MERCER
mass timber

Mercer Mass Timber

DESIGN GUIDE

Version 1.1
Release Date June 2024

A revolution is happening.

And Mercer Mass Timber is leading the way.

Mercer Mass Timber is at the forefront of innovation, paving the way for mass timber to become the foundation for future generations of high-performance, low-carbon buildings.

North America is in the early stages of a mass timber construction boom, driven by increasing demand and expanded building code acceptance of mass timber structures. As the availability of high-quality mass timber continues to grow in North America, it is poised to become the material of choice across various market sectors, building types, and geographical regions.

Mass timber allows developers, designers, and builders to move beyond the traditional construction trade offs – to create buildings that are sophisticated and efficient, rapidly assembled and structurally sound, affordable and aesthetically stunning.

With its inherent ability to sequester carbon over a building's lifespan, timber offers a natural and innovative alternative to steel and concrete. Given its proven benefits, cost-effectiveness, and renewable qualities, mass timber construction is rapidly emerging as the preferred choice for owners, architects, engineers, and builders alike.

Mercer Mass Timber is leveraging its industry leadership in wood innovation to shepherd clients into this next era of building design and construction. Regardless of the project—whether it aims to showcase beauty, technical leadership, functionality, or environmental stewardship—Mercer Mass Timber building products offer the ideal solution.

Table of Contents

This publication, prepared by Mercer Mass Timber, is intended to serve as a technical guide only. The project designer and professional engineer of record are responsible for providing final documented design and engineering advice for any general or specific use or application where Mercer CLT and glulam beams and columns are being used. Mercer Mass Timber will not be held liable for any direct or indirect use or reliance on information published herein.

Mercer Mass Timber (MMT) is a wholly-owned subsidiary of Mercer International.

Catalyst, Spokane, WA, US

BC Passive House, Mount Currie, BC, Canada

Benefits of Mass Timber Construction

1. Economically Competitive
2. Code-approved
3. Quality Assured
4. Adhesives
5. Biophilic Properties
6. An Engineered Solution
7. Environmentally Superior

1. Economically Competitive

Compared to traditional steel and concrete, mass timber construction shortens project schedules by transferring much of the on-site labor to the factory. Once on-site, it becomes more about assembly than construction.

Since a portion of the labor costs is included in the mass timber materials cost, it's crucial to compare the costs of the two systems at the 'installed-complete/structure' stage of the project. The cost benefits of mass timber construction can be summarized as follows:

Reduced Construction Cycle Time

- As a fully integrated system supplier, Mercer delivers ready-to-assemble mass timber building systems, complete with all connecting hardware and accessories.
- When specified by the contractor, Mercer components arrive on-site with all pick points clearly identified, supporting safe and efficient lifting.
- Compared to traditional practices, where steel bar reinforcing is manually tied on-site, forms and false work are constructed, and concrete is poured and left to set and strengthen, mass timber solutions can accelerate production schedules by as much as 25% (see Figure 1).
- As a part of The Mercer Mass Timber Advantage (see pages 18-19), further optimization of the construction schedule is achievable by coordinating the delivery and installation schedules.
- A compressed construction cycle not only accelerates completion but also minimizes the risk of delays inherent in extended cycles, potentially reducing the likelihood of claims and back charges.

For a comprehensive overview of our service offerings, refer to page 22.

Compressing the Typical Construction Schedule

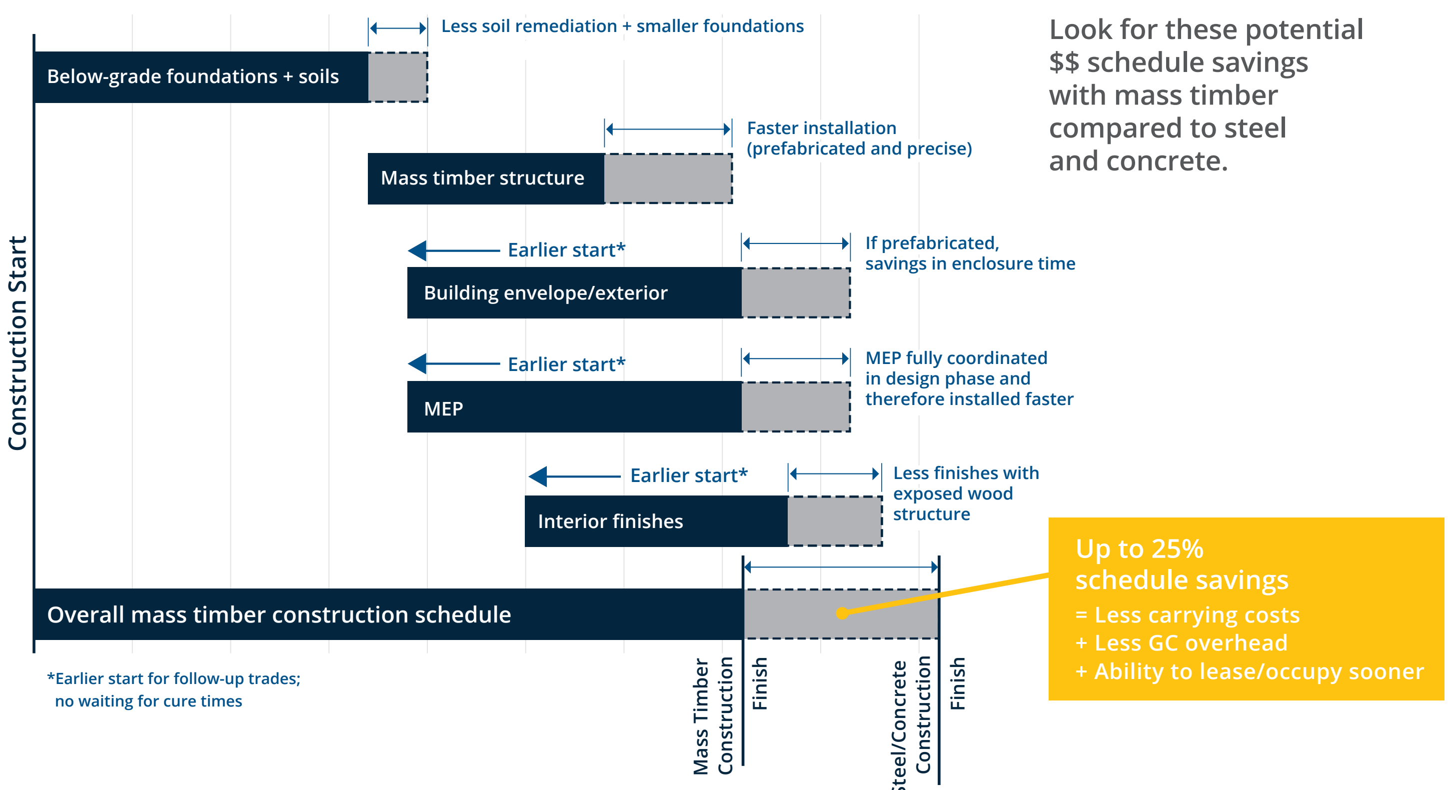


Figure 1: *Mass timber vs. steel/concrete construction schedule. Mass timber cost and design optimization checklists. WoodWorks – Wood Products Council*

Decreased Demand for Skilled Labor

- The availability of skilled labor is one of the industry's biggest challenges today, with more skilled laborers retiring from construction trades than entering.
- Mass timber construction shifts a significant portion of the on-site skilled labor to permanent manufacturing positions, significantly reducing labor costs for projects.

Improved Jobsite Safety Performance

- Fewer jobsite laborers and a shorter cycle time contribute to enhanced jobsite safety performance, often leading to lower insurance rates and reduced costs associated with claims and recordable incident investigations.

Reduced Foundation Costs

- Mass timber components are up to 75% lighter than traditional reinforced concrete components used in similar projects. This reduction in total building weight allows for smaller and lighter foundations, leading to the following benefits:
    - Cost savings from reduced materials and labor for footings and foundations.
    - A viable solution for development in areas with poor soil quality.
    - More cost-effective seismic solutions.

Improved Project ROI

- Accelerated build schedules materially reduce the cost of capital.

UBC Brock Commons - Tallwood House, Vancouver, BC, Canada

2. Code-Approved to North American Standards

The International Building Code (IBC) recognizes the following, provided they meet specific manufacturing standards, for use in mass timber construction building systems across various building typologies:

- Cross-laminated timber (CLT), when manufactured in accordance with the ANSI/APA PRG 320-2019 *Standard for Performance Rated Cross-laminated Timber*
- Structural glue-laminated timber (GLT/glulam), when manufactured in accordance with the ANSI/APA A190.1 - 2017 *Standard for Structural Glue-laminated Timber and Wood Construction Products*

These materials are approved for use in (see Figure 2):

- Multi-family residential buildings up to five stories.
- Conventional non-residential buildings up to six stories, including offices, banks, hotels, motels, dormitories, and other health facilities (excluding hospitals).
- Large non-residential buildings up to six stories, such as warehouses, stores, public and recreational facilities, schools, and government buildings.

Design Property Compatibility

The design capacities published in ANSI/APA PRG 320-2019 and ANSI A190.1 were derived analytically using the lumber properties published in the National Design Specification (NDS) for Wood Construction. Lumber from outside of North America has different characteristics, may not be recognized in the NDS and has published design values that are incompatible with those of North American lumber. As a result, the design properties for mass timber products manufactured with foreign species lumber should be carefully examined for compatibility with the North American design standards.

Mercer Mass Timber Products are Certified to be used as Slabs and Walls

The Mercer evaluation report provides CLT reference design values for allowable stress design (ASD) for bending and in-plane shear in accordance with IBC.

The CLT panels produced in our factories are produced for use as a diaphragm or shear walls, as per IBC without the requirement of an Alternate Means and Methods Request (AMMR) within jurisdictions governed by the IBC, specifically. The in-plane shear design values include major and minor stress and strength capacities based on standard in-plane shear testing per Section 8.5.6.1. of ANSI/APA PRG 320 and Annex A3 of ASTM D5456.

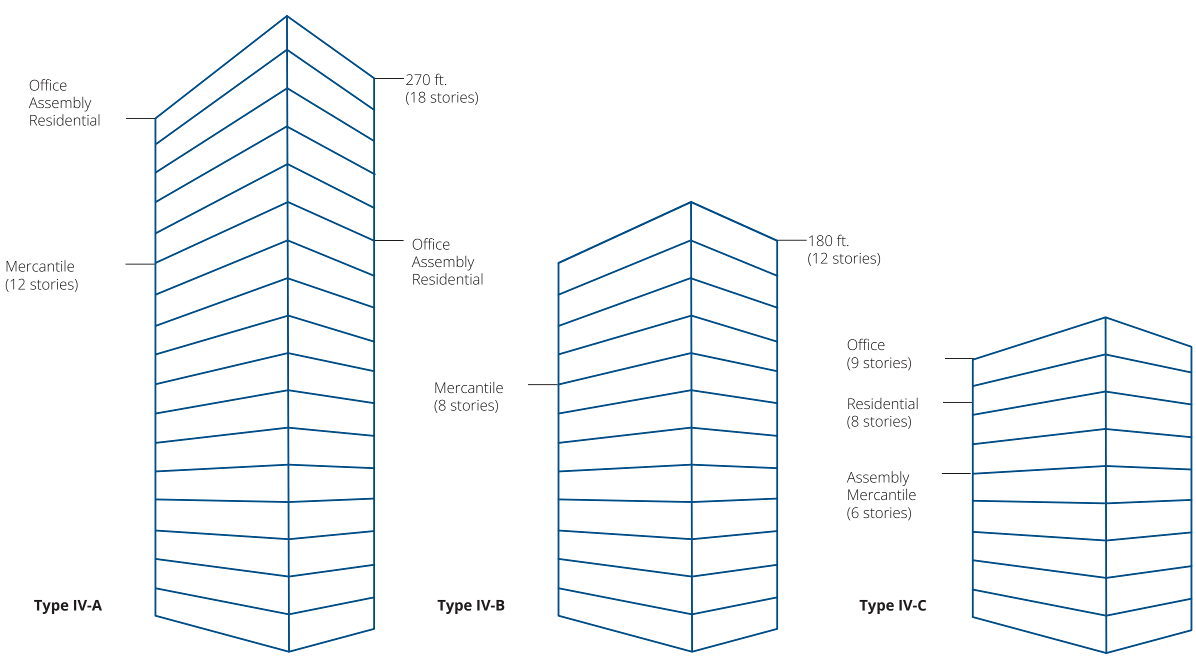


Figure 2: *Height Limits for Building Types IV-A, IV-B, and IV-C in the 2021 International Building Code (IBC), Woodworks - Wood Products Council*

3. Product Quality Assured

We are proud of our ongoing certification and adherence to the North American standards for cross-laminated timber and glue-laminated timber, as referenced throughout this guide. Mercer CLT and glulam are certified to meet the requirements of the Standard for Wood Products – structural glue-laminated timber and cross-laminated timber, as described in ANSI A190.1-2017 and ANSI/APA PRG 320-2019.

These standards outline the quality control measures required by ANSI, and compliance is verified by *APA – The Engineered Wood Association (www.apawood.org) through ongoing and monthly independent third-party inspection visits to Mercer's manufacturing operations. For more information on destructive performance testing, refer to Table 3 on page 29.

Further design considerations and local code approvals may be required when considering a foreign supply source, which can increase project timelines and cost. By adhering to these standards, Mercer can assure a standard of quality to the professionals who specify our products. For more information, refer to pages 12 and 13.

4. Adhesives

Mercer Mass Timber Adhesive Systems

The manufacturing of all code-approved mass timber products requires adhesives approved for face bond lamination and end-to-end finger jointing. Mercer uses adhesives specific to our manufacturing processes that are certified to North American testing and manufacturing standards.

All adhesives must conform to ASTM testing methods for fire, heat and moisture and must support ANSI manufacturing standards (see Table 1 below). These test methods and manufacturing standards are approved in the U.S. by the International Building Code (IBC). The IBC is a model building code developed by the International Code Council (ICC).

The adhesive component is product thickness and depth dependent and comprises approximately 1% by weight of Mercer's mass timber building products.

Glue-Bond Durability

The structural integrity of mass timber components depends upon the integrity of the glue-bond between the component lumber elements. This is true for the entire service life of these mass timber components. Conditions that can impact the glue-bond integrity are exposure to elevated heat (such as a fire event) and exposure to high moisture conditions for extended periods.

Fire Performance

The fire resistance of CLT and structural glulam is based on the certification requirements of the North American testing and manufacturing mass timber standards. These standards require rigorous adhesive heat durability testing to ensure mass timber product structural integrity under the most severe fire conditions.

Emissions

Both Henkel and Hexion adhesives used by Mercer for manufacturing our mass timber products are certified to UL GREENGUARD Gold. GREENGUARD Gold certified products are qualified to meet UL GREENGUARD standards for low chemical emissions into indoor air during product usage. These adhesives are formulated to meet or exceed all global emissions standards.

80M, Washington, DC, US

*At the time of this publishing, this only refers to MMT Okanagan and MMT Conway factories.

TABLE 1: ADHESIVES FOR CLT AND GLULAM MASS TIMBER PRODUCTS

ADHESIVE APPLICATION	ADHESIVE BRAND	ADHESIVE TYPE	EMISSIONS CERTIFICATION	ADHESIVE PERFORMANCE TESTING		
				FULL SCALE FIRE TEST	HEAT DELAMINATION	MOISTURE DURABILITY
Finger Joints CLT/Glulam	Hexion Cascomel™	Melamine Formaldehyde (MF)	UL GREENGUARD Gold	✓	✓	✓
Face Bond Glulam	Hexion EcoBind™	Melamine Formaldehyde (MF)	UL GREENGUARD Gold	✓	✓	✓
Face Bond CLT	Henkel Loctite HB X PURBOND	Polyurethane (PUR)	UL GREENGUARD Gold	✓	✓	✓

5. Biophilic Properties

As humans, we have an inherent desire to connect with nature and our environment. Increasingly, we're seeing projects that embrace this connection to the natural world, especially in corporate offices where creating an appealing workspace serves as both a benefit and a competitive advantage. Mass timber is the ideal structural material for this biophilic approach to design, delivering the warmth and beauty of wood while facilitating inviting designs featuring soaring ceilings, organic shapes, and open spaces. Whether the mass timber components are encapsulated or you choose to highlight the natural allure of the wood, you create environments that people are drawn to and want to return to time and again.

6. An Engineered Solution

CLT components, when manufactured in accordance with ANSI/APA PRG 320-2019 *Standard for Performance Rated Cross-laminated timber and Glulam Components* complying with ANSI A190.1 *Standard for Wood Products for Structural Glue-laminated timber*, are recognized in the National Design Specification (NDS) as structurally rated components.

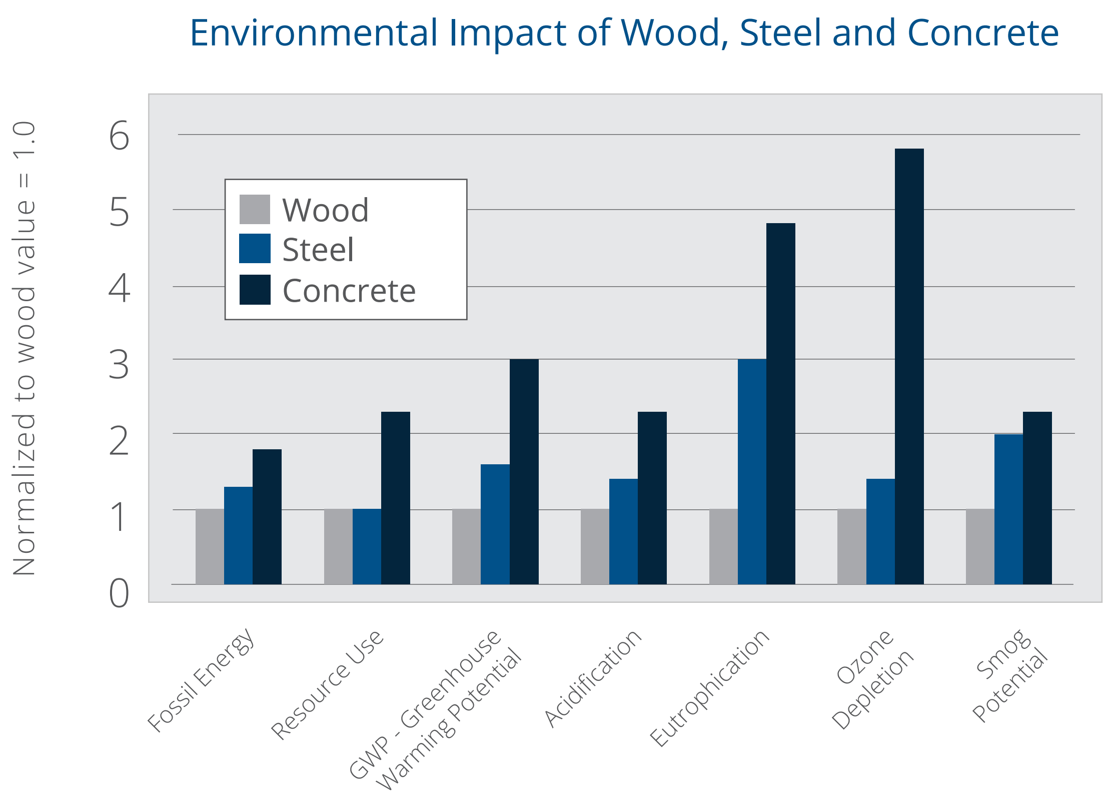
Design professionals employing mass timber construction can use the same engineering principles and standards with the same safety and code compliance recognition as are applied to materials such as steel and concrete. Mass timber embodies strength, resiliency and design ability expanse with the potential to reduce design time compared to other building material selections.

Catalyst, Spokane, WA, US

7. Environmentally Responsible

The United Nations states that two of the most compelling issues in the world today are shelter and climate change. Mass timber construction speaks to both.

- Wood as a building material is a renewable resource that can be regenerated through sustainable forestry practices. Mercer uses only wood that is sustainably harvested, including Forest Stewardship Council® (FSC®) (FSC-C005872), Sustainable Forestry Initiative® (SFI®), and the Programme for the Endorsement of Forest Certification (PEFC), chain-of-custody certified.
- Harvested timber retains its carbon through the life of the building, while reforestation through replanting increases the carbon capture rate by as much as a factor of two times over the same acreage.
- Located within the timberlands it draws upon, Mercer minimizes the transportation footprint required to produce mass timber components. This is most compelling when compared to importing competitive mass timber products or steel from offshore producers.
- Less energy is consumed in the production of mass timber components. By some estimates, wood conversion is as much as five times more efficient than cement for concrete and up to 20 times more energy efficient than the production of steel (see Figure 3).
- As a choice, mass timber construction enables a virtuous cycle of capturing carbon from the atmosphere while supporting the forestry practices of responsible harvesting techniques and reforestation practices.
- Both CLT and glulam beams and columns are ASTM certified with Environmental Product Declarations (EPD) to provide complete transparency of the materials used. EPDs are imperative for calculating building lifecycle costs.



Three hypothetical buildings (wood, steel and concrete) of identical size and configuration are compared. In all cases, impacts are lower for the wood design. **Source:** Dovetail Partners using the Athena Eco-Calculator

Figure 3: *Normalized comparison of environmental impacts of wood, steel and concrete buildings*


High Line Timber Bridge, New York, NY, US

The Mercer Mass Timber Advantage

1. A Vertically Integrated Team
2. Delivering New Levels of Value
3. Service Options

1. A Vertically Integrated Team

When you choose Mercer Mass Timber, you have the assurance you'll be working with:

- **The North American industry leader in mass timber construction.** Mercer proudly supports and is certified by all North American (US and Canada) building codes and manufacturing standards, boasting the largest production capacity in North America
- **A design partner.** Mercer employs a team of specialist engineers, BIM coordinators, fabrication designers, project managers, DfMA specialists, logistic experts, and mass timber installers at your disposal to execute a comprehensive value proposition. Our services can be precisely tailored to your needs, from early design and specification to the finest details of steel connections and hardware. We meticulously bring your vision to life, down to the last screw, nut, and bolt.
- **A project partner.** Mercer is fully 4D BIM capable, planning the delivery of every component to optimize your construction schedule, including the loading sequence of each truck. We can collaborate with specialized logistics companies to utilize staging yards near your job site, ensuring materials are readily available for a reliable installation schedule.
- **A fully integrated supplier.** Mercer supplies CLT and glulam beams and columns from our factories, as well as source and install off-site proprietary products, project-custom steel connections, and all related hardware.
- **A steward of the environment.** Mercer uses sustainably harvested wood, including SFI®, FSC®, and PEFC chain-of-custody certified materials. Certificates are available upon request.

UW Foster School of Business, Founders Hall, Seattle, WA, US


Okanagan College, Kelowna, BC, Canada

2. Delivering New Levels of Value

For decades, our experience as a world-renowned fabricator of complex mass timber components has endowed us with deep knowledge and expertise to create beautifully designed systems of the highest quality. Our work process is meticulously designed to ensure 100% accountability through every step of your project, including:

Mass Timber Design-Assist
Our world-class team of specialists in design, supply and assembly of mass timber structures have amassed the experience of every project we have supplied.

As a resource to your project design team, Mercer can engage in design-assist services tailored for your project needs: engineering, BIM coordination, project management, fabricability and constructibility input. We will share our best practices and value propositions with you to deliver the most cost-effective and creative solutions that meet or exceed the requirements of the US building codes, as well as your own high expectations.

Budgeting
Our estimators and senior designers possess deep knowledge of mass timber design and engineering, including hardware and connections to provide you with accurate and timely SD-, DD- and CD-level budgets and quotations for your project.

Project Execution Management
A dedicated project execution team composed of project managers, BIM coordinators, mass timber engineers and detailers are allocated to your job for an efficient design, fabrication, delivery and installation. The project manager is the single point of contact and the utmost in customer service.

Lumber Procurement
Through our strategic supply relationships, Mercer has dedicated personnel to procure a wide range of commodity lumber and raw materials, as well as the related steel and system accessories, to protect against raw material price volatility. This mitigates the risk of price escalation for projects that have deferred production windows or prolonged production cycles.

Sustainability
Mercer is a fully sustainability-certified manufacturer of mass timber building products and is committed to achieving the highest standards of sustainable construction requirements. Our mass timber building products can be supplied with SFI®, FSC®, and PEFC certification.

Fabrication Approval and 3D Modeling (LOD350)
Following the building design freeze, our fabrication approval team will create and coordinate an exact 3D model of your project including all mass timber components with all steel and hardware connectors, right down to every nut, bolt and screw, including vital details such as holes, daps, slots, counterbores and chamfers, for fabrication. This process allows us to envision potential construction issues long before arriving on the jobsite.

This approach is streamlined for an efficient fabrication approval process, where the focus shifts from a design development perspective to a fabrication sign-off for production mindset, namely finalizing exact component geometry, slab edges, member connections, panel connections and delivery sequence.

Fabrication
From an approved-to-produce 3D model, the data is transferred electronically, directly to our state-of-the-art CNC fabrication machinery where components are reproduced to extreme precision (less than 1/8”). Individual component shop drawings are produced with exacting specifications as part of our quality control best practices.

Quality and Application Assurance
Mercer maintains a rigorous Quality and Application Assurance program that meets or exceeds the standards set forth in the North American model building codes, throughout our process. Third-party inspected and verified, by APA and PFS-Teco.

Mercer proudly delivers the best-in-class product quality.

Codes and Standards Compliant
Mercer CLT and glulam beams and columns meet International Building Code (IBC) and National Design Specification (NDS) for CLT and glulam and are manufactured in accordance with ANSI/APA PRG 320-2019 *Standard for Performance Rated Cross-laminated Timber* and ANSI A190.1 *Standard for Wood Products – Structural Glue-laminated Timber.*

Our team takes pride in every project, from preliminary consultation and design through manufacturing, shipment and installation. We understand the many challenges of both design and construction and make it our primary goal to ensure that all processes run as smoothly as possible.

Options – Adhesives, Finishes and Coatings
We offer a variety of options to enhance the aesthetic appeal of glulam beams and columns, including two adhesives, three smooth finishes, three rustic finishes and a wide array of factory-applied coatings.

Packaging and Delivery
Secure arrival to the jobsite is the cornerstone of our delivery system. Depending on the job requirements, we factory install connectors and test-fit pieces to ensure smooth on-site assembly.

Glulam beams and columns are individually wrapped and sealed, corners are protected and additional packaging such as plywood sheathing is added when necessary. Please refer to page 54 for additional care and handling recommendations.

Coordinated Installation
The Mercer team can self-perform the installation of mass timber projects or, together with the project manager, coordinate with the project installation team to ensure safe and efficient on-site deliveries and installation. The result is a building with optimized structural performance, rapid assembly and superior aesthetic appeal.

Superior Engineering for Superior Performance

Staggered Multiple Piece Lamination vs. Block Glued Layup Methodology

When manufacturing wide-section members, Mercer utilizes a staggered multiple piece lamination technique as described in ANSI A190.1, section 9.3.

In contrast, the block glued methodology, commonly used by foreign manufacturers, allows for narrower single-lamination components to be edge-glued along the face of the two beams to produce built-up wide-section components. These edge-laminated blocks create a continuous, vertical shear plane between the two edge-glued narrow beams.

The multiple piece layup where edge laminations are both staggered and face glued is a preferred methodology because it creates more diffused shear planes, better dimensional stability and increased homogenization of the lamstock in the glulam structural member.

Diffused Shear Planes: Foreign manufacturers commonly use a block glued methodology where narrower single-lam components are edge-glued to produce built-up wide components. This creates a continuous vertical shear plane between the two edge-glued components. In contrast, the multiple piece lamination technique creates noncontiguous vertical glue-line shear planes through the components.

Dimensional Stability: Based upon the same principle of an increased number of elements within the component, a staggered multiple piece lamination layup reduces the dimensional tendencies of any one element and can potentially increase the overall stability of the component. This can be most prominently realized in wider and deeper sections.

Increased Homogenization: Glulam beams and columns constructed through the staggered multiple piece lamination technique are composed of more individual elements than through a single lamination layup practice. This increased number of elements acts to further diffuse the impact of any one element on the resulting component and creates a more homogeneous construction.

Staggered Multiple Piece Lamination

- The staggered multiple piece lamination method creates a noncontiguous shear plane in the glulam member.
- This staggered layup does not rely on the glue line integrity to the same degree as the forces can be resisted by the overlapping laminations in shear.
- This staggered glulam composition method is implicitly safer, more robust and does not demand the same degree of quality control over the glue line integrity as the block glued lamination method.

Block Glued Gluman

- The block glued glulam lamination method creates a contiguous vertical shear plane that relies on the glue-bond line integrity to transfer loads through the glulam member.
- In an asymmetric loading application, the load component must transfer across the glue line in shear to allow the glulam member to act as a compound unit.

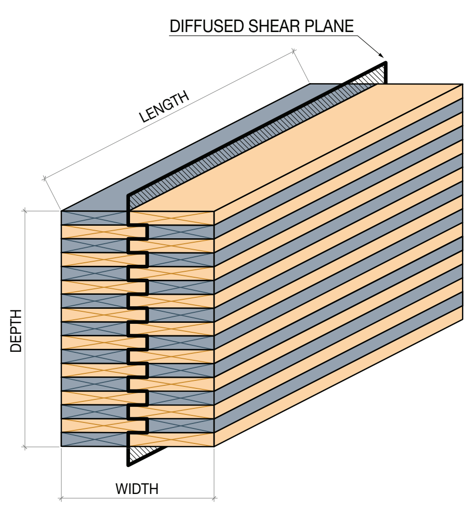


Figure 4: *Staggered multi-piece lamination method*

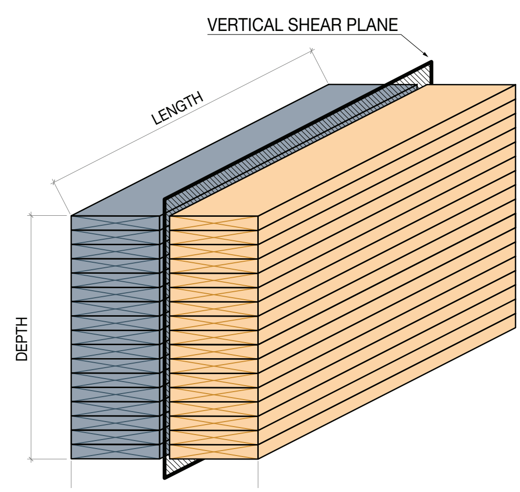


Figure 5: *Block glued multi-piece lamination method*

Over 60 years of North American combined Mass Timber Expertise

When you choose Mercer, you'll be working with the North American industry leader in mass timber manufacturing and project delivery, a company at the forefront of the mass timber revolution. Compared with the costs and logistics of working with overseas manufacturers, Mercer is the right choice for simplified construction and sustainability.

We are also your partner in the process. We use 3D Building Information Modeling (BIM) to detail your vision down to the last screw, nut and bolt. Our sophisticated CNC machinery ensures extreme precision (less than 1/8") in all our fabrication. No other manufacturer in North America can match our quality and precision on CLT and glulam building products. We plan the delivery of every component to maximize your construction schedule, right down to how each member is loaded on every truck.

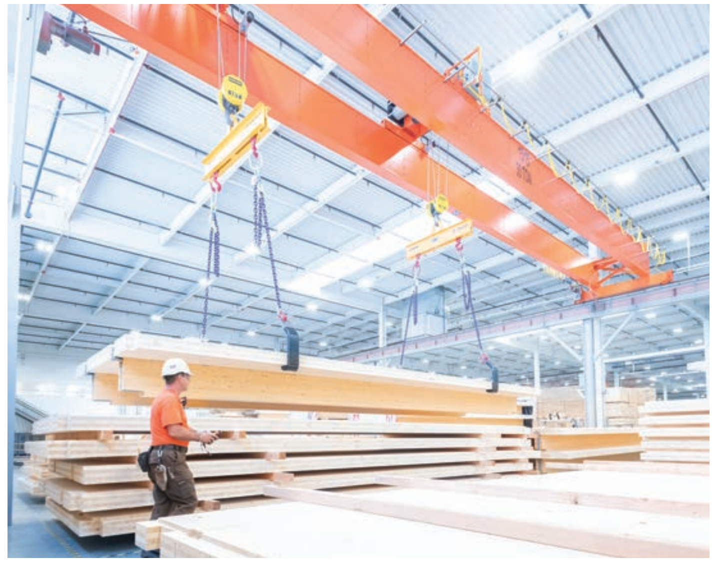
We work closely with you every step of the way. That's an advantage that overseas companies simply cannot achieve.

Mercer Spokane Factory, Spokane, WA, US

As a Manufacturer, Mercer Mass Timber Delivers

Defect-free quality, the first time, every time. Mercer utilizes state-of-the-art CNC robotics, along with a rigorous Quality and Application Assurance program throughout our process, from 3D modeling and inline lumber testing to test-fitting all component connections, ensuring what is delivered to the jobsite matches precisely with the 3D model created in our design center.

Our advanced scheduling system allows for your job to be delivered in-full, on-time and in-spec. This will take place when milestone-based scheduling is adhered to, allowing for production to meet your expected deliveries.



3. Service Options

Our customers are at the heart of our business. Mercer offers a range of design and fabrication service levels, each incorporating various elements of The Mercer Advantage. The service options range from fabrication only of your approved shop drawings, to traditional supply with our technical services, to consulting on cost efficiency through an engagement of design for manufacturing and assembly. We will work with you to understand your needs, preferences and budget to select the right service level for your project.

Our service options include:

FABRICATION ONLY

- Supply of mass timber components per your approved single-piece shop drawings or fully detailed 3D model

TRADITIONAL SUPPLY

- Complete detailing and supply of mass timber kit-of-parts (including steel connectors and hardware) per Mercer single-piece shop drawings, as approved by the project's Architect, Engineer and Contractor (AEC) team
- Project management and scheduling services, ensuring your mass timber kit-of-parts arrives on-site, on-time, in-full and on-spec to meet your construction schedule

DESIGN ASSIST AND SUPPLY

- Collaborate with the AEC team to achieve design cost optimization through efficiencies in manufacture and on-site assembly of the mass timber kit-of-parts
- Complete detailing and supply of mass timber kit-of-parts (including steel connectors and hardware) per Mercer single-piece shop drawings, as approved by the AEC team
- Project management and scheduling services, ensuring your mass timber kit-of-parts arrives on-site, on-time, in-full and on-spec to meet your construction schedule

DELEGATED DESIGN A ND SUPPLY

- Provide mass timber specialty engineering design services with consent and collaboration with the EOR and with respect to the architect's design intent
- Complete detailing and supply of mass timber kit-of-parts (including steel connectors and hardware) per Mercer single-piece shop drawings, as approved by the AEC team
- Project management and scheduling services, ensuring your mass timber kit-of-parts arrives on-site, on-time, in-full and on-spec to meet your construction schedule

We believe that Mercer is uniquely positioned to meet even the most challenging project requirements. We are confident that you will find our decades of North American experience and expertise worthy of further discussion.

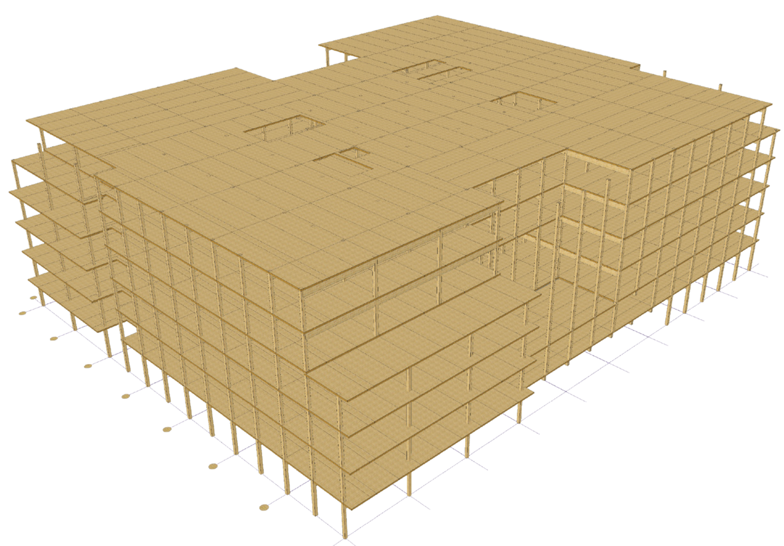
Mass Timber Design Process

1. Mass Timber Design-Assist Process

Once you've determined mass timber construction is your preferred building approach and chosen Mercer as your supply partner, we recommend the following series of steps and decisions to help guide your progression forward.

1	Determine standard grid pattern(s) for your design.
2	Select a mass timber building system for your project.
3	Consider each design element (fire performance, acoustics and sound transmission, vibration control, etc.) through the Design Considerations section in the guide (pages 25-51) and the effect each consideration may have on member sizing.
4	Using the engineering design properties provided in the guide for Mercer CLT (see pages 25-35) and glulam beams and columns (see pages 37-54), determine preliminary member sizing for individual grid assemblies for the load and applicable code requirements of your project.
5	As you develop a working design solution, your Mercer regional manager will work with you to complete your design, including grid layout and member sizing and positioning, as well as to develop a preliminary budget for your project. Feel free to contact your Mercer regional manager at any time during the process.

As always, we're here to assist. Regardless of what level you ultimately work with us—whether design, supply, fabrication only or any stage in between—we recommend you engage one of our team of mass timber specialists as early in the process as possible.



CLT Products

Mercer Mass Timber Cross-laminated Timber (CLT)

As a North American manufacturer with deep roots in wood construction, we understand building codes and the construction process. Our history is also what makes us uniquely suited to deliver solutions that serve the construction industry.

CLT is an eco-friendly engineered product that replaces concrete for various purposes like floors, walls, roofs, cores and shafts. It can span in two directions and it is carbon negative. Using CLT can revolutionize modern-day construction.

The technical information in this guide is compiled to support you in developing designs that specify Mercer CLT panels. If you have questions and need help, let our qualified team of mass timber specialists and technical support representatives help you specify the right solution for your project.

MERCER MASS TIMBER CLT ADVANTAGES:

- North American (US and Canada) code-approved
- Superior wood fiber and appearance
- Engineering, BIM coordination, fabrication approval services available
- CNC fabricated to exacting tolerances
- Delivered in coordinated sequence to installation schedule
- Steel and connecting hardware included
- All required holes, daps, slots, counterbores and chamfers included
- Rigorous quality control process

Earth Sciences Building, UBC, Vancouver, BC, Canada

1. CLT Product Applications

Floors

Mercer CLT panels are ideally suited for modern floor systems because they are two-way span capable and ship to site as ready-to-install components, greatly simplifying building construction and increasing jobsite productivity. Mercer CLT products help ensure an optimized structural solution that allows you to install up to 700-square-feet per lift, or over 15,000-square-feet per day.

Roofs

Mercer CLT panels provide overhanging eaves and span a variety of roof layouts. Their inherent thermal insulation contributes to a more efficient envelope assembly. Panels can be as thin as 3.43"(87mm) and as thick as 12.42"(315mm), resulting in a maximum roof span of 40' with appropriate loading. CLT roofs are installed quickly, allowing projects to approach lockup and a watertight state in a short amount of time.

Walls

Mercer CLT wall panels are a lighter, cost-competitive alternative to traditional load bearing wall systems like precast concrete and tilt-ups, but with much better thermal performance. When used as a system with wall and roof panels, there is an inherent gain in energy efficiency in the building design.

CLT walls can be used as non-load bearing or load bearing. Additionally, the latest revision of ASCE (American Society of Civil Engineers) and SDPWS (Special Design Provisions for Wind & Sesimic) has formally recognized CLT walls as lateral load resisting systems.

As vertical and horizontal load-bearing elements, Mercer CLT

Shear Walls and Diaphragms

Mercer CLT panels are certified to use as lateral force-resisting systems (LFRS) for both wind and seismic loads per ASCE7-22 and SDPWS-2021.

Mercer pioneered the use of CLT as shear walls in the Catalyst project (Spokane, WA) and of CLT diaphragms on the UW-FSB project (Seattle, WA). Our APA and PFS-Teco certifications provide in-plane shear capacities that can be used for LFRS design, in accordance to US design standards.

Cores and Shafts

Mercer CLT panels are well suited for use in cores and shafts. These can be erected quicker and easier than comparable steel and concrete designs while still providing lateral bracing. Elevator and stair shafts can achieve two-hour fire resistance ratings.

2. Mass Timber Building Code Considerations

The International Building Code (IBC) recognizes cross-laminated timber (when manufactured per ANSI/APA PRG 320-2019 Standard (for Performance Rated Cross-Laminated Timber), and Glue-Laminated Timber (when manufactured per ANSI/APA A190.1). Mercer, as a manufacturer of these components certified in North America, adheres to these standards.

The values in this table are generalized. The validity of this information is the responsibility of the Architect and Engineer.

CONSTRUCTION TYPE (OCCUPATION CLASS*)	BUILDING HEIGHT*	ALLOWABLE FOR EXPOSED TIMBER**	FIRE RESISTANCE RATING (FLOORS AND MAIN FRAME**)
II-A/B, I-A/B (B)	Roof only (max 2 story) or Fire-retardant-treated wood or Alternate Fire Testing per 2303.2, as well as non-bearing elements.		
III-B (B)	4 stories / 75’	100%	0h
III-A (B)	6 stories / 85’	100%	1h
IV-HT (B)	6 stories / 85’	100%	HT
IV-C (B)	9 stories / 85’	100%	2h
IV-B (B)	12 stories / 180’	Partial (IBC 2024)	2h
IV-A (B)	18 stories / 270’	0%	2h (3h primary frame)
V-B (GENERAL)	1-3 stories / 40-60’	100%	0h
V-A (GENERAL)		0% to 100%	0h to 1h

*Assumes Occupancy Classification (B) - Office Space U.N.O. For other occupancy classes, see IBC. Building height corresponds to a sprinklered building.
**Fire ratings for interior Primary Structural Frame and floors. See IBC 2024 for other building elements and other special considerations related to the protection of wood.
***IBC 2024 code provisions may not be implemented in the jurisdictions. A full list can be seen here.
https://www.woodworks.org/resources/status-of-building-code-allowances-for-tall-mass-timber-in-the-ibc/

Manufacturers of mass timber components of cross-laminated timber, certified in North America, adhere to the standards set forth as described above.

Mercer Mass Timber APA and PFS-TECO Reports

The Mercer Mass Timber APA PR-L314 (Mercer Okanagan), APA PR-L347 (Mercer Conway) and PFS-Teco BPER 0141 (Mercer Spokane) evaluation reports provides Mercer CLT reference design values for allowable stress design (ASD) for bending and in-plane shear in accordance with IBC.

This additional recognition allows Mercer CLT to be considered for use as a diaphragm per IBC without the requirement of an Alternate Means and Methods Request (AMMR) within jurisdictions governed by the IBC, specifically. The in-plane shear design values include major and minor stress and strength capacities based on standard in-plane shear testing per Section 8.5.6.1. of ANSI/APA PRG 320 and Annex A3 of ASTM D5456. Using Mercer CLT for diaphragm use is advantageous since additional layers of plywood are not required to satisfy code requirements.

Product Quality Assured

We are proud of our ongoing certification and adherence to the North American cross-laminated timber and glue-laminated timber standards referenced throughout this guide. Mercer CLT is certified to meet the requirements of *Standard for Wood Products – Structural Glue-laminated Timber and Cross-laminated Timber (GLT/CLT)* as described in *ANSI A190.1-2017* and *ANSI/APA PRG 320-2019*.

These standards outline the quality control requirements required by ANSI and are verified by APA – The Engineered Wood Association (www.apawood.org) through ongoing and monthly independent third-party inspection visits to Mercer's manufacturing operations. For more information on destructive performance testing, see Table 3 on page 29.

Further design considerations and local code approvals may be required when considering a foreign supply source, which can increase project timelines and cost. By adhering to these standards, Mercer can assure a standard of quality to the professionals who specify our products.

3. Adhesives

Mercer Mass Timber Adhesive Systems

The manufacturing of all code-approved mass timber products to produce long length lamellas requires adhesives approved for face bond lamination and end-to-end finger jointing. Mercer uses adhesives specific to our manufacturing processes that are certified to North American testing and manufacturing standards.

All adhesives must conform to ASTM testing methods for fire, heat and moisture and must support ANSI manufacturing standards (see Table 2 below). These test methods and manufacturing standards are approved in the US by the International Building Code (IBC). The IBC is a model building code developed by the International Code Council (ICC).

The adhesive component is product thickness and depth dependent and comprises approximately 0.5% by weight of Mercer's mass timber building products.

Glue-Bond Durability

The structural integrity of mass timber components depends upon the integrity of the glue-bond between the component lumber elements. This is true for the entire service life of these mass timber components. Conditions that can impact the glue-bond integrity are exposure to elevated heat (such as a fire event) and exposure to high moisture conditions for extended periods.

Fire Performance

The fire resistance of cross-laminated timber and structural glue-laminated timber is based on the certification requirements of the North American testing and manufacturing mass timber standards. Mercer uses heat-resistant glues in its production of CLT, as required per PRG-320:2019 Annex B which requires rigorous adhesive heat durability testing to ensure mass timber product structural integrity under the most severe fire conditions.

Mercer has successfully passed 2-hr Fire Resistance Rating (FRR) tests to ASTM E119 on 5-ply CLT panels produced in several facilities. We can provide test evidence to design teams and the authority having jurisdiction (AHJ) that Mercer CLT products perform better than the numerical model proposed in NDS Chapter 12. This allows the use of 5-ply CLT panels on 2-hr FRR scenarios, like in Building Types IV-A, IV-B and IV-C per IBC.

Emissions

Both Henkel and Hexion adhesives used by Mercer for manufacturing our mass timber products are certified to UL GREENGUARD Gold. GREENGUARD Gold certified products are qualified to meet UL GREENGUARD standards for low chemical emissions into indoor air during product usage. These adhesives are formulated to meet or exceed all global emissions standards.

Figure 6: *Glue-bond sample test blocks*

TABLE 2: ADHESIVES FOR CLT MASS TIMBER PRODUCTS

ADHESIVE APPLICATION	ADHESIVE BRAND	ADHESIVE TYPE	EMISSIONS CERTIFICATION	ADHESIVE PERFORMANCE TESTING		
				FULL SCALE FIRE TEST	HEAT DELAMINATION	MOISTURE DURABILITY
Finger Joints CLT	Hexion Cascomel™	Melamine Formaldehyde (MF)	UL GREENGUARD Gold	✓	✓	✓
Face Bond CLT	Henkel Loctite HB X PURBOND	Polyurethane (PUR)	UL GREENGUARD Gold	✓	✓	✓

TABLE 3: DESTRUCTIVE PERFORMANCE TESTING

TYPE	METHODOLOGY
SHEAR TESTING	Test blocks are sampled where the glue-bond lines are mechanically loaded to withstand failure
CYCLIC – DELAMINATION TEST	Advanced wood aging process designed to simulate environmental trauma across 50 years of exterior service
END JOINT TENSION TESTING	Destructive lot-testing of manufactured finger joints to ensure that final products meet the prescribed strength ratings

Note: As a standard procedure, each test result is documented and used to certify Mercer Mass Timber products prior to shipment.

4. Mercer CLT Product Characteristics

TABLE 4: PRODUCT CHARACTERISTICS

	MMT OKANAGAN	MMT CONWAY	MMT SPOKANE
MAXIMUM PANEL SIZE	10' x 40' (3,048 mm x 12,192 mm)	12' x 60' (3,660 mm x 18,288 mm)	12' x 60' (3,660 mm x 18,288 mm)
MAXIMUM THICKNESS	12.42" (315 mm)		
MINIMUM THICKNESS	3.43" (87 mm)		3.24" (82mm)
PRODUCTION WIDTHS	8', 10' (2,438 mm, 3,048 mm)	7'-10½" to 11'-6" (2,400 mm to 3,505 mm)	9'-9" to 11'-9" (2,972 mm to 3,581 mm)
MOISTURE CONTENT	12% (+/-3%) at time of manufacturing		
FACE BOND GLUE TYPE	Henkel Loctite HB X PURBOND		
FINGER JOINT GLUE TYPE	Hexion Cascomel®	Henkel Loctite HB X PURBOND	
SPECIES	SPF, DF-L, SYP	SYP	SPF, DF-L, SYP
LUMBER GRADES	SPF #2, SPF MSR 2100, SPF #3, DF-L #2, SYP #2, SYP #3	SYP #2, SYP MSR 2100	SPF #2, SPF #3, SPF MSR 2100, DF-L #2, DF-L #3, DF-L MSR 2100, SYP #2, SYP MSR 2100
STRESS GRADES	V2M1.1, V2.1, E1M4, E1M5	V3M1, V3.1, E4M2, E4M3	1.4V, 1.8M
MANUFACTURING CERTIFICATION	APA-PR L314	APA-PR L347	PFS-TECO BPER 0141
DENSITY	SPF: 30pcf DF-L: 35pcf SYP: 40pcf		
MOISTURE DIMENSIONAL STABILITY	Longitudinal and Transverse 0.01% per % change in MC. Thickness 0.20% per % change in MC		
THERMAL CONDUCTIVITY	R value: 1.2 per inch ($h \cdot ft^2 \cdot °F$ /Btu)		
CO_2 SEQUESTRATION	37.4 lbs/ft^3 (subject to local manufacturing and distances)	IN PROGRESS	
DIMENSIONAL TOLERANCES			
THICKNESS	+/- 1/16" (2 mm) or 2% of CLT thickness, whichever is greater		
WIDTH	+/- 1/8" (3 mm) of the CLT width		
LENGTH	+/- 1/4" (6 mm) of the CLT length		
SQUARENESS	Panel face diagonals shall not differ by more than 1/8" (3 mm)		
STRAIGHTNESS	Deviation of edges from a straight line between adjacent panel corners shall not exceed 1/16" (2 mm)		
MACHINED SURFACES	+/- 1/8" (3 mm) with all tooling units except the chainsaw, which is +/- 1/4" (6 mm)		

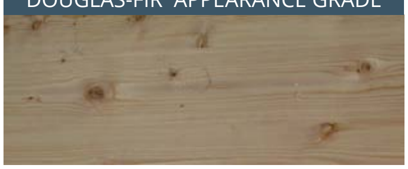
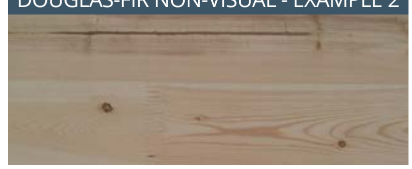
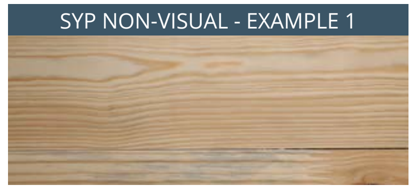
4. Mercer CLT Panel Layups

For technical information on Mercer CLT products, please refer to the Mercer Mass Timber Product Catalog.

5. Mercer CLT Finishes and Appearance Classification

TABLE 5: CLT FINISHES

	VISUAL	NON-VISUAL
INTENDED USE	Where one or both faces are left exposed	Where both faces are covered by another material
FACE LAYER - V SERIES	SPF #2&Btr Appearance Grade, Douglas-fir, Appearance Grade, SP #2&Btr Appearance Grade	SPF #2&Btr, SP #2&Btr
FACE LAYER - E SERIES	SPF MSR 2100 Square Edge	SPF MSR 2100, SP MSR 2100
SANDED FACE	80 grit Note: Final finishing prep work must be completed on-site, including cleaning and touch-up of panels	N/A

	ALLOWABLE FIBER CHARACTERISTICS	
SHAKE AND CHECKS	Several up to 24" long, none through	As per NLGA #2, SPF #2&Btr
STAIN	Up to a max of 5% blue stain, heart stain allowed Note: E Series panels have no blue stain restrictions	Allowed, not limited
KNOTS	Firm & Tight (NLGA #2)	NLGA #2
PITCH STREAKS	Not limited	Not limited
WANE ON FACE	None	Allowed
SIDE PRESSURE	Yes	None
SURFACE QUALITY	SPF APPEARANCE GRADE  DOUGLAS-FIR APPEARANCE GRADE  SYP APPEARANCE GRADE 	SPF NON-VISUAL - EXAMPLE 1  DOUGLAS-FIR NON-VISUAL - EXAMPLE 2  SYP NON-VISUAL - EXAMPLE 1 

6. Panel Applications

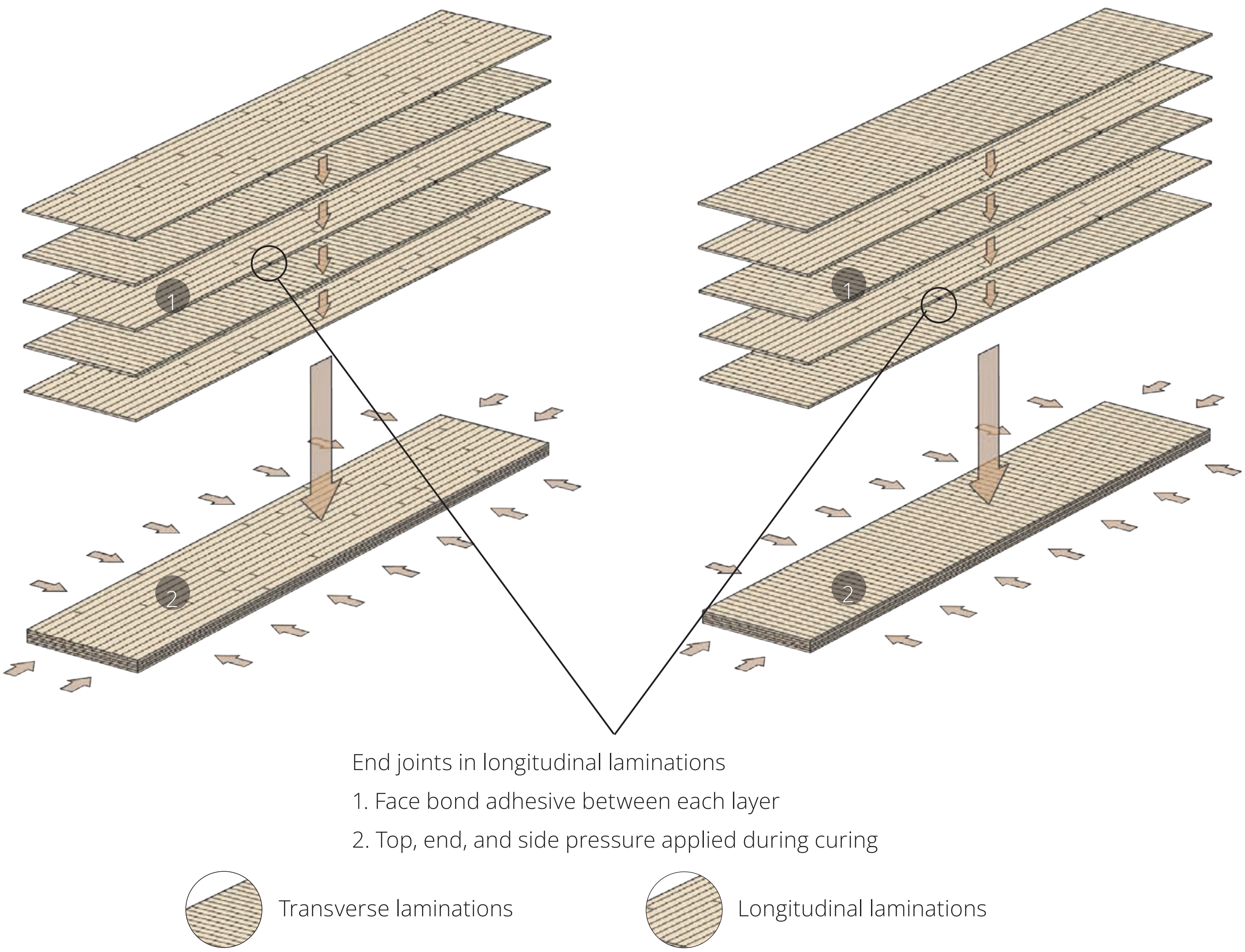
Mercer CLT panels are primarily intended for one-way slab, single or multi-span behavior in the panel strong direction for out-of-plane loads and acts as the floor/roof diaphragm without the addition of plywood sheathing or structural concrete topping for in-plane loading. The bottom face of appropriately-sized floor panels may be visually exposed and achieve a 1- or 2-hour fire resistance rating through charring of the wood.

The width of laminations (boards) in outer visible layers and inner layers of panels are nominally 6 inches. Architectural and Industrial Appearance surface classifications are available, where an Architectural Appearance surface classification may be specified on one, both, or neither of the faces of the panel. Our CLT is compatible with a number of different surface treatments (i.e., painted, stained, sealed, etc.), which should be evaluated on a project-by-project basis.

Boards are end jointed (finger-jointed) at random lengths to create continuous boards from which the billet is laid up. End joints are cut parallel to the wide face of laminations, thus the fingers will be visible on the narrow face of boards. Transverse boards may not contain finger joints.

Finished panels are accurately fabricated from full billets to the user-specified size, shape, and level of detail by state-of-the-art CNC machines installed at production at each facility to provide precise field fit. Consult with Mercer on a project basis to review the manufacturability of the proposed CLT panelization, holes, and edge cut fabrication at early design stages.

Layup of a 5-ply Mercer CLT Billet



7. Structural Panel Properties and Allowable Design

TABLE 6: ALLOWABLE DESIGN PROPERTIES FOR LAMINATIONS - **WESTERN SPECIES** (SPF & DF-L)*

CLT GRADE	MAJOR STRENGTH DIRECTION						MINOR STRENGTH DIRECTION					
	F_B (psi)	E (10^6 psi)	F_T (psi)	F_C (psi)	F_V (psi)	F_S (psi)	F_B (psi)	E (10^6psi)	F_T (psi)	F_C (psi)	F_V (psi)	F_S (psi)
V2.1 1.4V 875 SPF 1.4V 875 DF-L	875	1.4	450	1,150	135	45	500	1.2	250	650	135	45
V2M1.1	875	1.4	450	1,150	135	45	875	1.4	450	1,150	135	45
E1M4 1.8M 2100 SPF 1.8M 2100 DF-L	2,100	1.8	1,575	1,875	160	50	500	1.2	250	650	135	45
E1M5	2,100	1.8	1,575	1,875	160	50	875	1.4	450	1,150	135	45

Notes:

1. Tabulated values are allowable design values and not permitted to be increased for the lumber size adjustment factor in accordance with the NDS.
2. The CLT grades are developed based on APA and PFS-Teco Certifications. Please refer to specific grade layups for complete panel information.
3. The design values shall be used in conjunction with the section properties provided by the CLT manufacturer based on the actual layup used in manufacturing the CLT panel (see table above).

TABLE 7: ALLOWABLE DESIGN PROPERTIES FOR LAMINATIONS (**SOUTHERN SPECIES**)*

CLT GRADE	MAJOR STRENGTH DIRECTION						MINOR STRENGTH DIRECTION					
	F_B (psi)	E (10^6 psi)	F_T (psi)	F_C (psi)	F_V (psi)	F_S (psi)	F_B (psi)	E (10^6psi)	F_T (psi)	F_C (psi)	F_V (psi)	F_S (psi)
V3.1	750	1.4	450	1,250	175	55	450	1.3	250	725	175	55
V3M1 1.4V 750 SYP	750	1.4	450	1,250	175	55	750	1.4	450	1,250	175	55
E4M3	2,100	1.8	1,575	1,875	175	55	450	1.3	250	725	175	55
E4M2 1.8M 2100 SYP	2,100	1.8	1,575	1,875	175	55	750	1.4	450	1,250	175	55

Notes:

1. Tabulated values are allowable design values and not permitted to be increased for the lumber size adjustment factor in accordance with the NDS.
2. The CLT grades are developed based on APA Product Report PR-L314, APA Product Report PR-L347 and PFS-Teco Building Product Evaluation Report BPER-0141. Please refer to specific grade layups for complete panel information.
3. The design values shall be used in conjunction with the section properties provided by Mercer Mass Timber based on the actual layup used.
4. Values are calculated per one-foot-wide section of panel.

*This list is non exhaustive. Contact Mercer Mass Timber for additional grades.

7. Structural Panel Properties and Allowable Design

TABLE 8: ALLOWABLE STRESS DESIGN CAPACITIES FOR **WESTERN SPECIES***

CLT GRADE	PANEL	WEIGHT lbs/ft²	MAJOR STRENGTH DIRECTION				MINOR STRENGTH DIRECTION			
			$F_BS_{EFF,0}$ (lbs-ft/ft)	$EI_{EFF,0}$ (10^6lbs-in²/ft)	$GA_{EFF,0}$ (10^6lbs/ft)	$V_{S,0}$ (lbf/ft)	$F_BS_{EFF,0}$ (lbs-ft/ft)	$EI_{EFF,90}$ (10^6lbs-in²/ft)	$GA_{EFF,90}$ (10^6lbs/ft)	$V_{S,90}$ (lbf/ft)
V2.1 1.4V 875 SPF 1.4V 875 DF-L	87 V	8.5	1,440	56	0.48	1,230	35	0.36	0.30	240
	90 V	8.8	1,500	60	0.39	1,270	115	2.0	0.44	425
	150 V	14.8	3,450	229	0.78	2,120	1,010	51	0.89	1,270
	139V	13.7	3,325	206	0.96	1,970	540	21	0.60	980
	191V	18.8	5,925	503	1.40	2,700	1,220	83	0.91	1,710
	243V	23.9	9,200	995	1.90	3,450	2,140	209	1.20	2,450
V2M1.1	105 V	10.3	2,050	96	0.53	1,490	280	3.7	0.53	495
	175 V	17.2	4,725	366	1.10	2,480	2,410	96	1.10	1,490
	245 V	24.1	8,350	906	1.60	3,475	5,550	366	1.60	2,480
	315 V	30.9	12,925	1,806	2.10	4,475	9,800	906	2.10	3,475
E1M4 1.8M 2100 SPF 1.8M 2100 DF-L	87 E	8.5	3,475	72	0.50	1,230	35	0.40	0.38	270
	139 E	13.7	7,975	264	0.99	1,970	540	21	0.77	1,090
	191 E	18.8	14,175	645	1.50	2,700	1,230	83	1.10	1,910
	243 E	23.9	22,075	1,278	2.00	3,450	2,160	209	1.50	2,725
E1M5	105 E	10.3	4,900	123	0.54	1,490	275	3.70	0.66	550
	175 E	17.2	11,250	469	1.10	2,480	2,400	96	1.30	1,650
	245 E	24.1	19,900	1,161	1.60	3,475	5,550	366	2.00	2,750
	315 E	30.9	30,850	2,314	2.10	4,475	9,825	906	2.60	3,850

TABLE 9: ALLOWABLE STRESS DESIGN CAPACITIES **SOUTHERN PINE***

CLT GRADE	PANEL	WEIGHT lb/ft²	MAJOR STRENGTH DIRECTION					MINOR STRENGTH DIRECTION		
			$F_BS_{EFF,0}$ (lbf-ft/ft)	$EI_{EFF,0}$ (10^6 lbf-in²/ft)	$GA_{EFF,0}$ (10^6 lbf/ft)	$F_BS_{EFF,90}$ (lbf-ft/ft)	$V_{S,0}$ (lbf/ft)	$EI_{EFF,90}$ (10^6 lbf-in²/ft)	$GA_{EFF,90}$ (10^6 lbf-in²/ft)	$V_{S,90}$ (lbf/ft)
V3.1	87 V SP	11.4	1,240	56	0.51	35	1,510	0.39	0.30	295
	139 V SP	18.2	2,850	206	1.00	485	2,410	23	0.61	1,200
	191 V SP	25	5,075	503	1.50	1,100	3,300	91	0.91	2,100
	243 V SP	31.9	7,900	996	2.10	1,920	4,200	227	1.20	3,000
V3M1 1.4V 750 SYP	105 V SP	13.8	1,750	95	0.53	235	1,820	37	0.53	605
	150 V SP	19.7	2,950	230	0.90	1,510	2,600	60	0.90	1,560
	175 V SP	22.9	4,025	366	1.10	2,060	3,025	95	1.10	1,820
	245 V SP	32.1	7,125	906	1.60	4,750	4,250	366	1.60	3,025
	315 V SP	41.3	11,050	1,806	2.10	8,375	5,450	906	2.10	4,250
E4M3	87 E SP	11.4	3,475	72	0.53	35	1,510	0.39	0.38	295
	139 E SP	18.2	7,975	264	1.10	485	2,410	23	0.77	1,200
	191 E SP	25	14,200	646	1.60	1,100	3,300	91	1.20	2,100
	243 E SP	31.9	22,075	1,278	2.10	1,940	4,200	229	1.50	3,000
E4M2 1.8M 2100 SYP	105 E SP	13.8	4,900	123	0.50	140	1,820	3.4	0.65	605
	175 E SP	22.9	11,250	469	1.10	1,240	3,025	89	1.30	1,820
	245 E SP	32.1.3	19,875	1,160	1.50	2,850	4,250	341	2.00	3,025
	315 E SP	41.3	30,800	2,312	2.00	5,050	5,450	845	2.60	4,250

*Not all layups shown. Some layups might be specific to a factory. Contact Mercer Mass Timber for more details.

Western Species (SPF, DF-L)

TABLE 10: SINGLE SPAN CLT FLOOR SLABS, SLD=40 PSF. INCLUDES PANEL SELF-WEIGHT AND LIVE LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	RESIDENTIAL SPACE LIVE LOAD=40 PSF			OFFICE SPACE LIVE LOAD=50 PSF			MECHANICAL ROOM LIVE LOAD=75 PSF			STORAGE AREA LIVE LOAD=100 PSF		
	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD
87 V	8.56	9.33	11.36	8.53	9.10	10.77	8.47	8.60	9.63	8.40	8.19	8.78
87 E	9.22	10.15	17.69	9.19	9.90	16.77	9.12	9.36	14.99	9.05	8.91	13.67
90 V	8.73	9.44	11.57	8.70	9.20	10.97	8.63	8.70	9.81	8.57	8.28	8.95
105 V	9.98	10.95	13.40	9.95	10.69	12.72	9.87	10.11	11.40	9.80	9.63	10.41
105 E	10.75	11.90	20.85	10.71	11.61	19.79	10.63	10.97	17.71	10.56	10.45	16.17
139 V	12.39	14.12	16.74	12.35	13.80	15.92	12.27	13.11	14.31	12.18	12.53	13.10
139 E	13.35	15.38	26.05	13.31	15.03	24.77	13.21	14.26	22.24	13.12	13.63	20.35
150 V	12.75	14.43	16.95	12.71	14.11	16.13	12.62	13.40	14.51	12.54	12.80	13.30
175 V	14.57	16.69	19.52	14.53	16.33	18.60	14.43	15.53	16.77	14.34	14.86	15.39
175 E	15.70	18.18	30.40	15.66	17.78	28.95	15.55	16.89	26.08	15.45	16.15	23.92
191 V	15.92	18.58	21.72	15.88	18.19	20.71	15.78	17.33	18.70	15.68	16.61	17.19
191 E	17.16	20.28	33.79	17.12	19.85	32.21	17.00	18.90	29.06	16.90	18.11	26.68
243 V	19.26	22.83	26.35	19.21	22.38	25.19	19.09	21.39	22.85	18.98	20.54	21.06
243 E	20.78	24.95	41.11	20.72	24.45	39.27	20.60	23.35	35.58	20.47	22.41	32.77
245 V	18.74	21.94	25.04	18.70	21.51	23.94	18.58	20.54	21.72	18.48	19.71	20.02
245 E	20.19	24.01	38.99	20.14	23.52	37.26	20.02	22.45	33.76	19.90	21.54	31.09
315 V	22.67	26.83	30.13	22.61	26.33	28.88	22.49	25.23	26.34	22.37	24.28	24.37
315 E	24.36	29.19	46.59	24.30	28.65	44.67	24.17	27.46	40.74	24.04	26.43	37.69

Notes:

1. See Table 11 for notes.

TABLE 11: DOUBLE SPAN CLT FLOOR SLABS, SDL=40 PSF. INCLUDES PANEL SELF-WEIGHT AND LIVE LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	RESIDENTIAL SPACE LIVE LOAD=40 PSF			OFFICE SPACE LIVE LOAD=50 PSF			MECHANICAL ROOM LIVE LOAD=75 PSF			STORAGE AREA LIVE LOAD=100 PSF		
	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD
87 V	10.27	12.69	11.36	10.24	12.39	10.77	10.16	11.74	9.63	10.08	11.20	8.78
87 E	11.07	13.82	17.69	11.03	13.49	16.77	10.95	12.78	14.99	10.87	12.19	13.23
90 V	10.47	12.90	11.57	10.44	12.59	10.97	10.36	11.92	9.81	10.28	11.37	8.95
105 V	11.98	14.97	13.40	11.94	14.62	12.72	11.85	13.86	11.40	11.77	13.23	10.41
105 E	12.90	16.29	20.85	12.86	15.90	19.79	12.76	15.07	17.71	12.67	14.38	15.83
139 V	14.87	19.16	16.74	14.82	18.74	15.92	14.72	17.82	14.31	14.62	17.06	13.10
139 E	16.02	20.88	26.05	15.97	20.42	24.77	15.86	19.41	22.24	15.75	18.57	20.35
150 V	15.30	19.66	16.95	15.26	19.23	16.13	15.15	18.29	14.51	15.05	17.51	13.30
175 V	17.48	22.74	19.52	17.43	22.26	18.60	17.31	21.21	16.77	17.20	20.32	15.39
175 E	18.85	24.79	30.40	18.79	24.26	28.95	18.66	23.10	26.08	18.54	22.12	23.92
191 V	19.11	25.20	21.72	19.06	24.68	20.71	18.93	23.55	18.70	18.81	22.59	17.19
191 E	20.60	27.51	33.79	20.54	26.94	32.21	20.40	25.69	29.06	20.28	24.63	26.68
243 V	23.11	30.96	26.35	23.05	30.36	25.19	22.91	29.05	22.85	22.78	27.93	21.06
243 E	24.93	33.84	41.11	24.87	33.18	39.27	24.71	31.72	35.58	24.57	30.48	32.77
245 V	22.49	29.87	25.04	22.43	29.29	23.94	22.30	28.01	21.72	22.17	26.93	20.02
245 E	24.23	32.65	38.99	24.17	32.01	37.26	24.02	30.59	33.76	23.88	29.39	31.09
315 V	27.20	36.54	30.13	27.14	35.88	28.88	26.99	34.43	26.34	26.85	33.17	24.37
315 E	29.23	39.71	46.59	29.16	30.00	44.67	29.00	37.42	40.74	28.85	36.06	37.69

Notes:

1. For panel properties refer to Table 8. Span tables are intended for Preliminary Sizing only.
2. Span Tables includes self-weight plus a superimposed dead load of SDL=40psf. This is SDL covers a typical 2” thick concrete topping + 15psf for miscellaneous imposed dead loads.
3. For double span situation, both spans are assumed to be equal. Live load pattern loading have not been considered. Live loads are assumed to be uniform over both spans.
4. Deflection checks were made assuming a maximum allowable deformation of L/240 (L = span) under total load, including creep behavior as defined on NDS clause 3.5.2 with Kcr=2.0
5. Vibration design is based on the approach outlined in the CLT Handbook as described on the latest US Mass Timber Floor Vibration Design guide. Vibration span values are increased by 20% for doublespan situations based on the US CLT Handbook and the Mass Timber Floor Vibration Guide. The effect of flexible supports (e.g. glulam beams) is not considered on the vibration results presented. More sophisticated vibration analysis might be required.
6. ASD spans shown are established not to exceed the maximum Moment and Shear capacities of the panels, as per ASD design methodology defined on the NDS. All adjustment factors outlined in NDS Table 10..3.1 have assumed as 1.0
7. Span tables values are only valid the major strength direction of the CLT panels.
8. Bolded values indicate spans that exceed manufacturing capacities (60’ single span panel, 2x30’ for double span.) In some manufacturing planets and situations, the maximum limit might be reduced. Contact Mercer Mass Timber for more details.

Southern Species (SYP)

TABLE 12: SINGLE SPAN CLT FLOOR SLABS, SDL=40 PSF. INCLUDES PANEL SELF-WEIGHT AND LIVE LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	RESIDENTIAL SPACE LIVE LOAD=40 PSF			OFFICE SPACE LIVE LOAD=50 PSF			MECHANICAL ROOM LIVE LOAD=75 PSF			STORAGE AREA LIVE LOAD=100 PSF		
	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD
87 V SP	8.54	9.29	10.48	8.51	9.07	9.94	8.45	8.58	8.89	8.39	8.18	8.12
87 E SP	9.19	10.09	17.54	9.16	9.84	16.64	9.09	9.32	14.89	9.03	8.88	13.60
105 V SP	9.96	10.95	12.34	9.92	10.69	11.72	9.85	10.13	10.51	9.78	9.66	9.61
105 E SP	10.71	11.86	20.59	10.67	11.58	19.56	10.59	10.97	17.53	10.52	10.46	16.03
139 V SP	12.35	14.02	15.36	12.31	13.71	14.62	12.23	13.04	13.16	12.15	12.48	12.07
139 E SP	13.28	15.24	25.70	13.24	14.90	24.46	13.15	14.17	22.02	13.06	13.56	20.18
175 V SP	14.51	16.64	17.93	14.47	16.28	17.10	14.38	15.52	15.45	14.29	14.86	14.19
175 E SP	15.59	18.00	29.88	15.55	17.62	28.50	15.45	16.79	25.74	15.35	16.08	23.66
191 V SP	15.86	18.43	19.87	15.82	18.05	18.97	15.72	17.23	17.16	15.62	16.52	15.79
191 E SP	17.06	20.02	33.24	17.02	19.61	31.73	16.91	18.71	28.71	16.81	17.95	26.42
243 V SP	19.17	22.62	24.08	19.12	22.19	23.05	19.01	21.24	20.95	18.90	20.43	19.34
243 E SP	20.62	24.53	40.25	20.57	24.07	38.52	20.45	23.03	35.02	20.34	22.14	32.33
245 V SP	18.66	21.79	22.89	18.62	21.37	21.91	18.51	20.45	19.92	18.41	19.65	18.39
245 E SP	20.04	23.57	38.18	19.99	23.12	36.55	19.88	22.11	33.23	19.77	21.25	30.67
315 V SP	22.52	26.56	27.42	22.47	16.09	26.32	22.35	25.05	24.07	22.24	24.14	22.31
315 E SP	24.22	28.78	45.83	24.17	28.27	44.00	24.04	27.13	40.23	23.92	26.14	37.29

Notes:

1. See Table 13 for notes.

TABLE 13: DOUBLE SPAN CLT FLOOR SLABS, SDL=40 PSF. INCLUDES PANEL SELF-WEIGHT AND LIVE LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	RESIDENTIAL SPACE LIVE LOAD=40 PSF			OFFICE SPACE LIVE LOAD=50 PSF			MECHANICAL ROOM LIVE LOAD=75 PSF			STORAGE AREA LIVE LOAD=100 PSF		
	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD	VIBRATION	L/240	ASD
87 V SP	10.25	12.64	10.48	10.21	12.34	9.94	10.14	11.70	8.89	10.06	11.17	8.12
87 E SP	11.03	13.73	17.54	10.99	13.41	16.64	10.91	12.71	14.89	10.83	12.14	13.60
105 V SP	11.95	14.93	12.34	11.91	14.59	11.72	11.82	13.85	10.51	11.74	13.23	9.61
105 E SP	12.85	16.19	20.59	12.81	15.82	19.56	12.71	15.01	17.53	12.62	14.34	16.03
139 V SP	14.82	19.02	15.36	14.78	18.62	14.62	14.67	17.72	13.16	14.58	16.98	12.07
139 E SP	15.94	20.67	25.70	15.89	20.22	24.46	15.78	19.26	22.02	15.68	18.44	20.18
175 V SP	17.41	22.61	17.93	17.36	22.14	17.10	17.25	21.13	15.45	17.15	20.27	14.19
175 E SP	18.71	24.50	29.88	18.66	23.99	28.50	18.54	22.89	25.74	18.42	21.95	23.66
191 V SP	19.03	24.98	19.87	18.98	24.48	18.97	18.86	23.39	17.16	18.74	22.46	15.79
191 E SP	20.48	27.15	33.24	20.42	26.61	31.73	20.29	25.42	28.71	20.17	24.41	26.42
243 V SP	23.00	30.65	24.08	22.95	30.08	23.05	22.81	28.82	20.95	22.69	27.74	19.34
243 E SP	24.74	33.27	40.25	24.68	32.65	38.52	24.54	31.28	35.02	24.40	30.10	32.33
245 V SP	22.39	29.61	22.89	22.34	29.06	21.91	22.21	27.83	19.92	22.09	26.78	18.39
245 E SP	24.05	32.07	38.18	23.99	31.47	36.55	23.85	30.14	33.23	23.72	29.00	30.67
315 V SP	27.02	36.10	27.42	26.96	35.48	26.32	26.82	34.10	24.07	26.69	32.90	22.31
315 E SP	29.06	39.17	45.83	29.00	38.49	44.00	28.85	36.99	40.23	28.70	35.68	37.29

Notes:

1. For panel properties refer to Table 9. Span tables are intended for Preliminary Sizing only.
2. Span Tables includes self-weight plus a superimposed dead load of SDL=40psf. This is SDL covers a typical 2" thick concrete topping + 15psf for miscellaneous imposed dead loads.
3. For double span situation, both spans are assumed to be equal. Live load pattern loading have not been considered. Live loads are assumed to be uniform over both spans.
4. Deflection checks were made assuming a maximum allowable deformation of L/240 (L = span) under total load, including creep behavior as defined on NDS clause 3.5.2 with Kcr=2.0
5. Vibration design is based on the approach outlined in the CLT Handbook as described on the latest US Mass Timber Floor Vibration Design guide. Vibration span values are increased by 20% for doublespan situations based on the US CLT Handbook and the Mass Timber Floor Vibration Guide. The effect of flexible supports (e.g. glulam beams) is not considered on the vibration results presented. More sophisticated vibration analysis might be required.
6. ASD spans shown are established not to exceed the maximum Moment and Shear capacities of the panels, as per ASD design methodology defined on the NDS. All adjustment factors outlined in NDS Table 10..3.1 have assumed as 1.0
7. Span tables values are only valid the major strength direction of the CLT panels.
8. Bolded values indicate spans that exceed manufacturing capacities (60' single span panel, 2x30' for double span.) In some manufacturing planets and situations, the maximum limit might be reduced. Contact Mercer Mass Timber for more details.

Western Species (SPF, DF-L)

TABLE 14: SINGLE SPAN CLT ROOF SLABS, SDL=25 PSF AND LR=20PSF. INCLUDES PANEL SELF-WEIGHT AND SNOW LOADS AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	SNOW ROOF LOAD S=20 PSF			SNOW ROOF LOAD S=30 PSF			SNOW ROOF LOAD S=50 PSF			SNOW ROOF LOAD S=100 PSF		
	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD
87 V	10.92	15.87	14.57	10.92	13.82	13.39	10.92	11.58	11.69	10.92	9.07	9.26
87 E	11.91	17.25	22.73	11.91	15.01	20.87	11.91	12.58	18.21	11.91	9.84	14.41
90 V	11.07	16.19	14.81	11.07	14.08	13.62	11.07	11.78	11.90	11.07	9.19	9.44
105 V	12.79	18.94	17.07	12.79	16.47	15.73	12.79	13.78	13.79	12.79	10.75	10.97
105 E	13.93	20.55	26.62	13.93	17.86	24.51	13.93	14.94	21.45	13.93	11.64	17.05
139 V	16.27	24.57	21.07	16.27	21.40	19.51	16.27	17.96	17.20	16.27	14.11	13.79
139 E	17.77	26.68	32.88	17.77	23.23	30.41	17.77	19.49	26.77	17.77	15.31	21.42
150 V	16.62	25.39	21.25	16.62	22.10	19.70	16.62	18.52	17.41	16.62	14.51	13.99
175 V	19.12	29.72	24.30	19.12	25.86	22.59	19.12	21.68	20.03	19.12	16.98	16.18
175 E	20.88	32.26	37.96	20.88	28.07	35.25	20.88	23.52	31.21	20.88	18.40	25.15
191 V	21.15	33.11	26.90	21.15	28.85	25.06	21.15	24.22	22.28	21.15	19.04	18.05
191 E	23.15	35.97	42.00	23.15	31.34	39.07	23.15	26.31	34.68	23.15	20.68	28.03
243V	25.74	41.59	32.20	25.74	36.25	30.14	25.74	30.44	26.99	25.74	23.95	22.08
243 E	28.20	45.20	50.41	28.20	39.39	47.13	28.20	33.07	42.13	28.20	26.01	34.37
245 V	24.77	40.24	30.58	24.77	35.04	28.64	24.77	29.39	25.65	24.77	23.06	20.99
245 E	27.16	43.70	47.79	27.16	38.06	44.69	27.16	31.93	39.96	27.16	25.07	32.61
315 V	29.95	50.66	36.21	29.95	44.11	34.11	29.95	37.00	30.81	29.95	29.04	25.50
315 E	32.57	55.02	56.00	32.57	47.92	52.75	32.57	40.21	47.65	32.57	31.58	39.44

Notes:

1. See Table 15 for notes.

TABLE 15: DOUBLE SPAN CLT ROOF SLABS, SDL=25 PSF AND LR=20PSF. INCLUDES PANEL SELF-WEIGHT AND SNOW LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	SNOW ROOF LOAD S=20 PSF			SNOW ROOF LOAD S=30 PSF			SNOW ROOF LOAD S=50 PSF			SNOW ROOF LOAD S=100 PSF		
	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD
87 V	14.81	21.39	14.57	14.81	18.65	13.39	14.81	15.67	11.69	14.81	12.35	9.26
87 E	16.15	23.26	22.73	16.15	20.27	20.87	16.15	17.03	18.21	16.15	13.42	14.41
90 V	15.05	21.85	14.81	15.05	19.04	13.62	15.05	15.99	11.90	15.05	12.57	9.44
105 V	17.39	25.56	17.07	17.39	22.27	15.73	17.39	18.70	13.79	17.39	14.71	10.97
105 E	18.97	27.75	26.62	18.97	24.17	24.51	18.97	20.29	21.45	18.97	15.95	17.05
139 V	22.02	33.08	21.07	22.02	28.85	19.51	22.02	24.27	17.20	22.02	19.15	13.79
139 E	24.05	35.92	32.88	24.05	31.32	30.41	24.05	26.34	26.77	24.05	20.78	21.42
150 V	22.55	34.22	21.25	22.55	29.83	19.70	22.55	25.07	17.41	22.55	19.75	13.99
175 V	25.95	40.04	24.30	25.95	34.91	22.59	25.95	29.34	20.03	25.95	23.12	16.18
175 E	28.36	43.49	37.96	28.36	37.91	35.25	28.36	31.86	31.21	28.36	25.09	25.15
191 V	28.62	44.56	26.90	28.62	38.87	25.06	28.62	32.70	22.28	28.62	25.82	18.05
191 E	31.32	48.41	42.00	31.32	42.22	39.07	31.32	35.52	34.68	31.32	28.04	28.03
243 V	34.82	55.96	32.20	34.82	48.81	30.14	34.82	41.07	26.99	34.82	32.44	22.08
243 E	38.15	60.82	50.41	38.15	53.05	47.13	38.15	44.64	42.13	38.15	35.25	34.37
245 V	33.61	54.20	30.58	33.61	47.26	28.64	33.61	39.74	25.65	33.61	31.34	20.99
245 E	36.82	58.84	47.79	36.82	51.32	44.69	36.82	43.15	39.96	36.82	34.04	32.61
315 V	40.67	68.22	36.21	40.67	59.49	34.11	40.67	50.02	30.81	40.67	39.46	25.50
315 E	44.19	74.07	56.00	44.19	64.60	52.75	44.19	54.33	47.65	44.19	42.87	39.44

Notes:

1. For panel properties refer to Table 8. Span tables are intended for Preliminary Sizing only.
2. Span Tables includes self weight plus a superimposed dead load of SDL=25psf. This SDL covers a typical roof finishes + 15psf for miscellaneous imposed dead loads. An ordinary roof live load or Lr=20psf is also considered for Total deflection and ASD calculations.
3. For double span situation, both spans are assumed to be equal. Snow load pattern loading or snow drifts have not been considered. Snow loads are assumed to be uniform over both spans. Deflection checks were made assuming a maximum allowable deformation of L/240 (L = span) under total load, including creep behavior as defined on NDS clause 3.5.2 with Kcr=2.0
4. Deflection checks were made assuming for total load composed of D+Lr for a deformation of limit of L/240, i.e., including creep behaviour as defined on NDS clause 3.5.2 with Kcr=2.0, as well as for the instantaneous deflection under the specified Snow Load for a deflection limit of L/360.ASD spans shown are established not to exceed the maximum Moment and Shear capacities of the panels, as per ASD design methodology defined on the NDS. All adjustment factors outlined in NDS Table 10..3.1 have assumed as 1.0
5. ASD spans shown are established not to exceed the maximum Moment and Shear capacities of the panels, as per ASD design methodology defined on the NDS. All adjustment factors outlined in NDS Table 10.3.1 have assumed as 1.0 except the load duration factor, that was taken as CD=1.15
6. Span tables values are only valid the major strength direction of the CLT panels.
7. Bolded values indicate spans that exceed manufacturing capacities (60’ single span panel, 2×30’ for double span). In some manufacturing plants and situations, the maximum limit might be reduced. Contact Mercer Mass Timber for more details.

Southern Species (SYP)

TABLE 16: SINGLE SPAN CLT ROOF SLABS, SDL=25 PSF AND LR=20PSF. INCLUDES PANEL SELF-WEIGHT AND SNOW LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT Panel	SNOW ROOF LOAD S=20 PSF			SNOW ROOF LOAD S=30 PSF			SNOW ROOF LOAD S=50 PSF			SNOW ROOF LOAD S=100 PSF		
	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD
87 V SP	11.70	15.89	13.38	11.70	13.83	12.32	11.70	11.59	10.78	11.70	9.09	8.56
87 E SP	12.71	17.26	22.40	12.71	15.03	20.62	12.71	12.59	18.04	12.71	9.86	14.33
105 V SP	13.75	18.98	15.65	13.75	16.51	14.44	13.75	13.83	12.69	13.75	10.82	10.12
105 E SP	14.91	20.60	26.11	14.91	17.91	24.10	14.91	15.00	21.17	14.91	11.72	16.88
139V SP	17.40	24.58	19.24	17.40	21.41	17.84	17.40	17.98	15.78	17.40	14.13	12.69
139 E SP	18.91	26.70	32.18	18.91	23.26	29.85	18.91	19.53	26.39	18.91	15.35	21.23
175 V SP	20.53	29.77	22.19	20.53	25.93	20.67	20.53	21.75	18.39	20.53	17.08	14.91
175 E SP	22.23	32.28	36.98	22.23	28.11	34.46	22.23	23.57	30.65	22.23	18.49	24.85
191V SP	22.63	33.13	24.47	22.63	28.87	22.84	22.63	24.25	20.37	22.63	19.08	16.57
191 E SP	24.59	36.01	40.93	24.59	31.38	38.21	24.59	26.35	34.08	24.59	20.73	27.72
243 V SP	27.53	41.64	29.22	27.53	36.29	27.43	27.53	30.49	24.65	27.53	24.01	20.26
243 E SP	29.88	45.22	48.85	29.88	39.41	45.85	29.88	33.10	41.21	29.88	26.05	33.86
245 V SP	26.57	40.33	27.76	26.57	35.13	26.06	26.57	29.48	23.43	26.57	23.16	19.26
245 E SP	28.77	43.70	46.32	28.77	38.06	43.48	28.77	31.93	39.09	28.77	25.07	32.13
315 V SP	32.09	50.70	32.71	32.09	44.17	30.90	32.09	37.08	28.02	32.09	29.14	23.32
315 E SP	34.80	55.02	54.69	34.80	47.92	51.65	34.80	40.21	46.84	34.80	31.58	38.97

Notes:

1. See Table 17 for notes.

TABLE 17: DOUBLE SPAN CLT ROOF SLABS, SDL=25 PSF AND LR=20PSF. INCLUDES PANEL SELF-WEIGHT AND SNOW LOAD AS BELOW. MAXIMUM SPAN IN[FT]

CLT PANEL	SNOW ROOF LOAD S=20 PSF			SNOW ROOF LOAD S=30 PSF			SNOW ROOF LOAD S=50 PSF			SNOW ROOF LOAD S=100 PSF		
	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD	TOTAL L/240	SNOW L/360	ASD
87 V SP	15.82	21.40	13.38	15.82	18.66	12.32	15.82	15.69	10.78	15.82	12.36	8.56
87 E SP	17.20	23.27	22.40	17.20	20.28	20.62	17.20	17.05	18.04	17.20	13.43	14.33
105 V SP	18.63	25.59	15.65	18.63	22.31	14.44	18.63	18.74	12.69	18.63	14.76	10.12
105 E SP	20.22	27.78	26.11	20.22	24.21	24.10	20.22	20.34	21.17	20.22	16.00	16.88
139 V SP	23.51	33.08	19.24	23.51	28.86	17.84	23.51	24.27	15.78	23.51	19.16	12.69
139 E SP	25.54	35.94	32.18	25.54	31.35	29.85	25.54	26.37	26.39	25.54	20.82	21.23
175 V SP	27.77	40.09	22.19	27.77	34.96	20.67	27.77	29.40	18.39	27.77	23.19	14.91
175 E SP	30.10	43.48	36.98	30.10	37.91	34.46	30.10	31.88	30.65	30.10	25.14	24.85
191 V SP	30.56	44.57	24.47	30.56	38.88	22.84	30.56	32.72	20.37	30.56	25.84	16.57
191 E SP	33.21	48.45	40.93	33.21	42.26	38.21	33.21	35.56	34.08	33.21	28.08	27.72
243 V SP	37.18	56.00	29.22	37.18	48.86	27.43	37.18	41.12	24.65	37.18	32.50	20.26
243 E SP	40.37	60.83	48.85	40.37	53.07	45.85	40.37	44.65	41.21	40.37	35.27	33.86
245 V SP	35.95	54.28	27.76	35.95	47.34	26.06	35.95	39.82	23.43	35.95	31.43	19.26
245 E SP	38.95	58.84	46.32	38.95	51.32	43.48	38.95	43.15	39.09	38.95	34.04	32.13
315 V SP	43.43	68.23	32.71	43.43	59.51	30.90	43.43	50.06	28.02	43.43	39.52	23.32
315 E SP	47.14	74.07	54.69	47.14	64.60	51.65	47.14	54.33	46.84	47.14	42.87	38.97

Notes:

1. For panel properties refer to Table 9. Span tables should be used under dry conditions and for Preliminary Sizing only.
2. Span Tables includes self weight plus a superimposed dead load of SDL=25psf. This SDL covers a typical roof finishes + 15psf for miscellaneous imposed dead loads. An ordinary roof live load or Lr=20psf is also considered for Total deflection and ASD calculations.
3. For double span situation, both spans are assumed to be equal. Snow load pattern loading or snow drifts have not been considered. Snow loads are assumed to be uniform over both spans.
4. Deflection checks were made assuming for total load composed of D+Lr for a deformation of limit of L/240, i.e., including creep behaviour as defined on NDS clause 3.5.2 with Kcr=2.0, as well as for the instantaneous deflection under the specified Snow Load for a deflection limit of L/360.
5. ASD spans shown are established not to exceed the maximum Moment and Shear capacities of the panels, as per ASD design methodology defined on the NDS. All adjustment factors outlined in NDS Table 10.3.1 have assumed as 1.0 except the load duration factor, that was taken as CD=1.15
6. Span tables values are only valid the major strength direction of the CLT panels.
7. Bolded values indicate spans that exceed manufacturing capacities (60’ single span panel, 2×30’ for double span). In some manufacturing plants and situations, the maximum limit might be reduced. Contact Mercer Mass Timber for more details.

TABLE 18: MERCER CLT IN-PLANE SHEAR DESIGN PROPERTIES

CLT LAYUP		LAYUP ID	THICKNESS, T_P (in)	IN-PLANE SHEAR STRESS		IN-PLANE SHEAR CAPACITY (b)	
				$F_{V,E,O}$ (psi)	$F_{V,E,90}$ (psi)	$F_{V,E,0}\,T_P$ (lbs/ft of width)	$F_{V,E,90}\,T_P$ (lbs/ft of width)
SPF DF-L	V2.1	87 V	3.43	175	235	7,200	9,700
		139 V	5.47	175	235	11,500	15,400
		191 V	7.52	175	235	15,800	21,200
		243 V	9.57	175	235	20,100	27,000
	V2M1.1 1.4V 875 SPF 1.4V 875 DF-L	90 V	3.54	190	215	8,100	9,100
		105 V	4.14	195	290	9,700	14,400
		150 V	5.90	240	235	17,000	16,600
		175 V	6.9	270	290	22,400	24,000
		245 V	9.66	270	290	31,300	33,600
		315 V	12.42	270	290	40,200	43,200
	E1M4 1.8M 2100 SPF	87 E	3.43	175	235	7,200	9,700
		139 E	5.47	175	235	11,500	15,400
		191 E	7.52	175	235	15,800	21,200
		243 E	9.57	175	235	20,100	27,000
	E1M5	105 E	4.14	195	290	9,700	14,400
		175 E	6.9	270	290	22,400	24,000
		245 E	9.66	270	290	31,300	33,600
		315 E	12.42	270	290	40,200	43,200
SYP	V3.1	87 V SP	3.43	193	259	7,900	10,700
		139 V SP	5.47	193	259	12,700	17,000
		191 V SP	7.52	193	259	17,400	23,400
		243 V SP	9.57	193	259	22,200	29,700
	V3M1 1.4V 750 SYP	105 V SP	4.14	215	319	10,700	15,800
		150 V SP	5.900	240	235	17,000	16,600
		175 V SP	6.9	297	319	24,600	26,400
		245 V SP	9.66	297	319	34,400	37,000
		315 V SP	12.42	297	259	44,300	38,600
	E4M3	87 E SP	3.43	193	259	7,900	10,700
		139 E SP	5.47	193	259	12,700	17,000
		191 E SP	7.52	193	259	17,400	23,400
		243 E SP	9.57	193	259	22,200	29,700
	E4M2 1.8M 2100 SYP	105 E SP	4.14	215	319	10,700	15,800
		175 E SP	6.9	297	319	24,600	26,400
		245 E SP	9.66	297	319	34,400	37,000
		315 E SP	12.42	297	319	44,300	47,500

Notes:

1. The tabulated values are allowable design values.
2. The tabulated values are for the full thickness (t_p) of the CLT. The values shall be reduced when the CLT panel thickness is less than the full thickness.
3. Some values are based on test results from other layups. Refer to the relevant APA and PFS-Teco documents for more details.

*Not all layups shown. Some layups might be specific to a factory. Contact Mercer Mass Timber for more details.

80M, Washington, DC, US

Mercer Mass Timber Glulam Beams and Columns

1. Code Acceptance and Quality Assurance Standards
2. Adhesives
3. Product Characteristics
4. Appearance Classifications
5. Camber Standards
6. Allowable Design Stress Properties
7. Load Capacity Tables
8. Engineering Properties

Mercer Mass Timber Glulam Beams and Columns

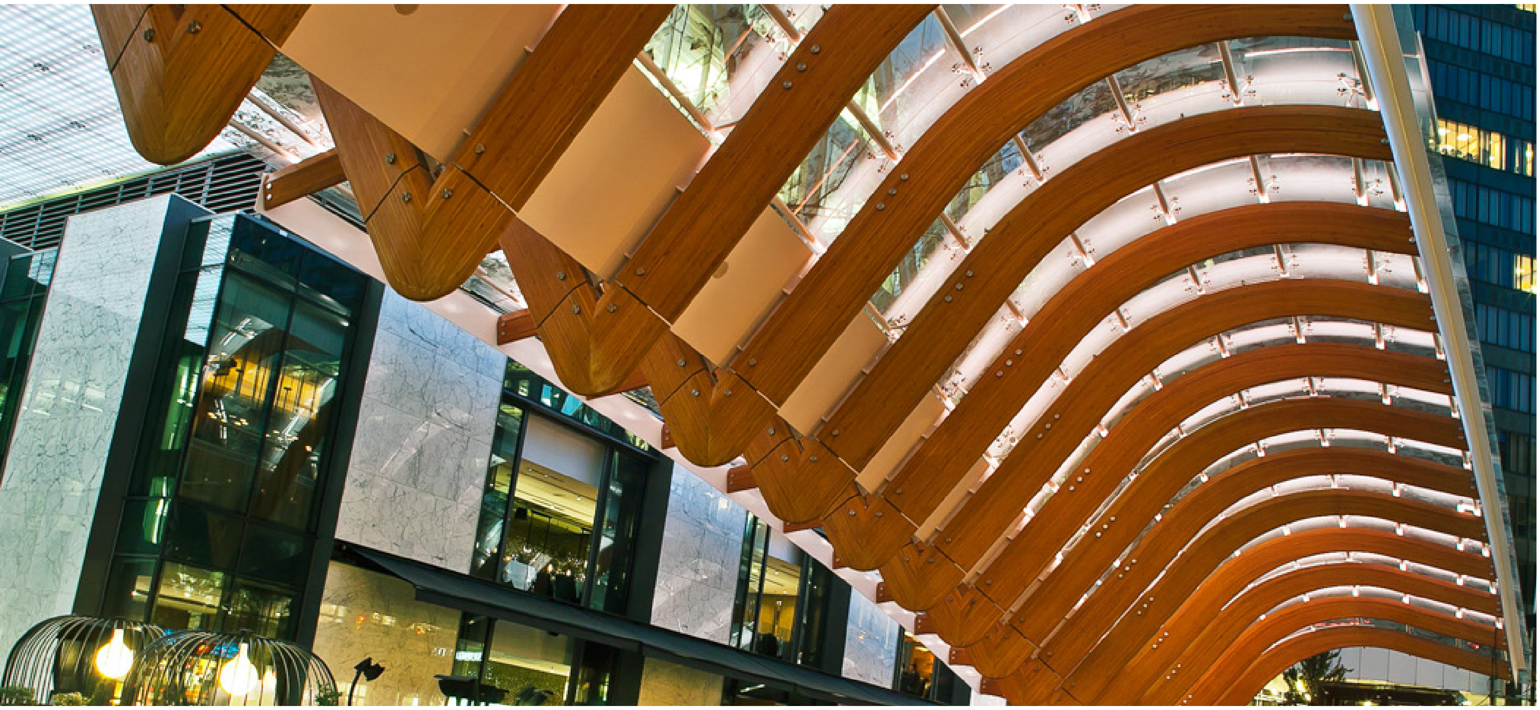
Mercer glulam is manufactured using the highest-quality, sustainably harvested lumber, produced to exacting standards and finished to create North America's most beautiful glulam beams and columns, allowing you to expose the structural elements of your building as a high-grade visual component.

Manufactured in a wide range of shapes, sizes and finish options to match the vision of your design, with options like factory-installed connections and factory-applied stain, Mercer glulam beams and columns stand above all others. When combined with Mercer CLT walls, floors and roof panels, Mercer glulam is a key component of beautiful, economically efficient structures.

The technical information in this guide is compiled to support you in developing designs that specify Mercer glulam beams and columns. If you have questions and need help, let our qualified team of mass timber specialists and technical support representatives help you specify the right solution for your project.

MERCER GLULAM ADVANTAGES:

- North American (US and Canada) code-approved
- Range of shapes and sizes
- Superior wood fiber and appearance
- Engineering, BIM coordination, fabrication approval services available
- Available in sanded, high-quality finish
- Prefabricated kit-of-parts, CNC-fabricated to tight tolerances
- Top-notch project delivery experience
- BIM modeling options
- Shop-assembled steel connections, proprietary hangers and reinforcement screws
- Rigorous quality control process
- Delivered in coordinated sequence to installation schedule
- Installation services available



TELUS Garden Office, Vancouver, BC, Canada

1. Code-approved to North American Standards

The International Building Code (IBC) recognize structural glue-laminated timber as a structural material for wood construction when manufactured in accordance with ANSI A190.1 Standard for Wood Products – Structural glue-laminated timber.

The IBC approves the use of structural glue-laminated timber as a structural member for Type IV Construction and Chapter 5 of the NDS references design values, design equations and overall engineering design specification for structural glue-laminated timber.

Manufacturers of glue-laminated timber, certified in North America, adhere to the standards set forth as described above.

Product Quality Assured

We are proud of our ongoing certification and adherence to the North American cross-laminated timber and glue-laminated timber standards referenced throughout this guide. Mercer glulam is certified to meet the requirements of *Standard for Wood Products – Structural Glue-laminated Timber and Cross-laminated Timber (CLT)* as described in *ANSI A190.1-2017.*

These standards outline the quality control requirements required by ANSI and are verified by the APA – The Engineered Wood Association (www.apawood.org) through ongoing and monthly independent third-party inspection visits to Mercer's manufacturing operations. For more information on destructive performance testing, Table 18 on page 29.

By adhering to these standards, Mercer can assure a standard of quality to the professionals who specify our products.

2. Adhesives

Mercer Mass Timber Adhesive System

The manufacturing of all code-approved mass timber products to produce long length lamellas requires adhesives approved for face bond lamination and end-to-end finger jointing. Mercer uses adhesives specific to our manufacturing processes that are certified to North American testing and manufacturing standards.

All adhesives must conform to ASTM testing methods for fire, heat and moisture and must support ANSI manufacturing standards (see Table 11 below). These test methods and manufacturing standards are approved in the US by the International Building Code (IBC). The IBC is a model building code developed by the International Code Council (ICC) .

The adhesive component is product thickness and depth dependent and comprises approximately 0.3% by weight of Mercer's mass timber building products.

Glue-Bond Durability

The structural integrity of glulam components depends upon the integrity of the glue-bond between the component lumber elements. This is true for the entire service life of these mass timber components. Conditions that can impact the glue-bond integrity are exposure to elevated heat (such as a fire event) and exposure to high moisture conditions for extended periods.

Fire Performance

The fire resistance of glue-laminated timber is based on the certification requirements of the North American testing and manufacturing mass timber standards. These standards require rigorous adhesive heat durability testing to ensure mass timber product structural integrity under the most severe fire conditions. Mercer glulam products complies with these standards.

Emissions

Both Henkel and Hexion adhesives used by Mercer for manufacturing our mass timber products are certified to UL GREENGUARD Gold. GREENGUARD Gold certified products are qualified to meet UL GREENGUARD standards for low chemical emissions into indoor air during product usage. These adhesives are formulated to meet or exceed all global emissions standards.

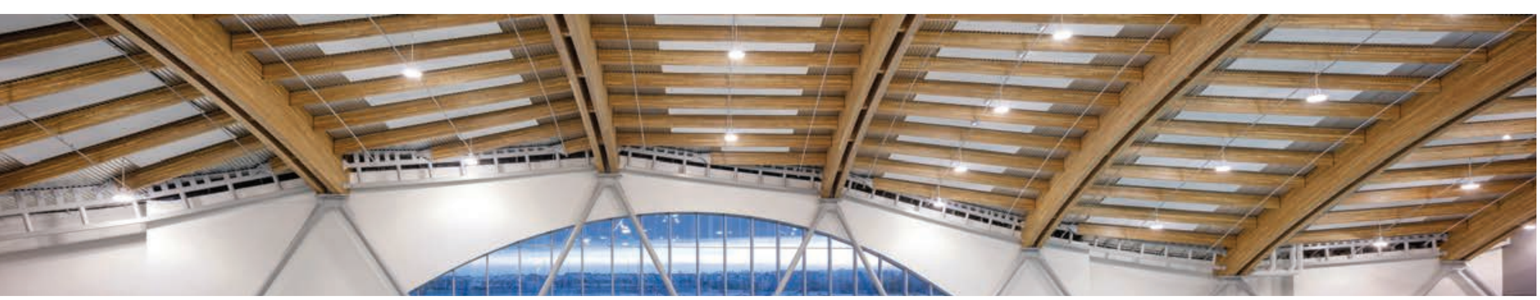
TABLE 19: ADHESIVES FOR GLULAM AND CLT MASS TIMBER PRODUCTS

ADHESIVE APPLICATION	ADHESIVE BRAND	ADHESIVE TYPE	EMISSIONS CERTIFICATION	ADHESIVE PERFORMANCE TESTING		
				FULL SCALE FIRE TEST	HEAT DELAMINATION	MOISTURE DURABILITY
Finger Joints CLT/Glulam	Hexion Cascomel™	Melamine Formaldehyde (MF)	UL GREENGUARD Gold	✓	✓	✓
Face Bond Glulam	Hexion EcoBind™	Melamine Formaldehyde (MF)	UL GREENGUARD Gold	✓	✓	✓

3. Mercer Glulam Product Characteristics

TABLE 20: PRODUCT CHARACTERISTICS

PRODUCT CHARACTERISTICS	DOUGLAS-FIR	SOUTHERN PINE
WOOD SPECIES	Interior Douglas-fir (Pseudotsuga menziesii var. glauca)	Southern Yellow pine (Pinus palustris)
FACE BOND GLUE TYPE	Hexion EcoBind™	Henkel Loctite HB-X PURBOND
FINGER JOINT GLUE TYPE	Hexion Cascomel®	Hexion Cascomel®
SFI/FSC CERTIFICATION	Available upon request	
MOISTURE CONTENT	12% (+/-3%) at time of manufacturing	
SPECIFIC GRAVITY, SG	0.50	0.55
DENSITY	35 lbs/ft³	40 lbs/ft³
CERTIFICATIONS	ANSI A190.1, ANSI 117, CSA O122 and CSA O177	
DIMENSIONAL TOLERANCES		
WIDTH	+/- 1/16" (2 mm)	
DEPTH	1/8" (3 mm) per foot (305 mm) of depth. -3/16" (5 mm) or 1/16" (2 mm) per foot of depth, whichever is larger.	
LENGTH	Up to 20' (6.1 m), +/- 1/16" (2 mm). Over 20' (6.1 m), +/- 1/16" (2 mm) per 20' (6.1 m) of length or fraction thereof.	
CAMBER OR STRAIGHTNESS	Tolerances for camber are applicable at the time of manufacture without allowance for dead load deflection. Up to 20’ (6.1 m), the tolerance is +/- 1/4” (6 mm). Over 20’ (6.1 m), the tolerance shall increase 1/8” (3 mm) per each additional 20’ (6.1 m) or fraction thereof, but not to exceed 3/4” (19 mm). The tolerances are intended for use with straight or slightly cambered members and are not applicable to curved members such as arches. Refer to table <15> for additional information on camber availability.	
SQUARENESS OF CROSS SECTION	The tolerance for squareness shall be within +/- 1/8” (3 mm) per foot (305 mm) of specified depth unless a specially shaped section is specified. Squareness shall be measured by placing one leg of a square across a top and/ or bottom face and measuring the offset from the other leg of the square to the member at the opposite face of the beam.	
MACHINED SURFACES	+/- 1/8" (3 mm) with all tooling units except the chainsaw, which is +/- 1/4" (6 mm)	
MIN MAX WIDTH	See page 50	
AVAILABLE SIZES	**MERCER OKANAGAN**	**MERCER CONWAY**
MAX LENGTH STANDARD	60' (18.3 m)	65' (19.8 m)
MAX LENGTH SPECIALTY	110' (33.5 m)	65' (19.8 m)
MAX DEPTH STANDARD	4' (1.2 m)	3.54' (1.08 m)
MAX DEPTH SPECIALTY	8' (2.4 m)	-
MINIMUM DEPTH	4 1/2" (114 mm)	4 1/8" (104 mm)



Shane Homes YMCA at Rocky Ridge, Calgary, AB, Canada

4. Glulam Appearance Classifications

Listed below are the ANSI A190.1 appearance classifications that glulam products must meet. At Mercer Mass Timber, glulam exceeds visual standards set by ANSI A190.1 (see Table 13 below). Lower-grade appearances are available by request. For more on Mercer glulam finishes, refer to page 33.

INDUSTRIAL

- Glulam laminations may possess the natural growth characteristics of the lumber grade.
- No voids or low laminations are filled.
- Sides are planed true to specified dimensions.
- Occasional planing misses are permitted.
- No sanding.
- Members have a "hit and miss" (more miss) appearance.
- Wood inserts and filling are not required.
- Glue smear is allowed.

ARCHITECTURAL

- The wide face of laminations that are exposed should be free of loose knots. Otherwise, glulam laminations may possess the natural growth characteristics of the lumber grade.
- Exposed corners should be eased.
- In exposed surfaces, voids measuring over 3/4" (19 mm) long should be filled.
- Open knot holes on the wide face that are exposed should be filled.
- All occurrences of pencil wane should be repaired with filler up to a maximum of 8" (203 mm). For pencil wane longer than 8" (203 mm), wood inserts should be used.
- Voids greater than 1/16" (2 mm) wide in edge joints on the wide exposed face should be filled with wood tone color filler.
- Exposed faces should be surfaced smooth planed.
- Misses, wane and low laminations should not be permitted. Occasional repaired pencil wane should be permitted subject to Section 11.3.2.1.
- Corners of the member exposed should be eased with a minimum radius of 1/8" (3 mm).

PREMIUM

- Laminations should be selected to minimize loose knots, knot holes, pencil wane, bark inclusions and visible voids after final member surfacing.
- Knots should be limited to 20% of the net face of the lamination and not over two maximum sized knots should occur in a 6' (1.83 m) length. Otherwise, laminations are permitted to possess their natural growth characteristics.
- In exposed surfaces, voids measuring over 3/4" (19 mm) should be filled, or with clear wood inserts to match wood tone and grain color. A void not repaired is permitted to be longer than 3/4" (19 mm) if its areas do not exceed 1/2" squared (3.23 cm^2).
- Repair requirements as noted above will apply when occasional voids occur due to loose knots, unsound knots or knotholes.
- All occurrences of pencil wane should be repaired with filler up to a maximum of 8" (203 mm). For pencil wane longer than 8" (203 mm), wood inserts should be used.
- Voids greater than 1/16" (2 mm) wide in edge joints on the wide exposed face should be filled with wood tone color filler.
- Exposed faces should be surfaced smooth planed.
- Misses, wane and low laminations should not be permitted. Occasional repaired pencil wane should be permitted.
- Corners of the member exposed should be eased with a minimum radius of 1/8"(3 mm).

TABLE 21: GLULAM ADDITIONAL APPEARANCE STANDARD FEATURES

ADDITIONAL FEATURES FOR MERCER MASS TIMBER GLULAM BEAMS AND COLUMNS INCLUDE:
1. All Architectural and Premium Mercer Mass Timber glulam beams and columns exposed faces surfaces are sanded smooth to 80 grit.
2. Mercer Mass Timber uses epoxy putty for correcting larger voids to assure adhesion.
3. For a staggered multi piece lamination layup, a full length wood spline insert is applied on the visible face to cover gaps of the adjacent boards.
4. Mercer Mass Timber glulam beams and columns can be coated with a factory-applied light-bodied sealer that provides some temporary protection to the finished surface during shipping and through the construction phase.
5. For additional information on appearance classifications, refer to ANSI A190.1.

Mercer Glulam Standard Width Sectional Diagram

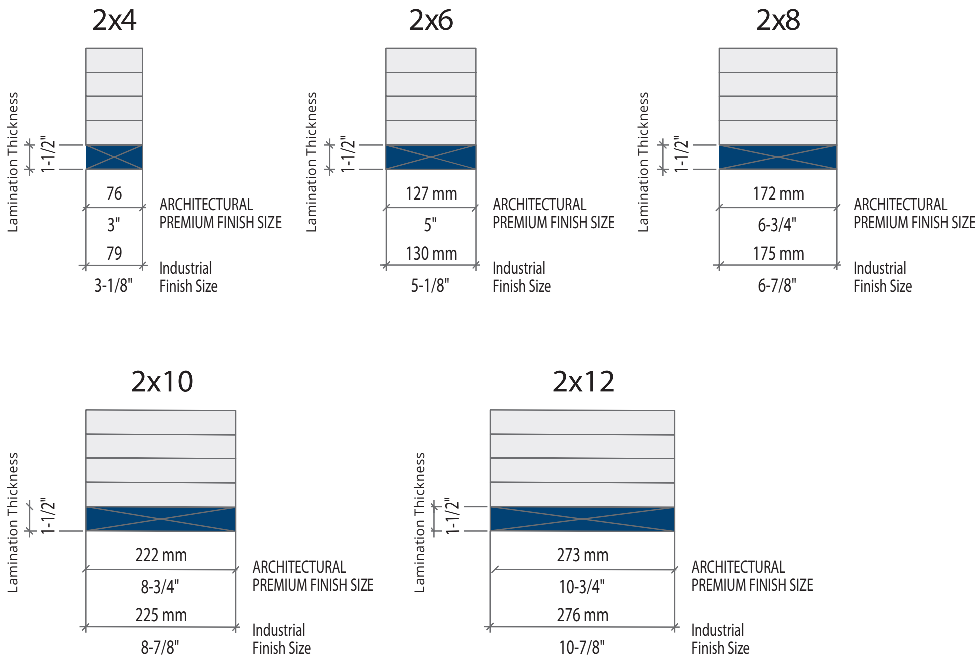


Figure 7: *Single lamination beams*eams

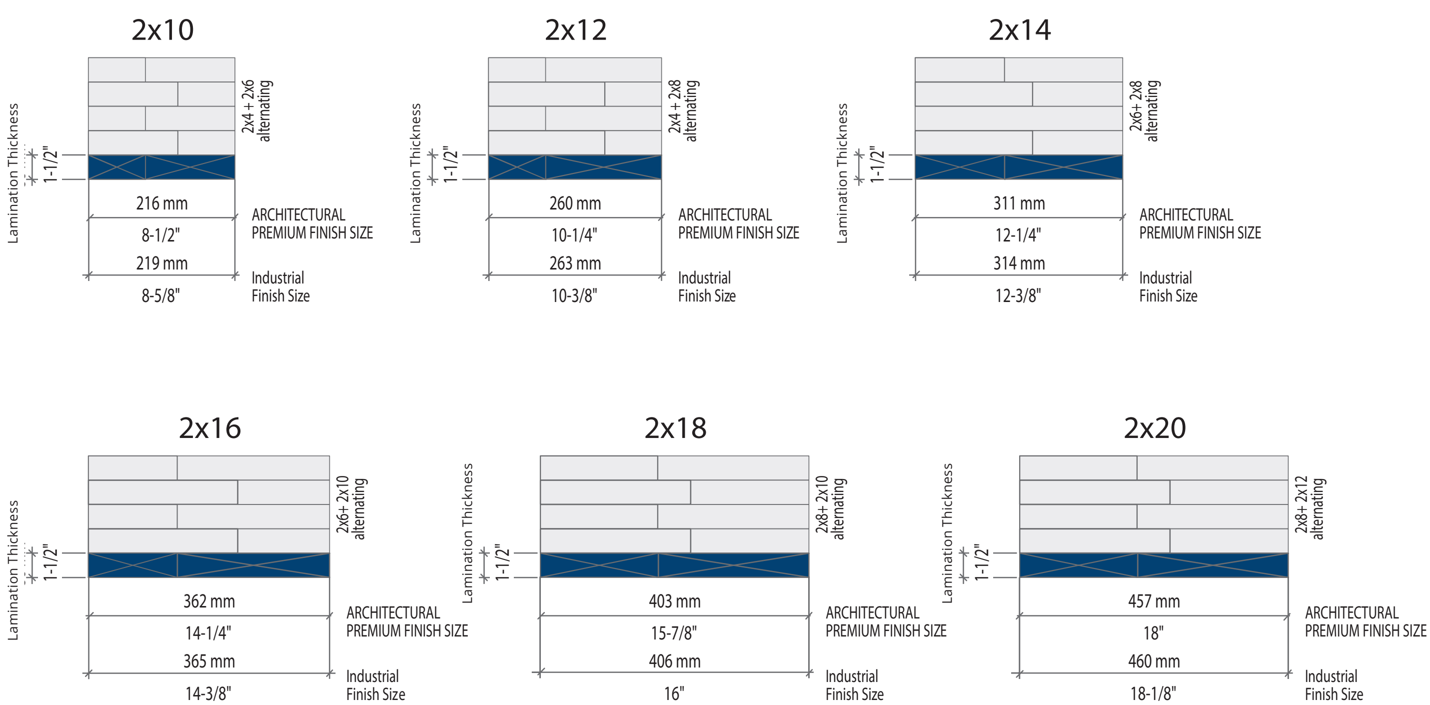


Figure 8: *Staggered multi-piece lamination*

Note: All premium finished beams used for either appearance grade or with tight tolerance connections are additional undersized by 1/4" (6 mm) in depth from full lamination roundings:

D. Fir: 1.5" (38 mm) X # OF LAMS - 1/4" (6 mm)

SP: 1 3/8" (35 mm) X # OF LAMS -1/4" (6 mm).

TABLE 22: FINISHED WIDTHS OF GLULAM BEAMS

NOMINAL SIZE	FINISHED WIDTHS*					
	INDUSTRIAL		ARCHITECTURAL		PREMIUM	
	(in)	(mm)	(in)	(mm)	(in)	(mm)
2x4	3-1/8	79	3	76	3	76
2x6	5-1/8	130	5	127	5	127
2x8	6-7/8	175	6-3/4	172	6-3/4	172
2x10	8-5/8	219	8-1/2	216	8-1/2	216
2x12	10-3/8	263	10-1/4	260	10-1/4	260
2x14	12-3/8	314	12-1/4	311	12-1/4	311
2x16	14-3/8	365	14-1/4	362	14-1/4	362
2x18	16	406	15-7/8	403	15-7/8	403
2x20	18-1/8	406	18	457	18	457

Note: Widths noted above apply to all manufactured species.
*Other widths available from Mercer Mass Timber

Staggered Multiple Piece Lamination: Mercer utilizes a staggered multiple piece lamination layup technique as described in ANSI A190.1, section 9.3, in the manufacture of wide-section members for glulam beams and columns. Mercer analysis concludes staggered multiple piece lamination layup as a preferred methodology as follows:

- **Increased Homogenization:** Glulam beams and columns constructed through the staggered multiple piece lamination technique are composed of more individual elements than through a single lamination layup practice. This increased number of elements acts to further diffuse the impact of any one element on the resulting component and creates a more homogeneous construction.
- **Dimensional Stability:** Based upon the same principle of an increased number of elements within the component, a staggered multiple piece lamination layup reduces the dimensional tendencies of any one element and can potentially increase the overall stability of the component. This can be most prominently realized in wider, deeper sections.

5. Camber

Four standard levels of camber are available. Camber falling outside these standards is custom processed and will carry additional fabrication costs as arches. Standard camber carry no additional costs. Camber cannot be used with complex multi-point connections or pre-engineered tight tolerance connections. Camber should only be used when simple bucket or knife plate connections are used on each end of the beam.

TABLE 23: CAMBER STANDARDS

CAMBER	BEAM SPAN (ft)						RADIUS (ft)
	20'	30'	40'	50'	60'	70'	
1	0.46"	1.03"	1.83"	2.86"	4.12"	5.61"	1,310'
2	0.33"	0.74"	1.31"	2.05"	2.95"	4.01"	1,833'
3	0.23"	0.52"	0.92"	1.43"	2.06"	2.81"	2,620'
4	0.18"	0.41"	0.73"	1.15"	1.65"	2.25"	3,274'

1. Camber shown in inches. Camber is only available at the Mercer Okanagan factory. It is not possible to camber members produced in the Mercer Conway factory.
2. Recommended Camber = 1.5 x dead load deflection for roof applications
   1 x dead load deflection for floor applications
3. Camber is NOT recommended when using tight-tolerance pre-engineered connections.
4. Camber is NOT recommended when using beam systems with multiple interconnections as installation becomes difficult and deflection loads can cause dynamic stresses on connections.
5. Multiple span beam applications cannot have camber applied.

6. Glulam Stress Grades

Mercer glulam structural members are classified as either primarily axially loaded members or primarily bending members per the National Design Specification (NDS). The significance of the member being an axial or bending member influences the type of boards used for the laminations and also the location of where the specific board types exist. For axial members, the entire makeup of laminations are the same and each individual board has the same strength properties. For bending members, the highest quality boards are located on the outer laminations where the tension and compression stresses are the highest.

More information on our Mercer glulam stress grades is provided below:

TABLE 24: GLULAM COLUMN ALLOWABLE DESIGN PROPERTIES

COLUMN ALLOWABLE DESIGN STRESS PROPERTIES (psi)											
COMBINATION	E_{MEAN}	E_{MIN}	F_C	F_T	F_{BX}	F_{BY}	F_{CPX}	F_{CPY}	F_{VX}	F_{VY}	SG
2 DF, L2	1,700,000	850,000	1,950	1,550	2,100	2,300	740	740	300	260	0.50
50 SP, N1D14	1,900,000	1,000,000	2,300	1,550	2,100	2,300	740	740	300	260	0.55

Notes:

1. Allowable design strengths are shown for prismatic beams with loads applied primarily in axial compression.
2. Properties shown are for allowable strength design (ASD).
3. Design strengths assumes 4 or more laminations.

The values listed for Mercer glulam beams and columns are baseline properties that require modification depending on the size of the member, the type of loads applied and the environmental conditions, as per the National Design Specification for Wood Construction (NDS). Adjustment factors to be considered include:

C_D	Duration of load .9 dead loads 1.0 normal loads 1.15 snow loads 1.25 construction loads 1.6 wind and earthquake loads
C_M	Moisture (wet service)
C_T	Temperature
C_L	Beam stability
C_V	Volume effect
C_{FU}	Flat use factor
C_C	Curvature factor
C_F	Form factor
C_P	Column stability factor
C_B	Bearing factor

Not all factors need be applied in all applications or for all design values. Refer to the National Design Specification for Wood Construction (NDS) for a listing of which adjustment factors are required for specific situations.

DF NAME CONVENTION

EWS 24F V4 / DF

- Species designation from ANSI 117
- Unbalanced (V4) vs. Unbalanced (V8) layup (see page 47)
- Rated Bending Stress in psi x 100
- Engineered Wood System

SP NAME CONVENTION

EWS 24F V4 / SP

- Species designation from ANSI 117
- Unbalanced (V3) vs. Unbalanced (V8) layup (see page 47)
- Rated Bending Stress in psi x 100
- Engineered Wood System

TABLE 25: GLULAM BEAM ALLOWABLE DESIGN STRESS PROPERTIES

MERCER MASS TIMBER GLULAM BEAM LAYUP DESIGNATIONS AND DESIGN STRESS PROPERTIES (psi)														
COMBINATION	BENDING ABOUT X-X						BENDING ABOUT Y-Y					AXIAL LOADING		SG
	F_{BX+}	F_{BX-}	F_{CPX}	F_{VX}	E_X	$E_{X\ MIN}$	F_{BY}	F_{CPY}	F_{VY}	E_Y	$E_{Y\ MIN}$	F_T	F_C	
24F-V8 DF	2,400	2,400	650	265	1,800,000	950,000	1,550	560	230	1,600,000	850,000	1,650	1,100	0.50
24F-V4 DF	2,400	1,850	650	265	1,800,000	950,000	1,450	560	230	1,600,000	850,000	1,650	1,100	0.50
24F-V8 SP	2,400	2,400	740	300	1,800,000	950,000	1,700	650	260	1,600,000	850,000	1,150	1,650	0.55
24F-V3 SP	2,400	2,000	740	300	1,800,000	950,000	1,700	650	260	1,600,000	850,000	1,150	1,650	0.55

Notes:

1. Allowable design strengths are shown for prismatic beams with loads applied primarily in bending.
2. Properties shown are for allowable strength design (ASD).
3. The reference allowable shear design value, Fvy, shall be multiplied by 0.4 for members 5,7,9 laminations and 0.5 for all other layups of DF species split-lam layups. See Page 86, Figure 37 for reference to split-lam layups.
4. Design strengths assumes 4 or more laminations.

GLULAM BEAM LAYUP PATTERNS ANSI/APA 117 STANDARD

V4/V3 – Unbalanced Beam Layup

Use a V4 layup for short cantilever or most economical solution to simple span application.

V8 – Balanced Beam Layup

When dealing with a beam that is supported by multiple bearings or a beam that is cantilevered over a support, then a V8 balanced layup is typically required.

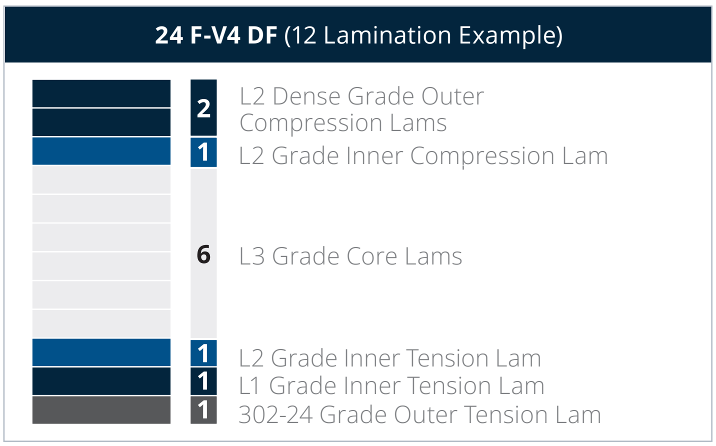


Figure 9: *Unbalanced layup - D.Fir*

EXAMPLE FOR 12 LAMINATIONS

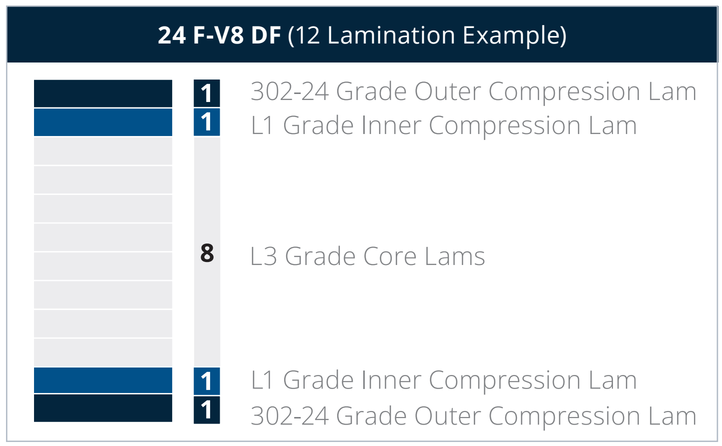


Figure 10: *Balanced layup - D.Fir*

EXAMPLE FOR 12 LAMINATIONS

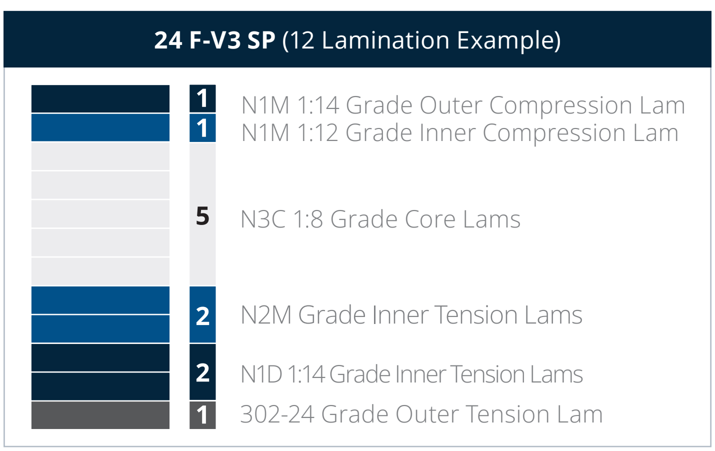


Figure 11: *Unbalanced layup - SP*

EXAMPLE FOR 12 LAMINATIONS

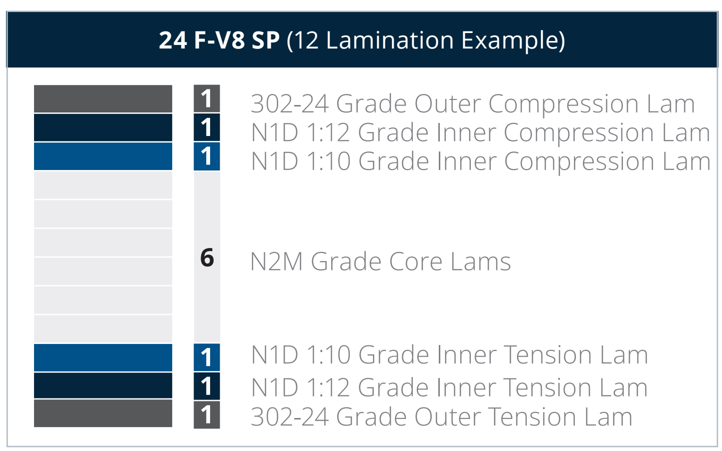


Figure 12: *Balanced layup - SP*

EXAMPLE FOR 12 LAMINATIONS

Note: See ANSI 117 for layup requirements of alternative beam depths. Example provided is for 12 laminations.

TABLE 26: GLULAM COLUMN CAPACITIES

Allowable axial capacities - Allowable Eccentricity = 1/16 (D or W)

	AXIAL CAPACITY (lbs)						
	COLUMN SIZE B (in) x D (in)	COLUMN LENGTH (ft)					
		10	12	14	16	18	20
COMB. 2 DF	8.5 x 8.75	67,200	60,800	53,900	47,300	41,200	38,400
	10.25 x 10.25	101,000	93,900	85,500	76,900	68,600	61,100
	12.25 x 13.75	171,900	163,700	154,900	145,600	134,200	122,700
	14.25 x 14.75	214,600	205,400	195,600	185,300	174,600	163,600
	15.875 x 16.25	246,300	237,100	227,400	217,500	207,000	196,300
	18 x 19.25	331,100	321,400	311,100	300,600	289,700	278,400
COMB. 50 SP	8.5 x 9.375	89,900	81,500	71,400	61,900	53,600	46,600
	10.25 x 10.75	130,000	121,700	112,000	101,900	91,400	81,100
	12.25 x 13.5	205,100	195,900	185,800	174,900	161,000	146,900
	14.25 x 14.875	265,700	255,700	244,700	232,800	220,000	206,600
	15.875 x 16.25	304,400	294,800	284,000	272,400	260,000	247,000
	18 x 19	407,300	397,400	386,300	374,300	361,500	348,000

TABLE 27: GLULAM COLUMN CAPACITIES

Allowable axial capacities - Allowable Eccentricity = 1/2 (D or W)

	AXIAL CAPACITY (lbs)						
	COLUMN SIZE W (in) x D (in)	COLUMN LENGTH (ft)					
		10	12	14	16	18	20
COMB. 2 DF	8.5 x 8.75	33,600	31,600	29,400	27,100	24,800	22,600
	10.25 x 10.25	49,400	47,200	44,300	41,300	38,400	35,600
	12.25 x 13.75	81,300	78,100	74,800	71,600	68,400	65,200
	14.25 x 14.75	100,400	96,700	93,100	89,500	85,900	82,300
	15.875 x 16.25	109,500	106,000	102,600	99,300	96,000	92,700
	18 x 19.25	144,900	140,900	137,100	133,500	129,900	126,400
COMB. 50 SP	8.5 x 9.375	45,100	42,600	39,900	37,100	34,200	31,400
	10.25 x 10.75	64,100	61,400	58,200	54,700	51,200	47,700
	12.25 x 13.5	99,100	95,700	92,100	88,400	84,500	80,500
	14.25 x 14.875	127,200	123,400	119,400	115,300	111,000	106,600
	15.875 x 16.25	138,900	135,400	131,800	128,100	124,300	120,300
	18 x 19	183,900	180,100	176,300	172,300	168,300	164,100

Notes:

1. Column tables are for preliminary design only and final design should include detailed analysis of loads, eccentricities and connections.
2. Loads shown are allowable axial loads (AAL), in pounds.
3. Eccentricities assumed to be applied on the depth.
4. Calculations as per NDS.
5. Design capacities do not consider fire rating.
6. Normal load duration was assumed (CD-1.0). Provided values must be adjusted by CD for other cases.

Fort McMurray Airport, Fort McMurray, AB, Canada

TABLE 28: ENGINEERING PROPERTIES OF GLULAM BEAMS: **DOUGLAS-FIR** (D.FIR)

3.125" BEAM WIDTH, B (IN)													
BEAM DEPTH d (in)	**8.75**	**10.25**	**11.75**	**13.25**	**14.75**	**16.25**	**17.75**	**19.25**	**20.75**	**22.25**	**23.75**	**25.25**	**26.75**
WEIGHT PER FT (lb/ft)	6.6	7.8	8.9	10.1	11.2	12.3	13.5	14.6	15.8	16.9	18	19.2	20.3
A (in^2)	27.3	32	36.7	41.4	46.1	50.8	55.5	60.2	64.8	69.5	74.2	78.9	83.6
S_x (in^3)	39.9	54.7	71.9	91.4	113.3	137.5	164.1	193	224.3	257.8	293.8	332.1	372.7
Ix (in^4)	175	280	423	606	836	1,118	1,456	1,858	2,327	2,869	3,489	4,192	4,985
EI (x 10^6 lbf-in^2)	314	505	760	1,090	1,504	2,011	2,621	3,344	4,188	5,163	6,280	7,546	8,973
M_r (lbf-ft)	7,975	10,944	14,382	18,288	22,663	27,507	32,291	37,376	42,789	48,525	54,579	60,948	67,627
V_r (lbf)	4,831	5,659	6,487	7,315	8,143	8,971	9,799	10,628	11,456	12,284	13,112	13,940	14,768
5.125" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**11.75**	**13.25**	**14.75**	**16.25**	**17.75**	**19.25**	**20.75**	**22.25**	**23.75**	**25.25**	**26.75**	**28.25**	**29.75**
WEIGHT PER FT (lb/ft)	14.6	16.5	18.4	20.2	22.1	24	25.8	27.7	29.6	31.5	33.3	35.2	37.1
A (in^2)	60.2	67.9	75.6	83.3	91	98.7	106.3	114	121.7	129.4	137.1	144.8	152.5
S_x (in^3)	117.9	150	185.8	225.6	269.1	316.5	367.8	422.9	481.8	544.6	611.2	681.7	756
Ix (in^4)	693	994	1,371	1,833	2,388	3,047	3,816	4,704	5,721	6,875	8,175	9,629	11,245
EI (x 10^6 lbf-in^2)	1,247	1,788	2,467	3,299	4,299	5,484	6,868	8,468	10,299	12,376	14,715	17,332	20,242
M_r (lbf-ft)	23,586	29,860	36,218	43,116	50,543	58,490	66,948	75,910	85,369	95,318	105,751	116,664	128,050
V_r (lbf)	10,639	11,997	13,355	14,713	16,071	17,429	18,787	20,146	21,504	22,862	24,220	25,578	26,936
6.75" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**17.75**	**19.25**	**20.75**	**22.25**	**23.75**	**25.25**	**26.75**	**28.25**	**29.75**	**31.25**	**32.75**	**34.25**	**35.75**
WEIGHT PER FT (lb/ft)	29.1	31.6	34	36.5	39	41.4	43.9	46.3	48.8	51.3	53.7	56.2	58.7
A (in^2)	119.8	129.9	140.1	150.2	160.3	170.4	180.6	190.7	200.8	210.9	221.1	231.2	241.3
S_x (in^3)	354.4	416.9	484.4	556.9	634.6	717.3	805	897.8	995.7	1,098	1,206	1,319	1,437
Ix (in^4)	3,146	4,013	5,026	6,196	7,536	9,055	10,767	12,682	14,811	17,166	19,759	22,600	25,701
EI (x 10^6 lbf-in^2)	5,662	7,222	9,046	11,153	13,564	16,300	19,381	22,827	26,660	30,899	35,566	40,680	46,262
M_r (lbf-ft)	64,760	74,942	85,780	97,263	109,382	122,130	135,499	149,481	164,070	179,260	195,044	211,418	228,375
V_r (lbf)	21,167	22,956	24,744	26,533	28,322	30,111	31,899	33,688	35,477	37,266	39,054	40,843	42,632
8.50" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**23.75**	**25.25**	**26.75**	**28.25**	**29.75**	**31.25**	**32.75**	**34.25**	**35.75**	**37.25**	**38.75**	**40.25**	**41.75**
WEIGHT PER FT (lb/ft)	49.1	52.2	55.3	58.4	61.5	64.6	67.7	70.8	73.9	77	80.1	83.2	86.3
A (in^2)	201.9	214.6	227.4	240.1	252.9	265.6	278.4	291.1	303.9	316.6	329.4	342.1	354.9
S_x (in^3)	799.1	903.2	1,013	1,130	1,253	1,383	1,519	1,661	1,810	1,965	2,127	2,295	2,469
Ix (in^4)	9,489	11,403	13,558	15,970	18,651	21,617	24,881	28,459	32,364	36,611	41,215	46,189	51,547
EI (x 10^6 lbf-in^2)	17,081	20,526	24,405	28,745	33,572	38,910	44,786	51,226	58,256	65,901	74,187	83,140	92,785
M_r (lbf-ft)	134,602	150,289	166,740	183,946	201,898	220,590	240,014	260,163	281,030	302,610	324,897	347,884	371,568
V_r (lbf)	35,665	37,917	40,170	42,422	44,675	46,927	49,180	51,432	53,685	55,937	58,190	60,442	62,695
10.25" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**26.7**	**28.25**	**29.75**	**31.25**	**32.75**	**34.25**	**35.75**	**37.25**	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**
WEIGHT PER FT (lb/ft)	66.6	70.4	74.1	77.9	81.6	85.3	89.1	92.8	96.5	100.3	104	107.7	111.5
A (in^2)	274.2	289.6	304.9	320.3	335.7	351.1	366.4	381.8	397.2	412.6	427.9	443.3	458.7
S_x (in^3)	1,222	1,363	1,512	1,668	1,832	2,004	2,183	2,370	2,565	2,767	2,977	3,195	3,421
Ix (in^4)	16,350	19,257	22,491	26,067	30,004	34,318	39,028	44,149	49,700	55,698	62,160	69,104	76,546
EI (x 10^6 lbf-in^2)	29,430	34,663	40,483	46,921	54,007	61,773	70,250	79,468	89,460	100,257	111,888	124,387	137,783
M_r (lbf-ft)	197,339	217,703	238,950	261,072	284,061	307,907	332,604	358,144	384,521	411,727	439,756	468,604	498,262
V_r (lbf)	48,440	51,156	53,872	56,589	59,305	62,021	64,737	67,454	70,170	72,886	75,602	78,319	81,035

TABLE 28 con't: ENGINEERING PROPERTIES OF GLULAM BEAMS: **DOUGLAS-FIR** (D.FIR)

12.25" BEAM WIDTH B (IN)

BEAM DEPTH d (in)	**29.75**	**31.25**	**32.75**	**34.25**	**35.75**	**37.25**	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**	**46.25**	**47.75**
WEIGHT PER FT (lb/ft)	88.6	93	97.5	102	106.4	110.9	115.4	119.8	124.3	128.8	133.2	137.7	142.2
A (in^2)	364.4	382.8	401.2	419.6	437.9	456.3	474.7	493.1	511.4	529.8	548.2	566.6	584.9
S_x (in^3)	1,807	1,993	2,189	2,395	2,609	2,832	3,065	3,307	3,558	3,819	4,088	4,367	4,655
Ix (in^4)	26,879	31,153	35,858	41,014	46,643	52,764	59,398	66,566	74,289	82,587	91,482	100,993	111,141
EI (x 10^6 lbf-in^2)	48,383	56,076	64,545	73,826	83,957	94,974	106,916	119,819	133,720	148,657	164,667	181,787	200,054
M_r (lbf-ft)	280,529	306,501	333,489	361,485	390,480	420,464	451,430	483,371	516,278	550,144	584,964	620,730	657,436
V_r (lbf)	64,384	67,630	70,877	74,123	77,369	80,615	83,862	87,108	90,354	93,600	96,847	100,093	103,339

14.25" BEAM WIDTH B (IN)

BEAM DEPTH d (in)	**32.75**	**34.25**	**35.75**	**37.25**	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**	**46.25**	**47.75**	**49.25**	**50.75**
WEIGHT PER FT (lb/ft)	113.4	118.6	123.8	129	134.2	139.4	144.6	149.8	155	160.2	165.4	170.6	175.8
A (in^2)	466.7	488.1	509.4	530.8	552.2	573.6	594.9	616.3	637.7	659.1	680.4	701.8	723.2
S_x (in^3)	2,547	2,786	3,035	3,295	3,566	3,847	4,139	4,442	4,756	5,080	5,415	5,760	6,117
Ix (in^4)	41,713	47,711	54,258	61,378	69,095	77,434	86,418	96,071	106,417	117,481	129,287	141,858	155,218
EI (x 10^6 lbf-in^2)	75,083	85,879	97,664	110,480	124,372	139,381	155,552	172,928	191,551	211,466	232,716	255,344	279,392
M_r (lbf-ft)	382,114	414,192	447,414	481,770	517,251	553,849	591,554	630,358	670,255	711,236	753,294	796,423	840,615
V_r (lbf)	82,448	86,224	90,001	93,777	97,553	101,329	105,106	108,882	112,658	116,434	120,211	123,987	127,763

16" BEAM WIDTH B (IN)

BEAM DEPTH d (in)	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**	**46.25**	**47.75**	**49.25**	**50.75**	**52.25**	**53.75**	**55.25**	**56.75**
WEIGHT PER FT (lb/ft)	150.7	156.5	162.4	168.2	174	179.9	185.7	191.5	197.4	203.2	209	214.9	220.7
A (in^2)	620	644	668	692	716	740	764	788	812	836	860	884	908.
S_x (in^3)	4,004	4,320	4,648	4,988	5,340	5,704	6,080	6,468	6,868	7,280	7,704	8,140	8,588
Ix (in^4)	77,581	86,943	97,031	107,869	119,486	131,909	145,164	159,279	174,280	190,194	207,050	224,872	243,689
EI (x 10^6 lbf-in^2)	139,645	156,498	174,655	194,164	215,075	237,436	261,295	286,701	313,704	342,350	372,689	404,770	438,641
M_r (lbf-ft)	574,085	614,703	656,551	699,620	743,900	789,384	836,063	883,931	932,979	983,201	1,034,590	1,087,139	1,140,842
V_r (lbf)	109,533	113,773	118,013	122,253	126,493	130,733	134,973	139,213	143,453	147,693	151,933	156,173	160,413

18" BEAM WIDTH B (IN)

BEAM DEPTH d (in)	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**	**46.25**	**47.75**	**49.25**	**50.75**	**52.25**	**53.75**	**55.25**	**56.75**
WEIGHT PER FT (lb/ft)	169.5	176.1	182.7	189.2	195.8	202.3	208.9	215.5	222	228.6	235.2	241.7	248.3
A (in^2)	697.5	724.5	751.5	778.5	805.5	832.5	859.5	886.5	913.5	940.5	967.5	994.5	1,021.50
S_x (in^3)	4,504	4,860	5,229	5,611	6,007	6,417	6,840	7,276	7,726	8,190	8,667	9,157	9,661
Ix (in^4)	87,278	97,811	109,159	121,353	134,422	148,397	163,309	179,188	196,065	213,969	232,931	252,981	274,150
EI (x 10^6 lbf-in^2)	157,101	176,060	196,487	218,435	241,960	267,115	293,957	322,539	352,916	385,144	419,275	455,366	493,471
M_r (lbf-ft)	638,283	683,444	729,972	777,856	827,088	877,658	929,558	982,778	1,037,312	1,093,150	1,150,285	1,208,711	1,268,419
V_r (lbf)	123,225	127,995	132,765	137,535	142,305	147,075	151,845	156,615	161,385	166,155	170,925	175,695	180,465

20" BEAM WIDTH B (IN)

BEAM DEPTH d (in)	**38.75**	**40.25**	**41.75**	**43.25**	**44.75**	**46.25**	**47.75**	**49.25**	**50.75**	**52.25**	**53.75**	**55.25**	**56.75**
WEIGHT PER FT (lb/ft)	188.4	195.7	203	210.2	217.5	224.8	227.3	239.4	246.7	254	261.3	268.6	275.9
A (in^2)	775	805	835	865	895	925	935	985	1,015.00	1,045.00	1,075.00	1,105.00	1,135.00
S_x (in^3)	5,005	5,400	5,810	6,235	6,675	7,130	7,285	8,085	8,585	9,100	9,630	10,175	10,735
Ix (in^4)	96,976	108,679	121,288	134,836	149,358	164,886	170,292	199,098	217,850	237,743	258,812	281,090	304,612
EI (x 10^6 lbf-in^2)	174,557	195,623	218,319	242,705	268,844	296,795	306,525	358,377	392,129	427,937	465,861	505,962	548,301
M_r (lbf-ft)	701,771	751,423	802,579	855,226	909,355	964,955	983,814	1,080,531	1,140,489	1,201,881	1,264,699	1,328,936	1,394,584
V_r (lbf)	136,917	142,217	147,517	152,817	158,117	163,417	165,183	174,017	179,317	184,617	189,917	195,217	200,517

Notes:

1. 24F-V8 glulam.
2. Uniformly distributed loading.
3. Depths are based on 1.5" (38 mm) lamination thickness.
4. Beam properties calculated based on actual depths and "Quality" finish widths.
5. Beam weight is based on density of 35pcf and "Industrial" finish widths.
6. Beam span for bending moment calculations assumed to be 18x actual depth.
7. Beam engineering properties are calculated in accordance with NDS.
8. These tables do not account for charring fire protection. Fire protection should be provided by encapsulation with a fire rating material as required by the applicable Building Code. Alternatively, NDS Annex B can be used to calculate effective charring to provide fire protection.
9. Assumed modification factors:
   - standard term load duration (C_D = 1.0)
   - dry service condition (C_M = 1.0)
   - no preservative treatment (C_t = 1.0)
   - continuous lateral support along compression edge (C_L = 1.0)

TABLE 29: ENGINEERING PROPERTIES OF GLULAM BEAMS: **SOUTHERN YELLOW PINE** (SYP)

3.125" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**8**	**9.375**	**10.75**	**12.125**	**13.5**	**14.875**	**16.25**	**17.625**	**19**	**20.375**	**21.75**	**23.125**	**24.5**
WEIGHT PER FT (lb/ft)	6.9	8.1	9.3	10.5	11.7	12.9	14.1	15.3	16.5	17.7	18.9	20.1	21.3
A (in^2)	24	28.2	32.3	36.4	40.5	44.6	48.8	52.9	57	61.1	65.3	69.4	73.5
S_x (in^3)	32.2	44.2	58	73.8	91.5	111	132.5	155.8	181.1	208.2	237.2	268.2	301
Ix (in^4)	129	208	313	449	619	828	1,080	1,377	1,725	2,127	2,587	3,109	3,697
EI (x 10^6 lbf-in^2)	233	374	563	808	1,115	1,491	1,943	2,479	3,105	3,829	4,657	5,596	6,655
M_r (lbf-ft)	6,360	8,729	11,473	14,592	18,084	21,952	23,050	27,112	31,504	36,225	41,275	46,655	52,365
V_r (lbf)	4,806	5,631	6,455	7,280	8,105	8,929	9,754	10,578	11,403	12,228	13,052	13,877	14,701

5.125" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**10.75**	**12.125**	**13.5**	**14.875**	**16.25**	**17.625**	**19**	**20.375**	**21.75**	**23.125**	**24.5**	**25.875**	**27.25**
WEIGHT PER FT (lb/ft)	15.3	17.3	19.2	21.2	23.1	25.1	27	29	31	32.9	34.9	36.8	38.8
A (in^2)	53.9	60.8	67.7	74.6	81.5	88.4	95.3	102.2	109.1	115.9	122.8	129.7	136.6
S_x (in^3)	97	123.3	152.9	185.5	221.4	260.4	302.6	347.9	396.4	448.1	502.9	560.9	622.1
Ix (in^4)	523	750	1,035	1,384	1,804	2,302	2,883	3,555	4,323	5,196	6,178	7,277	8,499
EI (x 10^6 lbf-in^2)	941	1,350	1,863	2,492	3,248	4,143	5,189	6,398	7,782	9,352	11,120	13,098	15,298
M_r (lbf-ft)	19,173	24,384	30,220	36,682	38,518	45,306	52,644	60,534	68,973	77,964	87,505	97,596	108,238
V_r (lbf)	10,787	12,165	13,543	14,921	16,299	17,677	19,055	20,433	21,811	23,189	24,567	25,945	27,323

6.75" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**14.875**	**16.25**	**17.625**	**19**	**20.375**	**21.75**	**23.125**	**24.5**	**25.875**	**27.25**	**28.625**	**30**	**31.375**
WEIGHT PER FT (lb/ft)	27.9	30.5	33	35.6	38.2	40.8	43.4	45.9	48.5	51.1	53.7	56.3	58.8
A (in^2)	101	110.4	119.7	129	138.4	147.7	157	166.4	175.7	185	194.4	203.7	213
S_x (in^3)	251.3	299.8	352.7	409.8	471.2	536.9	606.9	681.2	759.7	842.5	929.7	1,021	1,116
Ix (in^4)	1,875	2,444	3,117	3,904	4,814	5,855	7,037	8,367	9,855	11,510	13,341	15,357	17,565
EI (x 10^6 lbf-in^2)	3,374	4,398	5,611	7,028	8,665	10,539	12,666	15,060	17,739	20,719	24,014	27,642	31,617
M_r (lbf-ft)	49,680	52,166	61,359	71,298	81,983	93,413	105,589	118,510	132,177	146,590	161,749	177,653	194,303
V_r (lbf)	20,208	22,075	23,941	25,807	27,673	29,539	31,406	33,272	35,138	37,004	38,870	40,737	42,603

8.5" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**21.75**	**23.125**	**24.5**	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**
WEIGHT PER FT (lb/ft)	51.4	54.6	57.8	61.1	64.3	67.7	70.8	74.1	77.3	80.6	83.8	87.1	90.3
A (in^2)	185.5	197.2	208.9	220.6	232.4	244.1	255.8	267.5	279.2	290.9	302.7	314.4	326.1
S_x (in^3)	674.2	762.1	855.4	954.1	1,058	1,167	1,282	1,402	1,528	1,659	1,795	1,937	2,084
Ix (in^4)	7,353	8,837	10,507	12,376	14,455	16,754	19,285	22,059	25,086	28,379	31,948	35,804	39,959
EI (x 10^6 lbf-in^2)	13,235	15,906	18,913	22,277	26,019	30,157	34,713	39,705	45,155	51,082	57,506	64,448	71,926
M_r (lbf-ft)	117,309	132,600	148,827	165,990	184,090	203,127	223,100	244,009	265,854	288,637	312,355	337,010	362,602
V_r (lbf)	37,096	39,440	41,783	44,127	46,470	48,814	51,158	53,501	55,845	58,188	60,532	62,876	65,219

10.25" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**	**39.625**	**41**	**42.375**
WEIGHT PER FT (lb/ft)	73.7	77.6	81.5	85.4	89.3	93.2	97.2	101.1	105	106.9	112.8	116.7	120.7
A (in^2)	265.6	279.7	293.8	307.9	322	336.1	350.2	364.3	378.4	392.5	406.6	420.7	434.8
S_x (in^3)	1,148	1,273	1,405	1,543	1,688	1,839	1,996	2,161	2,331	2,508	2,692	2,882	3,078
Ix (in^4)	14,898	17,399	20,167	23,213	26,552	30,196	34,160	38,456	43,098	48,099	53,473	59,232	65,392
EI (x 10^6 lbf-in^2)	26,816	31,319	36,300	41,784	47,794	54,354	61,488	69,221	77,576	86,578	96,251	106,618	117,705
M_r (lbf-ft)	199,803	221,590	244,504	268,546	293,714	320,010	347,433	375,983	405,660	436,465	468,397	501,456	535,642
V_r (lbf)	53,116	55,937	58,758	61,579	64,400	67,221	70,042	72,863	75,684	78,505	81,326	84,147	86,968

TABLE 29 con't: ENGINEERING PROPERTIES OF GLULAM BEAMS: **SOUTHERN YELLOW PINE** (SYP)

12.25" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**	**39.625**	**41**	**42.375**
WEIGHT PER FT (lb/ft)	88	92.7	97.4	102.1	106.8	111.4	116.1	120.8	125.5	130.2	134.8	139.5	144.2
A (in^2)	317.7	334.5	351.4	368.3	385.2	402	418.9	435.8	452.6	469.5	486.4	503.3	520.1
S_x (in^3)	1,373	1,523	1,681	1,846	2,019	2,200	2,388	2,584	2,788	3,000	3,220	3,447	3,682
Ix (in^4)	17,820	20,812	24,123	27,767	31,760	36,120	40,860	45,999	51,551	57,534	63,961	70,851	78,218
EI (x 10^6 lbf-in^2)	32,075	37,462	43,421	49,980	57,169	65,015	73,549	82,798	92,793	103,560	115,130	127,532	140,793
M_r (lbf-ft)	238,995	265,056	292,465	321,222	351,327	382,781	415,583	449,734	485,232	522,079	560,275	599,818	640,710
V_r (lbf)	63,534	66,909	70,283	73,657	77,032	80,406	83,780	87,155	90,529	93,904	97,278	100,652	104,027
14.25" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**	**39.625**	**41**	**42.375**
WEIGHT PER FT (lb/ft)	102.4	107.9	113.3	118.8	124.2	129.6	135.1	140.5	146	151.4	156.8	162.3	167.7
A (in^2)	369.8	389.4	409	428.7	448.3	468	487.6	507.2	526.9	546.5	566.2	585.8	605.4
S_x (in^3)	1,598	1,773	1,956	2,149	2,350	2,560	2,780	3,008	3,246	3,492	3,748	4,012	4,286
Ix (in^4)	20,742	24,225	28,079	32,320	36,969	42,043	47,561	53,542	60,005	66,968	74,450	82,470	91,045
EI (x 10^6 lbf-in^2)	37,335	43,606	50,541	58,176	66,543	75,677	85,610	96,376	108,009	120,543	134,010	148,445	163,881
M_r (lbf-ft)	278,187	308,522	340,425	373,898	408,941	445,552	483,734	523,484	564,804	607,694	652,152	698,180	745,778
V_r (lbf)	73,953	77,881	81,809	85,736	89,664	93,592	97,519	101,447	105,375	109,302	113,230	117,158	121,086
16" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**	**39.625**	**41**	**42.375**
WEIGHT PER FT (lb/ft)	115	121.1	127.2	133.3	139.4	145.6	151.7	157.8	163.9	170	176.1	182.2	188.3
A (in^2)	411.6	433.5	455.4	477.2	499.1	521	542.8	564.7	586.5	608.4	630.3	652.1	674
S_x (in^3)	1,780	1,974	2,178	2,392	2,616	2,850	3,095	3,349	3,614	3,888	4,172	4,467	4,771
Ix (in^4)	23,091	26,969	31,259	35,981	41,156	46,804	52,948	59,607	66,801	74,553	82,882	91,810	101,357
EI (x 10^6 lbf-in^2)	41,564	48,544	56,266	64,765	74,080	84,248	95,306	107,292	120,243	134,196	149,188	165,258	182,442
M_r (lbf-ft)	309,695	343,465	378,982	416,246	455,257	496,016	538,521	582,774	628,774	676,521	726,015	777,256	830,245
V_r (lbf)	82,329	86,702	91,074	95,447	99,819	104,192	108,564	112,937	117,310	121,682	126,055	130,427	134,800
18" BEAM WIDTH B (IN)													
BEAM DEPTH d (in)	**25.875**	**27.25**	**28.625**	**30**	**31.375**	**32.75**	**34.125**	**35.5**	**36.875**	**38.25**	**39.625**	**41**	**42.375**
WEIGHT PER FT (lb/ft)	129.4	136.3	143.1	150	156.9	163.8	170.6	177.5	184.4	191.3	198.1	205	211.9
A (in^2)	466.8	491.6	516.4	541.2	566	590.8	615.6	640.3	665.1	689.9	714.7	739.5	764.3
S_x (in^3)	2,018	2,238	2,470	2,713	2,967	3,232	3,510	3,798	4,098	4,409	4,732	5,066	5,411
Ix (in^4)	26,185	30,583	35,447	40,802	46,670	53,076	60,043	67,594	75,752	84,543	93,988	104,112	114,938
EI (x 10^6 lbf-in^2)	47,133	55,049	63,805	73,443	84,007	95,537	108,077	121,668	136,354	152,177	169,179	187,402	206,889
M_r (lbf-ft)	351,192	389,487	429,763	472,021	516,259	562,479	610,680	660,863	713,026	767,171	823,297	881,405	941,493
V_r (lbf)	93,361	98,319	103,278	108,236	113,195	118,153	123,111	128,070	133,028	137,987	142,945	147,904	152,862

Notes:

1. 24F-V8 SP glulam.
2. Uniformly distributed loading.
3. Depths are based on 1.375" (35 mm) lamination thickness.
4. Beam properties calculated based on actual depths and "Quality" finish widths.
5. Beam weight is based on density of 40 lb/ft3 and "Industrial" finish widths.
6. Beam span for bending moment calculations assumed to be 18x actual depth.
7. Beam engineering properties are calculated in accordance with NDS.
8. These tables do not account for charring fire protection. Fire protection should be provided by encapsulation with a fire rating material as required by the applicable Building Code. Alternatively, NDS Annex B can be used to calculate effective charring to provide fire protection.
9. Assumed modification factors:
   - standard term load duration (C_D = 1)
   - dry service condition (C_M = 1)
   - no preservative treatment (C_T = 1)
   - continuous lateral support along compression edge (C_L = 1)

Postmark, Shoreline, WA, US

Mercer Mass Timber
Care, Handling, Rigging and Installation

Mercer CLT and Glulam: Care, Handling, Rigging and Installation

Packaging

All Mercer CLT panels and glulam beams and columns are wrapped (individual, bundle, tarp) and protected at the factory to ensure arrival on-site in the best possible condition.

Daily Sequencing

As part of our services, our project management and in-house installation teams will collaborate with the project's construction team to coordinate delivery and construction schedules. In the event temporary site storage is required, please see "Storage" for recommendations.

Handling

Use care and caution when lifting, ensuring consideration of weights and following all appropriate site safety procedures. Do not drag, dump or drop mass timber building components to unload from truck.

Always use wide nylon or fabric straps or slings with corner protectors when lifting Mercer CLT panels and glulam members, to prevent surface damage or crushing of edges. Do not walk across panels or members or handle product with soiled or oily hands, tools or connecting hardware.

Rigging & Shoring

Before installation, Mercer CLT panels and glulam beams can be prepared for safe lifting and hoisting. All lifting equipment, rigging, and hoisting devices must be designed by the installer's erection engineer. Our in-house engineers and fabrication specialists are equipped to inform and guide the project team towards a competent solution and/or provide professional engineering advice.

Storage

Store Mercer CLT and glulam elements on a flat surface, raised off ground contact by 6" to 12" using clean, wooden blocking spaced to ensure no product deflection. Separate courses with additional blocking, ensuring blocking is vertically aligned/ stacked.

Cover product with good-quality, clean tarpaulin to protect from adverse weather conditions and UV exposure. Water will stain the product. Prolonged exposure to sunlight will cause "tanning" and will discolor the product. UV-resistant temporary sealants can be applied in the factory to minimize the impact of moisture and UV, but this does not eliminate the need for adequate storage on site.

For long-term storage, cut slits in the bottom of the wrapping to allow ventilation and drainage of any entrapped moisture. Mercer recommends retaining factory-applied wrapping on product until fully installed and building is enclosed to best protect finished surfaces.

Finishing

Wood finishes are a necessary component of preserving your products. Bare wood products highlight the natural beauty of wood but may check, swell and change color over time.

Final finish coating of visually exposed Mercer CLT and glulam members is recommended and should be applied after the building is enclosed but prior to introducing heat in the building. Finish sanding with 80 grit sandpaper in the direction of the wood grain is recommended prior to application of finishing product to exposed surfaces. Ensure that finishes are compatible with factory applied temporary coating systems.

Follow all application directions of finishing product. Finishing a small, concealed test area to ensure satisfactory end-results is always recommended.

Conditioning

In order to minimize adverse checking and/or dimensional movement in Mercer CLT and glulam members, it is critical that the product is allowed to gradually adjust to final ambient moisture and temperature conditions over a period of several weeks.

Upon building closure, adjust building temperature and relative humidity slowly, over a series of weeks, allowing mass timber components equilibrium to adjust more naturally. Remember, room temperatures near ceilings can be several degrees warmer than at floor level.

Do not expose Mercer CLT and glulam beams and columns directly to forced air during this period to avoid abrupt checking.


Fastenal HQ, Winona, MN, US

Catalyst, Spokane, WA, US

Mercer Mass Timber Construction Services

Mercer Mass Timber Construction Services

Mercer can offer in-house construction services to ensure that the installation of our mass timber products is easy, safe and efficient. We have a team of experienced mass timber erectors with over a decade of experience in the installation of timber buildings in North America.

Unparalleled Advantages of Mercer Mass Timber Installation Services

Logistics Coordination for Mass Timber Deliveries

Leveraging our vertical integration, we streamline logistics coordination for mass timber deliveries. This approach ensures efficient and timely delivery, minimizing delays and optimizing project timelines.

Reduction in Scope Gap for General Contractors/Owners

By having control over the entire process from engineering to manufacturing and installation, we significantly reduce scope gaps, fostering a smoother project execution and minimizing discrepancies.

Off-site Assembly Assistance

Our ability to perform off-site assembly, including the installation of necessary hardware at our factories, reduces on-site installation complexities. This approach ensures precision and quality while enhancing project efficiency.

Installation Sequence/Trucking Sequence Transparency

We maintain transparent and clear installation sequences and trucking sequences, providing comprehensive visibility to stakeholders. This transparency minimizes uncertainties and enhances project planning.

Value Engineering Propositions

Our comprehensive understanding and collaboration among our engineering, manufacturing, and construction teams under one roof enable us to offer value engineering propositions. This results in optimized solutions that balance functionality, aesthetics, and cost-effectiveness.

Timber Expertise

Our construction team boasts an exceptional level of expertise in mass timber construction, having overseen the successful installation of numerous mass timber structures across a diverse array of project types and geographic locations. With a track record encompassing multi-family residences, commercial establishments, residential buildings, and warehouse-industrial structures, our team has demonstrated proficiency and versatility in handling various project complexities.

We can Partner with Your Installer of Choice

We can also work closely with one of the numerous mass timber installers in the market. We will nurture a collaborative environment and seek installation sequence and detailing feedback from your installer, as well as agreeing on the delivery sequence.

Sequencing

Truckload sequencing is a standard feature of Mercer's mass timber packages, with the exact sequence established during the shop drawing process. Wherever possible, Mercer CLT panels are arranged to be erected directly from the delivery truck to their installation point. However, to ensure safe shipment, some panels or members may be delivered out of sequence to facilitate the safe transportation of the load to the site.

Please contact Mercer Mass Timber to learn more about truckload sequencing.

Site Assembly Drawings

Design for Manufacture and Assembly (DfMA) is at the core of what we do. Our team ensures that every component of your project can be produced, delivered, and installed with maximum efficiency. We can generate site assembly drawings from the approved 3D model to provide clear and precise instructions for the installation team, facilitating an efficient site installation.

For more information about our site assembly drawings services, please contact Mercer Mass Timber.

References

CLT Handbook - Chapter 12, Canada, 2019.
CLT Handbook - Chapter 12, US, 2013.

Coming Soon

Additional Features and Canadian Design Values

As a successor to the technical guide published by Structurlam, the Mercer Mass Timber Technical Guide will be expanded to encompass the latest product and service offerings.

At MMT, our goal is to develop the most advanced mass timber building systems in the world, making them more widely available, more efficiently produced, and of higher quality than ever before. Leveraging our comprehensive expertise in mass timber and our unprecedented investments in R&D, testing, manufacturing, design, engineering, and construction, we provide our partners with the most cutting-edge building systems available.

Join us in the mass timber revolution.

Duke University Student Wellness Center, Durham, NC, US

3935 Lakeshore, Kelowna, BC, Canada

Mercer Mass Timber (MMT) is a wholly-owned subsidiary of Mercer International, a global provider of renewable materials and energy.

clt@mercerint.com
mercermasstimber.com

Mercer Mass Timber

MMT Project Services

700 West Pender Street, Suite 1120
Vancouver, BC, V6C 1G8
Canada

MMT Construction Services

19202 Garland Avenue
Spokane Valley, WA 99027
United States

MMT Manufacturing

Mercer Conway
1800 Sturgis Road
Conway, AR 72034
United States

Mercer Spokane
19202 Garland Avenue
Spokane Valley, WA 99027
United States

Mercer Okanagan
1716 Wallis Road
Okanagan Falls, BC V0H 1R2
Canada

clt@mercerint.com
mercermasstimber.com