

Mass Timber Products: Innovative Wood-Based Building Materials

Mass timber products, also known as wood-based engineered construction materials, are becoming widely prevalent in the design and construction sector. Being a cost-effective, carbon-efficient, durable, and sustainable building option, mass timber construction has already had a profound impact on residential and non-residential applications in Europe. Likewise, it has been reaching new heights in Canada and is recently gaining momentum in the United States. Envisioned as a substitute for the traditional building materials of concrete, masonry, and steel, all forestry stakeholders have reason to be excited about these new timber products. The most widespread mass timber product is cross-laminated timber (CLT), which is currently on a rapid upward trajectory in North America.

Cross-Laminated Timber (CLT) Basics

- CLT is an innovative secondary wood product and a remarkable alternative to traditional building materials.
- The CLT concept is similar to plywood except for the absence of veneer layers.
- CLT panels consist of an odd number of layers (typically three to nine) of dimensional lumber stacked perpendicular to the adjacent layers and then glued together to form structural panels (Figure 1).
- CLT contains only two materials: lumber and adhesive.
- Currently, CLT in the United States is made from softwoods. Some initiatives are currently exploring the use of hardwoods.

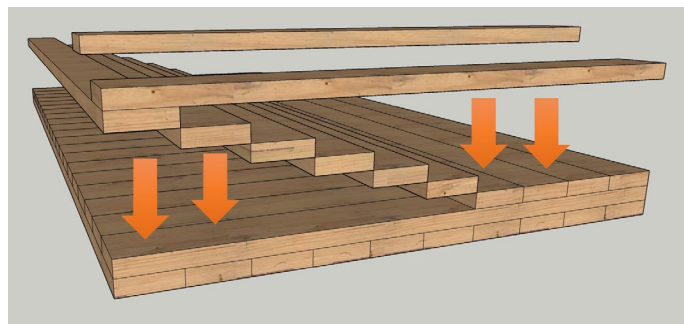


Figure 1. Cross laminated timber assembly.

Over the last 30 years, CLT has been used for a wide range of applications in Europe and Australia, including single and multi-family residential buildings, schools, and office buildings. CLT panels are manufactured with lengths up to 60 feet and widths up to 10 feet. These panels are used in structural walls, ceilings and roofs, and in combination with other construction materials. CLT panels are typically prefabricated with pre-cut openings for doors, windows, and stairs.

Why Mass Timber Products?

There are several benefits associated with mass timber products. These benefits range from environmental to social, which are listed in Table 1.

Table 1. Benefits of mass timber products

Benefits of Mass Timber Products			
Environmental	Low-carbon alternative to steel and concrete	Carbon sequestration	Renewable source with promising end of life prospective
Economic	Potential of local economic benefits	Reduced construction time and financing cost	Reduced labor requirements
Construction	Suitable for modular design concepts	High compatibility with traditional and innovative construction systems	High degree of pre-manufacturing for on-site assembly
Well-being	Wood is perceived to be healthy	Appealing and innovative	Compliance with emission goals



Cross laminated timber (CLT)
Source: StructureCraft



Nail laminated timber (NLT)
Source: StructureCraft



Glue laminated timber (GLT)
Source: StructureCraft



Dowel laminated timber (DLT)
Source: StructureCraft



Mass plywood panel (MPP)
Source: Frereslumber

Other Types of Mass Timber Products

While CLT is the most common and widely accepted product, several types of mass timber products are available for architects, designers, and builders for use in residential and non-residential construction. The various types of mass timber products include (Think Wood, 2017):

- Nail laminated timber (NLT): Similar to CLT, NLT panels are created from dimension lumber stacked on edge, but instead of glue, it is fastened with nails or screws to create a larger structural panel. Due to its variety of textured appearances as a substitute for concrete slabs and steel decking, NLT is used in flooring, decking, roofing and walls, and even in elevator and stair shafts in mid-rise wood-frame buildings.
- Glue laminated timber (GLT or Glulam): Glulam consists of individual dimension lumber stacked in parallel layers and then bonded together with durable, moisture-resistant adhesives. With its excellent strength and stiffness properties, GLT is typically used for beams and columns in residential and commercial construction.
- Dowel laminated timber (DLT): DLT panels are produced from softwood lumber and utilize wooden dowels instead of glues resins, nails, or metal fasteners to form beams and panels. DLT is particularly best suited for horizontal spans in flooring and roofing applications due to its unidirectional grains structure.
- Mass plywood panel (MPP): MPP is similar to CLT, but it is constructed from large-scale plywood panels. It uses engineered veneer and custom plywood layups as a base material rather than lumber. Freres Lumber Company in Lyons, Oregon manufactures MPP in the northwest United States.

Current Market Status and Future Prospects

Over the past few years, several current and completed construction projects have created a movement around mass timber products, in particular CLT. Mass timber's reputation as a sustainable, durable, and eco-friendly building material has boosted markets for CLT and other mass timber products around the world. The global CLT production in 2015 exceeded 620,000 cubic meters, and it is expected to double by 2020 (Gatterer, 2017). The global CLT market is projected to be valued at \$2.07 billion by 2025. North America's demand for CLT was valued at \$119 million in 2016, and this region will likely remain the second largest market in the world.

Consumers are expected to prefer wood-based construction over concrete in the future, driving further market growth. One example of CLT use is shown in Figure 2—the completed Brock Commons, an 18-story housing complex, at the University of British Columbia. In the southern United States, the Home2 Suites Hotel in Mount Pleasant, South Carolina, incorporates CLT in its flooring system. It is the first commercial project in South Carolina to include CLT. The use of CLT will increase the sustainability of the building and the anticipated green building standard ratings. Similarly, the University of Arkansas is currently pursuing plans to construct a 200,000 square foot, 368-room residence hall. The five-story building will be the first large-scale mass timber residence hall project in the United States.

The first certified CLT produced in the United States was supplied by DR Johnson Lumber Co. in Riddle, Oregon, in 2015. In 2016, Smartlam in Columbia Falls, Montana, started to manufacture structural CLT. Several new initiatives have been announced to add CLT capacity in the United States. Kattera, a technology and construction firm, is currently establishing CLT production in Spokane Valley, Washington with production planned to begin in 2018. International Beams, a manufacturer of I-Joists, is currently in the process of developing CLT production in their Dothan, Alabama facility—the first to use Southern Yellow Pine. Rather than using CLT as a building material, Sterling Lumber in Phoenix, Illinois, advertises CLT as a matting product. As shown in Figure 3, they use CLT to stabilize unstable or wet grounds at construction sites. With innovative uses across a variety of commercial and residential projects, mass timber will occupy a significant space in the construction industry.



Figure 2. CLT use in Brock Commons Tallwood House in Vancouver, BC (www.vancouver.housing.ubc.ca)
Source: Brudder, naturallywood.com.

Prospects in North Carolina

North Carolina has about 18.14 million acres of timberland, primarily dominated by hardwoods in terms of number of species, acres of timberland, and live standing tree inventory. Most of the wood and fiber resources available throughout the coastal plains and piedmont regions have been consumed by several sawmills, pulp and OSB mills, and recently pellet mills. While timber markets for softwood products, particularly pine species, have reportedly performed better compared to the South-wide average, recent timber market trends indicate that both hardwood saw log and pulpwood markets are down substantially in North Carolina. Given that hardwood resources are underutilized by the existing forest product industry, and low value wood can be used in mass timber production, raw material availability in the state could provide a huge opportunity for the mass timber industry. To date, not a single facility produces mass timber products in the southern United States, one of the largest wood basket regions in the world.

Key Challenges

- Update local building codes to recognize CLT
- Demystify seismic and fire performance of mass timber
- Introduce mass timber products to enrich the landscape of environmentally friendly building products
- Create a local supply and demand

In recent years, research has solved many issues associated with CLT. Still today, there are some noticeable barriers to the establishment and expansion of the CLT market in the United States (Mallo and Espinoza, 2015). The greatest barrier for CLT is reported to be its lack of availability in the marketplace.



Figure 3. Sterling Lumber CLT matting. Source: SterlingSolutions.com.

While CLT currently meets international building code requirements for residential, commercial, institutional, and industrial facilities, it must be adopted by U.S. state and local building codes to become a standard building material. CLT was approved by the American National Standards Institute in 2012 and incorporated in North American building codes in 2015 as a heavy timber element. Similarly, although CLT has excellent performance ratings against earthquake and fire, many consumers and construction professionals still fear that CLT buildings are at greater risk to seismic and fire hazards.

It appears that most of these barriers exist due to gaps in knowledge among market participants (Oregon BEST, 2017). Education covering the entire supply chain, including both supply-side (CLT manufacturers) and demand-side (construction sector), is needed to correct outdated misinformation and myths about mass timber products. Creating skilled labor and training architects, engineers, and developers is crucial as well.

Conclusion

The mass timber products industry, primarily led by CLT, is an emerging sector of the forest product industry. It comes with tremendous upside potential in both residential and non-residential construction in the United States. Having several environmental and economic advantages over traditional building materials, it has

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gained momentum in both demand and supply in the United States. While the southern timber markets are currently depressed primarily due to over-supply of raw materials, this new and eco-friendly forest product industry has a bright future prospect in the United States in the foreseeable future.

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