

# Beauty and Strength

AN EXAMINATION OF WESTERN RED CEDAR FINISHES AS A COMPLEMENT TO MASS TIMBER SYSTEMS MADE OF DOUGLAS FIR, SPRUCE-PINE-FIR, AND SOUTHERN YELLOW PINE

Sponsored By:



Photo courtesy of Brad Nicol Photography.

## WHAT IS MASS TIMBER?

Due to revised building codes and a growing awareness of the environmental benefits of building with wood over more energy-intensive materials such as steel and concrete, the number of mass timber buildings being constructed is rising nationwide.<sup>1</sup> These buildings are not only environmentally superior and just as structurally sound, but they are beautiful.<sup>2</sup> Mass timber is a new category of wood products comprised of smaller solid softwood lumber components bonded together with adhesives, nails, or dowels that produce large-format panel, beam, and column elements. These products are used as load-bearing materials, as they

provide exceptional strength and stability while being lightweight, making a new generation of high-performance buildings possible.<sup>3</sup> When left exposed, mass timber products also provide exceptional beauty to interior spaces and they can be “designed to curve and cantilever, achieving expressive long-spanning designs.”<sup>4</sup>

## TYPES OF MASS TIMBER

There are several types of mass timber products that you should be aware of, as they each have different structural and aesthetic merits: cross-laminated timber, dowel-laminated timber, nail-laminated timber, and glued-laminated timber.

## LEARNING OBJECTIVES

1. Discover the different types of mass timber products, applications for mass timber construction, and the softwood lumber species that are used to manufacture mass timber products, including Douglas fir, spruce-pine-fir, and Southern pine.
2. Examine the benefits of mass timber, from carbon sequestration to construction efficiencies.
3. Review how Western red cedar products can be used on both exteriors and interiors to complement mass timber construction.
4. Explore several projects where Western red cedar was used to complement mass timber structures.

## CONTINUING EDUCATION

This course is approved for AIA, IDCEC, and GBCI Learning Unit Credits.



Use the learning objectives to focus your study as you read this article. For details on the learning units or credit information, and to earn credit and obtain a certificate of completion, visit <http://go.hw.net/ARI2225> to view the entire CEU and complete the quiz. If you are new to Hanley Wood University, CEU courses are free of charge once you create a new learner account; returning users log in as usual.

## Cross-Laminated Timber (CLT)

Cross-laminated timber has been widely adopted in Europe but is gaining popularity in the U.S. The product is typically made from solid sawn laminations and is manufactured in accordance with ANSI/APA PRG 320, a standard that ensures manufacturing, qualification, and quality assurance is the same across North America. CLT consists of layered lumber boards (usually three, five, or seven) stacked and glued crosswise at 90-degree angles. These alternating grains improve CLT panels' dimensional stability and deliver excellent structural rigidity in both directions. Finger joints and structural adhesive connect the boards. The thickness of



CLT consists of layered lumber boards (usually three, five, or seven) stacked and glued crosswise at 90-degree angles; these alternating grains improve CLT panels' dimensional stability and deliver excellent structural rigidity in both directions. Photo courtesy of Structurlam.

CLT laminations typically ranges from 5/8 inch to 2 inches, with widths from 2.5 to 5.5 inches. CLT panels can be manufactured to custom sizes, but each manufacturer has specific product dimensions and transportation restrictions may ultimately limit their size.<sup>5</sup> CLT is manufactured to specific structural performance requirements with lay-ups made with MSR (Machine Stress Rated) lumber or visually graded lumber. There are three major softwood lumber species used:

- Douglas fir-larch, or simply Douglas fir, is plentiful and dimensionally stable. While all lumber benefits from some degree of "seasoning" to adjust to the humidity conditions of its surrounding atmosphere before it's installed, Douglas fir seasons well in position and can be cut, nailed, and fastened in "green" then allowed to air dry during construction.
- Spruce-pine-fir (SPF) is a grouping that includes species such as balsam fir, red pine, red spruce, black spruce, Engelmann spruce, and lodgepole pine. Lumber manufactured from these species is commonly found in building supply stores throughout the U.S.,

identified on the grade stamp as either "S-P-F" or "SPFs."

- Southern pine lumber features excellent fastener-holding ability, providing framing components with strong connections. Its inherent strength contributes to long, clear spans that reduce the need for intermediate columns and load-bearing walls. Using today's design technology, creative roof and ceiling styles are possible using southern pine.

CLT panels have many applications including roofs, walls, and floors; cantilevered floors and balconies; and load-bearing elevator shafts and stairs. According to the 2022 Mass Timber Design Manual, "The panels' ability to resist high racking and compressive forces makes them especially cost-effective for multistory and long-span diaphragm applications. In structural systems, such as walls, floors, and roofs, CLT panels serve as load-bearing elements and are well suited to taller timber construction. CLT can be left exposed in building interiors — up to 8 or 9 stories in Type IV-C buildings under the 2021 IBC (depending on occupancy), offering additional aesthetic attributes."<sup>6</sup> CLT can also be manufactured to different appearance classifications.

#### Dowel-Laminated Timber (DLT)

Dowel-laminated timber panels are a newer mass timber product that are made from dimensional softwood lumber boards (2x4, 2x6, 2x8, etc.) that are friction-fit together with dowels made from hardwood lumber. The softwood lumber species used is typically Douglas fir, SPF, or Southern pine. Because it is constructed entirely of wood with no metal connectors, DLT is easily processed and cut using computerized numerical control (CNC) machinery. The Design Manual notes several aesthetic benefits of dowel-laminated timber: "Alternating patterns of lumber can be used to create various aesthetic appearances, and it can be bent and assembled to create curved structures. DLT panels can also accommodate mechanical services and sound absorbing insulation [that is] tucked away as part of its cut and design." DLT panels can even be mechanically bonded to a cast-in-place concrete topping to form

## GLOSSARY

**Biophilic Design:** The practice of connecting people and nature within the built environment

**Carbon Sequestration:** The process of capturing and storing atmospheric carbon dioxide with the goal of reducing global climate change

**Closed-Loop System:** Production processes that reuse material waste created during product manufacturing to create new products, thereby preserving natural resources and diverting waste from the landfill

**Cross-Laminated Timber (CLT):** A mass timber product typically made from solid sawn laminations, of Douglas fir, spruce-pine-fir, or Southern pine species CLT consists of layered lumber boards (usually three, five, or seven) stacked and glued with structural adhesive crosswise at 90-degree angles

**Life Cycle Assessment (LCA):** A method of assessing the environmental impacts of a commercial product, process, or service at all stages of its life cycle, from raw material extraction through final disposal

**Mass Timber Construction:** Buildings constructed using a category of engineered wood products typically made of large, solid wood panels, columns, or beams often manufactured off-site for load-bearing wall, floor, and roof construction

**Mass Timber Product:** Thick, compressed layers of wood, creating strong, structural load-bearing elements that can be constructed into panelized components; they are typically formed through lamination, fasteners, or adhesives

**Soffit:** The horizontal underside of an exterior or interior construction element, such as a roof overhang

**Timber Concrete Composite (TCC):** A hybrid panelized system that creates a composite action between timber and concrete that enables designers to increase spans, reduce deflections, improve vibration performance, and streamline structures; electrical, mechanical, and acoustic systems can be integrated into the structural panels

**Western Red Cedar:** Scientific name *Thuja plicata*, it is an evergreen coniferous tree that is native to western North America

timber concrete composite (TCC) panels, a hybrid system used to reduce cross sections, increase spans, and lessen noise transfer and vibrations.

### Nail-Laminated Timber (NLT)

Nail-laminated timber, which used to be known as heavy timber or mill decking, is a century-plus-old construction method that was used to construct 19th and early-20th century industrial buildings such as factories and warehouses.<sup>7</sup> NLT panels spanned between solid timber posts and beams to create incredibly sturdy flooring systems and can still be seen today in historic buildings that have been repurposed for commercial or residential space. The mass timber product fell out of favor for concrete and steel construction after several major urban fires but is now a practical option again due to improved sprinkler systems, more stringent fire code, the domestic availability of wood, and knowledge about the sustainability of renewable wood building products. An added bonus is that the product does not require a dedicated manufacturing facility and it can be fabricated with readily available dimensional lumber.

NLT is made from dimension lumber stacked on edge and fastened together with nails (or less commonly screws) to form a solid structural element. The typical softwood lumber species used in the manufacture of DLT are Douglas fir, SPF, or Southern pine. The resulting panels have a nominal thickness ranging between 4 and 12 inches.<sup>8</sup> NLT gets its strength and durability from the nails or screws fastening the individual pieces of lumber together. Adding plywood or oriented strand board sheathing on one face of the panel helps with dimensional stability and creates a diaphragm to transfer lateral forces, allowing NLT to be used as a shear wall or structural diaphragm. WoodWorks notes, "NLT offers a consistent appearance for decorative or exposed-to-view applications and can include curves and cantilevers."

### Glued-Laminated Timber

Glued-laminated timber, often referred to as glulam, is one of the oldest and most widely used mass timber products because it can be used in many applications and in almost all



NLT is made from dimension lumber stacked on edge and fastened together with nails (or less commonly screws) to form a solid structural element. Photo courtesy of Think Wood.

construction types from buildings to major load-bearing structures such as bridges, canopies, and pavilions. The product is manufactured in conformance with the ANSI A190.1-2022 standard, and composed of individual dimension lumber laminations, typically Douglas fir, SPF, or Southern pine, that are bonded together with durable, moisture-resistant adhesives. The wood laminations are selected and positioned based on their performance characteristics, but the grain always runs parallel with the length of the member.

Glulam can be customized to create straight, tapered, arched, or curved elements such as columns and beams, or it can be affixed side-by-side to form panels. Per the Mass Timber Design Manual, "While typically used as beams and columns, designers can use glulam in the plank orientation for floor or roof decking similar to NLT. It is particularly well suited to long-spanning structures and custom curvilinear shapes and combines well with hybrid assemblies and building systems."

### APPLICATIONS FOR MASS TIMBER<sup>9</sup>

As large solid wood elements or panels, mass timber products can be used for load-bearing wall, floor, and roof construction, as well as in load-bearing elevator shafts and stairs. They can be designed to curve and cantilever, achieving expressive long-spanning designs, or can be bonded with concrete to form timber concrete composite (TCC) floors. As mentioned earlier, this hybrid system creates a

composite action between the two materials, which "enables designers to increase spans, reduce deflections, improve vibration performance, and streamline structures in pursuit of sustainable architecture and cost efficiency." Electrical, mechanical, and acoustic systems can be integrated into the structural panels. Because the timber carries a portion of the load, these panels reduce the proportion of carbon-intensive concrete components.<sup>10</sup>

Additionally, mass timber can be used as a complement to other building systems in conjunction with light-frame wood construction or in other types of hybrid structures. This variety of products gives design teams flexibility and versatility, especially since they can be combined to form customized structural assemblies. Designers are using mass timber products to construct multifamily housing, healthcare facilities, public buildings, tall-wood structures, and mixed-used commercial offices, a key use for mass timber construction. While steel and concrete have been used in more recent history to construct office buildings, "mass timber is rising in popularity and is equally capable of accommodating the needs of a modern workplace."<sup>11</sup> This is because mass timber construction is ideal for today's open office layouts and offers aesthetic warmth and biophilic benefits of natural wood when it's left exposed.

WoodWorks tracks mass timber projects

across the U.S. and reports that “As of June 2022, 1,502 mass timber projects had been constructed or were in design in all 50 states, in the multi-family, commercial, or institutional categories.”<sup>12</sup>

### SUSTAINABILITY BENEFITS

Mass timber construction is a boon to sustainable design because of its many environmental benefits and contributions to biophilic design. From carbon sequestration to preventing deforestation, building with mass timber products reduces a building’s carbon footprint<sup>13</sup> and can improve occupant well-being.<sup>14</sup>

### Carbon Sequestration

Wood as a building material offers two main advantages when compared to alternative materials and methods such as concrete and steel construction:<sup>15</sup>

1) Harvesting wood is less carbon intensive than extracting energy intensive materials from the ground, and

2) Timber buildings store carbon that would otherwise be emitted back into the atmosphere.

Growing forests absorb and store carbon, and release oxygen, over extended periods of time. Harvesting and replanting increases forests’ carbon sink potential as the rate of sequestration is greater during a tree’s young, robust growth. Active forest management, or forest thinning, mitigates wildfires, cuts carbon emissions, replenishes area waterways, expands wildlife habitat, and creates jobs in rural areas. This is considered a closed-loop cycle because of the natural processes of growth, decay, and disturbances, but it is also a closed-loop cycle when forests are harvested for use in products or energy. WoodWorks notes, “The biogenic carbon cycle fundamentally differs from the open/one-way flow of fossil carbon to the atmosphere.” In addition, wood products are approximately 50% carbon by dry weight, meaning mass timber buildings can store carbon that would otherwise be emitted back into the atmosphere well into the future, reducing their global warming potential. This carbon is stored for the lifetime of the structure, or longer if it’s reclaimed and reused for another application.<sup>16</sup>

### QUIZ

- Which of the following mass timber products consists of layered lumber boards (usually three, five, or seven) stacked and glued crosswise at 90-degree angles?
 

A. CLT	C. NLT
B. DLT	D. Glulam
- Which of the following softwood lumber species can be used to manufacture CLT in conformance with the ANSI/APA PRG 320 standard?
 

A. Douglas Fir-Larch	C. Southern Pine
B. Spruce-Pine-Fir	D. All of the above
- CLT can be left exposed in building interiors up to \_\_\_\_\_ stories in Type IV-C buildings under the 2021 IBC (depending on occupancy).
 

A. 5 or 6	C. 7 or 8
B. 6 or 7	D. 8 or 9
- Which mass timber product is made from dimension lumber stacked on edge and fastened together with nails or screws to form a solid structural element?
 

A. CLT	C. NLT
B. DLT	D. Glulam
- Which type of mass timber product can be used in both buildings and major load-bearing structures such as bridges, canopies, and pavilions?
 

A. CLT	C. NLT
B. DLT	D. Glulam
- As of June 2022, how many mass timber projects had been constructed or were in design in all 50 states, in the multi-family, commercial, or institutional categories?
 

A. 205	C. 1502
B. 500	D. 1205
- Wood products are approximately \_\_\_\_\_ percent carbon by dry weight, meaning mass timber buildings can store carbon that would otherwise be emitted back into the atmosphere well into the future, reducing their global warming potential.
 

A. 15	C. 50
B. 25	D. 75
- CLT components weigh about \_\_\_\_\_ percent less than concrete equivalents, which can result in additional savings via lower transportation costs, smaller building foundations, reduced crane and heavy equipment rentals, lower interior finishing costs, and less material waste.
 

A. 20	C. 40
B. 30	D. 50
- The \_\_\_\_ IBC was the first to incorporate CLT as a structural building product when it was recognized for use in Type IV (heavy timber, HT) construction.
 

A. 2012	C. 2018
B. 2015	D. 2021
- The 2021 IBC includes provisions for up to \_\_\_\_\_ stories of Type IV-A construction for Business and Residential Occupancies.
 

A. 8	C. 12
B. 9	D. 18

### SPONSOR INFORMATION



The Western Red Cedar Lumber Association represents quality “Real Cedar” producers, distributors and retailers throughout North America. Founded in 1954 and known as “the voice of the cedar industry,” WRCLA offers extensive resources to assist with selection, specification and quality standards. For more information, visit [RealCedar.com](http://RealCedar.com).



The Wood Institute has over 170 accredited education courses for architects, engineers, general contractors, and code officials. Find out what’s new and next for wood design and construction in one of the many courses available. Topics range from light wood frame, mass timber, embodied carbon, LCA, fire and seismic performance, and biophilia. Courses are approved for CE credit by the AIA, GBCI, NCSEA, ICC, and AIBD.



Wood's lighter environmental footprint can contribute to low- and zero-carbon construction. Design by Lorcan O'Herlihy Architects [LOHA]. Photo courtesy of Jason Keen.

### Calculating the Wood Carbon Footprint of a Building

Buildings consume nearly half the energy produced in the United States, use three quarters of the electricity, and account for nearly half of all carbon dioxide (CO<sub>2</sub>) emissions.<sup>17</sup> This carbon footprint can be reduced by building with a higher percentage of wood, such as with engineered wood products. The embodied carbon of different materials can be compared if they have the same functional equivalency, which means they provide the same service for the same length of time. This can be determined with life-cycle assessments (LCAs), an important tool helping designers make wise low carbon material choices, such as specifying mass timber.

When considered over the product's lifetime — from the harvest of raw materials through manufacturing, transportation, construction, and disposal or recycling — mass timber has less embodied energy, produces less air and water pollution, and has a smaller environmental footprint than other energy-intensive structural materials such as concrete and steel, which are made from substances that must be mined and heated to extremely high temperatures.<sup>18</sup> Wood building products have lower embodied carbon than other materials because they require far less energy to manufacture, and their manufacture uses very little energy from fossil fuels. There

are many reasons why wood products are less energy intensive. The practice of on-site energy generation using biomass at the mill is one aspect.

This lighter environmental footprint can contribute to low- and zero-carbon construction. The product's light weight also reduces transportation-related emissions and can decrease foundation costs compared to steel and concrete assemblies. "As CLT components weigh about 30% less than concrete equivalents, additional savings can be found via lower transportation costs, creating smaller building foundations, reduced crane and heavy equipment rental needs, lower interior finishing costs, and less material waste, which would offset higher initial costs."<sup>19</sup>

In their "Buildings as a Global Carbon Sink" study for the journal *Nature*, the authors note that "The anticipated growth and urbanization of the global population over the next several decades will create a vast demand for the construction of new housing, commercial buildings, and accompanying infrastructure. The production of cement, steel, and other building materials associated with this wave of construction will become a major source of greenhouse gas emissions."<sup>20</sup> This demand can be exploited by constructing buildings with bio-based materials and assemblies that have low embodied carbon emissions and high carbon storage capacity. They say, "We can create a durable, humanmade global

carbon pool while simultaneously reducing CO<sub>2</sub> emissions."<sup>21</sup>

Structurelam, a manufacturer of mass timber components, has this to say when comparing concrete and steel to mass timber construction: "Despite being five-times lighter than concrete, CLT has comparable strength per weight ratio to concrete and the multi-layer wooden panel spans in two directions. Each layer is placed cross-wise to the adjacent layers to increase its stability and strength. Buildings using mass timber carry the same strength as concrete while minimizing cost and building time. This strength also allows modern connection engineering to dissipate seismic forces in a highly effective manner, enabling mass timber buildings to commonly outperform other systems in terms of cost and life safety in earthquake zones."<sup>22</sup>

### Preventing Deforestation

Although counterintuitive, the demand for forest products can actually lead to an increase in forest land. When a forest becomes profitable, it reduces the amount of land that would otherwise be developed for other uses such as agriculture and development by giving owners an incentive to manage the land for sustainable long-term market value. Higher demand leads to more supply (or growth). Conversely, deforestation (land-use change) occurs when there is higher demand for the land than for wood products. In fact, "data shows that global regions with the highest levels of industrial timber harvest and forest product output are also regions with the lowest rates of deforestation."<sup>23</sup>

In addition, many trees harvested for mass timber products are procured by sustainable methods and from sustainably managed forests, including those infected with pine beetle and spruce budworm that can no longer benefit their ecosystem. Structurelam says, "If those dead trees were to remain in the forest, they would emit CO<sub>2</sub> into the atmosphere instead of storing it. However, if trees have already died due to pine beetle contamination, the timber is still sound and useable for construction for up to 10 years. By utilizing that wood before it goes to waste, CLT becomes a building product that not only sequesters tons of carbon, but also reduces

greenhouse gas emissions during construction through the prefabrication process.”<sup>24</sup>

Sustainably managed forests support biodiversity, water quality, and habitat preservation through forest certification and best management practices. Fortunately, we have a ready source of sustainably harvested timber in the United States. “There are about 96 million acres of certified forests in the US, which is about 19% of total US timberland—above the global average of 11%.”<sup>25</sup> That being said, specifiers must still be aware of where the wood they are specifying comes from to ensure the timber is not illegally sourced or supporting poor forest management practices.

### Biophilic Design

An added benefit of building with wood is its ability to support biophilic design principles that aim to “reduce stress, enhance creativity and clarity of thought, improve our well-being, and expedite healing” by connecting building occupants with nature, whether actual or a symbolic representation.<sup>26</sup> This can be accomplished by using natural shapes and forms, natural materials (e.g., wood), natural patterns, daylighting, water features, and vegetation, among other tactics.

Designers are looking for simple ways to improve the way people feel inside a

building, through design choices such as the use of exposed wood. An increasing number of studies focused on wood’s biophilic qualities have linked the use of exposed wood in buildings with improved occupant well-being. “When wood is left exposed as the structure or an interior finish material, it helps complement biophilic design goals as people associate the grain, texture, visual warmth, and color of wood with nature.”<sup>27</sup> With warmth of touch, richness of texture, and fresh wood scent, wood buildings are naturally biophilic, enhancing well-being and increasing the quality of life.

### PERFORMANCE BENEFITS

There are numerous performance benefits of mass timber, but you may be surprised to learn that fire, wind, and seismic resistance are three of the most important that have allowed these products to comply with new building codes so that commercial buildings can be constructed taller and in more municipalities.

#### Fire Resistance

Mass timber elements such as glulam beams and CLT slabs have been rigorously tested for their fire resistance properties. Mass timber products char at a very predictable rate (approximately 1-1/2” per hour) and because they char on the outside, the char on heavy

timber and mass timber elements actually creates a protective layer over the interior wood. Mass timber’s density also doesn’t allow for sufficient heat to cause a flame.<sup>28</sup>

In fact, “Mass timber elements can be designed so a sufficient cross-section of wood remains to sustain the design loads for the required duration of fire exposure. This sets mass timber apart as a unique building material—one that is able to achieve structural performance and passive fire-resistance objectives for larger and taller wood buildings than ever before, while offering enhanced aesthetic value and environmental responsibility.”<sup>29</sup> There is a great deal of information available in the Mass Timber Design Guide that you should consult regarding mass timber assemblies and penetration fire stopping systems, as well as data regarding fire resistance tests.

#### Wind and Seismic Resistance

The use of CLT floor and roof panels as a primary gravity force-resisting component is becoming commonplace and until now designers needed to receive approval from Authorities Having Jurisdiction (AHJ) to use CLT as a structural diaphragm on a case-by-case basis. The American Wood Council (AWC) recently released the 2021 Special Design Provisions for Wind and Seismic (2021 SDPWS) to standardize how to use CLT floor and roof panels as a structural diaphragm, including understanding shear capacity, diagrams of components and panel-to-panel connections, and design loads.<sup>30</sup> In addition, the more extensive CLT Diaphragm Design Guide should be referenced, as it includes the design of collector and chord details, full examples, and pre-calculated tables of connection capacities.

#### Construction Efficiencies

Highly prefabricated mass timber building systems can be assembled by fewer workers, especially on tight, difficult-to-reach construction sites. This is because they are assembled like a kit of parts so a job site doesn’t have to accommodate a large crew and a lot of equipment. Pre-fabricated components arrive on-site ready to be lifted into place and secured with steel connectors, which “makes it possible for larger towers to



Designers are looking for simple ways to improve the way people feel inside a building, through design choices such as the use of exposed wood. Design by aodbt architecture + interior design. Photo courtesy of Garrett Kendel from King Rose Visuals.



Mass timber is revolutionizing how buildings are constructed, thanks in part to provisions allowing the construction of taller mass timber buildings as part of the 2021 International Building Code (IBC). Design by aodbt architecture + interior design. Photo courtesy of Garrett Kendel from King Rose Visuals.

have multiple floors constructed per week.”<sup>31</sup> This speed results in savings and revenue for the owner, who can open a building sooner. Prefabricated construction can be particularly useful for repeatable building types such as hotels, multifamily residential, and student dorms. In addition, mass timber is unique in that it draws installation techniques from other construction types, which means that professionals with concrete, precast, tilt-up, and structural steel experience can readily adapt to these materials. An added bonus is safer and quieter construction sites, which allows construction in urban areas with minimal disturbance to the public.<sup>32</sup>

### CODE CONSIDERATIONS<sup>33</sup>

It's important to understand under what circumstances the code currently allows the use of mass timber in commercial and multi-family construction. Mass timber is revolutionizing how buildings are constructed, thanks in part to provisions allowing the construction of taller mass timber buildings

## CASE STUDY 1

### CHUNG TAI ZEN CENTER: BOULDER, COLORADO



Design by Sopher Sparn Architects. Photo courtesy of Brad Nicol Photography.

The soon-to-be-completed Chung Tai Zen Center, also called the Great Dharma Chan Monastery, is a 25,000 square foot Buddhist meditation center that will consist of a main sanctuary building and associated residential monastery on a rural 35-acre site in Boulder, CO. The single-story structure, designed by Boulder-based Sopher Sparn architects, has expansive interior spaces with high volumes made possible by multiple types of mass timber products. The exposed CLT ceiling/roof deck in the meditation hall and dining halls gives guests the impression of a “floating roof.” The long-span mass timber glulam beams and CLT deck are supported by a combination of hidden steel columns and exposed hybrid glulam and steel columns. This exposed mass timber structure is meant to evoke an overhead forest canopy, ideal for natural serenity and Buddhist meditation.<sup>34</sup> In addition, the Western red cedar siding on the Zen Center is kiln dried, clear, vertical grain (VG) grade tongue and groove with a fine-line edge detail installed horizontally.

With these materials, the architects were able to build the Chung Tai Zen Center sustainably. According to Woodworks, “The facility will be Net Zero Energy, producing more energy than it uses. The intention for the center’s design encourages mindfulness and incorporates a harmonic relationship with the environment. The timber and wood in the project provide a connection with the natural world and it brings a warm calming environment into the project.”<sup>35</sup>

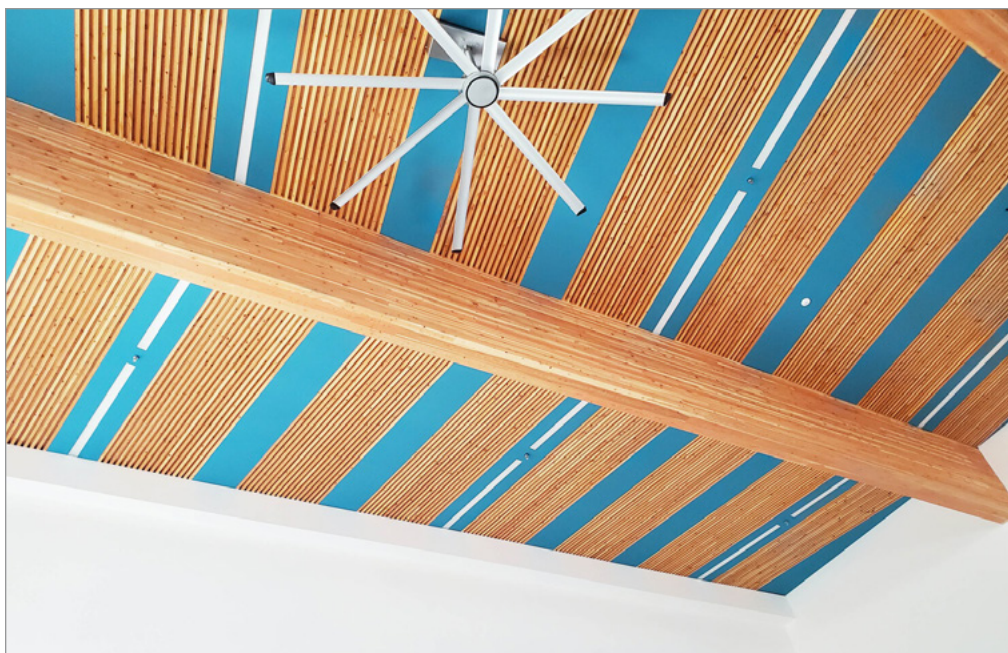
as part of the 2021 International Building Code (IBC), in part because of the attributes we just discussed. In the event of a fire, mass timber products char on the outside, forming a protective layer while retaining strength. Mass timber hybrid structures meet, and in some cases exceed, the seismic performance of comparable steel and concrete buildings, achieving sufficient stiffness, strength, and ductility to resist strong winds and earthquakes.

A building’s assigned construction type is the main indicator of where and when all wood systems can be used. The 2015 IBC was first to incorporate CLT as a structural building product when it was recognized for use in Type IV (heavy timber, HT) construction. In response to the increasing use of CLT and other mass timber building components in Types III, IV, and V construction, the 2018 IBC added more detail to clarify the requirements of heavy timber construction.

Most recently, the height of mass timber buildings has also been on the rise supported by changes to the 2021 IBC, which includes three new construction types:

- Type IV-A – Maximum 18 stories, with noncombustible protection on all mass timber elements
- Type IV-B – Maximum 12 stories, limited area of exposed mass timber walls and ceilings allowed
- Type IV-C3 – Maximum 9 stories, all mass timber permitted to be exposed with a few exceptions (e.g., shafts) and designed for 2-hour fire resistance.

These new types are based on the existing Heavy Timber construction type (renamed Type IV-HT) but with specified hourly fire resistance ratings for building elements and added levels of noncombustible protection. The code includes provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies. Mass timber can be left exposed in building interiors—up to 8 or 9 stories in Type IV-C buildings under the 2021 IBC (depending on occupancy), offering additional aesthetic attributes.



At the Shxw'owhamel Community Hall + Health Centre in Hope, British Columbia, the lobby and gym were constructed with glulam beams and DLT panels in the gym ceiling. The exterior of the Sequel Elder's Circle, a traditional winter pit dwelling, features Western red cedar exterior cladding and soffits. Western red cedar was also used for interior wall cladding and ceilings in the lobby and administration wing of the centre. Design by Urban Arts Architecture Inc. Photo courtesy of Dave Best.

### WESTERN RED CEDAR BENEFITS

Although not used for mass timber production, Western red cedar has numerous performance attributes that make it suitable for both interior and exterior applications. But the most important may be its natural insect, rot, and decay resistance, provided by the same natural compounds that give cedar its signature aroma. Western red cedar is also very dimensionally stable, with a very low shrinkage factor and high resistance to warping, twisting, and checking. The wood's low density provides superior thermal insulation because it has a high proportion of air-filled cell cavities, helping to keep a building cool in the summer and well-insulated in the winter. This low density also makes the material light weight for easier transport and installation.

### WESTERN RED CEDAR COMPLEMENTS MASS TIMBER

The structural elements of mass timber are often left exposed on interiors because the wood itself is inherently beautiful. Western red cedar can be used for many exterior and interior applications to complement these exposed elements and further enhance biophilic design. With a uniform, fine-grained

## CASE STUDY 2

### WANUSKEWIN INTERPRETIVE CENTRE: SASKATOON, SASKATCHEWAN



Design by aodbt architecture + interior design. Photograph courtesy of Garrett Kendel from King Rose Visuals

The remodeling of the Wanuskewin Interpretive Centre, originally constructed in 1992, sought to tell the rich historical and cultural background of the Cree people who have resided here for the past 6,400 years. "Mass timber and glulam beams play a strong role throughout the thoughtfully designed spaces, creating a natural and welcoming space that celebrates the rich and long history of the Indigenous Peoples of the Northern Plains. The new cedar shakes on the roof and vertical cedar exterior wall panels not only offer stunning natural beauty but were also intentionally selected to align with the materiality of the traditional buildings for the Northern Plains indigenous peoples."

texture and colors ranging from amber yellow to sienna brown, it introduces warm, natural beauty to interiors and is ideal for exterior applications with mass timber due to its durability, beauty, and sustainability.

We've discussed how efficient mass timber construction is, with tall-wood buildings being constructed relatively quickly, year-round, in any type of weather. Similarly, Western red cedar is readily and easily workable on a construction site and can arrive ready to be installed. It can come pre-finished so that weather is not a factor and the material is dry before installation; or, it can be finished on-site or left in its natural state to develop its characteristic "silver gray" patina when exposed to the elements.





Cedar siding performs better and requires less maintenance than most man-made materials that attempt to simulate a wood appearance, such as fiber cement and plastic composites. Design by Ankrom Moisan. Photo courtesy of Waiting.

### EXTERIOR RED CEDAR APPLICATIONS

Western red cedar's natural durability and physical properties make it highly versatile and ideal for exterior applications such as siding, trim, soffits, and landscape features. In fact, the wood is so highly coveted that many man-made siding and trim materials attempt to mimic the grain and color of cedar.

#### Siding

Western red cedar has remained a popular siding material for decades, despite the plethora of new products that have emerged on the market. Cedar siding performs better and requires less maintenance than most man-made materials that attempt to simulate a wood appearance, such as fiber cement and plastic composites. Cedar siding provides a wealth of options to provide the perfect look for a commercial building due to its warmth and depth. It can be finished to complement all styles, bridging the gap between rustic and modern, and comes in a variety of grades that are divided into clear and knotty. Cedar is also available in numerous profiles including bevel siding, tongue and groove, lap siding (also called shiplap), and board and batten. These profiles can be installed vertically or horizontally and will create different shadow and line effects once on the wall.

#### Trim

Western red cedar trim boards are generally used in applications such as corner boards, fascia, skirting, and detail around windows and doors. Like siding, they are available in a variety of grades and textures to complement the building's style. Clear boards have a limited number of natural characteristics and are specified when a "clean," fine appearance of the highest quality is desired. They are supplied kiln dried. Knotty boards present a more rustic appearance and may be specified seasoned or unseasoned. If unseasoned, they must be dried prior to finishing. Western red cedar boards may be specified in one of three surface textures to enhance design flexibility: rough; surfaced one side, two edges (S1S2E); or surfaced four sides (S4S). Surfaced one side, two edges is a versatile product that is the most popular choice for trim boards. The surfacing process results in a rough sawn face and a smooth back that provides uniform width and thickness tolerances. Typically graded from the rough face, it may be reversible to the smooth back.

#### Soffits

Soffits are the underside of an exterior element and are typically not an area that designers give much consideration. Vented

### CASE STUDY 3

## AEGIS LIVING LAKE UNION: SEATTLE, WASHINGTON



Design by Ankrom Moisan. Photo courtesy of Aaron Locke.

Opened in August 2022, Aegis Living Lake Union is the world's first assisted living community built to meet the rigorous sustainability building standards of the Living Building Challenge 3.1 Petal Certification for Energy, Place, and Beauty. It is also part of Seattle's Living Building Pilot project and won an award from the International Future Living Institute. According to the facility's website, "It is designed to be emission-free and energy-efficient, and harnesses solar power and rainwater. Inspired by the history of rowing on Lake Union, the community's architecture resembles a shell house design, and the exterior features a striking mural of the legendary rowing team from the University of Washington who won Gold in the 1936 Olympics."<sup>36</sup>

Senior Living News notes, "Standard electricity supports the entire 70,000 square foot building and offsets 105% of the building's total energy demand through various energy reduction measures, including an onsite solar array and offsite solar energy farms that generate 1.7 million kilowatt hours. The building has also reduced its overall energy draw by 25% (relative to a comparable building type) through key features that include an enhanced thermal envelope comprised of triple pane window glazing, thermal insulation for exterior walls, and heat recovery through forced-air ventilation. Other features that reduce the energy draw include a recirculating heat pump system, LED lighting, and sensors to monitor use and high-efficiency appliances."<sup>37</sup> Both knotty and clear grades of Western red cedar were used to clad the building, which features two different siding profiles: shiplap and bevel.



Western red cedar soffits can be used to coordinate with exterior cedar siding or create a seamless aesthetic with interior cedar ceilings. Design by Shelter Residential Design. Photo courtesy of Sam Jim Canzia.

soffits are often made of vinyl, aluminum, or steel and provide ventilation and protection from pests, but they are often unattractive. Wood soffits, on the other hand, provide high style and can be used in areas where ventilation is not needed, such as interiors, or outdoors if adequate spacing is provided for proper air circulation. Western red cedar soffits can be used to coordinate with exterior cedar siding or create a seamless aesthetic with interior cedar ceilings.

### Landscape Features

Because Western red cedar is naturally resistant to rot and decay, stable, cool under foot, and beautiful, it's also an ideal choice for decking and other outdoor applications such as pergolas, gazebos, covered walkways, fences, and garden benches.

### INTERIOR WESTERN RED CEDAR APPLICATIONS

Architects and building owners are starting to appreciate cedar's stunning appearance and ability to beautify interior spaces, particularly when use in conjunction with mass timber. Western red cedar introduces warm, natural beauty into interiors and will last the lifetime of the building if cared for properly. Because

it's protected from the elements, the wood can be left unfinished, and it won't change color as it does naturally when exposed to weather. Or, simple clear finishes and light stains may be all that is needed to bring out the grain and character of the wood. Regardless of a room's style or size, cedar's unique look, feel, and smell can enhance the occupant's experience. In terms of versatility, no other building material compares. Whether it's an expansive ceiling and soffit system, an artistic feature wall, or exposed posts and beams, bringing cedar inside to complement mass timber construction is the best way to add visual appeal and create a greater connection to nature.

### Paneling

Nothing enriches a building's interior quite like tongue-and-groove paneling. Whether it's just one dramatic feature wall in a strikingly modern setting or an entire room with rustic charm, tongue-and-groove paneling, feature walls, and room dividers will elevate the beauty and vivacity of the space. Like all cedar products, tongue-and-groove is incredibly versatile. For example, you can specify tongue-and-groove paneling with a rough face for a more textured look or

## CASE STUDY 4

### LA CONNER SWINOMISH LIBRARY: LA CONNER, WASHINGTON



Rendering courtesy of BuildingWork.

The new La Conner Swinomish Library is now the cornerstone of the La Conner National Historic District, a small, rural town in western Washington state. There were strict historic preservation guidelines, which dictated the architectural character of the new 5,000 square foot public building on a tight 10,000 square foot lot. The project is also targeting LEED Silver certification. According to Seattle architecture firm BuildingWork, "The new building features scale massing, visual hierarchy, careful proportioning, and wood cladding and detailing; design decisions that enable the architecture to reference its historic context while being decidedly contemporary."<sup>38</sup>

The project was a collaboration between the city of La Conner and the Swinomish tribe, with its design reflecting and honoring their many contributions. BuildingWork notes, "Swinomish elder and master carver Kevin Paul created a traditional totem pole using cedar sourced through Wild Edge Woods in Oso, which will stand at the library entrance. The library district serves about 5,000 in the region, including residents of La Conner and Shelter Bay and members of the Swinomish Indian Tribal Community. The library will double the size of the current building and will include new features such as a meeting room."<sup>39</sup>

The library is constructed of CLT structural panels including 3-ply CLT roof panels, 3-ply CLT wall panels, and 5-ply CLT floor panels. Glulam beams were also used in the construction, as were two patterns of pre-finished, engineered Western red cedar siding – both in clear and knotty grades.

smooth face for a more polished look. The pieces can be furnished with V-joint, flush-joint, fine line reveal, or radius joint and the desired shadowing effect can be achieved by combining one of these joinery techniques with select surface textures.

#### Ceiling and Soffit System

As for ceilings, Western red cedar paneling can work well in both contemporary and traditional designs — especially when it's fanned out in a natural range of colors. Exposed cedar posts and beams, or cedar soffits, can carry from the exterior to the interior for a look that connects the indoors to the out.

#### CONCLUSION

As you've learned, the number of mass timber buildings being constructed nationwide (and globally) is on the rise due to updated building codes that allow mass timber products to be used in more building types and at taller heights. The growing awareness of mass timber's environmental benefits and construction efficiencies has also accelerated the use of these products

in civic buildings, multifamily residences, and mixed used commercial buildings, among other project types. These buildings are not only environmentally superior and just as structurally sound as comparable concrete and steel buildings, but they are beautiful. Using Western red cedar products can further enhance this beauty and biophilic design, perfectly complementing mass timber construction. Whether used as exterior siding and trim or for soaring ceilings and paneling, Western red cedar meets the many demands of design professionals, contractors, and building owners. It too is a sustainable material that can be used on projects of all types to add warmth and depth of character that blends seamlessly with mass timber construction. ■

#### ABOUT THE WRITER

Paige Lozier is an experienced writer of digital and print publications, primarily within the design and construction industries. She received a Bachelor's degree in Interior Design and a Master's degree in Historic Preservation from the University of Georgia.

#### CASE STUDY 5

### LEON LEBENISTE FINE FURNISHINGS AND ARCHITECTURAL WOODWORK: SQUAMISH, BRITISH COLUMBIA

Jon Hewitt, owner of Leon Lebiniste Fine Furnishings and Architectural Woodwork, recently moved his high-end interior woodworks business into a new 28,000 square foot building in Squamish, BC. The three-story building houses a factory, showroom, café, and several other artist studios.<sup>40</sup> John Hemsworth of Hemsworth Architecture designed the building to showcase wood, the client's bread and butter. The design incorporates a CLT structure for the floors, mezzanine, and roof, over a glulam post and beam support system. The walls are wood framed, externally insulated, and clad in Western red cedar with all wood products, including the mass timber, which is sourced and supplied locally from British Columbia. The use of prefabricated mass timber accelerated the construction schedule and allowed materials to be delivered to the site using "just-in-time delivery."

## REFERENCES

1. <https://www.woodworks.org/resources/u-s-mass-timber-projects/>
2. Carbon, Fossil Fuel, and Biodiversity Mitigation With Wood and Forests, *Journal of Sustainable Forestry*, 2014, p. 254
3. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
4. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
5. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
6. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
7. <https://www.treehugger.com/old-new-again-nail-laminated-timber-4857648>
8. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
9. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
10. <https://structurecraft.com/materials/mass-timber/timber-concrete-composite>
11. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
12. <https://www.woodworks.org/publications-media/building-trends-mass-timber/>
13. <https://www.fastcompany.com/90574889/wood-buildings-should-be-a-requirement-of-any-climate-change-policy>
14. Is Interior Wood Use Psychologically Beneficial? A Review of Psychological Responses Toward Wood, *Wood and Fiber Science* V.42(2): 211. 2010, p. 203, <https://wfs.swst.org/index.php/wfs/article/viewFile/1365/1365>
15. A Synthesis of Research on Wood Products & Greenhouse Gas Impacts, FPIInnovations, 2nd Edition, Sathre, R., O'Connor, J., 2019, p. 3, <https://www.canfor.com/docs/why-wood/tr19-complete-pub-web.pdf>
16. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
17. <https://www.thinkwood.com/continuing-education/calculate-wood-carbon-footprint>
18. A Synthesis of Research on Wood Products & Greenhouse Gas Impacts, FPIInnovations, 2nd Edition, Sathre, R., O'Connor, J., 2019, p. 3, <https://www.canfor.com/docs/why-wood/tr19-complete-pub-web.pdf>
19. <https://www.sustainalytics.com/esg-research/resource/investors-esg-blog/mass-timber-in-construction>
20. <https://www.nature.com/articles/s41893-019-0462-4>
21. <https://www.nature.com/articles/s41893-019-0462-4.epdf>
22. <https://www.structurlam.com/whats-new/news/concrete-vs-cross-laminated-timber/>
23. <https://www.thinkwood.com/sustainable-architecture-design/sustainable-forestry>
24. <https://www.structurlam.com/whats-new/news/concrete-vs-cross-laminated-timber/>
25. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
26. <https://www.terrabinbrightgreen.com/reports/14-patterns/>
27. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
28. Charring Behavior of Structural Timber Elements in Full-Scale Fire Tests of Three Story Timber School Buildings, Waseda University, Department of Architecture, 2016.
29. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
30. CLT Diaphragm Design for Wind and Seismic Resistance. 2022. WoodWorks - Wood Products Council.
31. <https://www.structurlam.com/whats-new/news/concrete-vs-cross-laminated-timber/>
32. <https://www.structurlam.com/whats-new/news/concrete-vs-cross-laminated-timber/>
33. Mass Timber Design Manual, Vol. 2. 2022. WoodWorks and Think Wood.
34. <https://www.sophersparn.com/blog-ssa/building-green-with-mass-timber>
35. <https://www.woodworkinnovationnetwork.org/projects/301>
36. <https://www.aegisliving.com/aegis-at-lake-union-seattle/>
37. <https://www.seniorlivingnews.com/aegis-living-opens-worlds-greenest-senior-living-community-in-seattle/>
38. <http://www.buildingwork.design/projects/la-conner-swinomish-library/>
39. <http://www.buildingwork.design/projects/la-conner-swinomish-library/>
40. <https://www.squamishchief.com/in-the-community/discover-squamish-crafting-a-design-and-innovation-hub-5167471>