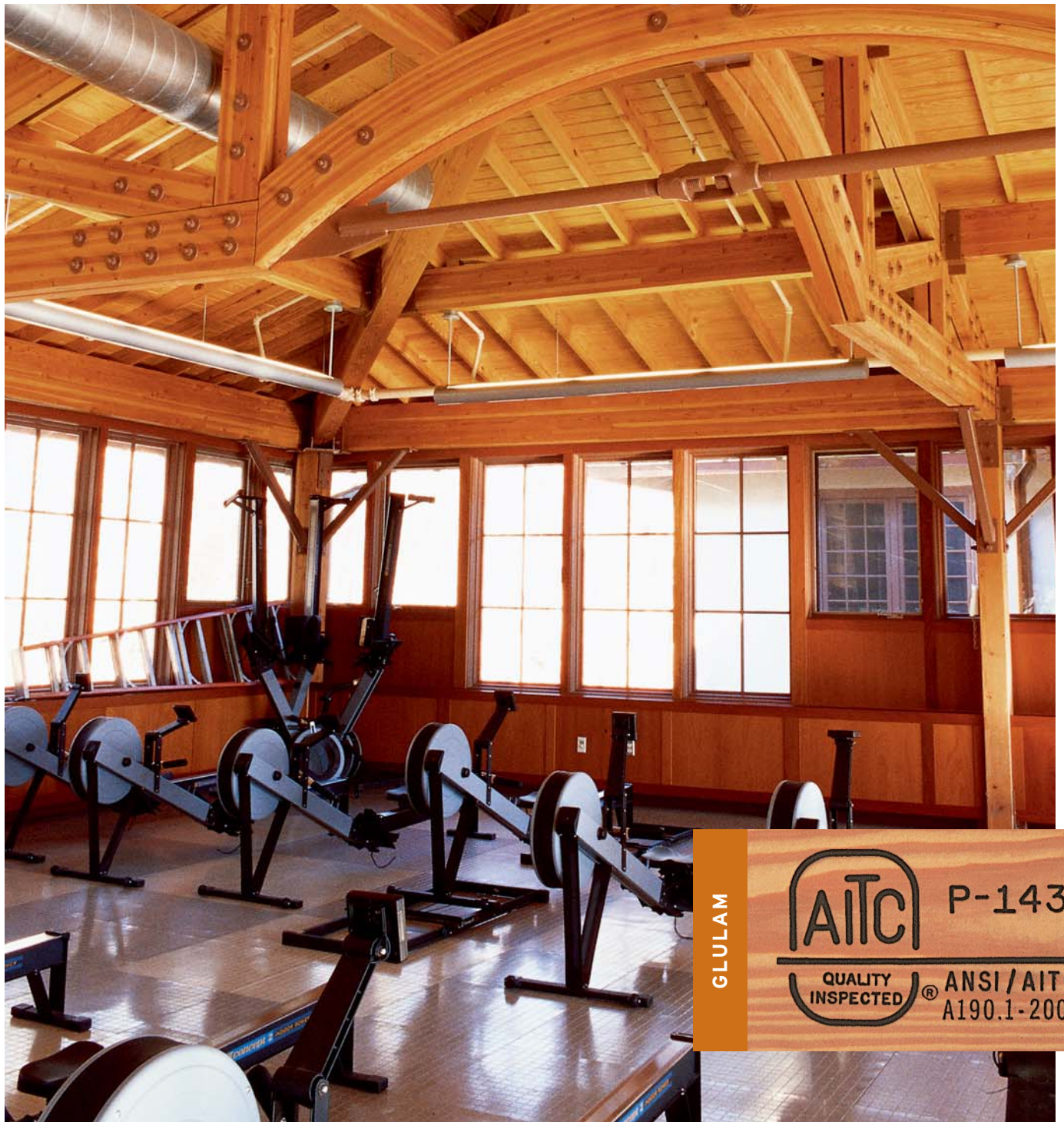




AMERICAN INSTITUTE OF TIMBER CONSTRUCTION

LAMINATED TIMBER ARCHITECTURE



GLULAM



P-143



ANSI / AITC
A190.1-2002

Glulam: Engineered Strength. Unsurpassed Versatility. Dependable Quality.

By combining engineered strength with the warmth and beauty of wood, structural glued laminated timber (glulam) offers designers a multitude of options for large, open spaces with minimum number of columns.

Structural glued laminated timber is manufactured by bonding assemblies of high-strength, kiln-dried lumber, with waterproof adhesives. Special bonding techniques allow individual lumber pieces to be joined end-to-end to form long laminations, then face-bonded to form deep timbers.

Glulam is manufactured in both softwood and hardwood species. Popular species include Douglas Fir-Larch, Southern Pine, and Alaskan Yellow Cedar. Other species are available upon request. AITC 117, *Design Specifications for Structural Glued Laminated Timber of Softwood Species*, and AITC 119, *Design Specifications for Structural Glued Laminated Timber of Hardwood Species*, provide detailed manufacturing and design information.

VERSATILE

The laminating process allows timbers to be produced in a variety of shapes from straight beams to graceful, curved arches. This architectural adaptability allows glulam to extend the enduring qualities of wood into applications as varied as individual designers' imaginations.

Common uses in residential construction include ridge beams, garage door headers, door and window headers, and columns. High strength and stiffness make glulam beams ideal for long-span girders and beams needed for commercial construction. Glulam arch systems and trusses further increase the aesthetic and structural possibilities when using laminated timber construction.



Only AITC-licensed glulam producers are permitted to use the AITC Quality Marks and Certificates to identify products conforming to ANSI/AITCA190.1.

The size of structural glued laminated timber members is limited only by transportation and handling constraints. Widths up to 10 ³/₄ inches are manufactured using single laminations across the width. Wider sizes are manufactured using two or more laminations across the width of the member. Typical depths range from 5 ¹/₂ inches up to several feet. Standard sizes are described in Standard AITC 113, *Standard for Dimensions of Structural Glued Laminated Timber*.

STRONG

Specially graded laminations with high strength and stiffness properties are carefully positioned within timbers to create glulam members with exceptional structural properties. The highest grades of lumber are used in the areas of greatest stress, with lower grades used where strength is not as critical. This lay-up concept makes very efficient use of the lumber resource. In a typical glulam beam, stresses are highest near the top and bottom of the member, so the highest grades are placed near the surfaces, with lower grades placed in the core.

The high strength and stiffness of laminated timbers enable glulam beams and arches to span large distances without intermediate columns. This translates to larger rooms and more design flexibility than with traditional timber construction.

DEPENDABLE

Structural glued laminated timbers have been used successfully in the United States for more than 70 years. In Europe, glulam has been used successfully for more than 100 years. AITC's quality program ensures consistent, reliable product performance by inspecting all stages of production for conformance with industry standards.

Initially developed in 1961, AITC certification and quality assurance programs are the best in the industry, ensuring safe, long-lasting, high-quality timber. The AITC product mark is the Symbol of Quality™ in engineered timber.

AITC's quality control and inspection system is based on three elements:

1. **Licensing of manufacturers.** AITC licenses qualified laminators whose personnel procedures and facilities have complied with the requirements of ANSI / AITC A190.1.
2. **Quality control maintenance.** Each licensee agrees to accept responsibility for maintaining a quality control system that is in compliance with ANSI / AITC A190.1, other AITC standards and AITC 200.
3. **Periodic plant inspection.** AITC's Inspection Bureau, a nationwide team of qualified inspectors, conducts frequent, unannounced audits and verification of laminators' in-plant quality control systems, procedures and production.

For designers and users, AITC brings together all aspects of the engineered timber industry through standards development and technical support activities. AITC standards are recognized by all major building codes in the United States. Standards and technical notes developed by AITC provide guidance to building officials and industry professionals in the design and use of glued laminated timber.



COVER: Glulam are a popular choice for the structural systems in recreational spaces. Boathouse, Princeton University.

ABOVE (top): Natural light flows through the open glulam system into library's interior spaces. Poynter Institute, St. Petersburg, FL. ARCHITECT: Jung/Brannen & Assoc.; STRUCTURAL ENGINEER: Weidinger Assoc. Consulting Engineers; CONTRACTOR: Federal Construction Co.

ABOVE (bottom): Wood ceilings and beams were selected for acoustical control. Performing Arts Center, North Texas University; Denton, TX. ARCHITECT: KVG Gideon Toll Architects; ENGINEER: Freese and Nichols, Inc.; CONTRACTOR: Huber, Hunt and Nichols, Inc.

Glulam: Splendid Arches. Custom Designs. Spectacular Structures.

The natural beauty of wood is unsurpassed. Exposed structural glued laminated timber provides structures with a warmth and beauty unrivaled by other building materials. Glulam members may be textured and finished to meet contemporary, traditional or historic buildings' appearance requirements.

Long, clear spans and majestic soaring arches are no problem for this versatile structural material. The laminating process used to manufacture glulam enables the creation of any number of straight, tapered or curved shapes. Graceful curved arches and beams are favored for many ecclesiastical designs. The AITC brochure *Structural Glued Laminated Timber in Religious Structures* showcases several outstanding structures with laminated timber framing.

Glued laminated timber trusses, beams and arches are used to provide efficient enclosures for expansive areas such as gymnasiums, educational and recreational facilities, indoor pools, auditoriums and shopping centers.

Pressure-treated glulam timbers or timbers manufactured from naturally durable wood species such as Alaska Cedar are well suited for creating beautiful and functional bridges and waterfront structures. Wood's ability to absorb impact forces created by traffic and its natural resistance to chemicals, such as those used for de-icing roadways, make it ideal for these installations. Glulam has been successfully used for pedestrian, forest, highway and railway bridges.

APPEARANCE GRADES

Appearance grades are assigned to timbers based on the requirements described in AITC 110 *Standard Appearance Grades for Structural Glued Laminated Timber*. These designations do not modify design values nor influence the grades of the lumber used in the laminations, nor change any other provisions governing the manufacture, use or structural performance of glued laminated timber. Four standard appearance grades are available:

- Industrial
- Framing
- Architectural
- Premium

Industrial grade is suitable for installations where the glulam member will not be exposed to view or when appearance is not a primary concern. Framing grades are surfaced hit-or-miss to match the widths of conventional framing and are ideal for concealed window and door headers. Architectural grade is recommended for most installations where appearance is important. Premium grade should be specified when appearance is of utmost importance. If a variation in the color or grain of the wood in adjacent laminations is also a consideration, designers may want to specify combinations manufactured from a single species or species group. Special textured surfaces, such as rough sawn, are also available from most manufacturers.



Renewable Resource, Sustainable Products

Only one primary building material comes from a renewable resource: wood. As it grows, it cleans the air and water and provides habitat, scenic beauty and opportunities for recreation. As a good environmental steward, the forest products industry employs sustainable forestry practices and efficiently uses harvested material. Virtually 100% of every log harvested, all under county, state and/or federal forestland management regulations, is utilized.

Of the structural building materials, it has the lowest energy requirements for its manufacture, significantly reducing the use of fossil fuels and environmental pollution compared to other materials. As part of a structure, wood's natural insulating properties (many times higher than steel or concrete) reduce the energy required to heat and cool the structure for its lifetime. Wood is reusable, easily recycled, and 100% biodegradable, and unlike the resources for other structural materials, the resource for wood volume has been increasing in U.S. net reserves since 1952, with growth exceeding harvest in the U.S. by more than 30%. Just like its parent material, glulam enjoys all of these natural benefits.

In addition to the great environmental benefits associated with wood, glulam timbers extend the available wood resource by using high-grade material only where it is needed in the lay-up. Glulam technology uses small dimension lumber to make large structural timbers, utilizing logs from second and third growth forests and timber plantations.



Sustainable products from a renewable resource.

ABOVE (top): St. Anastasia Catholic Church: St. Augustine, FL. ARCHITECT: Richard L. San Giovanni;
ENGINEER: C. Louis Structural Engineers; CONTRACTOR: Hall Construction Company, Inc.

ABOVE (bottom): North Syracuse Baptist Church: Syracuse, NY. ARCHITECT: RSA Architects;
CONTRACTOR: Butterfield Construction.



ABOVE (top): Exploration Place: Wichita, KS. ARCHITECT: Moshe Safdie & Associates with Schaeffer, Johnson, Cox, Frey; STRUCTURAL ENGINEER: Dudley Williams & Associates; CONTRACTOR: Dondlinger & Sons Construction.

ABOVE (bottom left): Originally designed in steel, the structural system for this winery in Sacramento, CA was switched to 48-ft. glulam because of product availability, reduced cost, a 20% faster installation time, and because the winery's humidity and fermentation fumes would not corrode the wood system. DESIGN & ENGINEERING: Summit Engineering, Inc.

ABOVE (bottom right): Residence: Aurora, OR. Laminated timbers permit large rooms with minimal columns, while providing the warmth of wood for living or work environments. ARCHITECT: Jack Smith F.A.I.A.; ENGINEER: Bouiss & Associates; CONTRACTOR: Busic Construction Company.

Installations In & Around Water

Experience shows that wood is one of the most suitable materials for construction in and around water. Wood is resilient enough to resist battering by the ocean and docking ships, and it is naturally resistant to the destructiveness of salt water. It doesn't rust or spall; it is not affected by corrosion.

Where wood is fully exposed to weather, or where protection from the elements is insufficient to ensure a moisture content of less than 20% in the glulam, pressure treatment with preservatives or the use of heartwood of a naturally durable species is required. Buildings housing wet processes, or where wood is in direct contact with the ground or water also require similar protection. AITC 109, *Preservative Treatment of Structural Glued Laminated Timber* provides specific recommendations for treated glulam.



Golf Course Bridge.



New covered bridge with laminated trusses. ENGINEER: USDA Forest Service.



Michigan arch bridge. ENGINEER: Northwest Design Group, Inc.

Glulam: Readily Available. Cost Effective. Easily Installed.

Frequently used for spans over 100' with no intermediate posts or columns, glulam construction is visually and structurally adaptable, generally reduces the overall cost of a project, and individual glulam are easily modified and installed on site—no special crews are required.

READILY AVAILABLE

AITC manufacturing plants are located throughout the United States. Straight beams in common sizes are mass produced and readily available at most building material and lumber distribution centers. Custom timbers may be obtained directly from laminating plants or a local representative, and can be cut-to-length and pre-fabricated in the laminating plant to arrive at the job site ready for immediate installation.

COST EFFECTIVE

The beauty of exposed glulam construction does not require the added expense of false ceilings to conceal structural framework. Accurate manufacturing reduces the need for on-site fabrication, minimizing waste and labor costs during installation. Equally important, glulam timbers are readily adapted to design changes and minor adjustments during construction. Because glulam may be easily modified in the field to fit existing conditions, renovation projects are also simplified.

The laminating process and use of kiln-dried lumber to manufacture glued laminated timbers minimize wood's natural propensity to check, twist, warp and shrink in service. Installations remain dimensionally stable and beautiful over time, virtually eliminating the need for expensive repairs and call backs.

EASILY INSTALLED

Smaller glulam members are easily maneuvered manually. Larger timbers and custom configurations can be installed with mobile construction equipment. Conventional hand and power tools are used for modifications and connections.

Standard connection details reduce mistakes and allow for rapid installation. AITC 104 *Typical Construction Details* provides additional guidance for detailing glulam timbers. The availability of long lengths eliminates the need for splices and reduces construction times. Off-site fabrication of custom laminated timbers further reduces installation time.



Inventory readily available from local distributors for prompt delivery.

Typical uses include:

- Complete structural systems
- Ridge beams
- Garage door headers
- Door and window headers
- Long-span girders



ABOVE (top): 30,000 sq. ft. residence: Newport Beach, CA. ARCHITECT: Brian Jeannete & Associates; Structural ENGINEER: Omnispan Corporation; CONTRACTOR: Buwalda Construction.

ABOVE (bottom): "We specify glulam for window and door headers and for ridge beams. It costs less than the alternatives for these applications and is faster to install." Hess Builders Inc.

Connection Details



Cantilever connection.



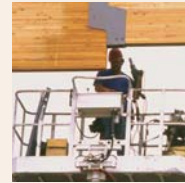
Beam hangers.



Garage door header.



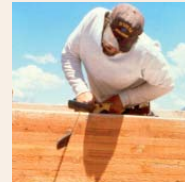
Truss connection.



Beam hangers.



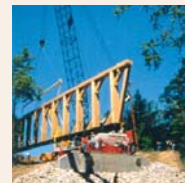
Installing a residential ridge beam.



Field cutting a stock beam.



Beam intersection connection.



Installing a glulam timber truss with mobile equipment.



Saw-textured beams are available from most manufacturers.



Custom fabrication for assembly with power tools.



Massive glulam timbers, spanning 115 feet, are being installed here to provide structure & decorative framing for the Unified Physical Education & Sports Complex in Coronado, CA. SHWC Architects reported, "steel could not have provided the dramatic design focus achieved with the exposed laminated trusses."

Fire Performance

Buildings constructed with large structural timbers have excellent fire-resistive qualities. U.S. model building codes recognize this and provide guidelines for ensuring fire resistant timber structures. Two distinct approaches are included in the codes: *Heavy Timber Construction* and *Fire Resistive Construction*.

HEAVY TIMBER CONSTRUCTION

Heavy Timber Construction has long been recognized by the model building codes as fire resistant. To meet the requirements of Heavy Timber Construction, limitations are placed on the minimum size, including depth and thickness, of all load-carrying wood members. Other requirements include the avoidance of concealed spaces under floors and roofs and the use of approved construction details. Minimum sizes for laminated timbers meeting the requirements of Heavy Timber Construction are contained in the building codes and in AITC 113 *Standard for Dimensions of Structural Glued Laminated Timber*.

The performance of Heavy Timber Construction under fire conditions is markedly superior to most unprotected “non-combustible” construction. Unprotected metals lose strength quickly and collapse suddenly under extreme heat. Steel weakens dramatically as its temperature climbs above 450° Fahrenheit, retaining only 10% of its strength at about 1380°F. The average building fire temperatures range from 1290°F to 1650°F.

In contrast, wood retains a significantly higher percentage of its original strength for a longer period of time, losing strength only as material is lost through surface charring. Fire fighting is safer due to elimination of concealed spaces and the inherent structural integrity of large glued laminated timbers. Additional information is contained in AITC’s *Superior Fire Resistance* brochure.



ABOVE (top): Typical glulam beam following a fire test. The outer surface of the beam has charred, while the inner areas remain unburned. The charred outer material acts as an insulator during fire, reducing the rate at which the inner material will burn.

ABOVE (bottom): Glulam framing was selected over steel for the Parhump Library in Nevada because, as noted by architects/engineers, Leo A Daly Associates, “the need to fire-proof steel trusses made them cost prohibitive.” The exposed glulam trusses also avoid the expense of suspended ceilings to cover overhead framework. CONTRACTOR: B&H Corporation.

FIRE RESISTIVE CONSTRUCTION

Fire resistance is the amount of time a structural member can support its load before collapsing. The goal of fire-resistive construction is to provide adequate fire protection for occupants to evacuate the building safely. For example, a one-hour rating means a member or assembly should be capable of supporting its full load without collapsing for at least one hour after a fire starts. The standard test for measuring fire resistance is the American Society of Materials and Testing (ASTM) Test Method E-119. Ratings of assemblies (including beams, walls and floors) are determined by test procedures that approximate actual fire conditions.

The results of ASTM fire tests for building assemblies, sponsored jointly by the American Forest & Paper Association (AF&PA) and the American Institute of Timber Construction, enable designers to calculate specific fire ratings for glulam members. Calculations are based on a consideration of member size, degree of fire exposure, and loads on the member. Additionally, fire-resistance ratings for glulam beams require lay-up modifications.

AITC Technical Note 7 *Calculation of Fire Resistance of Glued Laminated Timbers* and AF&PA Technical Report 10 *Calculating the Fire Resistance of Exposed Wood Members* provide detailed design methods and lay-up modifications required for fire-rated glulam construction.



RIGHT (top): 172 ft.-span arches, Animal Science Center, Univ. of Arkansas: Little Rock, AR. ARCHITECT: AMR Architect; STRUCTURAL ENGINEER: Engineering Consultants, Inc.; CONTRACTOR: Harrison Davis Construction.

RIGHT (middle): Ross High School: East Hampton, Long Island, NY. ARCHITECT: Richard Cook & Associates; CONTRACTOR: Telemar Construction.

RIGHT (bottom): 48-foot glulam was specified for this manufacturing plant in Fairfield, CA to simplify insulation and readily obtain product. Waiting for steel purlins and girders would have caused a 10-week delay and, in addition, the steel roof would have required rigid insulation on top of the roof deck (whereas the timber design called for the easier-to-install batt-type insulation). LE Boyd Roof Structures; ATMN Structural Engineers.

Equivalent Glulam Sections for Sawn Lumber, Steel, LVL and PSL

Sawn Lumber and Timber Beam Conversions to 24F-1.8E Glulam

| LUMBER OR TIMBER NOMINAL SIZE thickness x depth | 24F-1.8E DOUGLAS FIR GLULAM SIZES TO SUBSTITUTE FOR DOUGLAS FIR LUMBER OR TIMBERS OF <u>GRADE</u> : | | | 24F-1.8E SOUTHERN PINE GLULAM SIZES TO SUBSTITUTE FOR SOUTHERN PINE LUMBER OR TIMBERS OF <u>GRADE</u> : | | |
|--|--|----------------|----------------|--|----------------|----------------|
| | Select Structural | No.1 | No.2 | Select Structural | No.1 | No.2 |
| 3 x 8 | 3 1/8 x 7 1/2 | 3 1/8 x 7 1/2 | 3 1/8 x 7 1/2 | 3 x 6 7/8 | 3 x 6 7/8 | 3 x 6 7/8 |
| 3 x 10 | 3 1/8 x 9 | 3 1/8 x 9 | 3 1/8 x 9 | 3 x 9 5/8 | 3 x 9 5/8 | 3 x 9 5/8 |
| 3 x 12 | 3 1/8 x 12 | 3 1/8 x 10 1/2 | 3 1/8 x 10 1/2 | 3 x 11 | 3 x 11 | 3 x 11 |
| 3 x 14 | 3 1/8 x 13 1/2 | 3 1/8 x 13 1/2 | 3 1/8 x 12 | 3 x 13 3/4 | 3 x 12 3/8 | 3 x 12 3/8 |
| 4 x 6 | 3 1/8 x 6 | 3 1/8 x 6 | 3 1/8 x 6 | 3 x 6 7/8 | 3 x 6 7/8 | 3 x 6 7/8 |
| 4 x 8 | 3 1/8 x 9 | 3 1/8 x 7 1/2 | 3 1/8 x 7 1/2 | 3 x 8 1/4 | 3 x 8 1/4 | 3 x 8 1/4 |
| 4 x 10 | 3 1/8 x 10 1/2 | 3 1/8 x 10 1/2 | 3 1/8 x 10 1/2 | 3 x 11 | 3 x 9 5/8 | 3 x 9 5/8 |
| 4 x 12 | 3 1/8 x 12 | 3 1/8 x 12 | 3 1/8 x 12 | 3 x 12 3/8 | 3 x 12 3/8 | 3 x 12 3/8 |
| 4 x 14 | 3 1/8 x 15 | 3 1/8 x 15 | 3 1/8 x 13 1/2 | 3 x 15 1/8 | 3 x 13 3/4 | 3 x 13 3/4 |
| 4 x 16 | 3 1/8 x 16 1/2 | 3 1/8 x 16 1/2 | 3 1/8 x 16 1/2 | 3 x 16 1/2 | 3 x 16 1/2 | 3 x 16 1/2 |
| 6 x 8 | 5 1/8 x 7 1/2 | 5 1/8 x 7 1/2 | 5 1/8 x 7 1/2 | 5 x 8 1/4 | 5 x 8 1/4 | 5 x 6 7/8 |
| 6 x 10 | 5 1/8 x 10 1/2 | 5 1/8 x 10 1/2 | 5 1/8 x 9 | 5 x 9 5/8 | 5 x 9 5/8 | 5 x 9 5/8 |
| 6 x 12 | 5 1/8 x 12 | 5 1/8 x 12 | 5 1/8 x 12 | 5 x 12 3/8 | 5 x 12 3/8 | 5 x 11 |
| 6 x 14 | 5 1/8 x 13 1/2 | 5 1/8 x 13 1/2 | 5 1/8 x 13 1/2 | 5 x 13 3/8 | 5 x 13 3/4 | 5 x 12 3/8 |
| 6 x 16 | 5 1/8 x 16 1/2 | 5 1/8 x 16 1/2 | 5 1/8 x 15 | 5 x 15 1/8 | 5 x 15 1/8 | 5 x 15 1/8 |
| 6 x 18 | 5 1/8 x 18 | 5 1/8 x 18 | 5 1/8 x 16 1/2 | 5 x 17 7/8 | 5 x 17 7/8 | 5 x 16 1/2 |
| 6 x 20 | 5 1/8 x 19 1/2 | 5 1/8 x 19 1/2 | 5 1/8 x 18 | 5 x 19 1/4 | 5 x 19 1/4 | 5 x 17 7/8 |
| 8 x 10 | 6 3/4 x 10 1/2 | 6 3/4 x 10 1/2 | 6 3/4 x 9 | 6 3/4 x 9 5/8 | 6 3/4 x 9 5/8 | 6 3/4 x 9 5/8 |
| 8 x 12 | 6 3/4 x 12 | 6 3/4 x 12 | 6 3/4 x 12 | 6 3/4 x 12 3/8 | 6 3/4 x 12 3/8 | 6 3/4 x 11 |
| 8 x 14 | 6 3/4 x 13 1/2 | 6 3/4 x 13 1/2 | 6 3/4 x 13 1/2 | 6 3/4 x 13 3/4 | 6 3/4 x 13 3/4 | 6 3/4 x 12 3/8 |
| 8 x 16 | 6 3/4 x 16 1/2 | 6 3/4 x 16 1/2 | 6 3/4 x 15 | 6 3/4 x 15 1/8 | 6 3/4 x 15 1/8 | 6 3/4 x 15 1/8 |
| 8 x 18 | 6 3/4 x 18 | 6 3/4 x 18 | 6 3/4 x 16 1/2 | 6 3/4 x 17 7/8 | 6 3/4 x 17 7/8 | 6 3/4 x 16 1/2 |
| 8 x 20 | 6 3/4 x 19 1/2 | 6 3/4 x 19 1/2 | 6 3/4 x 19 1/2 | 6 3/4 x 19 1/4 | 6 3/4 x 19 1/4 | 6 3/4 x 17 7/8 |
| [2] 2 x 8 | 3 1/8 x 7 1/2 | 3 1/8 x 7 1/2 | 3 1/8 x 7 1/2 | 3 x 8 1/4 | 3 x 8 1/4 | 3 x 8 1/4 |
| [2] 2 x 10 | 3 1/8 x 10 1/2 | 3 1/8 x 9 | 3 1/8 x 9 | 3 x 9 5/8 | 3 x 9 5/8 | 3 x 9 5/8 |
| [2] 2 x 12 | 3 1/8 x 12 | 3 1/8 x 12 | 3 1/8 x 12 | 3 x 12 3/8 | 3 x 12 3/8 | 3 x 11 |
| [3] 2 x 8 | 5 1/8 x 7 1/2 | 5 1/8 x 7 1/2 | 5 1/8 x 7 1/2 | 5 x 8 1/4 | 5 x 6 7/8 | 5 x 6 7/8 |
| [3] 2 x 10 | 5 1/8 x 10 1/2 | 5 1/8 x 9 | 5 1/8 x 9 | 5 x 9 5/8 | 5 x 9 5/8 | 5 x 9 5/8 |
| [3] 2 x 12 | 5 1/8 x 12 | 5 1/8 x 12 | 5 1/8 x 10 1/2 | 5 x 11 | 5 x 11 | 5 x 11 |
| [4] 2 x 8 | 6 3/4 x 7 1/2 | 6 3/4 x 7 1/2 | 6 3/4 x 7 1/2 | 6 3/4 x 8 1/4 | 6 3/4 x 6 7/8 | 6 3/4 x 6 7/8 |
| [4] 2 x 10 | 6 3/4 x 10 1/2 | 6 3/4 x 9 | 6 3/4 x 9 | 6 3/4 x 9 5/8 | 6 3/4 x 9 5/8 | 6 3/4 x 9 5/8 |
| [4] 2 x 12 | 6 3/4 x 12 | 6 3/4 x 12 | 6 3/4 x 10 1/2 | 6 3/4 x 11 | 6 3/4 x 11 | 6 3/4 x 11 |

TABLE SPECIFICATIONS:

- These sizes are for dry service condition of use.
- Reverse use of this table to convert from glued laminated timber sizes to sawn lumber or timber sizes is non-conservative in all cases and is NOT PERMITTED.
- Smaller glued laminated timber sizes may be possible with engineering calculations based on actual span and loading conditions.
- Glued laminated timber beam sizes are based on a span to depth (L/d) ratio of 21. When the span to depth ratio is larger, sizes should be determined by engineering calculations.
- To determine glued laminated timber beam sizes, F_{bx} was adjusted by the volume factor. It is assumed that all beams are adequately braced for lateral stability.
- Tabulated beam sizes have been checked for adequacy in flexure, shear, and deflection.
- A minimum glued laminated timber depth of 6 inches is used in this table. Standard glued laminated timber sizes are used in this table.
- While these design conversions have been prepared in accordance with recognized engineering principles and are based on accurate technical data, conversions should not be used without competent examination and verification of the accuracy, suitability, and applicability by a qualified design professional.

Structural Composite Lumber (LVL & PSL) Beam Conversions to 24F-1.8E Glulam

| STRUCTURAL COMPOSITE LUMBER SIZE ¹ width x depth | 24F-1.8E DOUGLAS FIR GLULAM SIZES TO SUBSTITUTE FOR LAMINATED VENEER LUMBER (LVL) OR PARALLEL STRAND LUMBER (PSL) | | | 24F-1.8E SOUTHERN PINE GLULAM SIZES TO SUBSTITUTE FOR LAMINATED VENEER LUMBER (LVL) OR PARALLEL STRAND LUMBER (PSL) | | |
|--|---|----------------|----------------|---|------------|----------------|
| 3 1/2 x 9 1/2 | 3 1/8 x 12 | 5 1/8 x 9 | 6 3/4 x 9 | 3 x 12 3/8 | 5 x 9 5/8 | 6 3/4 x 8 1/4 |
| 3 1/2 x 11 7/8 | 3 1/8 x 15 | 5 1/8 x 12 | 6 3/4 x 10 1/2 | 3 x 15 1/8 | 5 x 12 3/8 | 6 3/4 x 11 |
| 3 1/2 x 14 | 3 1/8 x 18 | 5 1/8 x 13 1/2 | 6 3/4 x 12 | 3 x 17 7/8 | 5 x 13 3/4 | 6 3/4 x 12 3/8 |
| 3 1/2 x 16 | 3 1/8 x 21 | 5 1/8 x 15 | 6 3/4 x 13 1/2 | 3 x 19 1/4 | 5 x 15 1/8 | 6 3/4 x 13 3/4 |
| 3 1/2 x 18 | 3 1/8 x 22 1/2 | 5 1/8 x 18 | 6 3/4 x 15 | 3 x 22 | 5 x 17 7/8 | 6 3/4 x 15 1/8 |
| 5 1/4 x 9 1/2 | - | 5 1/8 x 12 | 6 3/4 x 10 1/2 | - | 5 x 12 3/8 | 6 3/4 x 9 5/8 |
| 5 1/4 x 11 7/8 | - | 5 1/8 x 15 | 6 3/4 x 13 1/2 | - | 5 x 15 1/8 | 6 3/4 x 12 3/8 |
| 5 1/4 x 14 | - | 5 1/8 x 16 1/2 | 6 3/4 x 15 | - | 5 x 16 1/2 | 6 3/4 x 15 1/8 |
| 5 1/4 x 16 | - | 5 1/8 x 19 1/2 | 6 3/4 x 16 1/2 | - | 5 x 19 1/4 | 6 3/4 x 16 1/2 |
| 5 1/4 x 18 | - | 5 1/8 x 22 1/2 | 6 3/4 x 19 1/2 | - | 5 x 22 | 6 3/4 x 19 1/4 |
| 7 x 9 1/2 | - | 5 1/8 x 15 | 6 3/4 x 12 | - | 5 x 13 3/4 | 6 3/4 x 12 3/8 |
| 7 x 11 7/8 | - | 5 1/8 x 18 | 6 3/4 x 15 | - | 5 x 16 1/2 | 6 3/4 x 15 1/8 |
| 7 x 14 | - | 5 1/8 x 21 | 6 3/4 x 18 | - | 5 x 19 1/4 | 6 3/4 x 16 1/2 |
| 7 x 16 | - | 5 1/8 x 24 | 6 3/4 x 19 1/2 | - | 5 x 22 | 6 3/4 x 19 1/4 |
| 7 x 18 | - | 5 1/8 x 27 | 6 3/4 x 22 1/2 | - | 5 x 24 3/4 | 6 3/4 x 22 |

¹ Structural composite lumber may be made up of a single piece or multiple pieces nailed together per manufacturer's guidelines to make wider beams.

TABLE SPECIFICATIONS:

- These sizes are for dry service condition of use.
- Reverse use of this table to convert from glued laminated timber sizes to structural composite lumber sizes is non-conservative in all cases and is NOT PERMITTED.
- PSL F_b is adjusted by a size factor of $C_F = (12/d)^x$ where $x = 0.111$.
- LVL F_b is adjusted by a size factor of $C_F = (12/d)^x$ where $x = 0.143$ for depths larger than 12 inches and $x = 0.133$ for depths less than or equal to 12 inches.
- SCL design values are based on the highest published values available at the time of printing this table. Glulam sizes in this table will be conservative for SCL with lower values.
- Smaller glued laminated timber sizes may be possible with engineering calculations based on actual span and loading conditions.
- Glued laminated timber beam sizes are based on a span to depth (L/d) ratio of 21. When the span to depth ratio is larger, sizes should be determined by engineering calculations.
- To determine glued laminated timber beam sizes, F_{bx} was adjusted by the volume factor. It is assumed that all beams are adequately braced for lateral stability.
- Tabulated beam sizes have been checked for adequacy in flexure, shear, and deflection.
- A minimum glued laminated timber depth of 6 inches is used in this table. Standard glued laminated timber sizes are used in this table.
- While these design conversions have been prepared in accordance with recognized engineering principles and are based on accurate technical data, conversions should not be used without competent examination and verification of the accuracy, suitability, and applicability by a qualified design professional.

ASTM A36 Grade, 36 ksi Steel Beam Conversions to 24F-1.8E Glulam

| STEEL SECTION | 24F-1.8E DOUGLAS FIR GLULAM SIZES TO SUBSTITUTE FOR 36 KSI STEEL SECTIONS | | | 24F-1.8E SOUTHERN PINE GLULAM SIZES TO SUBSTITUTE FOR 36 KSI STEEL SECTIONS | | |
|---------------|--|----------------|----------------|--|------------|----------------|
| W 6 x 9 | 3 1/8 x 10 1/2 | 5 1/8 x 9 | 6 3/4 x 9 | 3 x 11 | 5 x 9 5/8 | 6 3/4 x 8 1/4 |
| W 8 x 10 | 3 1/8 x 13 1/2 | 5 1/8 x 12 | 6 3/4 x 10 1/2 | 3 x 13 3/4 | 5 x 11 | 6 3/4 x 9 5/8 |
| W 8 x 15 | 3 1/8 x 15 | 5 1/8 x 13 1/2 | 6 3/4 x 12 | 3 x 16 1/2 | 5 x 12 3/8 | 6 3/4 x 12 3/8 |
| W 12 x 14 | 3 1/8 x 18 | 5 1/8 x 15 | 6 3/4 x 15 | 3 x 17 7/8 | 5 x 15 1/8 | 6 3/4 x 13 3/4 |
| W 12 x 16 | 3 1/8 x 19 1/2 | 5 1/8 x 16 1/2 | 6 3/4 x 15 | 3 x 19 1/4 | 5 x 16 1/2 | 6 3/4 x 15 1/8 |
| W 12 x 19 | 3 1/8 x 21 | 5 1/8 x 18 | 6 3/4 x 16 1/2 | 3 x 22 | 5 x 17 7/8 | 6 3/4 x 16 1/2 |
| W 10 x 22 | 3 1/8 x 22 1/2 | 5 1/8 x 18 | 6 3/4 x 16 1/2 | 3 x 22 | 5 x 17 7/8 | 6 3/4 x 15 1/8 |
| W 12 x 22 | 3 1/8 x 24 | 5 1/8 x 19 1/2 | 6 3/4 x 16 1/2 | 3 x 23 3/8 | 5 x 19 1/4 | 6 3/4 x 16 1/2 |
| W 14 x 22 | - | 5 1/8 x 21 | 6 3/4 x 18 | - | 5 x 20 3/8 | 6 3/4 x 17 7/8 |
| W 12 x 26 | - | 5 1/8 x 21 | 6 3/4 x 19 1/2 | - | 5 x 20 3/8 | 6 3/4 x 19 1/4 |
| W 14 x 26 | - | 5 1/8 x 22 1/2 | 6 3/4 x 19 1/2 | - | 5 x 22 | 6 3/4 x 19 1/4 |
| W 16 x 26 | - | 5 1/8 x 22 1/2 | 6 3/4 x 21 | - | 5 x 23 3/8 | 6 3/4 x 20 5/8 |
| W 12 x 30 | - | 5 1/8 x 24 | 6 3/4 x 21 | - | 5 x 23 3/8 | 6 3/4 x 19 1/4 |
| W 14 x 30 | - | 5 1/8 x 24 | 6 3/4 x 21 | - | 5 x 23 3/8 | 6 3/4 x 20 5/8 |
| W 16 x 31 | - | 5 1/8 x 25 1/2 | 6 3/4 x 22 1/2 | - | 5 x 24 3/4 | 6 3/4 x 23 3/8 |
| W 14 x 34 | - | 5 1/8 x 27 | 6 3/4 x 22 1/2 | - | 5 x 26 1/8 | 6 3/4 x 22 |
| W 18 x 35 | - | 5 1/8 x 28 1/2 | 6 3/4 x 25 1/2 | - | 5 x 27 1/2 | 6 3/4 x 24 3/4 |
| W 16 x 40 | - | 5 1/8 x 31 1/2 | 6 3/4 x 27 | - | 5 x 30 1/4 | 6 3/4 x 26 1/8 |
| W 21 x 44 | - | 5 1/8 x 34 1/2 | 6 3/4 x 30 | - | 5 x 33 | 6 3/4 x 30 1/4 |
| W 18 x 50 | - | 5 1/8 x 36 | 6 3/4 x 31 1/2 | - | 5 x 34 3/8 | 6 3/4 x 30 1/4 |
| W 21 x 50 | - | 5 1/8 x 37 1/2 | 6 3/4 x 33 | - | 5 x 35 3/4 | 6 3/4 x 31 3/8 |
| W 18 x 55 | - | 5 1/8 x 39 | 6 3/4 x 33 | - | 5 x 37 1/8 | 6 3/4 x 31 3/8 |
| W 21 x 62 | - | - | 6 3/4 x 39 | - | - | 6 3/4 x 35 3/4 |

TABLE SPECIFICATIONS:

- These sizes are for dry service condition of use.
- Reverse use of this table to convert from glued laminated timber sizes to steel sections is non-conservative in all cases and is NOT PERMITTED.
- Smaller glued laminated timber sizes may be possible with engineering calculations based on actual span and loading conditions.
- Glued laminated timber beam sizes are based on a span to depth (L/d) ratio of 21. When the span to depth ratio is larger, sizes should be determined by engineering calculations.
- To determine glued laminated timber beam sizes, F_{bx} was adjusted by the volume factor. It is assumed that all beams are adequately braced for lateral stability.
- Tabulated beam sizes have been checked for adequacy in flexure and deflection. It is the responsibility of the designer to check for adequacy in shear.
- A minimum glued laminated timber depth of 6 inches is used in this table. Standard glued laminated timber sizes are used in this table.
- While these design conversions have been prepared in accordance with recognized engineering principles and are based on accurate technical data, conversions should not be used without competent examination and verification of the accuracy, suitability, and applicability by a qualified design professional.

Design Aids

AITC is committed to helping designers and builders get the information they need.

The AITC web site, www.aitc-glulam.org, provides access to numerous design aids—from capacity tables for glulam beams and columns to complete design standards and technical notes. Please refer to the outside back cover for a list of selected publications. AITC Technical Services is also available to help answer glulam-related inquiries.

THIS PAGE (right): Residence: McCall, ID.

THIS PAGE (below): John XXIII Catholic Church: Albuquerque, NM. ARCHITECT: Sierra Architects. CONTRACTOR: Klinger Contractors. Glulam structural framing (instead of steel) saved approximately 30% on cost of the "crown", a 60-ft. dome of natural light.

OPPOSITE PAGE (top): YMCA Pool: Brewton, AL. ARCHITECT: Dampier and Associates; STRUCTURAL ENGINEER: Joseph and Spain; CONTRACTOR: Stuart Construction Associates.

OPPOSITE PAGE (below): Albertson Shopping Center: Jackson, WY. ARCHITECT: Jeffrey A. Shneider; STRUCTURAL ENGINEER: Rex Harrison Engineering; CONTRACTOR: Bateman Hall.

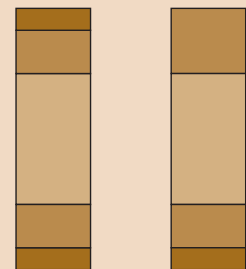




Balanced and Unbalanced Beams

Structural glued laminated timbers are permitted to be laid up with lumber grades placed symmetrically or asymmetrically about the neutral axis of the member. Timbers with symmetric lay-ups are referred to as “balanced” and have the same design values for positive and negative bending. Timbers with asymmetric lay-ups are referred to as “unbalanced” and have higher design stresses for positive bending (tension on bottom) than negative bending. Unbalanced lay-ups are generally used for simple, single-span beams, while balanced lay-ups are used for continuous or cantilevered beams. However, for most residential applications where cantilever lengths are relatively short, a stock unbalanced glulam can be used. Cantilevered roof overhangs of up to 20% of the main span can be accommodated using an unbalanced beam without special lay-ups. For longer length cantilevers, balanced beams should be specified.

The topside of unbalanced beams is required to be marked “TOP” by the manufacturer to ensure proper installation.



BALANCED

UNBALANCED

Balanced beams use the same grades in the top half of the beam as in the bottom half. The upper and lower halves are mirror images of each other.

Unbalanced beams use higher grades in the bottom half than in the top half.

Standards

AITC 104-03 *Typical Construction Details.*

Detailed sketches and descriptions for construction utilizing structural glued laminated timber, including details to avoid.

AITC 108-93 *Standard for Heavy Timber Construction.*

Requirements for Heavy Timber Construction, including minimum sizes for timber components and detailing requirements.

AITC 109-2007 *Standard for Preservative Treatment of Structural Glued Laminated Timber.* Design considerations and requirements for the preservative treatment of structural glued laminated timber.

AITC 110-01 *Standard Appearance Grades for Structural Glued Laminated Timber.* Requirements for Framing, Industrial, Architectural, and Premium appearance grades of structural glued laminated timber.

AITC 111-05 *Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection.* Recommended specifications for sealers, wraps, and other protective measures for structural glued laminated timbers.

AITC 112-93 *Standard for Tongue-and-Groove Heavy Timber Roof Decking.* Provisions for solid-sawn, heavy timber roof decking, including installation requirements and design tables.

AITC 113-01 *Standard for Dimensions of Structural Glued Laminated Timber.* Standard sizes and tolerances for structural glued laminated timber.

AITC 117-2004 *Standard Specifications for Structural Glued Laminated Timber of Softwood Species.* Design and manufacturing requirements for structural glued laminated timber of softwood species, including tabulated design values and layup requirements for laminated timber combinations.

AITC 119-96 *Standard Specifications for Structural Glued Laminated Timber of Hardwood Species.* Design and manufacturing requirements for structural glued laminated timber of hardwood species, including tabulated design values and layup requirements for laminated timber combinations.

AITC 200-2004 *Manufacturing Quality Control Systems Manual.* Requirements for quality control systems used in the manufacture of structural glued laminated timber. Procedures for quality control tests required by ANSI/AITC A190.1.

ANSI/AITC A190.1-2007 *American National Standard, Structural Glued Laminated Timber.* The primary standard for the manufacture and quality control of structural glued laminated timber. Code-referenced requirements.

Other Publications

Glued Laminated Timber Bridge Systems Manual.

Methods and examples for the design of structural glued laminated timber bridges according to AASHTO ASD specifications. 45 pages.

Timber Construction Manual, 5th Ed. Hardbound reference book, published in 2004. Reflects current timber design methods. 477 pages.

Technical Notes

- #2 ***Deflection of Glued Laminated Timber Arches*** (1992)
- #7 ***Calculation of Fire Resistance of Glued Laminated Timbers*** (1996)
- #8 ***Bolts in Glued Laminated Timber*** (2002)
- #10 ***AITC Quality Control Program*** (2005)
- #11 ***Checking in Glued Laminated Timber*** (1987)
- #12 ***Designing Structural Glued Laminated Timber for Permanence*** (2002)
- #13 ***In-Service Inspection, Maintenance & Repair of Glued Laminated Timbers Subject to Decay Conditions*** (2005)
- #14 ***Use of Epoxies in Repair of Structural Glued Laminated Timber*** (2005)
- #18 ***Evaluation of Checking in Glued Laminated Timbers*** (2004)
- #19 ***Guidelines for Drilling or Notching of Structural Glued Laminated Timber Beams*** (2002)
- #20 ***Guidelines to Minimize Moisture Entrapment in Panelized Wood Roof Systems*** (1992)
- #21 ***Volume Effect Factor for Structural Glued Laminated Timber*** (2005)
- #23 ***Mathematical Solution for Design of a Three-Hinged Arch*** (1998)
- #24 ***Guide for Specifying Structural Glued Laminated Timber*** (2003)
- #25 ***Jobsite Care of Laminated Timbers in Arid Climates*** (2005)

Software

WoodWorks® Sizer Program An intuitive and easy to use software program for designing glulam beams and columns. Analyzes beams with 1 - 6 spans. I-joist-compatible glulam sizes are included in the beam database. Output shows input data; compares applied stresses to allowable stresses; and provides loading, deflection, shear, and moment diagrams.



American Institute of Timber Construction
PO Box 23145
Portland OR 97281
P: 503.639.0651
F: 503.684.8928
E: info@wclib.org