Structural Glued Laminated Timber of Softwood Species", AITC 117-2004 Design provided by AITC and the "Glulam Design Specification" provided by APA-EWS. These documents contain the allowable stresses for each species and combination grade. The design values listed are derived using the process contained in ASTM D3737, "Standard for Establishing Stresses for Structural Glued Laminated Timber"

Example:

"All glulam materials shall conform to the requirements of ANSI/AITC A190.1 and be stamped with an AITC quality mark or an APA-EWS trademark. Place stamps on surfaces that will not be exposed to view in the completed structure.

Submit Certificates of Conformance indicating that the glulam members conform to the requirements of ANSI/AITC A190.1"

[Back to Top](#)

Lumber Species:

Several wood species are contained in the glulam standards including Douglas fir, Hem-Fir, Southern Pine, Alaskan Yellow Cedar and Softwoods. However, just because a species is included in the standard, it does not mean it is readily available. Douglas fir is the predominate species in the Western United States and Southern Pine is used predominately in the East. Douglas fir should be specified on the west coast as it is the least expensive and easiest to obtain. However, if there are significant considerations such as a requirement for a naturally decay resistant species then a secondary species like Alaskan Yellow Cedar can be specified.

Example:

“Glulam members shall be manufactured from Douglas Fir laminating lumber.”

[Back to Top](#)

Adhesives

Before 1970, the laminating industry used both waterproof adhesives and non-waterproof adhesives and designers specified which type of adhesive was most appropriate for the project. Today, all of the laminators use and the ANSI standard requires 100% waterproof adhesives. It is sufficient to require that adhesive conform to AITC 405.

A few laminators offer clear adhesives that minimize the distinction between the laminations and cause the member to look more like a solid sawn timber.

Example:

“Adhesives used in the glulam manufacturing process shall conform to AITC 405 for wet use adhesives.”

[Back to Top](#)

Stress Class or Combination

There are three ways that the design stresses of glulam members are specified. The first is called the **stress class**. This method is intended for specifying the required stresses for bending members. In this system the allowable stresses are designated by specifying the allowable bending stress and the modulus of elasticity. For example, 24F-1.8E applies to any layup combination that attains a 2400 psi bending stress and a 1.8×10^6 psi. modulus of elasticity. The stress class designation includes minimum design values for horizontal shear, axial tension and compression, compression perpendicular to grain and specific gravity. There are several species/layup combinations that meet this designation and the supplier is allowed to choose any of the combinations that meet the design values of the class. This method was developed to reduce the number of combinations a designer had to consider and give the supplier the ability to choose the least expensive combination available.

The second method of specifying the allowable stresses is to directly specify the **layup combination** desired. For example, a DF 24F-V4 is used to specify a Douglas fir member with a bending stress of 2400 psi. The V indicates that this is a visual grade as opposed to an E-rated grade, which uses an “E” in the second term. The number 4 simply refers to the fourth combination with a 2400 psi allowable bending stress. These combinations are shown in Table A1 of the AITC 117 specification and Table 1 of the APA-EWS document and table 5A of the National Design Specification Supplement. These tables are specifically for bending members with loads applied perpendicular to the wide face of the lamination. The combinations in these tables have up to five zones of laminations each with a different grade of laminations as shown in figure 1. The highest strength laminations are placed on the outside faces where the stresses are the greatest. Lower grade laminations are placed in the middle of the beam corresponding to the lower bending stresses. This method of laying up the bending members optimizes the resource since the higher grade members are less available and more expensive.

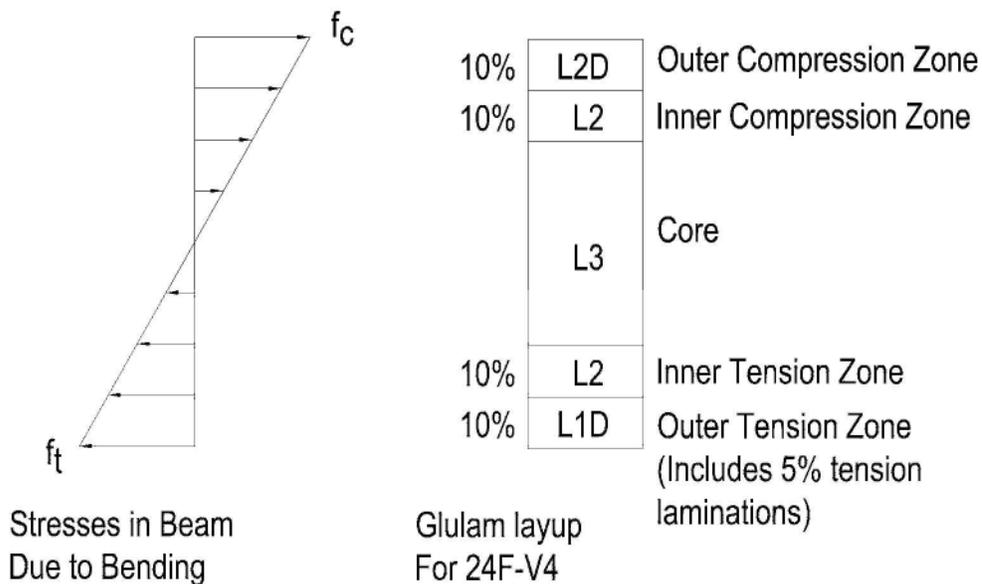


Figure 1. Lamination Layup for Bending Member.

In choosing bending members, it is important to distinguish between balanced and unbalanced layups. A balanced layup refers to a beam where the laminations are symmetrically placed so that the top of the beam has the same tensile strength as the bottom of the beam. This is required for beams with moments causing tension on the top of the beam such as cantilevers and continuous members.

Design values for members that are not stressed principally in bending are found in Tables A2, 2 and 5B in the AITC, APA and NDS documents respectively. With these members, a constant grade of lamination is used for the entire member. These combinations are used for columns, truss chords, and some arch members. In these loading conditions the stress in the members is nearly uniform and there is no advantage

to providing stronger laminations in the outer zones. These combinations are also used for bending members with the loads applied parallel to the wide face.

The third method of specifying glulam grades is to list the **required allowable stresses** for the members. Typically the bending stress, shear stress, modulus of elasticity, compressive stress, tensile stress and compressive stress perpendicular to grain are specified. The supplier then has the freedom to choose any species/laminating grade that meets these requirements. Again this is done to permit the supplier to choose the least expensive combination available meeting the design requirements.

Example:

“Simply supported beams shall be combination symbol 24F-V4. Cantilever beams and those continuous over a support shall be 24F-V8. Glulam columns shall be combination 2. Truss chords shall be combination 3 with tension laminations on both faces and truss webs shall be combination 2.”

[Back to Top](#)

Sizes

Standard sizes of glulam members are given in AITC 113, “Standard Dimensions for Structural Glued Laminated Timber.” The widths of glulam members are based on the width of the laminating lumber with an allowance for surfacing. For example a 2x6 board has net dimensions of 1 1/2” x 5 1/2” inches. After surfacing, the net size of the glulam member made with 2x6 lumber is 5 1/8”. Table 1 shows the standard widths of glulam members.

Nominal Width	3	4	6	8	10	12	14	16
Western Species	2-1/8 or 2-1/2	3-1/8	5-1/8	6-3/4	8-3/4	10-3/4	12-1/4	14-1/4
Eastern Species	2-1/8 or 2-1/2	3 or 3-1/8	5 or 5-1/8	6- 3/4	8-1/2	10-1/2	12	14

Table 1. Standard Widths for Glulam members.

The depth of the members is generally multiples of the lamination thickness used. Western Species members are made with 1-1/2” laminations and Eastern Species are made with 1-3/8” laminations. A member with 8 laminations will measure 12” and 11” for Western Species and Eastern Species respectively.

Non standard widths or depths can be made by planing a larger size to the desired size. This adds expense to the member.

Example:

“Sizes of glulam members shall be as shown on the drawings. The depth designated for shaped members refers to the depth at the bottom of the top shape. Add additional laminations as required to provide for depth of top shape.”

[Back to Top](#)

FSC Certification.

If the project has requirements for sustainability or green building, it is important to specify these requirements. More than half of the laminators in the United States and Canada are currently FSC certified. If the credit for a maximum 500 mile distance requirement from the plant to the jobsite is sought, this should also be specified.

Example:

“The glulam members on this project shall have an FSC certification for each member. Glulam members shall be manufactured at a plant located within 500 miles of the project site.”

[Back to Top](#)

Camber and Curvature

One of the advantages of glulam construction over solid sawn timbers is the ability to add camber to glulam members to offset the deflections due to dead load and long term creep. Camber is defined as, “the small amount of curvature built into a glued laminated timber to offset anticipated deflection or to facilitate roof drainage.” Stock beams typically use a 3500 ft. radius camber. This is adequate to keep most floor framing members from sagging under dead loads, but does not provide too much camber which makes it difficult to frame a flat floor. Camber can be specified in terms of the radius used, a percentage of the span length such as $L/500$ or in the case where the supplier is providing calculations, the camber can be specified as a multiple of the dead load deflection, such as 1.5 times Δ_{DL} . Camber is usually calculated as $1.5 * \Delta_{DL}$ to account for the immediate dead load deflection plus an allowance for long term creep. This provides for a relatively flat member after the building is completed. Cantilever beams are commonly cambered with a positive deflection in the main span and the cantilever end also cambered upward. When more pronounced curvature is desired, it is almost always described on the drawings by specifying the radius. It should be noted that the tolerances for straightness or camber apply to straight or slightly cambered members and are not applicable to curved members such as arches. There is a certain amount of “spring-back” when members are manufactured with a tight radius. The laminators attempt to account for this by over-bending the members to allow for spring-back. However the process is more of an art than a science. In most instances there is no disadvantage to having the shape of the member slightly off. However, if the curved glulam member needs to match the curve from another building element, the allowable tolerance in bending radius needs to be specified.

Refer to APA Technical Note EWS S550F, “Glulam Beam Camber” for further discussion.

Example:

“Provide camber for each glulam beam as indicated on the drawings. For members with no camber indicated, provide a radius of 2000’.”

[Back to Top](#)

Appearance Grade

The standard appearance grades for glulam members are Framing, Industrial, Architectural and Premium. Framing grades are members that have not been surfaced to the standard net size but are left the same width as the dimensional lumber sizes they are made from. For example, a 4 in. nominal member will be 3 ½”, the same width as the 2x4 laminations used to build the members. This grade is intended for members that are installed within the framing of the building walls, such as door and window headers, where a finished appearance is not warranted. The use of the full width member eases the construction of the framing since spacers are not required to flush out the member. These members have not been surfaced by a planer so a considerable amount of glue will be on the surface.

Industrial Appearance Grade members are used primarily for roof construction in industrial buildings or in unexposed applications such as above a ceiling area. These members are surfaced on two sides and the bottom edge. The voids resulting from knotholes are left unfilled. Voids as deep as one quarter the beam width and as long as half the beam width are permitted.

In Architectural Appearance Grade, all voids larger than ¾” in length are filled with a “wood toned” colored filler or with clear wood inserts. It is important to note that the choice is left to the laminator unless clear wood inserts are specified. Clear wood inserts are chosen to reasonably match the color and grain of the surrounding wood. Clear wood inserts are significantly more expensive than the wood toned colored filler. In architectural grade members the corners of the member exposed to view are eased, the exposed faces are surfaced smooth and the wide face of the lamination exposed to view must be free of all loose knots.

Premium Appearance Grade is the highest standard appearance grade. This grade requires all voids to be filled with filler or clear wood inserts. Additionally, the wide faces of the lamination exposed to view are selected for appearance and shall be free of loose knots. The knot size on this face is limited to 20% of the net face width. Again the corners of the exposed edges are eased. Current industry practice for easing the edges is to use a radius between 1/8” to ½”.

Appearance grades are defined in AITC 110, “Standard Appearance Grades for Structural Glued Laminated Timber.” Most project specifications reference this document.

It is possible to specify higher appearance requirements than those found in AITC 110. In this case the appearance requirements are agreed to between the buyer and seller. The buyer can specify hand selected, tight knot laminations with no voids in the exposed face or can specify clear grain, containing no exposed knots. The Beaverton Library is an example of the latter.

It is possible to specify a rough sawn finish for glulam members. This surface is usually accomplished by re-sawing the face of the members with a band saw. The re-sawn surface emulates a rough sawn timber member.

Example:

“Member not exposed to view in the completed work shall be Industrial Appearance Grade. Members exposed to view in the completed work shall be Architectural Appearance Grade. Truss members shall be Premium Re-sawn appearance.”

[Back to Top](#)

Timber Connections

When the scope of the glulam portion of the project includes the supply of the connecting steel and hardware, it is helpful to include the specifications for the steel plates, welding, hardware, and timber connectors in the glulam specification. Often the steel specifications on a project refer to steel framing and are not appropriate for the incidental steel and hardware used to manufacture heavy timber components such as trusses.

Example:

“Steel assemblies used to connect glulam to glulam shall be manufactured from ASTM A36 steel plate. All welding shall be performed by AWS certified welders to AWS specifications. Shop prime steel assemblies black. All connecting hardware shall be ASTM A307 shop prime black. 4” Malleable Iron Shear plates shall conform to Grade 32510 of ASTM Standard A47.”

[Back to Top](#)

Fire Resistive Construction

When the glulam members on a project are required to provide a fire resistance rating of one or more hours, the supplier must inform the manufacturer of this requirement. There are two code accepted methods calculating a fire resistance rating for a glulam member. The original method calculates the number of minutes a member is rated for based on member size and the percentage of the allowable load carried by the member. This method is included in IBC section 721.6.3. A more recent method uses the desired fire rating to determine the reduced section size of a member exposed to fire and the average ultimate strength of the wood to check the adequacy of a member. This method is shown in NDS chapter 16.

In each of these methods the manufacturer must be instructed to add an additional tension lamination to the exposed face(s) of the member and remove a core lamination. These members are then marked, “Fire Resistive – One Hour.” The shop drawings must indicate this requirement. Since an additional tension lamination is substituted for a core lamination at the time of manufacturing, it is not possible to upgrade a member once it leaves the plant.

Example:

“Glulam members marked FR on the plans shall be constructed to meet One hour fire resistive requirements. One core lamination shall be replaced with a tension lamination added to the outer tension zone. Mark each FR glulam “Fire Resistive-One Hour”. ”

[Back to Top](#)

Fabrication

The specifier should determine if the fabrication of the glulam members warrants shop fabrication. For warehouse construction and headers for wall framing, for example, the tools available in the field to fabricate the members will be adequate to cut the ends and bore the holes, etc. It will be desirable to specify shop fabrication for more architecturally important members such as trusses or arches or for connections such as kerfs, or top shapes, where the field conditions and tools are not suited to make acceptable cuts, holes, etc. Large members are difficult to maneuver and fabricate with the typical tools found at the jobsite.

Example:

“To the extent possible, shop-fabricate all glulam for connections and top shapes including cutting to length and drilling bolt holes. Provide uniform gaps no greater than 1/8 at the time of fabrication for all truss web to truss chord connections. End gaps between members shall be uniform and not exceed 1/8”. Holes shall be drilled perpendicular to the face of the member. Drill wide members from both sides as required to prevent mis-alignment of holes.”

[Back to Top](#)

Finish

There are three types of finish that are typically specified for glulam members. End Seal refers to applying a penetrating sealer to the ends of the members after end cuts are made. Moisture readily moves in and out of the member ends and can cause checking and/or splitting of the members. The sealers retard the rate of moisture movement which minimizes these effects.

One coat of the manufacturer’s standard clear penetrating sealer can also be specified. Like the end sealers, these retard the rate of moisture movement in the members. A coat of penetrating sealer also provides some resistance to road grime and dirt that is picked up on the jobsite. These sealers are not intended to be finish coatings but offer protection during transit and erection.

Glulams can be ordered with a factory stain or a finish sealer applied at the manufacturer’s facility. These are intended to be a finish coating. Refer to AITC 111, “Recommended Practice for Protection of Structural Glued Laminated Timber during Transit, Storage and Erection” for further discussion.

Example:

“Apply one coat of manufacturer’s penetrating sealer to each member after fabrication. End seal each end of each member immediately after cutting.”

[Back to Top](#)

Protection During Transit and Storage.

There are several levels of protection that can be used for glulam members during transit and storage. The most basic level is a load wrap where the truckload of members is enclosed on the top sides and ends with water resistant paper or opaque polyethylene or equivalent. This wrapping extends to the bottom of the load and is secured with staples, tape or other suitable fastenings that do not damage the exposed surfaces. Once the members are delivered, the wrappings are removed and the members are exposed. This level of protection is commonly used in warehouse or framing members.

Often members are bundled together and then wrapped. This wrapping provides protection both during transit and at the jobsite. When the members are removed from the bundle and placed in the structure, they are no longer protected.

Finally, members can be individually wrapped. By doing so, the wrapper can remain on the member during erection of the building and only those areas near connections are unwrapped. It is important to re-cover the exposed portions of the beam once the connections are made to prevent bleaching due to sun exposure.

In the case of bundle wrapped or individually wrapped members, it is important to slit the bottom of the wrapper while the members are stored. This allows trapped moisture to escape and minimizes the amount of checking, splitting or staining experienced by the members.

Refer to AITC 111, “Recommended Practice for Protection of Structural Glued Laminated Timber during Transit, Storage and Erection” for further discussion.

Example:

“Load wrap or bundle wrap industrial appearance grade members. Individually wrap Architectural and Premium Grade members. Individual wrappers shall remain on the members until they no longer serve a useful purpose including protection from weather, sunlight, soiling and damage from other trades. Slit the underside of wrappings to prevent the accumulation of moisture inside the wrapping.”

[Back to Top](#)

Preservative Treatments

When glulam members are directly exposed to the weather and not protected by a roof overhang or eave, it is important to apply a preservative treatment to prevent degradation due to fungus and/or insect attack. Preservative treating is done by placing the glulam

members into a pressure cylinder, filling the cylinder with preservative mixed with a liquid carrier and then pressurizing the cylinder to force the preservative into the members. The preservatives are designed to be toxic to decay fungus and insects and to chemically bond to the wood cells. There are several preservative treatments available on the market. However, not all preservatives are appropriate or available for glulams. AITC 109, “Standard for Preservative Treatment of Structural Glued Laminated Timber” offers a description of the types of treatments and limitations associated with each. Finishes such as latex paint may not be appropriate to use with preservative treated members. It is advisable to contact glulam suppliers to determine the best treating options for a particular use.

Example:

“Members directly exposed to the weather shall be preservatively treated with type C pentachlorophenol to a minimum net retention of 0.6 pcf. per AWPA specification C28.”

[Back to Top](#)

Execution

Jobsite Storage

The minimum requirements to protect the members during jobsite storage are specified in this section. Typically glulam members should be stacked on flat surface a minimum of 6” off the ground with supports spaced evenly and close enough together to prevent bending of the members. Members allowed to bend during storage may exhibit permanent deformations. Refer to APA Builder Tips R540, “Proper Storage and Handling of Glulam Beams” for more information.

Example:

“Store glulam material on a flat surface at least 6” above the ground. Place supports close enough together to prevent noticeable deflections.”

[Back to Top](#)

Installation

This section specifies the level of care the contractor must use when installing the glulam members.

Example:

“Install glulam member true, plumb and with uniform close fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place. Use non-marring nylon slings to lift members and corner protectors as required to prevent damage to member edges.”

[Back to Top](#)

Field Cutting, Notching and Drilling

The EOR may wish to limit the amount of field fabrication allowed. Included in this section are limitations on other trades such as plumbing and electrical contractors with

respect to notching and drilling of glulam members. See AITC Technical Note 19, “Guidelines for Drilling or Notching of Structural Glued Laminated Timber Beams.”

Example:

“Avoid cutting glulam members after fabrication. Where field fitting is unavoidable, comply with the requirements for shop fabrication. Field notching of glulam members is not allowed without approval from the engineer of record. Holes not shown on the Structural drawings or approved shop drawings shall not be drilled without approval from the engineer of record.”

[Back to Top](#)

All of the documents listed in this article are available to download from AITC at www.aitc-glulam.org and form APA-EWS at www.apawood.org.