An Overview of Cross-Laminated Timber in North America

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University of Belgrade Faculty of Forestry

INCREASING THE USE OF WOOD IN THE GLOBAL BIO-ECONOMY



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Outline

- Overview-Mass Timber
- What is Cross-Laminated Timber (CLT)
- CLT uses and benefits
- Where is CLT being used internationally and in North America?
- Standards and testing
- Opportunities & limitations for adoption of CLT/MPP
- New U.S. South CLT/MPP Study
- Final observations

What is Mass Timber? Includes Existing Products

Glulam Beams



Parallel Strand Lumber (PSL)





Laminated Strand Lumber (LSL)





What is Mass Timber? Includes Existing Products

Laminated Veneer Lumber (LVL)







I-Joists



North American EWP Output Up

	2017	2016	%
	Total	Total	Increase
Glulam (mmbf)	291.6	280.0	4.1
I-joist (million linear feet)	788.0	730.1	7.9
LVL (million cubic feet)	80.2	71.0	13.0

Source: APA - The Engineered Wood Association

What is Mass Timber?

Dowel-Laminated Timber (DLT)



Photos: StructureCraft

Nail-Laminated Timber (NLT)







What is Mass Timber?

Newest on the scene in the U.S.

Mass Plywood Panels (MPP)

Cross-Laminated Timber (CLT)

Mass Plywood Panels (MPP)

- A veneer-based engineered wood product, MPP is a massive, large-scale plywood panel with maximum finished panel dimensions up to 12 ft. wide by 48 ft. long and up to 24 inches thick.
- The panels may be customized to fit specific projects; constructed in 1-inch thick increments that provide superior strength and performance.
- What sets it apart is the fact that it uses engineered veneer and custom plywood layups as a base material rather than lumber.

What is Cross-Laminated Timber (CLT)?

CLT consists of layers of dimension (2" thick) lumber (three, five, or seven) oriented at right angles to one another.

Some face and back laminae are 1" thick.

Then edge/face glued to form structural panels with exceptional strength, dimensional stability, and rigidity.

Can be finger-jointed to increase length.

CLT panels can be made in dimensions up to 10 feet wide and 40 feet long and more than 12 inches thick.

Softwood or hardwood.

What is Cross-Laminated Timber (CLT)?









What is Cross-Laminated Timber (CLT)?

 Some designers view CLT as both a standalone system and product that can be used together with other wood products; it can also be used in hybrid applications with steel or concrete.



Photos: Rich Vlosky

CLT Uses and Benefits Structural/Properties

- Strong enough to replace concrete and steel in multistory buildings.
- Lighter and more flexible than standard materials and can withstand stress from earthquakes or storms, say its proponents.
- It is also more fire resistant than many standard materials such as wallboard.
- Nontoxic and a good insulator.

CLT Uses and Benefits Business/Social/Environmental

- Lower install cost....prefabricated panels delivered to job site.
- Could create manufacturing jobs in struggling, rural timber towns.
- Revenue stream for forest thinning.
- New markets for forest landowners.
- Could help state/local governments create a revenue stream from the undersize trees that are culled.
- Reduces structure carbon footprint.
- Sequesters carbon.
- Less waste.

CLT Uses and Benefits

LIGHT WOOD-FRAME POST + BEAM

MASS TIMBER



- Build a story/3 days
- Build a house in a week

Global CLT Supply & Demand

- During 2009-2016, the global production of cross-laminated timber grew at a CAGR of around 16% with Europe accounting for most of this market (BusinessWire 2017).
- About 60 European plants manufacture the product.
- CLT production expanded globally from ~650,000 cubic meters in 2015 to a ~1.2 million cubic meters in 2017 (UN).
- Major producers include Austria, Germany, Czech Republic, Finland, Italy, Spain and Switzerland.
- CLT global market expected to be valued at \$2.07 billion by 2025 (Grand View Research 2017).
- Institutional and commercial segments are expected to collectively account for 46.9% of the global market in 2025 (Grand View Research 2017).
- In the United Kingdom alone, there are about 600 CLT buildings
- Australia/New Zealand Many buildings constructed **from PINE**

North American CLT Manufacturing



North American CLT Manufacturing

- Current epicenter for North American CLT/(MPP) is the Pacific Northwest & British Columbia, Canada.
- Oregon and Washington, have shown great interest in pursuing CLT manufacturing and utilization strategically to enhance local economies.
- Canada-based companies Structurlam and Nordic Structures have been producing locally sourced CLT panels since 2010 and remain the largest Canadian CLT manufacturers to date.

North American CLT Manufacturing & Applications

- The U.S. CLT manufacturing started later with SmartLAM in Montana being the first U.S. based CLT company (2012).
 - As an example of the growth potential, SmartLAM has grown to produce over 1 million board feet of CLT permonth, with plans to expand and build another production facility.
- Another example is the D.R. Johnson Lumber Co. In Riddle, OR began manufacturing CLT in 2015.
- NO CLT MANUFACTURING FACILITIES IN THE U.S. SOUTH USING SOUTHERN YELLOW PINE!!

Heard on the Street Regarding CLT in the South....





- Stadium Drive Residence Halls
- CLT Structures
- S-P-F from Austria



- International Beam
- New Mill, Converted GE Bldg.
- Dothan, Alabama
- Currently: Glulam Beams
- Equipment for CLT is on the way across the Atlantic.
- Will Use *Southern Pine*

CLT Standards

- CLT manufacturers in Europe adopted a proprietary approach for panel mechanical properties.
- The first performance-based CLT material standard for CLT in North America was developed through the collaboration of *APA-The Engineered Wood Association* and *FPInnovations*.
- The *PRG320 standard* was published in 2012 and recognized by American National Standards Institute (ANSI).
- The standard specifies a total of 7 CLT performance grades and the testing methods to quantify and determine the grades.
- PRG320 is referenced in the 2015 edition of the National Design Specifications (NDS) for Wood Construction in the U.S., and the 2014 edition of the Canadian National Standard for Engineering Design in Wood (CSAO86).
- North American CLT manufactures have been gradually adopting this standard.

www.rethinkwood.com

Cross Laminated Timber (CLT) Handbook | ReThink Wood

Stora Enso (Finland)







ANSI/APA PRG 320-2012





AMERICAN NATIONAL STANDARD

Standard for Performance-Rated Cross-Laminated Timber

Breaking News! Washington State adopted CLT standards for Tall Buildings (March 13, 2018)

CLT Testing-Fire

- Federal testing: (CLT) components used in a multi-story apartment building would perform well in the event of a fire.
- With roughly 30% of the CLT ceiling area in the living room and bedroom exposed, the fire essentially put itself out once the furnishings and contents of the room had been consumed by fire.
- The underlying wood was protected by a layer of char during the 4-hour test.
- 2-Hour Burn Test Success-Required for Tall Buildings.





CLT Testing-Seismic

- On the world's largest earthquake simulator, a 2-storey structure was tested against a 6.7 magnitude earthquake simulation, which is the same magnitude as the Northridge earthquake that rattled Southern California in 1994.
- "Today was a great success," Andre Barbosa, an engineer at Oregon State University said. "We just ran Northridge twice, back to back.
- It was actually 125 percent Northridge and the building performed very well with no indication of damage."



CLT Manufacturing

D.R. Johnson Lumber Co., Riddle, Oregon



Building with CLT-Connectors/Fasteners



Building with CLT-Connectors/Fasteners









Photos: Rich Vlosky

Building with CLT - Prefabrication









Photos: Rich Vlosky

Building with CLT - Prefabrication

Portland, Oregon Carbon12 (Kaiser Group, Inc. and PATH Architecture, Inc.)

- Each panel has an exact position.
- Pre-fabricated at the manufacturing facility.



Stephanie Yao Long, The Oregonian

CLT Construction-Roof Systems



Smartlam, 2017

CLT Construction-Wall Systems



Smartlam, 2017

CLT Construction-Elevator Shafts



Smartlam, 2017

CLT Construction- Even Single Family House





Photos: Rich Vlosky

Tall Buildings: Where Most of the Excitement is! TALLWOOD

- The TallWood Design Institute is the nation's only research collaborative that focuses exclusively on the advancement of structural wood products.
- It conducts the research needed for widespread adoption of mass timber building technology in the U.S.
- The Institute is a partnership between <u>Oregon State</u> <u>University</u> and the <u>University of Oregon</u>, bringing together the strengths of OSU's <u>College of Forestry</u> and <u>College of Engineering</u>, and the University of Oregon's <u>College of Design</u>.

CLT Construction-Tall Buildings

Portland, Oregon Carbon12 (Kaiser Group, Inc. and PATH Architecture, Inc.)

A boutique collection of 14 units; 85 feet tall







CLT Construction-Tall Buildings



- Brock Commons, an 18-story University of British Columbia residence hall that went up at a pace of a floor every three days.
- CLT flooring was used over glulam beams with a concrete core.
- Was permitted only as an exception to the B.C. Building Code and the acceptance was based in part on covering all the timber with fire-rated gypsum wallboard.

Photos: UBC Public Affairs

Mass Timber Buildings are Getting Taller





CLT Construction-Buildings

Approval of mass timber in Vancouver high-rise a first in North America

Terrace House, with its highest point sitting at 232 feet above ground level, has received official approval to use *exposed mass timber* in the top seven stories of this 19-story building.



Wood Business-January 5, 2018

Potential CLT Being Markets (in addition to Tall Buildings)

- 90% buildings U.S. less than 12 stories.
- In mid-rise gap of 6-12 stories, wood is very efficient.
- Market for CLT in modular structures, such as military housing or tiny home construction.

CLT Construction-Buildings

Candlewood Suites Huntsville, AL Constructed 37% faster 44% less person-hours to construct



Photo credit: Lend Lease

The "Fair-Haired Dumbbell" Tall Wood Building in Portland, Oregon









Photos: Rich Vlosky

Limitations for CLT/MPP Adoption

- Limited awareness of emerging timber technologies
- Limited legislative support from government
- Lack of experienced designers
- Lack of experienced builders
- Lack of experienced architects
- Lack of knowledge about building codes
- Lack of suppliers

Final Observations

- CLT manufacturers in North America have seen steady growth since the product was first introduced.
- This trend will be driven by developing building codes, product testing, creating markets, and increasing CLT manufacturing.
- CLT is on a "quietly exciting" upward trajectory in North America and globally.





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