



# Recent Developments within CLT and Mass Timber

*Northwest Construction Consumer Council (NWCCC)*

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# Overview

- **Mass Timber**
  - Classifications
  - Uses
- **Cross Laminated Timber (CLT) Manufacturing Overview**
  - Supply chain
  - Feedstock/Lam-stock
  - Process
- **Next Steps**
  - Species mix
  - Fire concerns
  - Resin development
  - Durability improvements

# Using wood in buildings

## Light Frame Construction



- Size
  - 2x's
    - EWP used too
- Application
  - Residential and light commercial



- Size
  - EWP
    - LVL, Parallam, Glulam
  - Timbers
  - **CLT, NLT, DLT, MPP**
- Application
  - Mid to high-rise, commercial

## Mass Timber



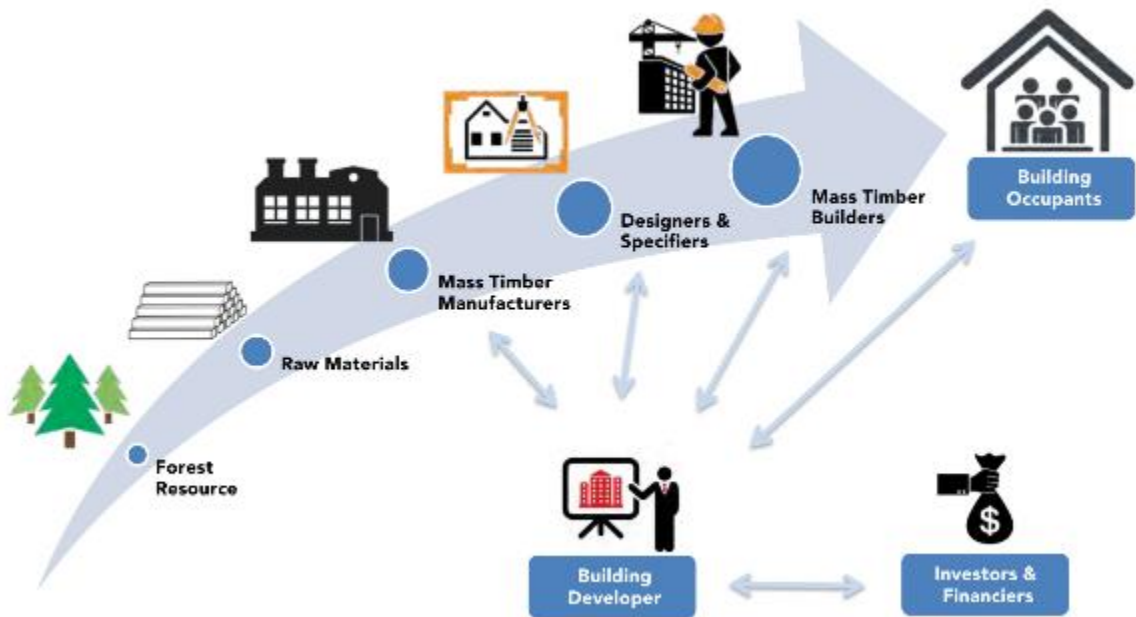
**Transition to  
Panel  
Assemblies**





# CLT Supply Chain

Where things change compared to wood and wood composites



More Design-  
Build  
Construction

# Mass Timber Panels

- Not just CLT
  - Nail Laminated Timber (NLT)
  - Dowel Laminated Timber (DLT)
  - Glue Laminated Timber (GLT)
- Mass Ply Panel (MPP)
  - Veneer based





# Not Just Structural - CLT Mats

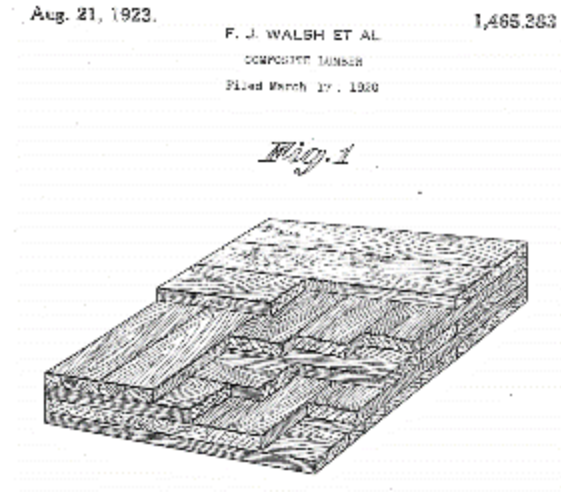
- Soil/ground sensitive areas
  - Traditionally NLT, but more CLT
  - Energy, logging, oil...
- CLT Mat Producers
  - Sterling®, Texas CLT®
    - Limited – Smartlam®, Structurlam®



# Cross Laminated Timber – The Origins

- Original Patent 1923 (WA)

- Cement and ¼" thick slats



- Europe

- Early adoption – 1990's

- US/NA

- 2010's

## Albina Yard (OR) -2016

- First building in US made from domestically-produced CLT.



# Current NA CLT Manufacturers

- Europe is leader
  - 2/3 of Global CLT volume
- Building Panel Classification
  - Architectural-grade
    - Wood exposed, aesthetics
  - Industrial-grade
    - Wood generally covered

COMPANY	LOCATION	STATUS	ESTIMATED MAXIMUM ANNUAL PRODUCTION CAPACITY OF OPERATING PLANTS (M3/YEAR)
binderholz	Live Oak, FL, US	Potential Plant Site	
binderholz	Enfield, NC, US	Potential Plant Site	
Boise Cascade	White City, OR	Operating	
OR Johnson	Riddle, OR, US	Idled	
Element5 #1	Ripon, QC, CA	Operating	
Element5 #2	St. Thomas, ON, CA	Operating	
Euclid	Heber City, UT, US	Small Scale - Operating	
Feres	Lyons, OR, US	Operating	
International Timberframes	Golden, BC, CA	Small Scale - Operating	
Kalesnikoff	South Slokan, BC, CA	Operating	
Mercer International	Spokane, WA, US	Operating	
Nordic Structures	Chibougamau, QC, CA	Operating	
Smartlam North America	Dothan, AL, US	Operating	
Smartlam North America	Columbia Falls, MT, US	Operating	
Sterling Lumber	Lufkin, TX, US	Operating	
Sterling Lumber	Phoenix, IL, US	Operating	
Stoltz Mass Timber	Columbia Falls, MT, US	Planned	
StructureCraft	Abbotsford, BC, CA	Operating	
Structurlam	Okanagan Falls, BC, CA	Operating	
Structurlam	Conway, AR, US	Operating	
Texas CLT	Magnolia, AR, US	Operating	
Timber Age	Durango, CO, US	Small Scale - Operating	
Vaagen Timbers	Colville, WA, US	Operating	
Total			1,767,500

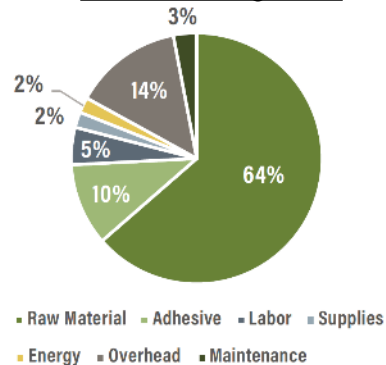


# The numbers.....

- Costs

- Unknowns
  - Estimating
    - Planning and Procurement
  - Insurance
- Trained workforce
- Material Perceptions
  - Fire, strength, etc..

Manufacturing costs



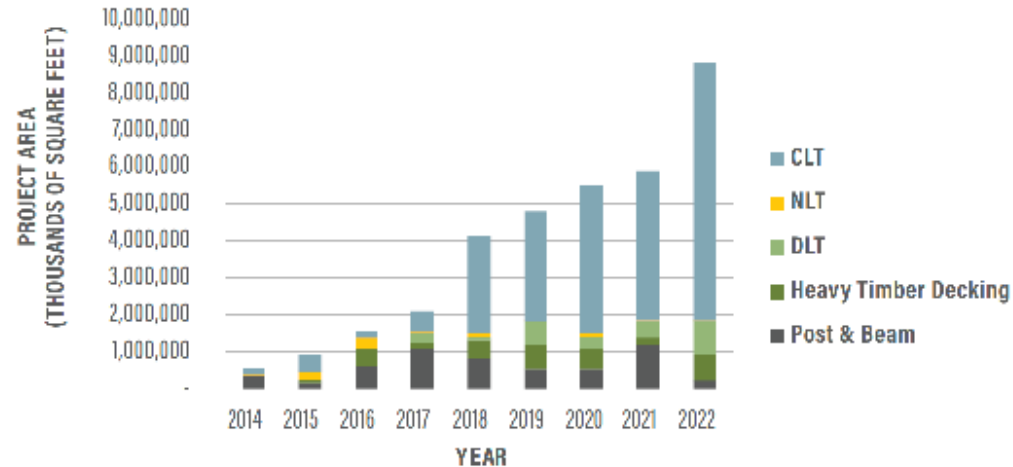
- Cost Savings?

- Lighter
  - Smaller cranes, design
- Faster
- Aesthetics
- C footprint

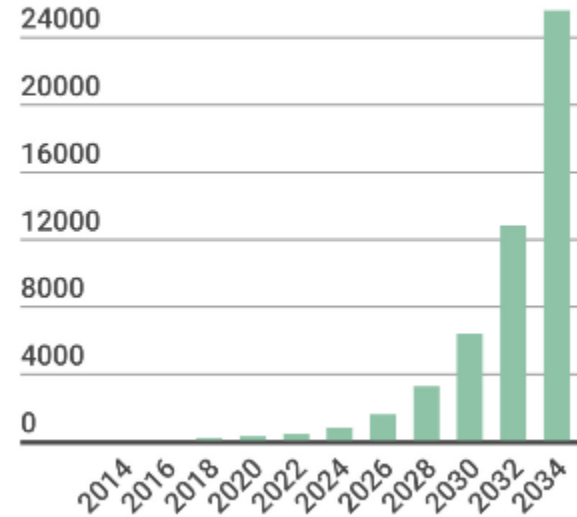


# CLT usage

- Future outlook



Data for North America  
Mass Timber Buildings Constructed Per Year



# Race to the top....

- High rise structures get the publicity
- Not much volume



[wsp.com/en-US/insights/tall-timber-how-high-can-clt-go](https://wsp.com/en-US/insights/tall-timber-how-high-can-clt-go)



[theb1m.com/video/top-5-the-world-s-tallest-timber-buildings](https://theb1m.com/video/top-5-the-world-s-tallest-timber-buildings)

## ...but midrise

- Much more volume and % utilized
  - More mid rise structure
  - More applications
  - More \$\$



fpinnovations.ca



aecom.com

Sweet spot for Mass Timber: 3-18 stories\*

# CLT Basics

- 90 deg orientation
- Flexible laminate stock width and thickness
  - Supply – around 1% of total NA dimensional lumber in US in 2019\*
- Laminates  $n=3-??$ 
  - Odd  $n$
- Pressed into panels



[vertuelab.org/fileadmin/media/Mass\\_Timber/](http://vertuelab.org/fileadmin/media/Mass_Timber/)



## CLT Process

- Lam Stock
  - Cut and conditioned (MC)
  - Graded
  - End finger-jointed
  - Planed to tight tolerance
- CLT fabrication
  - Oriented
  - Resin application
  - Layered to specified thickness
  - Pressed
    - Resin cured
  - Trimmed, cut, milled, and sanded



# Need for Finger Jointing

- CLT Panel length
  - Up to 60+'
  - Need continuous length
  - Allows use of shorts, offcuts



Kallesoe Machinery

# Research Areas for CLT

- Material
  - Species
    - Hardwoods, supply chain, mixed
  - Resins
  - Durability
    - Bio
    - Fire
- In-service
  - Performance
    - Seismic, durability
  - Design
    - Hybrid, fasteners



Sheling Pi, Colorado School of Mines

## 10-Story CLT Shake Test

- UCSD – summer 23



[woodworkingnetwork.com/video/earthquake-hit-10-story-mass-timber-structure-summer](https://woodworkingnetwork.com/video/earthquake-hit-10-story-mass-timber-structure-summer)



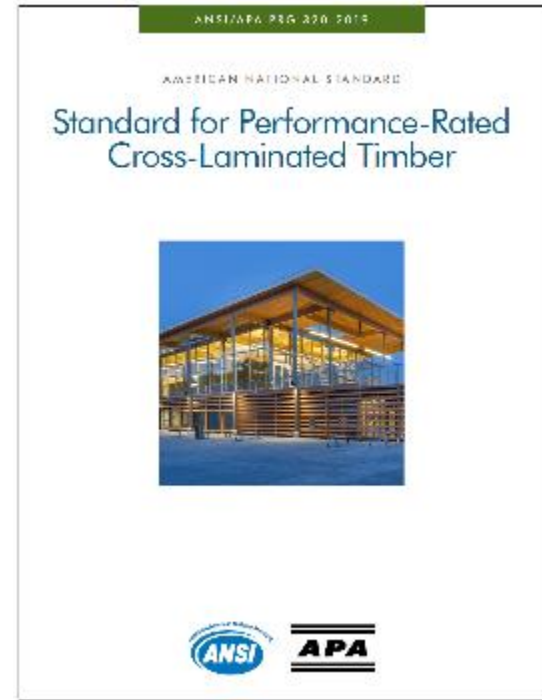
# Feedstock sources

- North America
  - All softwoods
    - SPF, DF/L, SYP
- Options now...
  - PP, GF, WH, other ALCS...
  - Lower properties
  - Defects
  - Processing and performance issues

COMPANY	WEBSITE	PANEL BRAND NAME	DESIGN GUIDE	PRODUCTS	SPECIES	PANEL TYPES	PANEL THICKNESS	MAX WIDTH	MAX LENGTH	ENVIRONMENTAL CERTIFICATION
Elements #1	<a href="https://elemenths.co/">https://elemenths.co/</a>	E5 CLT & E5 Nano CLT	Yes	CLT, GLT, BOX Panels, Nano CLT, CUPS, and NLT	SPF	A, I	3, 5, 7, and 9 ply (up to 15")	10.5' for visual grade and 11.48' for non-visual grade	52.5'	FSC
Freres	<a href="https://frereslumber.com/">https://frereslumber.com/</a>	MPP and MPL	Yes	Mass Plywood Panel, Mass Ply Lams, Plywood, Veneer	DF	A, I, M	up to 24"	11.83'	48'	American Tree Farm System
Kalesnikoff	<a href="https://www.kalesnikoff.com/">https://www.kalesnikoff.com/</a>	n/a	Yes	CLT, Glulam, GLT Panels, Japan Zebra, Lumber, Access Mats	SPF, DF-L, Hemlock	A, I, M	3 to 11 ply (2.00" to 15.10")	11.48'	60'	Sustainable forest certification available upon request
Nordic Structures	<a href="https://www.nordic.ca/en/home">https://www.nordic.ca/en/home</a>	X-Lam	Yes	CLT, Glulam, GLT Panels, I-joists	SPF (90% black spruce)	A, I	3, 5, 7, or 9 ply (3.5" up to 10.5")	8'	64'	FSC
Smartlam North America	<a href="https://www.smartlam.com/">https://www.smartlam.com/</a>	SmartShaft	Yes	CLT, Glulam, Elevator & Stairwell Shafts	DF-L, SPE, Hemlock, SYP**	A, I, M	3, 4, 5, 7, or 9 (4.13", 5.50", 6.88", 9.63", and 12.38")	***10', 11.25'	****51'	FSC, SFI
Sterling Solutions	<a href="https://www.sterlingsolutions.com/">https://www.sterlingsolutions.com/</a>	Terralam	Yes	CLT	SYP	A, I, M	3, 5, or 7 ply (4.125" to 9.625")	8'	18'	No
Structurecraft	<a href="https://structurecraft.com/">https://structurecraft.com/</a>	DowelLam - DLT	Yes	DLT	SPF, DF, Hemlock, Sitka Spruce, Western Red Cedar, Yellow Cedar	A, I	4" up to 12.25"	12'	60.5'	FSC, PEFC
Structurlam	<a href="https://www.structurlam.com/">https://www.structurlam.com/</a>	CrossLam CLT, GlulamPLUS	Yes	CLT, Glulam	*SPF, DF-L, SYP	A, I, M	3.43" to 12.42"	**10', 12'	***40', 62'	FSC, GreenGuard glue specification
Texas CLT	<a href="http://texasc.lt.com/">http://texasc.lt.com/</a>	n/a	Unknown	CLT	SYP	A, I, M	Unknown	Unknown	Unknown	Unknown
Vaagen Timbers	<a href="https://vaagentimbers.com/">https://vaagentimbers.com/</a>	n/a	Yes	CLT, Glulam, GLT	SPF, DF-L	A, I	4.13" to 9.63"	4'	60'	FSC
Vaagen Timbers	<a href="https://vaagentimbers.com/">https://vaagentimbers.com/</a>	n/a	Yes	CLT, GLT, GLT Panels	SPF, DF-L	A, I	4.13" to 9.63"	4'	60'	FSC

# Standards Limitations – Wood Species

- Limitations - PRG 320
  - Species
    - Recognized by ALSC or CLSAB
    - Minimum SG 0.35
  - Grades
    - $\parallel$  E -1.2Mpsi – No. 2 +
    - $\perp$  No. 3 +
  - MC –  $12\% \pm 3\%$
  - Dimensions
    - $\parallel$  Width  $> 1.75 \times t$
    - $5/8" < t < 2"$
  - Tolerances
    - $\pm 0.008$  " across width
    - $\pm 0.012$  " along length





# Species Mix ??

- You can make CLT from any species, but...
  - Supply chain, economics
  - Not a large volume
    - 1-2 % of dimensional stock
- Need for custom thickness
  - Not just 2x's
    - Beholden to stud market
- Mix for aesthetics
  - High grade surfaces



[americanhardwood.org/en/latest/blog/cross-laminated-collaboration](https://americanhardwood.org/en/latest/blog/cross-laminated-collaboration)

# CLT Resins

- Structural performance
  - ANSI 405
- Thermoset-based
  - Cross-linked, non-reversible
- Cold set
  - No heat or uv to cure
  - Cure times can be long
- Needs
  - Aesthetics
    - Clear glue line or not...
  - Fire
- Common Adhesives
  - Melamine urea formaldehyde (MUF)
    - 2 component, clear line, good fire
  - Para resorcinol formaldehyde (PRF)
    - 2 component, dark purple line, great for fire
  - Polyurethane (PU)
    - 1 component, clear line, better fire now

# Fire and Resin...

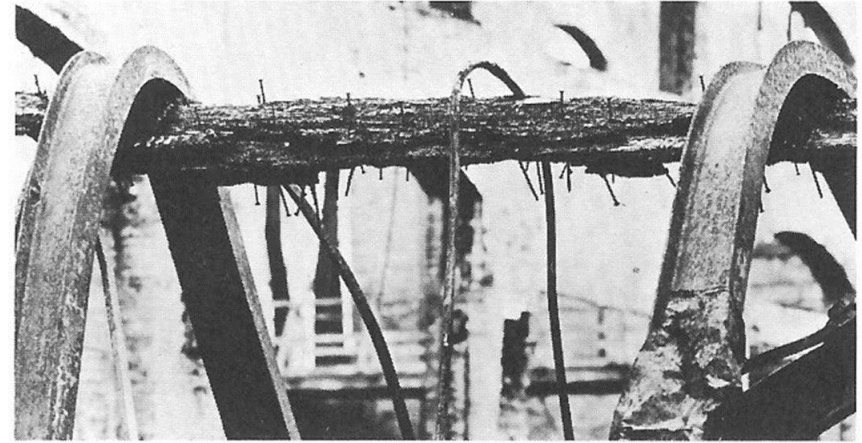
- Resin requirements
  - ANSI 405
  - Form char layer
    - Adhesive to act like wood
  - Not delam under heat
    - ASTM E119



Summary of Heat Resistant Adhesive (HRA) Approvals by ALSC Board of Review		
Method A Adhesives		
HRA Adhesive	Submitting Agency	Board of Review Action
Hexion Wonderbond MR-84 with Wonderbond M610LY (formerly Momentive MR84A with Momentive M610LY, formerly Hexion)	WWPA	Approved 7-23-07
Hexion Wonderbond MR-84 with Wonderbond M605LY (formerly Momentive MR84A with Momentive M605LY, formerly Hexion)	WWPA	Approved 7-23-07
Hexion Cascobel 4720 with Wonderbond 5025A (formerly Franklin Advantage 500 Prefere 4720 with Franklin Advantage Prefere 5025A)	WWPA	Approved 7-23-07
Hexion Cascophen AG-5675 with Cascoset FM-6310L (formerly Momentive PRF/AG-5675Q with Momentive FM6310L catalyst, formerly Hexion)	WWPA	Approved 7-23-07
Hexion Cascophen AG-5635 with Hexion Cascoset LQ-100 (formerly Momentive PRF/AG-5636Q with Momentive LQ100 catalyst, formerly Hexion)	WWPA	Approved 7-23-07
GP-4214 PRF with GP-4568 Hardener	TP	Approved 7-23-07
MOMENTIVE (formerly Hexion) Cascobel MF-3L with Wonderbond Hardener M-610LY	WWPA	Approved 11-1-07
PURBOND HB E032 (3074-3) Polyurethane	WWPA	Approved 7-24-08
Henkel TR4938/TR4937 EPI	WWPA	Approved 7-24-08
Hexion Wonderbond EPR-20 with Wonderbond M-318LY (formerly Momentive EPR-20 with Momentive M-318LY, formerly Hexion)	WWPA	Approved 11-6-08
PURBOND GT 20 (Resin) and PURBOND GT 205 (Catalyst)	WWPA	Approved 11-9-11
Franklin Adhesive Advantage EP-950A emulsion w/hardener 200 MDI (EPI)	WWPA	Approved 2-2-17
Hexion Cascophen LT-5210J with Cascoset FM-7400 Hardener	WWPA/ OLMA/ QFIC	Approved 2-1-18
Henkel Loctite UR 5180 (formerly Henkel Loctite UR5150NA)	CMSA	7-11-18 Approved 1-24-19
Henkel Loctite HBX032 Purbond	CMSA	11-21-19 Approved 4-9-20
Hexion Ecobind® 6500 and Wonderbond® Hardener M-700Y	WWPA	3-12-20 Approved 4-9-20

# Fire

- Perceptions and myths...
  - Wood burns
  - Large wood takes a while to burn
    - Retains properties
- Needs
  - Proper fire mitigation and management
  - Heat resistant resin



*Fig. 20-4. After fire scene. Shows a wood beam supporting twisted steel I-beams. (Forest Products Laboratory)*





# Bio-Durability

- New applications for wood in mass timber structures
  - Proper moisture management tools are lacking
- Needs
  - Proper design
    - Keep water away
  - Protection
    - Keep water from coming in
  - Treatment
    - Stop the onset
- WSU Research
  - USDA WI Grant #22-DG11062765-751
    - In-line use of borates in CLT processing
    - Nisus®, Mercer Mass Timber®





# CLT Research at WSU

- Pilot CLT line
  - Planer, resin application, 6x12' press
- Research areas
  - Processing
  - Durability
  - Hybrid
- <https://www.dropbox.com/s/pgs51sczfpptbd0/CLT%20Video%20-%20R4.mp4?dl=0>



# CLT Processing at WSU



# Questions????

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