



**WOODWORKS™**  
WOOD PRODUCTS COUNCIL



# Mass Timber Construction: Products, Performance and Design

**Momo Sun, PE, P.Eng.**

Regional Director

WoodWorks / Wood Products Council



T3 Minneapolis

Architect: MGA | Michael Green Architecture, DLR Group

Structural Engineer: Magnusson Klemencic Associates

Photo: Corey Gaffer courtesy Perkins + Will

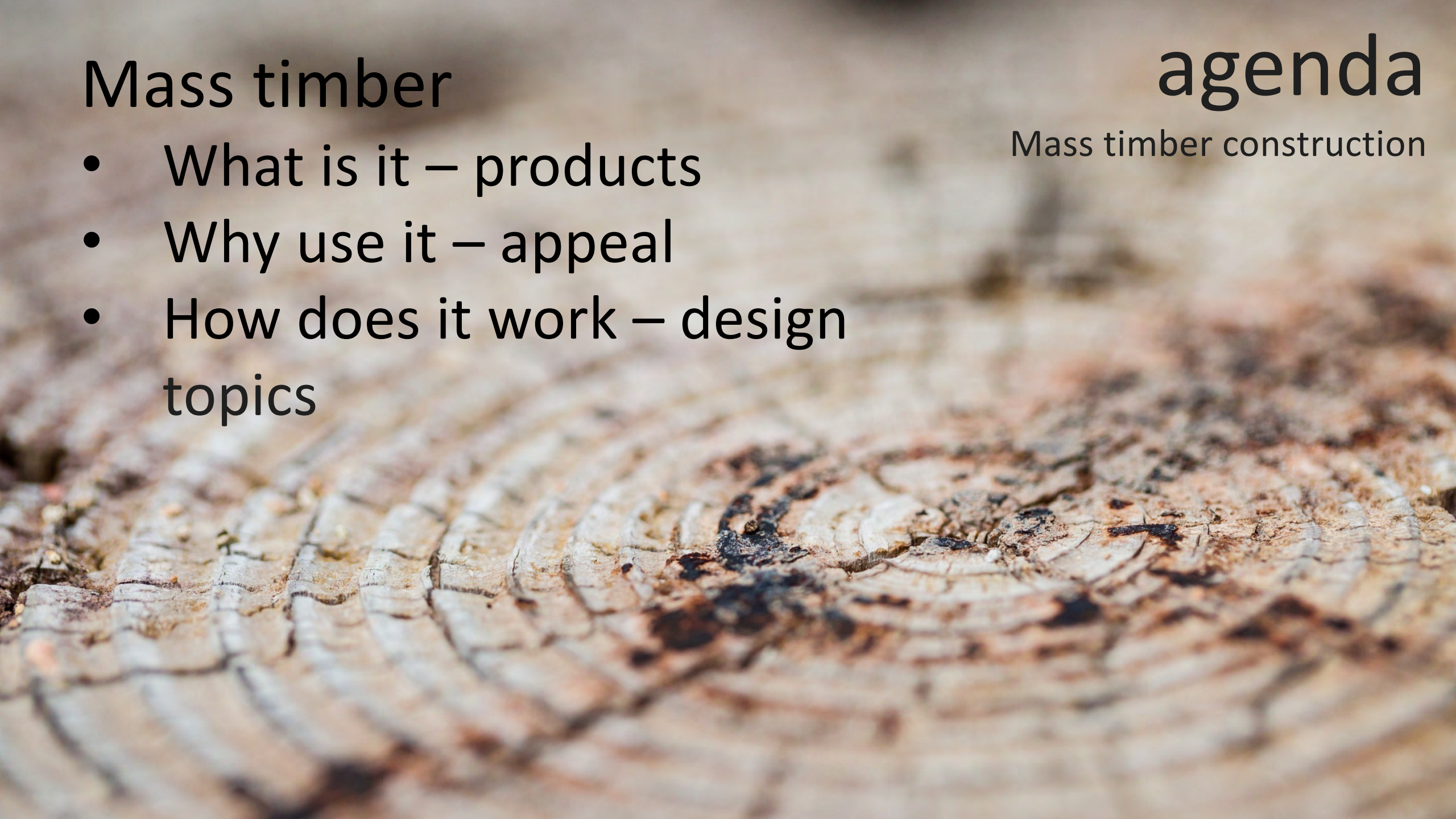


# Mass timber

- What is it – products
- Why use it – appeal
- How does it work – design topics

## agenda

Mass timber construction

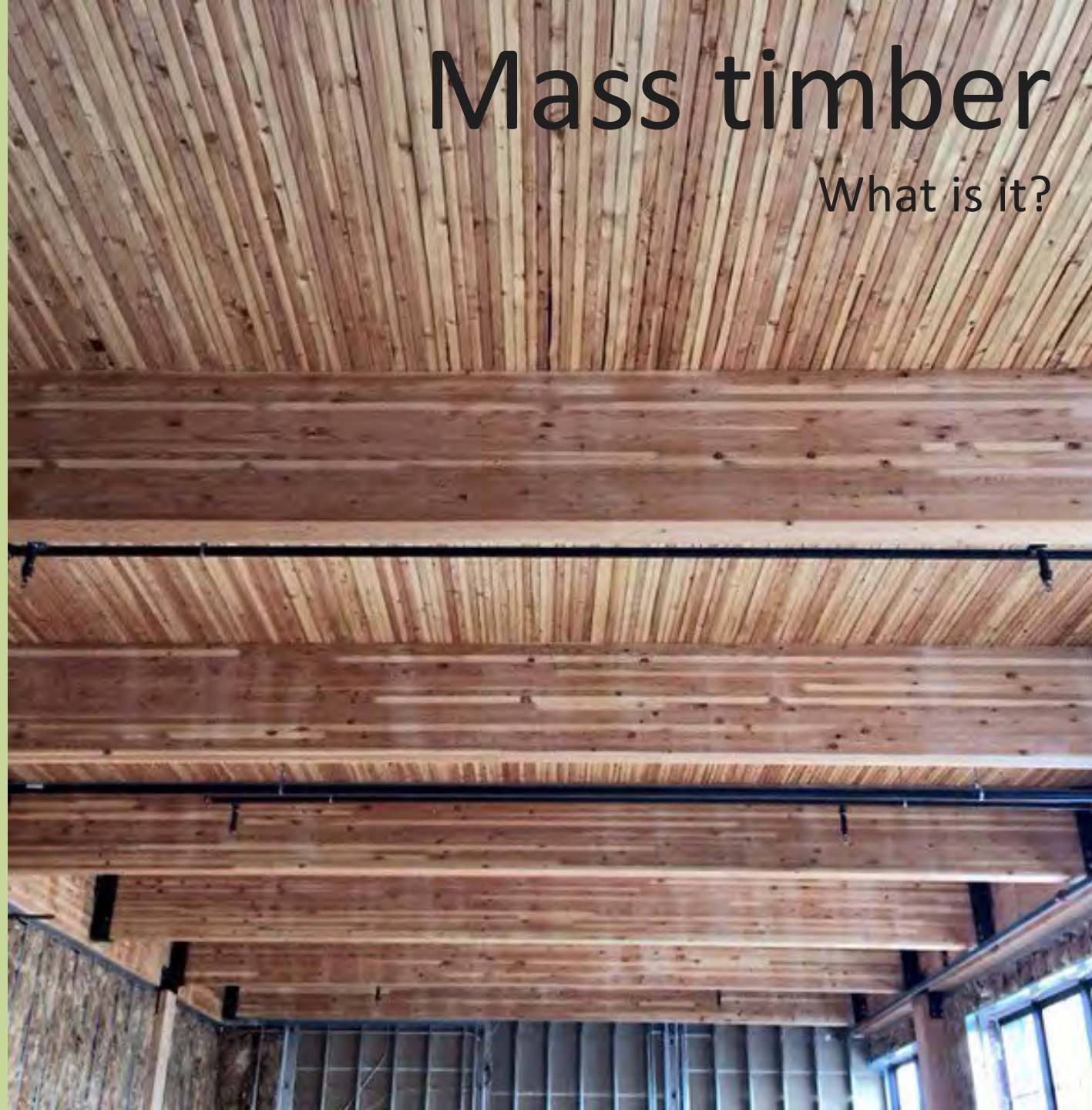




Mass timber is a category of framing styles often using small wood members formed into large panelized solid wood construction including CLT, NLT or glulam panels for floor, roof and wall framing

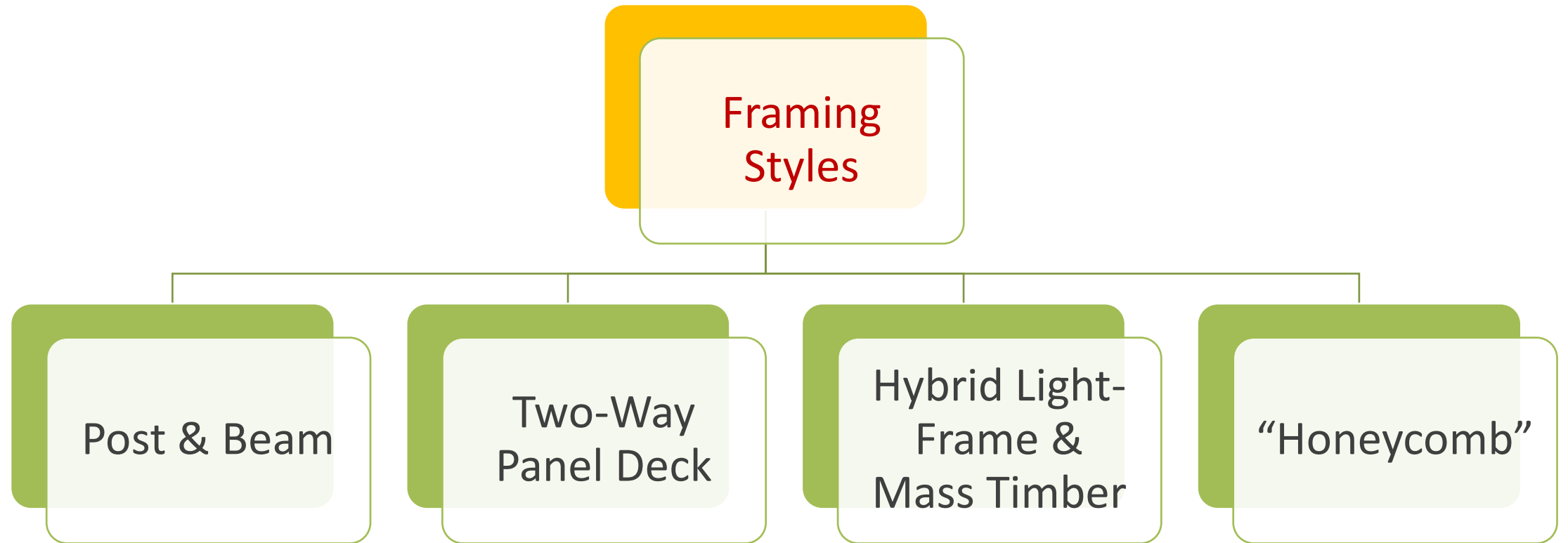
# Mass timber

What is it?



# Mass Timber Framing Systems

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# Post & Beam

The image shows a large, open-plan interior space with a prominent post-and-beam structural system. The ceiling is composed of light-colored wooden planks, and the walls are also made of wood. Several large, vertical wooden columns support the structure. A long, horizontal metal duct runs across the ceiling. Large windows on the left side provide a view of the city outside. The floor is a smooth, light-colored material, possibly concrete or polished wood. The overall atmosphere is bright and modern.

T3 Minneapolis  
Minneapolis, MN

Image Credit: Blaine Brownell





# Two-Way Panels



5 PLY CLT PANELS, 2-WAY SPAN  
~9'X13' GRID OF COLUMNS

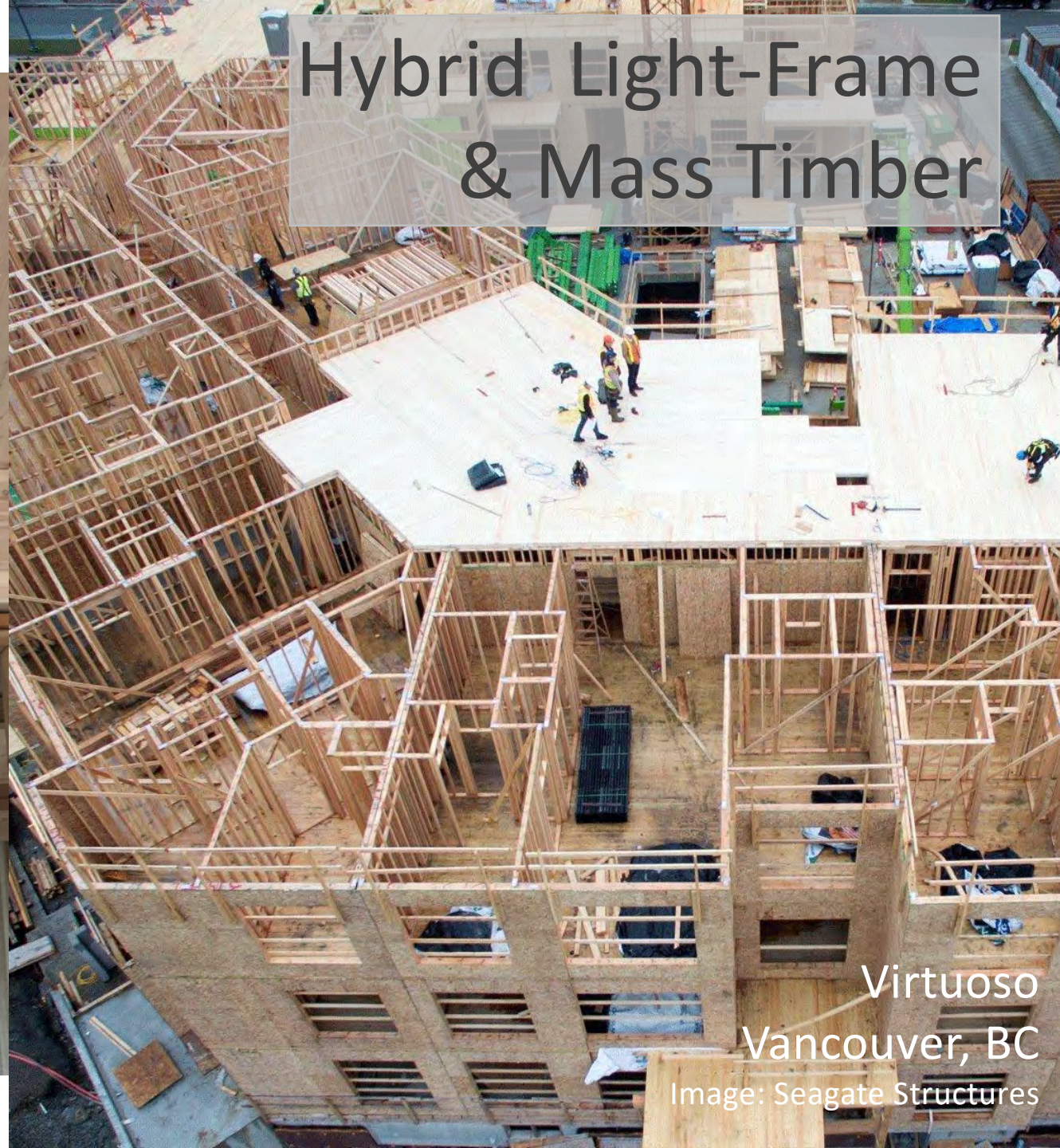
Brock Commons  
Vancouver, BC

Images: acton ostry architects





Carbon 12  
Portland, OR  
Image: WoodWorks



Hybrid Light-Frame  
& Mass Timber

Virtuoso  
Vancouver, BC  
Image: Seagate Structures



# HONEYCOMB

A construction site featuring a large, rectangular wooden formwork structure being hoisted by a yellow crane. Two construction workers, wearing hard hats and high-visibility vests, are positioned on the structure, likely guiding it into place. The structure is composed of light-colored wooden panels. In the background, a lush green hillside and a building are visible under a partly cloudy sky. A yellow crane arm is prominent in the foreground.

CANDLEWOOD SUITES  
REDSTONE ARESENAL,  
AL

Image Credit: Lend Lease

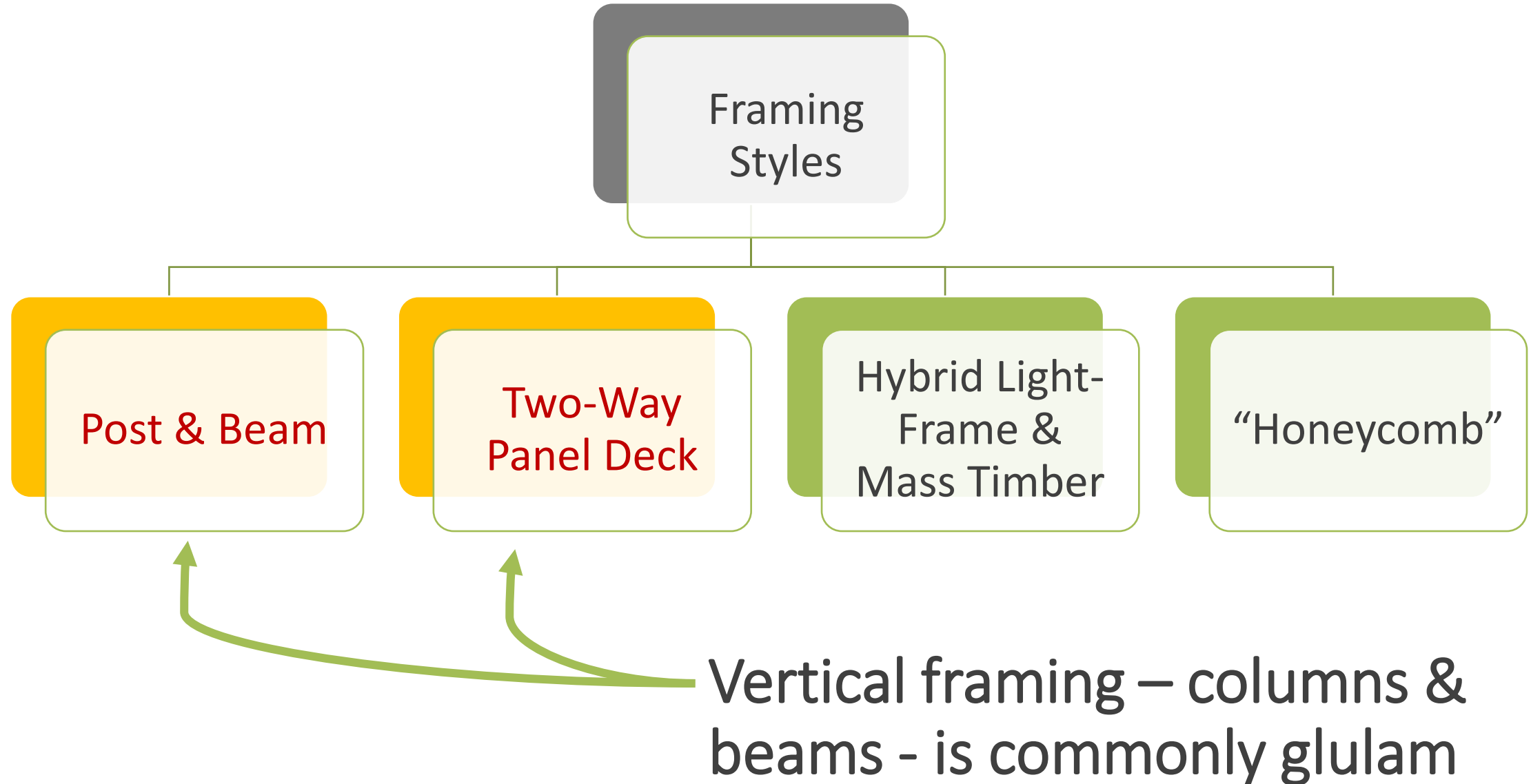


The image shows a large, open-plan interior space of a mass timber building. The ceiling is composed of large, light-colored wooden panels with exposed metal ductwork and piping. The walls are also made of wood, and there are large windows on the right side, providing a view of greenery outside. The floor is polished and reflects the light. In the background, there are desks, chairs, and a person standing near a desk. A large, dark, spherical object is visible in the center of the room. The overall atmosphere is modern and industrial, with a focus on natural materials.

**What's in a mass timber building?  
Products used**

# Mass Timber Framing Systems

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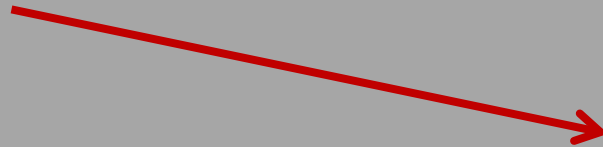
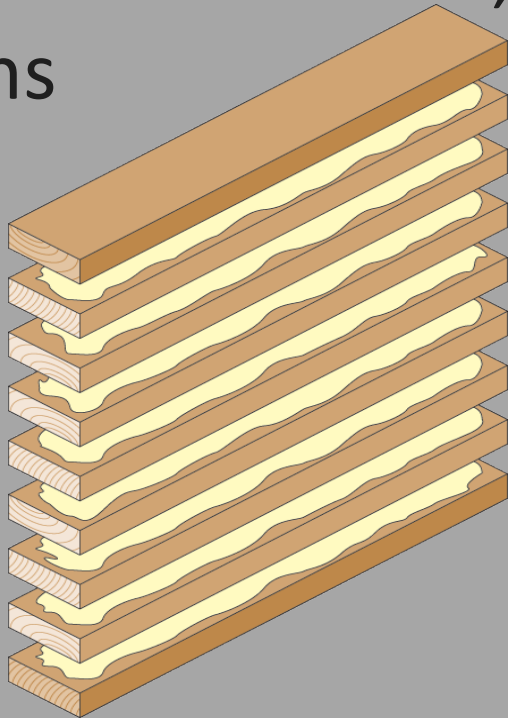


# Mass timber products

**Glulam** = a structural composite of lumber and adhesives

glulam

- Recognized in IBC 2303.1.3 using ANSI/AITC A 190.1 and ASTM D 3737
- Can be used for floor, roof purlins, beams, arches, columns





# Mass timber products

glulam specs:

Typical Widths:

3-1/8", 3-1/2", 5-1/8", 5-1/2", 6-3/4", 8-3/4",  
10-3/4", 12-1/4"

Typical Depths:

Increments per # of lams from 6" to 60"+  
western species lams are typically 1-1/2" thick

Southern pine lams are typically 1-3/8" thick

Typical Species:

Douglas-Fir, Southern Pine, Spruce

glulam

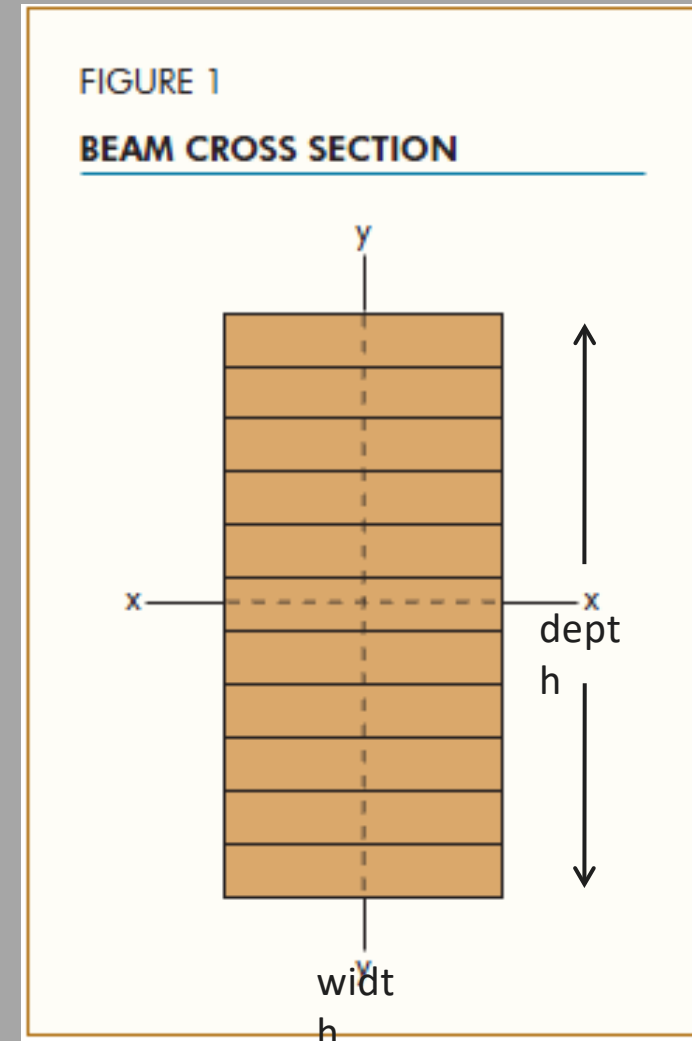


Image: APA Glulam Product Guide



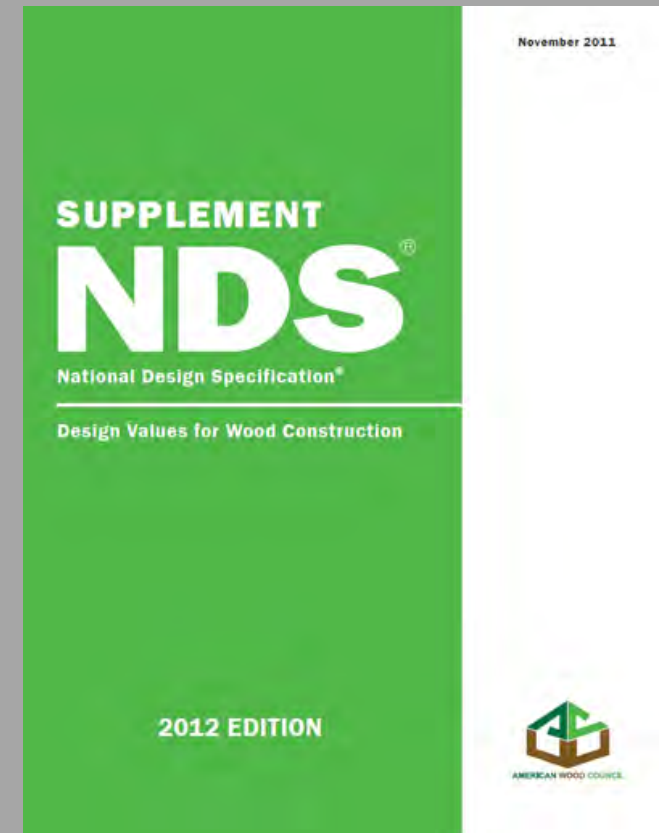
# Mass timber products

## Glulam design values

glulam

Combination Symbol	Species Outer/ Core	Bending About X-X Axis (Loaded Perpendicular to Wide Faces of Laminations)						
		Bending		Compression Perpendicular to Grain		Shear Parallel to Grain  $F_{vx}^{(2)}$ (psi)	Modulus of Elasticity	
		Bottom of Beam Stressed in Tension (Positive Bending)	Top of Beam Stressed in Tension (Negative Bending)	Tension Face	Compression Face		For Deflection Calculations	For Stability Calculations
		$F_{bx}^{+}$ (psi)	$F_{bx}^{-}$ (psi)	$F_{c \perp x}$ (psi)			$E_x$ ( $10^6$ psi)	$E_{x \min}$ ( $10^6$ psi)
		<b>24F-1.8E</b>		<b>2400</b>	<b>1450</b>	<b>650</b>		<b>265</b>
24F-V4	DF/DF	2400	1850	650	650	265	1.8	0.95
24F-V8	DF/DF	2400	2400	650	650	265	1.8	0.95
24F-E4	DF/DF	2400	1450	650	650	265	1.8	0.95
24F-E13	DF/DF	2400	2400	650	650	265	1.8	0.95
24F-E18	DF/DF	2400	2400	650	650	265	1.8	0.95
24F-V3	SP/SP	2400	2000	740	740	300	1.8	0.95
24F-V8	SP/SP	2400	2400	740	740	300	1.8	0.95
24F-E1	SP/SP	2400	1450	805	650	300	1.8	0.95
24F-E4	SP/SP	2400	2400	805	805	300	1.9	1.00

Source: nds supplement table 5a





# Mass timber products

glulam

## Glulam specs:

Pt readily available  
FRT may be available, varies by manufacturer & treater

Can be cambered, curved & tapered

Different  
Appearance Grades

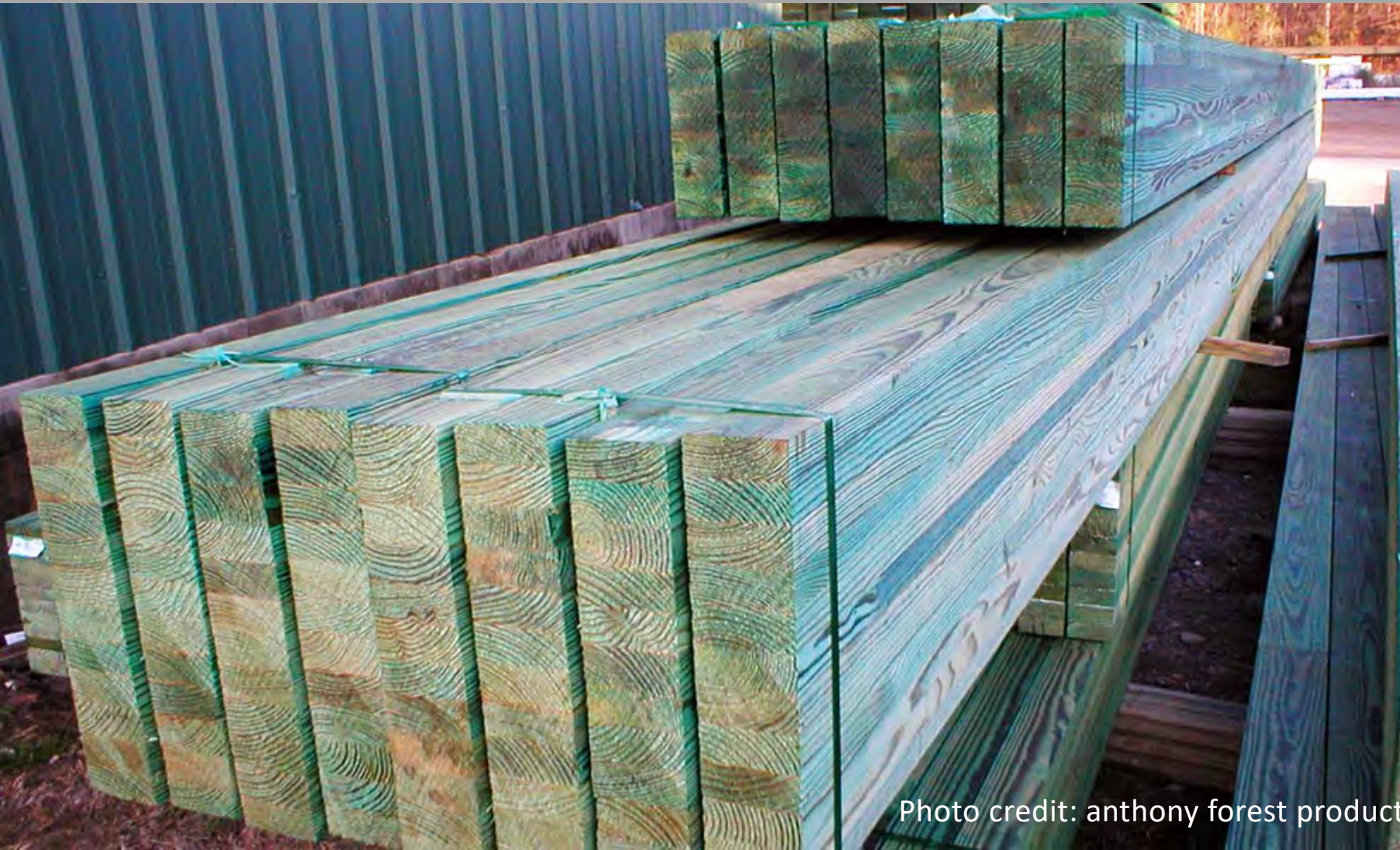


Photo credit: anthony forest products





WOOD, INNOVATION  
AND DESIGN CENTRE

- LECTURE THEATRE ↗
- GALLERY OF WOOD ←
- RESEARCH LAB →
- ELEVATOR ACCESS ↑
- EXIT TO 35th AVE ←
- LECTURE THEATRE ↙

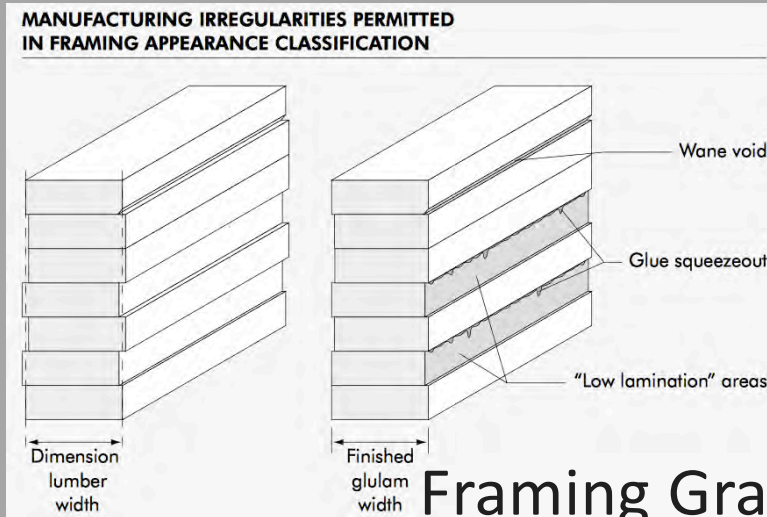
wheelchair icon →

Photo: Ema Peter Photography



# Mass timber products

glulam



Framing Grade

Glulam  
appearan  
ce grades



Images: American Laminators



# Mass timber products

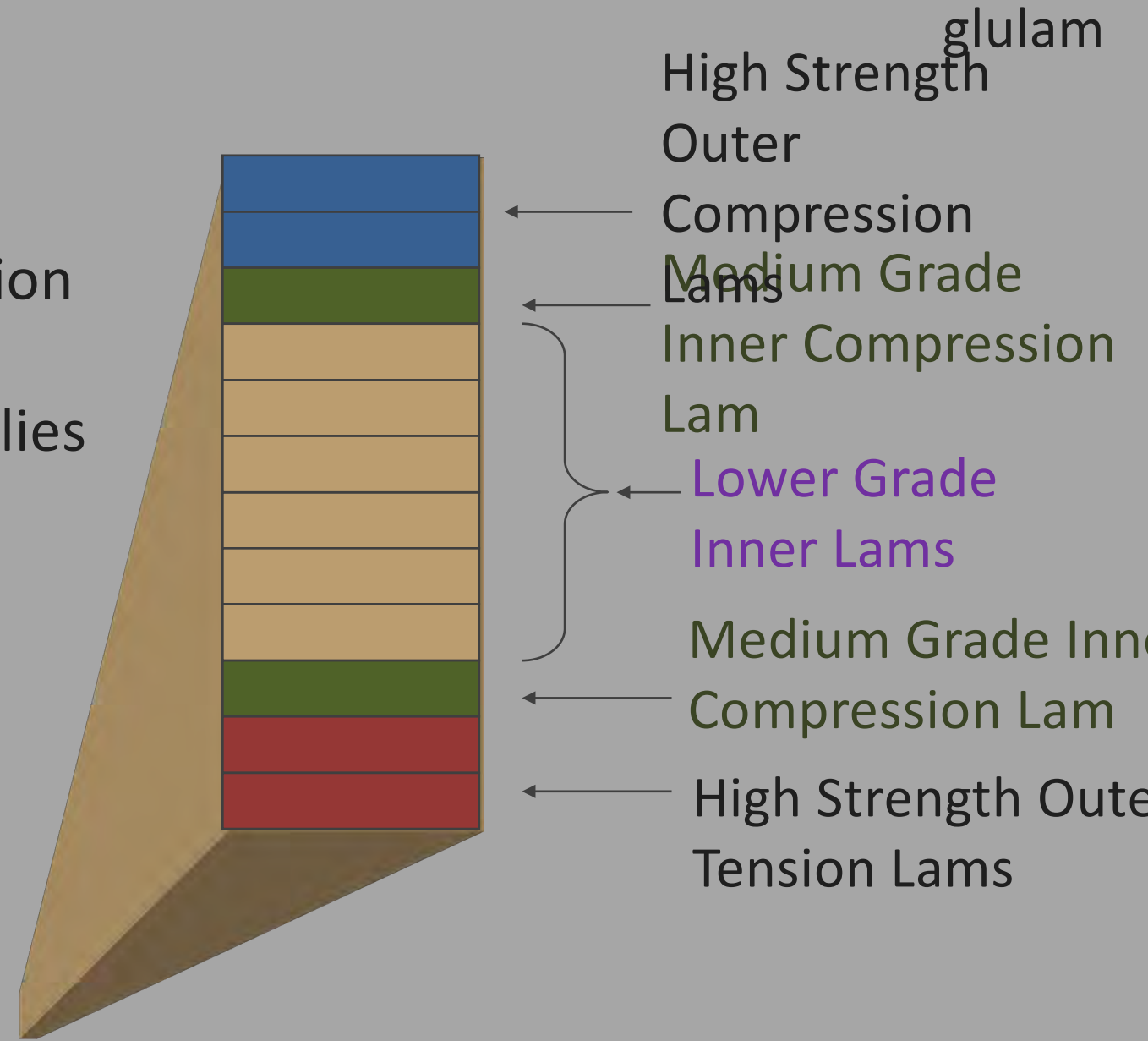
## Glulam layup:

Vary strength of laminations

- Higher strength lams at top and bottom - tension and compression stresses are high
- Lower strength lams in center plies



Image: Apa



# Flexibility of spans and shapes

The image shows the interior of the Richmond Olympic Oval, a large indoor sports arena. The most striking feature is the ceiling, which is composed of a series of long, curved, yellowish-brown structural ribs that converge towards the center. These ribs are supported by a network of smaller, lighter-colored beams. The ceiling is covered in a dense pattern of small, circular, recessed lights that create a warm, golden glow. Below the ceiling, the arena floor is a polished, light-colored material that reflects the ceiling and the surrounding environment. In the background, a large glass wall allows natural light to enter the space. The overall impression is one of a vast, open, and architecturally innovative interior space.

Richmond Olympic Oval, Richmond, BC, Canada  
Design Team: Cannon Design Architecture, Fast + Epp, Glotman  
Simpson  
Photo Credit: Stephanie Tracey, Craig Carmichael, Jon Pesochin, KK  
Law Creative, Ziggy Welsch



104' Span Glulam  
Arches  
Glulam purlins @ 4' o.c.



Lemay America auto museum  
Photo Credit: western wood structures



# First Tech Credit Union

Hillsboro, OR



5 stories  
156,000 sf



ARCHITECT: HACKER  
IMAGE CREDIT: StructurLam



# First Tech Credit Union

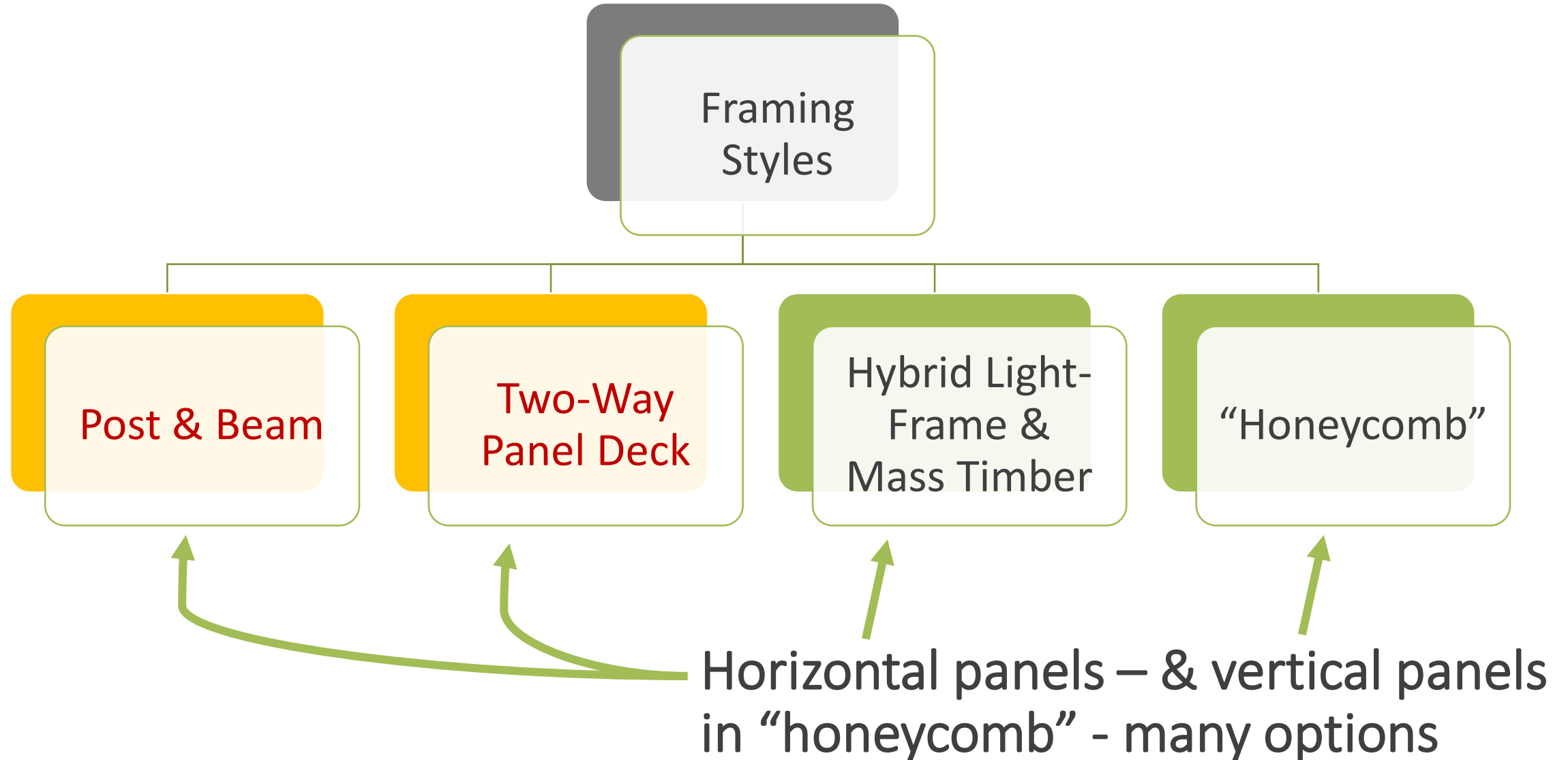
Hillsboro, OR



ARCHITECT: HACKER  
IMAGE CREDIT: StructurLam

# Mass Timber Framing Systems

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Glue Laminated Timber  
GLT



Laminated Veneer Lumber  
LVL



Parallel Strand Lumber  
PSL



Laminated Strand Lumber  
LSL



Cross Laminated Timber  
CLT



Nail Laminated Timber  
NLT



Timber-Concrete Composite  
TCC



**DLT** Dowel Laminated Timber



**MPP** Mass Plywood Panel

## Mass Timber Products

Photo credit: StructureCraft Builders/Freres Lumber

# Nail Laminated Timber

Photo credit: structurecraft  
Builders



# Mass timber products

## What is it?

Nail-laminated timber (NLT) is mechanically laminated to create a solid timber panel. NLT is created by placing dimension lumber (nominal 2x, 3x, or 4x thickness and 4 in. to 12 in. width) on edge and fastening the individual laminations together with nails.

Nail-laminated timber (NLT) panels

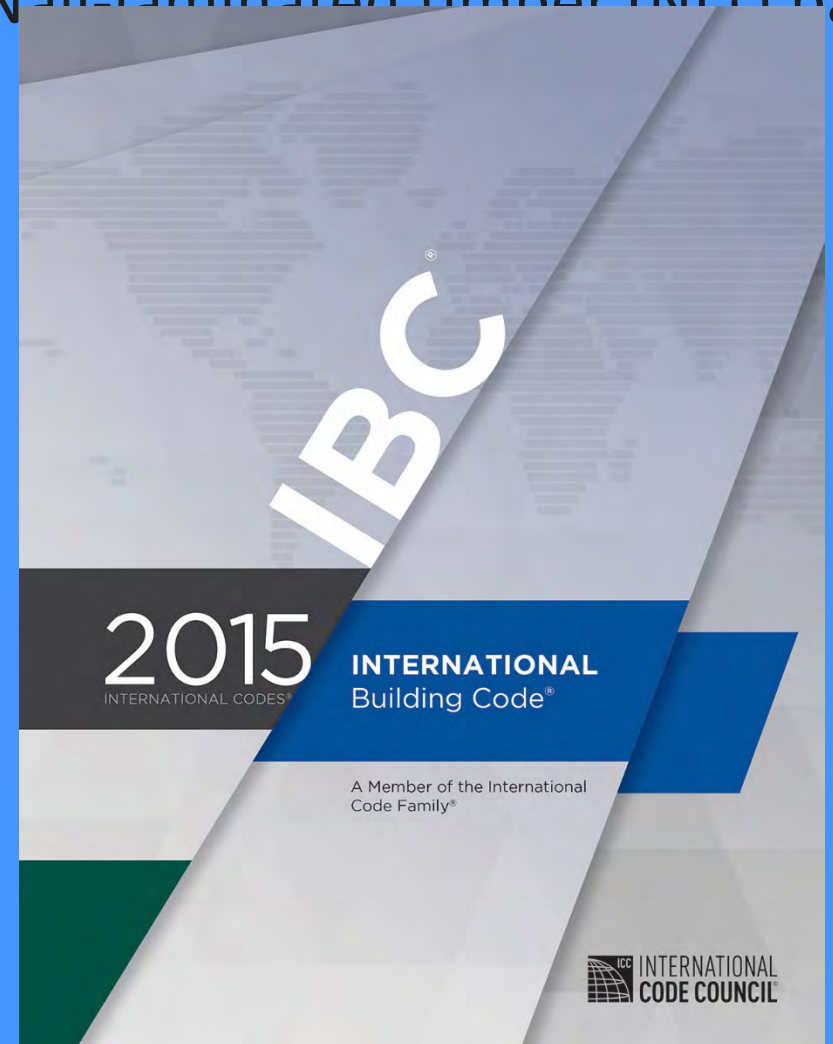
# Mass timber products

Nail-laminated timber (NLT) panels

**When does the code allow it to be used?**

IBC defines NLT as mechanically laminated decking per IBC 2304.9.3

Permitted anywhere that combustible materials and heavy timber are allowed, plus more





# Mass timber products

## When is it used?

NLT is typically used for floor and roof panels.

Plywood/OSB added to one face can provide in-plane shear capacity, allowing the product to be used as a diaphragm. Can also be used for walls, shafts.



Photo credit: structurecraft  
Builders



# Mass timber products

Nail-laminated timber (NLT) panels

often exposed on underside  
Structure is finish





# Mass timber products

Content includes:

Nail-laminated timber (NLT) panels

- Architecture
- Fire
- Structure
- Enclosure
- Supply and Fabrication
- Construction and Installation
- Erection engineering

Free download at

[www.thinkwood.com/nltguide](http://www.thinkwood.com/nltguide)

# Mass timber products

Nail-laminated timber (NLT) panels  
Nlt panels can be built on-site/in-place or pre-fabricated offsite



Photo Credit: john stamets



Photo Credit: structurecraft Builders



# t3 minneapolis

Minneapolis, mn



Photo Credit: Blaine Brownell



# t3 minneapolis

Minneapolis, mn

Type IV Construction  
7 stories (6 Timber on 1 Concrete)  
234,000 sf  
2x8 NLT Floor Panels w/3" Concrete Topping  
Glulam Beam and Column Frame  
20'x25' Grid

Image Credit: StructureCraft Builders



# t3 minneapolis

Minneapolis, mn







Image Credit: Field Condition/Flank



# 320 & 360 Wythe Ave.

New York, NY

3 story & 5 story buildings  
Mostly office, some  
apartments  
NIT & Glulam

FC



# 320 & 360 Wythe Ave.

New York, NY



# Mass timber products

Dowel-Laminated Timber (DLT)



Photo credit: StructureCraft  
Builders



# Mass timber products

Dowel-laminated timber (DLT) panels

DLT:

- Similar to NLT – Nails

Connecting Lams  
replaced with  
hardwood dowels

- Common in Europe – often referred to as Brettstapel
- Not currently recognized as prescriptively permitted material in IBC
- Timber Framers Guild



Photo credit: StructureCraft  
Builders

# Mass timber products

## Dowel Laminated Timber

Dowel-laminated timber (DLT) panels

The All Wood Panel

Mass Timber Design Guide

DLT: Similar to NLT – But lams are usually finger jointed in DLT so joint layups not a concern

credit: Structurecraft Builders



# Mass timber products

## Various profile options

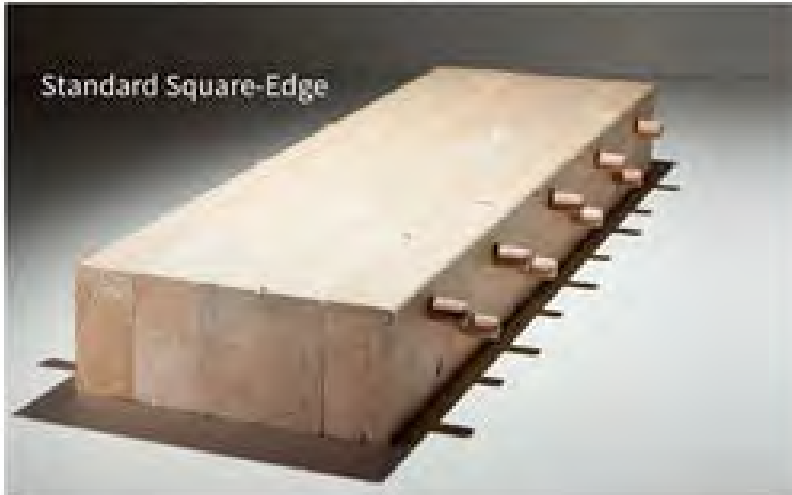


Photo credit: StructureCraft  
Builders

# 111 East Grand

Des Moines, IA



Credit: Nuemann Monson  
Architects courtesy: Ryan  
Companies

NEUMANN MONSON ARCHITECTS



# 111 East Grand

Des Moines, IA



Credit: StructureCraft Builders

4 story, 66,800 SF Spec office  
building







# Mass timber products

Glue-laminated timber (glT) panels

Photo credit: Structure Fusion

Photo credit: unalam



# Mass timber products

Glue-laminated timber (gLt) panels



## Glulam decking:

- Similar to deep glulam beams laid on their side
- Same code references and manufacturing standards as glulam beams and columns
- Be careful of design stresses and layups used – spec uniform layup (all lams same species & grade)



Image source: structurecraft  
Builders

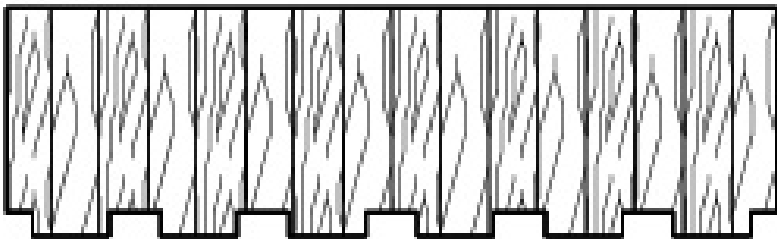


# Mass timber products

Same shrinkage and diaphragm considerations as nlt:

- Gap panels to allow movement
- Cover with wood structural panel for diaphragm
- Available in variety of

Fluted



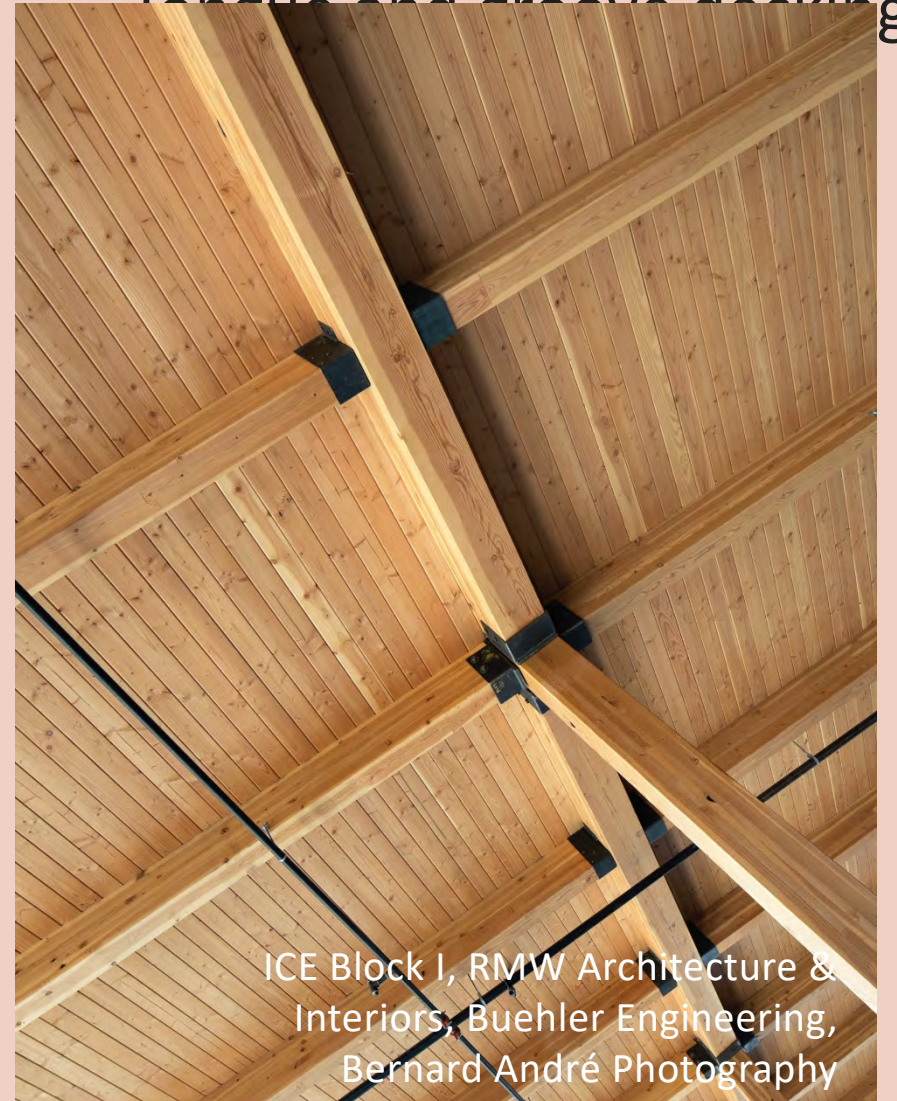


# Mass timber products

## Tongue and groove decking:

2x, 3x or 4x solid or laminated wood decking laid flat with interlocking tongue and groove on narrow (side) face

- Recognized in IBC 2304.8 (lumber decking)
- 2x usually has a single t&G; 3x and 4x usually have a double t&g
- 6" and 8" are common widths



ICE Block I, RMW Architecture &  
Interiors, Buehler Engineering,  
Bernard André Photography



# Ice block I

Sacramento, CA

ICE Block I, RMW Architecture &  
Interiors, Buehler Engineering, Bernard  
André Photography







Photo Credit: RMW Architecture

135,000 sf of retail and restaurant space  
Glulam frame, 3x T&G Decking



Ice block I  
Sacramento, CA

ICE Block I, RMW Architecture &  
Interiors, Buehler Engineering,  
Bernard André Photography



# Mass timber products

Cross-laminated timber (cLT)



# Mass timber products

Cross-laminated timber (cLT)

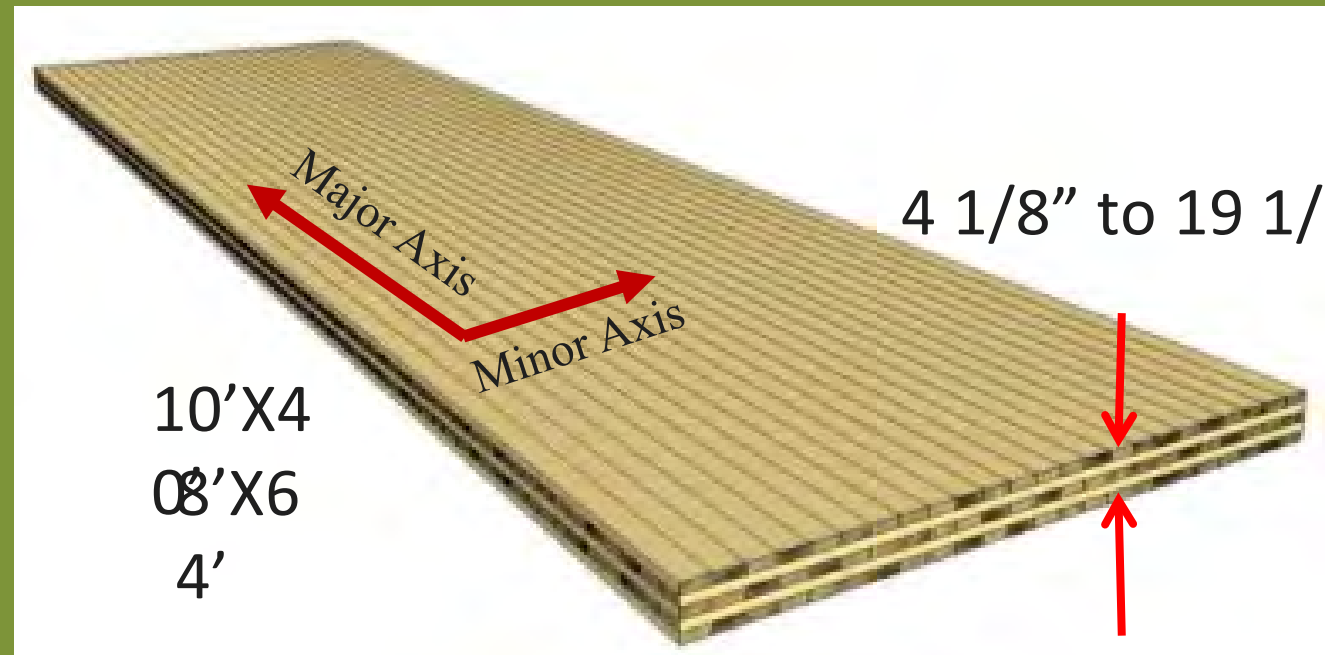
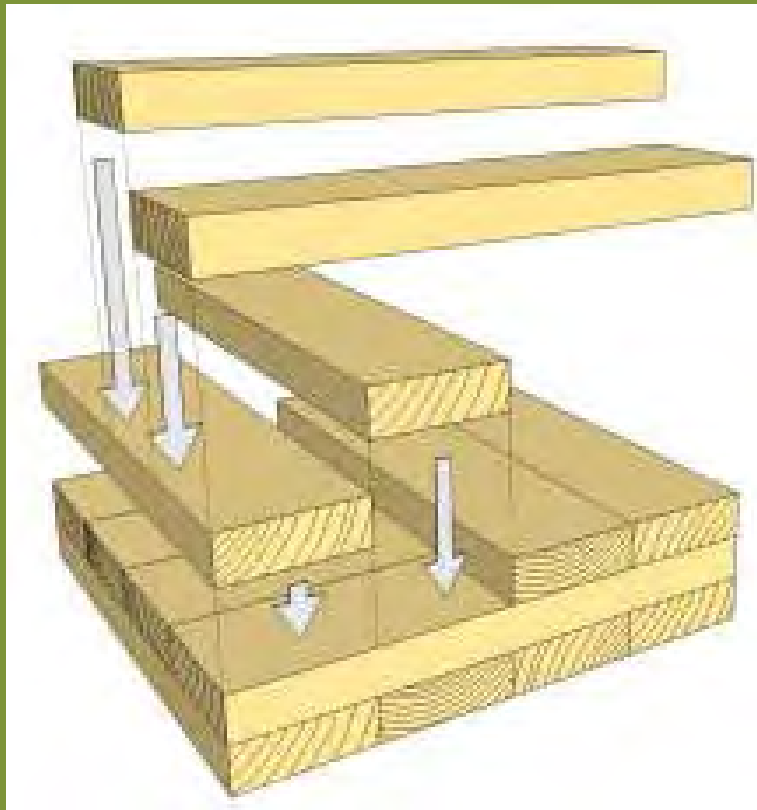
What is clt?

Solid wood panel

3 layers min. of solid sawn lams

90 deg. cross-lams

Similar to plywood sheathing





# Mass timber products

## Common clt layups

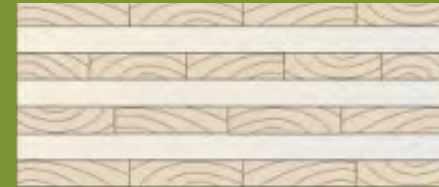
3-ply 3-layer



5-ply 5-layer



7-ply 7-layer



9-ply 9-layer



Cross-laminated timber (cLT)

7-ply 5-  
layer



9-ply 7-  
layer





# Mass timber products

Cross-laminated timber (cLT)

## CLT prefabrication

- Finished panels are planed, sanded, cut to size. Then openings are cut with precise CNC routers.
- Third party inspection at factory
- Custom engineered for material efficiency
- Custom designed for project
- Each panel numbered, delivered & installed in predetermined sequence





# ALBINA YARD

PORTLAND, OR



4 stories  
16,000 sf  
Green Roof



ARCHITECT: Lever Architecture  
IMAGE CREDIT: Lever Architecture



# Candlewood suites

Redstone arsenal, al



Image Credit: IHG® Army Hotels,  
Lendlease



# Candlewood suites

Redstone arsenal, al



Image Credit: Lend Lease & schaefer

# Candlewood suites

Redstone arsenal, al



Credit: Lend Lease & schaefer

- 62,600 sf, 4 story hotel, 92 private rooms
- CLT utilized for walls, roof panels, and floor panels
- 1,557 CLT Panels; Typical floor panel is 8'x50' & weighs 8,000 lbs
- Completed Late 2015

CASE STUDY

CANDLEWOOD SUITES®

## Construction Advantages Sell Hotel Developer on CLT

CLT builds faster and more safely with fewer workers

A photograph showing a construction site where large, rectangular, light-colored wooden panels (CLT) are being used for walls and floors. Several construction workers in safety gear are visible on the site. The panels are being hoisted by a crane, and the structure is under construction.

WoodWorks™  
WOOD PRODUCTS COUNCIL



PAL Portfolio	Typical New PAL Hotel (Actual*)	Redstone Arsenal (Actual)	Difference
Gross square feet (sf)	54,891	62,688	+14%
Average # of employees	18 (peak 26)	10 (peak 11)	-43%
Structural duration (days)	123	78	-37%
Structural person hours	14,735	8,203	-44%
Structural production rate/day	460 sf	803 sf	+75%
Overall schedule	15 months	12 months	-20%

\* PAL New Build Hotel Historical Average  
Source: Lendlease

Savings on this CLT  
project compared to  
typical light gauge steel  
construction

Candlewood Suites at Redstone Arsenal, AL  
4 Stories, 62k SF

43%

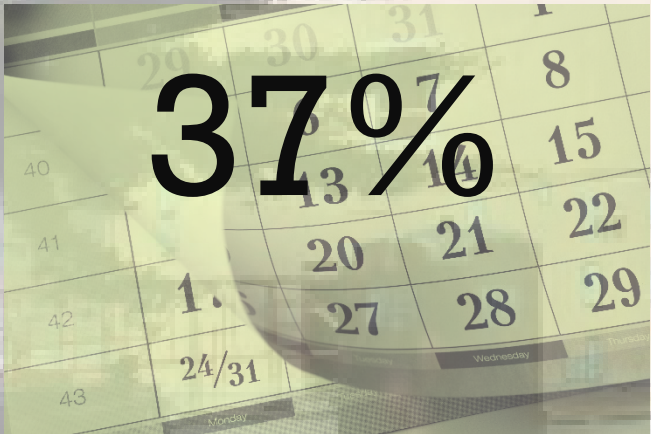


Image: Lendlease | Source: Lendlease<sup>2</sup>

# Mass timber products

Cross-laminated timber (clt)

In 2015 IBC, CLT is now defined in Chapter 2

Definitions:

**[BS] CROSS-LAMINATED TIMBER.** A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

and is referenced in Chapter 23:

**2303.1.4 Structural glued cross-laminated timber.** Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.





# LT product Reports

# Mass timber products

Cross-laminated timber (clt)

## INTERTEK DIRECTORY OF BUILDING PRODUCTS

KLH Massivholz GmbH - Massivholzplatten (solid wood slabs)  
CLT

KLH-Mas  
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lumber b  
a maxim  
½ in. (2.7

MATERI  
Test Stai  
ANSI/AF

For Use  
Grade

CV3M1  
Tabulate  
adjustme  
section p

For Use

Grade  
CV3M1  
Tabulate  
adjustme  
section p



### Structurlam CrossLam Structurlam Products LP

**PR-L314**

Revised May 9, 2016

Products: Stru  
Structurlam Pro  
2176 Governm  
Penticton, Britis  
(250) 492-8912  
[www.structurlam.com](http://www.structurlam.com)



### Nordic X-Lam Nordic Structures

**PR-L306**

Revised March 26, 2016

Products: Nordic X-Lam  
Nordic Structures  
1100 Avenue des Canadiens-de-Montreal, Suite 504  
Montreal, Quebec, Canada H3B 2S2  
(514) 871-8526  
[www.nordic.ca](http://www.nordic.ca)

1. Basis of th  
  - 2015 In  
Lamina
  - 2012 ar
  - 2015 In  
Cross-L
  - 2012 ar
  - ANSI/A  
Timber
  - FPinno  
other q
2. Product de  
Structurlam  
(SPF) lum  
approved l  
of enginee  
Structurlam  
used in flo  
120 inches
3. Design prt  
Structurlam  
or with the  
[www.structurlam.com](http://www.structurlam.com)

1. Basis of the product report:
  - 2015 International Building Code (IBC): Section 2303.1.4 Structural Glued Cross-Laminated Timber
  - 2012 and 2009 IBC: Section 104.11 Alternative materials
  - 2015 International Residential Code (IRC): Sections R502.1.6, R602.1.6, and R802.1.6 Cross-Laminated Timber
  - 2012 and 2009 IRC: Section R104.11 Alternative materials
  - ANSI/APA PRG 320-2012 and PRG 320-2011 Performance Rated Cross-Laminated Timber
  - FPinnovations Reports 201002775, 201004981, and 301010401, HPVA Report T-14054R, and other qualification data
2. Product description:  
Nordic X-Lam cross-laminated timber (CLT) is manufactured with spruce-pine-fir in accordance with the E1 or custom grades of ANSI/APA PRG 320 through product



### SmartLam Cross-Laminated Timber SmartLam, LLC

**PR-L319**

Issued August 15, 2016

Products: Sma  
SmartLam, LLC  
1863 13<sup>th</sup> Stree  
Columbia Falls  
(406) 862-0098  
[www.smartlam.com](http://www.smartlam.com)



### DRJ Cross-Laminated Timber Riddle Laminators, Inc.

**PR-L320**

Issued January 25, 2017

1. Basis of th  
  - 2015 In  
Lamine
  - 2012 ar
  - 2015 In  
Cross-L
  - 2012 ar
  - ANSI/A  
Timber
  - APA R
2. Product de  
SmartLam  
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and length
3. Design pri  
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design ad  
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[www.rdl.com](http://www.rdl.com)

Products: DRJ Cross-Laminated Timber  
Riddle Laminat  
1991 Pruner Ro  
P.O. Box 66  
Riddle, OR 974  
(541) 874-8267  
[www.drjlumber.com](http://www.drjlumber.com)



### FRERES Mass Panel Products Freres Lumber Co., Inc.

**PR-L325**

Issued July 3, 2018

Products: Freres Mass Panel Products  
Freres Lumber Co., Inc., 14114<sup>th</sup> St., Lyons, Oregon 97358  
(503) 859-2121  
[www.frereslumber.com](http://www.frereslumber.com)

1. Basis of th  
  - 2015 In  
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  - 2012 ar
  - 2015 In  
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Timber
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Allowable (1  
42 feet.
3. Design pri  
SmartLam  
design ad  
factors, et  
[www.rdl.com](http://www.rdl.com)

1. Basis of the product report:
  - 2018, 2015, and 2012 International Building Code (IBC): Section 104.11 Alternative materials
  - 2018, 2015, and 2012 International Residential Code (IRC): Section R104.11 Alternative materials
  - ANSI/APA PRG 320-2017 Performance Rated Cross-Laminated Timber
  - ASTM D5456-14b, D5456-13, and D5456-09 recognized by the 2018 IBC and IRC, 2015 IBC and IRC, and 2012 IBC and IRC, respectively
  - APA Report T2018P-21 and other qualification data
2. Product description:  
Freres mass panel products (MPP) are manufactured with 1-inch-thick Freres 1.6E Douglas-fir LVL in accordance with custom layouts of ANSI/APA PRG 320 through product qualification and mathematical models using principles of engineering mechanics. The LVL

# NEW MASS TIMBER DESIGN MANUAL

80+ pages of mass timber technical resources, case studies and more. Links directly to many additional resources.

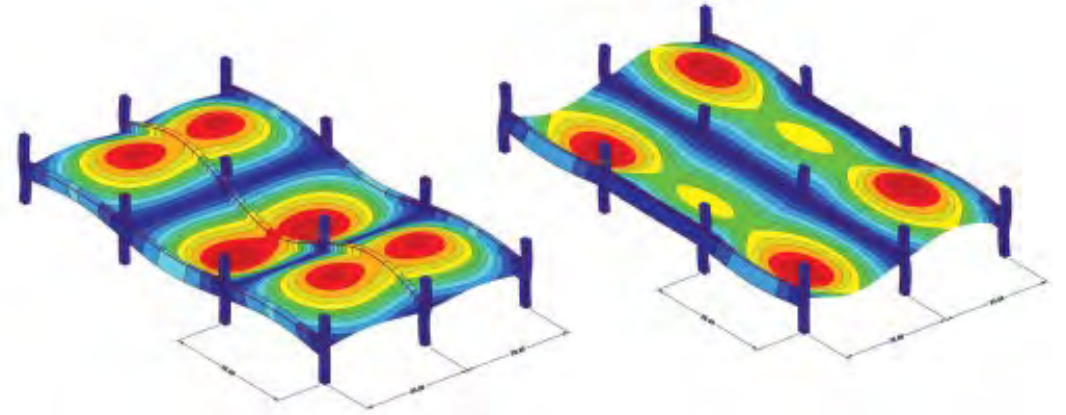
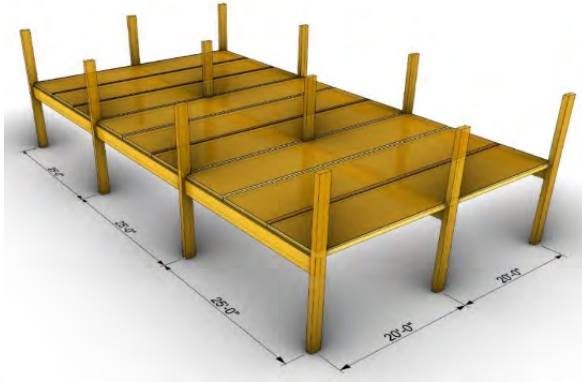
Jointly Produced By:



<https://info.thinkwood.com/masstimberdesignmanual>



# NEW MASS TIMBER FLOOR VIBRATION DESIGN GUIDE



U.S. Mass Timber  
Floor Vibration

**Design Guide**



**Worked office, lab and  
residential Examples**

*Covers simple and complex methods  
for bearing wall and frame supported  
floor systems*

# NEW MASS TIMBER CONNECTIONS INDEX

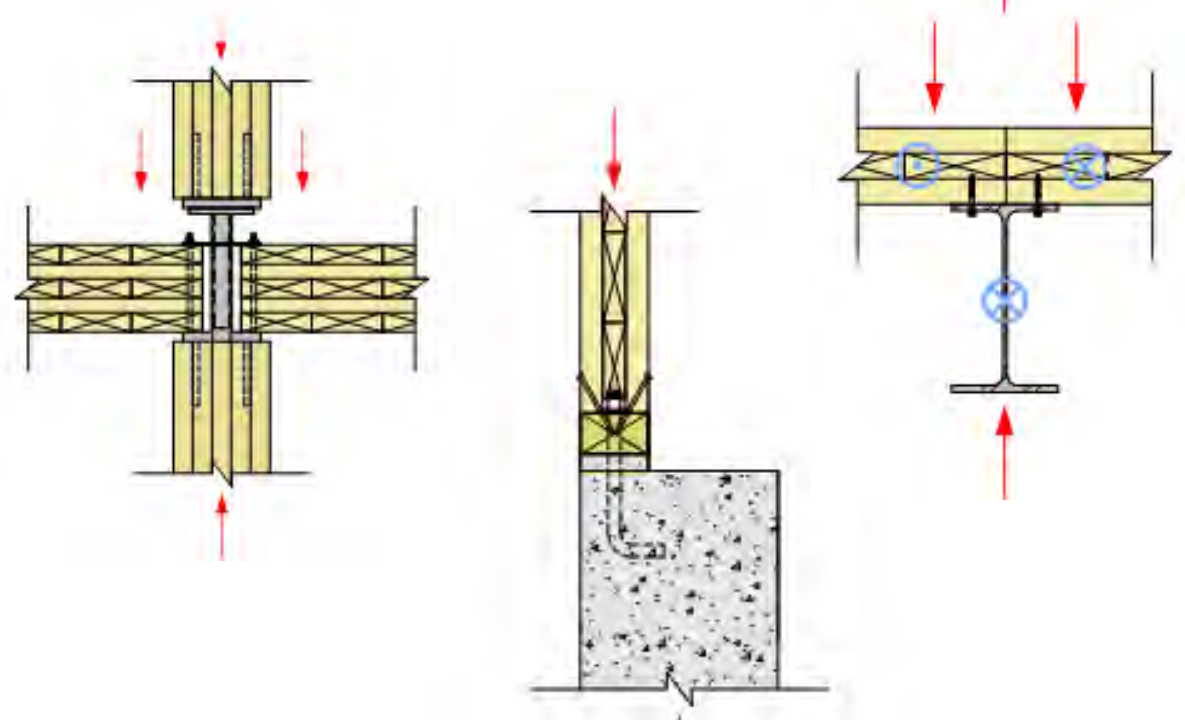


ARCHITECTURE  
URBAN DESIGN  
INTERIOR DESIGN



A library of commonly used mass timber connections with designer notes and information on fire resistance, relative cost and load-carrying capacity.

WoodWorks Index of  
Mass Timber Connections





# Grid options and member sizes: What's been done



# Bullitt center

Seattle, wa

11'-6" Beam Spacing  
11'-6" column spacing at exterior  
23'-0" Column Spacing at interior  
2x6 NLT Floor Deck





# Clay creative

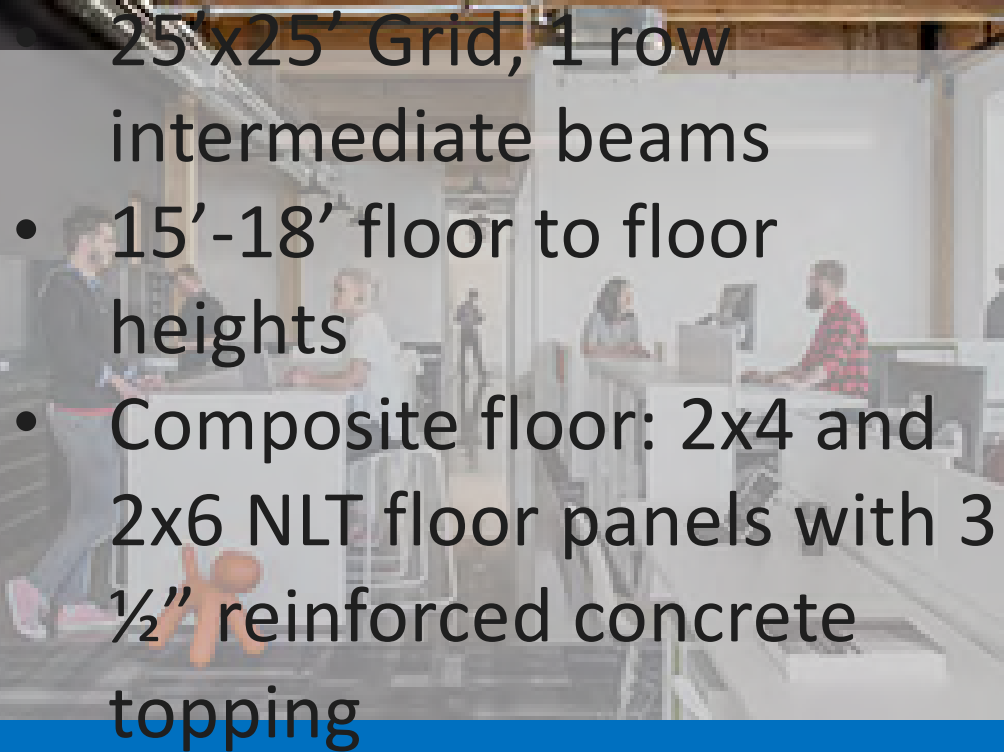
Portland, or

- ~8' finished floor to bottom of beam
- 25'x30' at perimeter
- 30'x30' bays at center
- 2x6 NLT Spans 15'
- Exterior steel moment frame keeps core area more versatile



# JUDSON BUILDING

VANCOUVER, WA

- 
- 25'x25' Grid, 1 row intermediate beams
  - 15'-18' floor to floor heights
  - Composite floor: 2x4 and 2x6 NLT floor panels with 3 ½" reinforced concrete topping





# t3 minneapolis

Minneapolis, mn



20'x25' Grid  
2x8 NLT Floor Panels span 20' w/3"  
Concrete Topping



# Mass timber appeal





# MARKET DRIVERS FOR MASS TIMBER

## PRIMARY DRIVERS

- » Construction Efficiency & Speed
- » Construction site constraints – Urban Infill
- » Innovation/Aesthetic

## SECONDARY DRIVERS

- » Carbon Reductions
- » Structural Performance – lightweight



Image Credit: Structure Fusion



# Mass timber appeal

Reduced construction time

**1 Floor = 3 Days**

**17 Floors Erected  
in 9.5 Weeks**

Brock Commons, Vancouver, BC

Source: naturally:wood<sup>5</sup>





# Mass timber appeal

Material mass

75% lighter weight than  
concrete

Source: Structurlam<sup>7</sup>



# Mass timber appeal

Material mass

Completed in 2012

10 stories

~ 105 ft. tall, > 18.6 K sqft.

3 year investment in R&D

Poor soils required a much lighter building



Forte', Victoria Harbor, Melbourne, Australia  
Architect: LendLease | Source: Lendlease<sup>8</sup>





## ESTIMATED ENVIRONMENTAL IMPACT OF WOOD USE



Volume of wood products used:  
2,233 cubic meters of CLT and Glulam



U.S. and Canadian forests grow this much wood in:  
6 minutes



Carbon stored in the wood:  
1,753 metric tons of CO<sub>2</sub>



Avoided greenhouse gas emissions:  
679 metric tons of CO<sub>2</sub>



Total potential carbon benefit:  
2,432 metric tons of CO<sub>2</sub>

### THE ABOVE GHG EMISSIONS ARE EQUIVALENT



511 cars off the road for a year



Energy to operate a home for 222 years

*\*Estimated by the Wood Carbon Calculator for Buildings, based on research by Sathre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations (this relates to carbon stored and avoided GHG).*

*\*CO<sub>2</sub> in this case study refers to CO<sub>2</sub> equivalent*

Source: Naturally:wood<sup>9</sup>

# Mass timber appeal

Reduced embodied carbon

Brock Commons,  
Vancouver, BC



Photo credit: acton ostry architects

# Mass timber appeal

Minimal waste





# Mass timber appeal

Mass timber elements fabricated to tight tolerances

Prefabricated and precise



Computer Numerically Controlled  
(CNC) connections

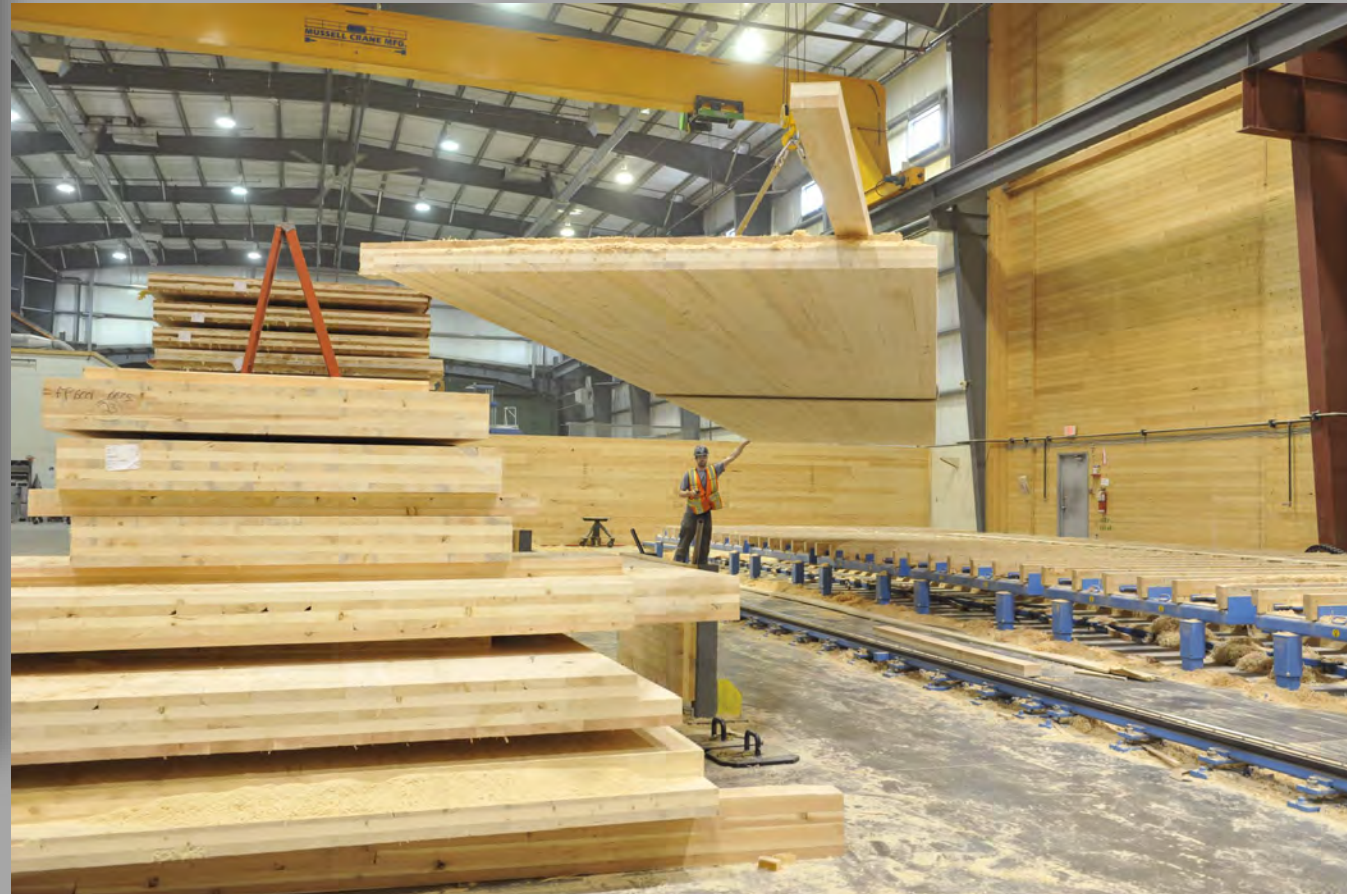
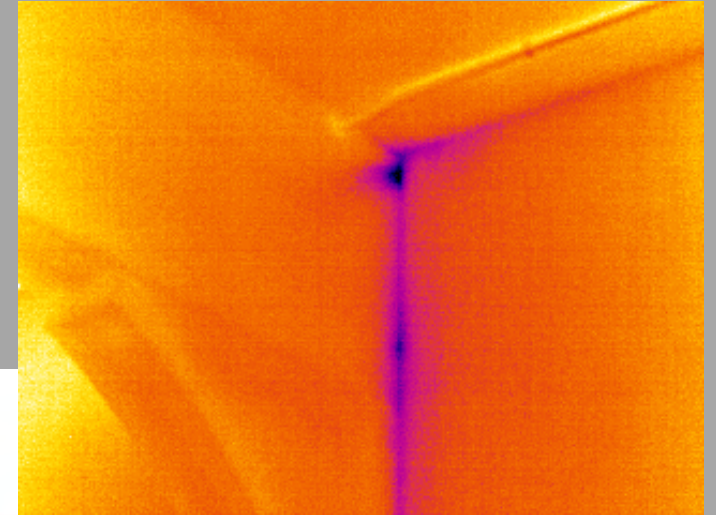


Photo credit: naturally:wood

# Mass timber appeal

Energy efficient



**Table 2**

Thermal resistance of typical softwood at various thicknesses and 12% moisture content

Thickness	1 in. (25 mm)	4 in. (100 mm)	6 in. (150 mm)	8 in. (200 mm)
R-value ( $\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}\cdot\text{Btu}^{-1}$ )	1.25	5.00	7.50	10.00
RSI ( $\text{m}^2\cdot\text{K}\cdot\text{W}^{-1}$ )	0.22	0.88	1.30	1.80

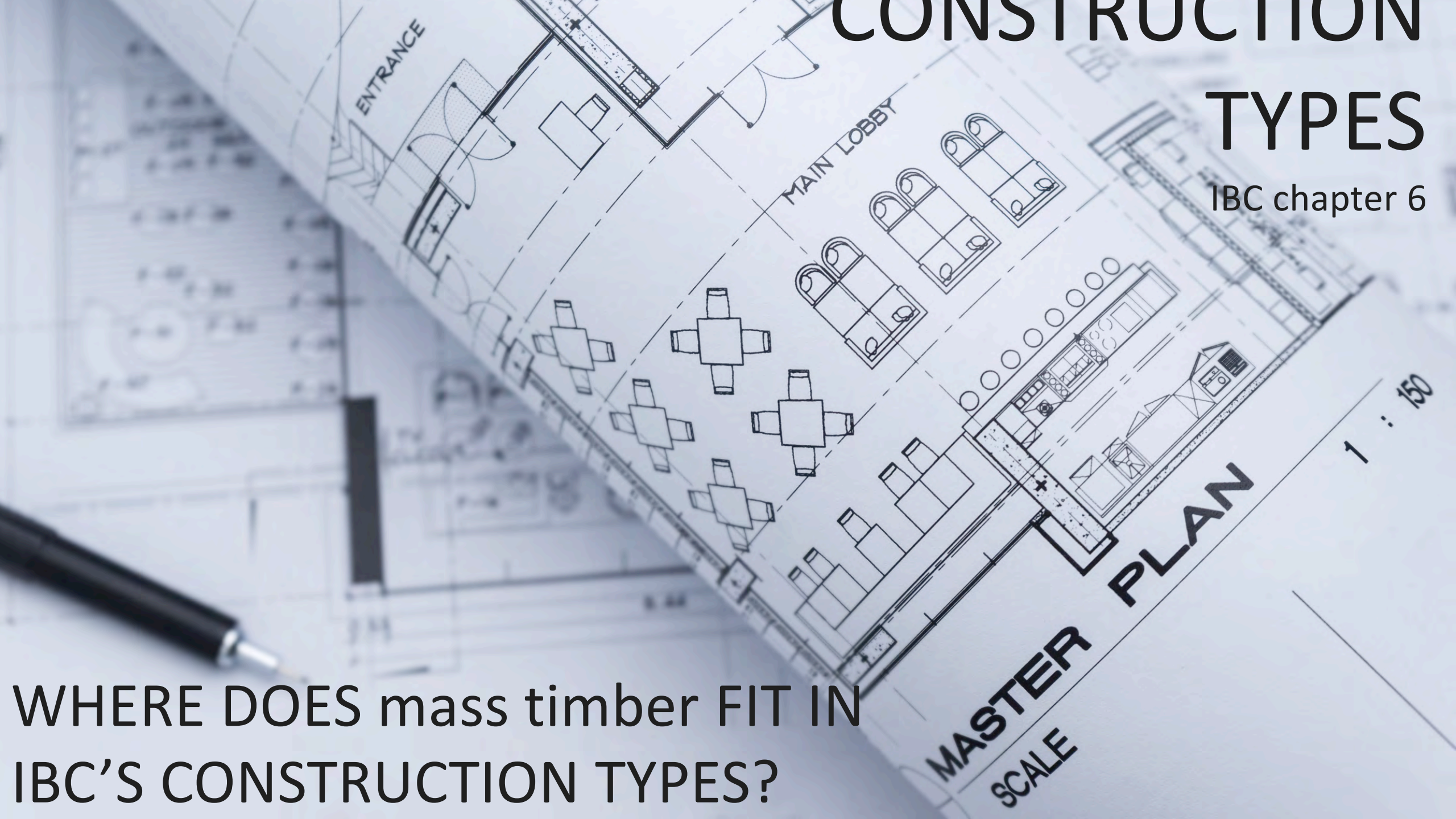
CLT has an R-value of approximately 1.25 per inch of thickness. Source: US CLT Handbook<sup>10</sup>



# CONSTRUCTION TYPES

IBC chapter 6

WHERE DOES mass timber FIT IN  
IBC'S CONSTRUCTION TYPES?





# Construction types

IBC 602

IBC DEFINES 5 CONSTRUCTION TYPES: I, II, III, IV AND V  
A BUILDING MUST BE CLASSIFIED AS ONE OF THESE

CONSTRUCTION TypeS I & II:  
ALL ELEMENTS REQUIRED TO BE NON-COMBUSTIBLE  
MATERIALS

HOWEVER, THERE ARE EXCEPTIONS INLCUDING SEVERAL  
FOR MASSTIMBER



# ALL WOOD FRAMED BUILDING CONSTRUCTION types

IBC 602

## **Type III**

Exterior walls non-combustible (may be FRTW)

Interior elements any allowed by code, INCLUDING MASS TIMBER

## **Type V**

All building elements are any allowed by code, INCLUDING MASS TIMBER

Types III and V are subdivided to A (protected) and B (unprotected)

## **Type IV (Heavy Timber)**

Exterior walls non-combustible (may be FRTW OR CLT)

Interior elements qualify as Heavy Timber (min. sizes, no concealed

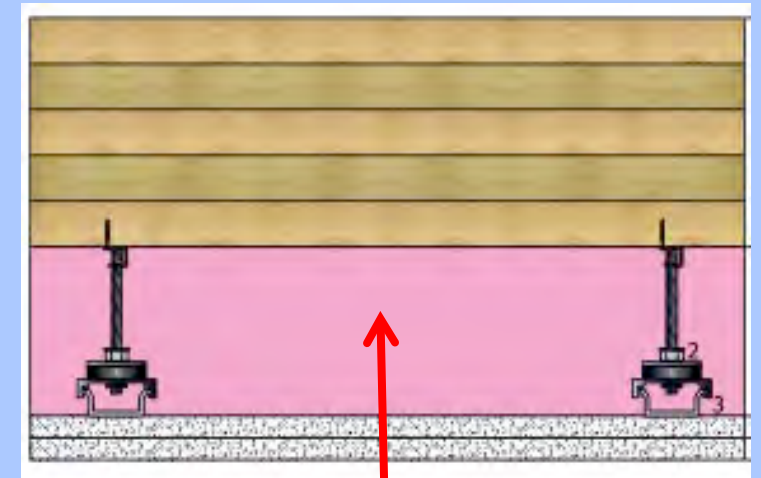
# Construction types

Ibc 602

## CONCEALED SPACES

Type IV Construction requires that interior elements be without concealed spaces:

- Concealed spaces include dropped ceilings, attics, chases, others
- Concealed space restriction does not apply to any other construction type. If using mass timber elements in non type IV construction, concealed spaces are permitted but may be required to be sprinklered
- Ibc 602.4.6 permits 1 hour fire resistance rated construction for partitions



Example of concealed space created by dropped ceiling



# Construction types

## Chapter 6: Types of Construction



Image: Christian Columbres Photography

Where does the code allow MT to be used?

- Type V: Interior elements, roofs & exterior walls

# Construction types

Type III: 6 stories



Allowable mass timber  
building size for  
group B occupancy  
with NFPA 13  
Sprinkler

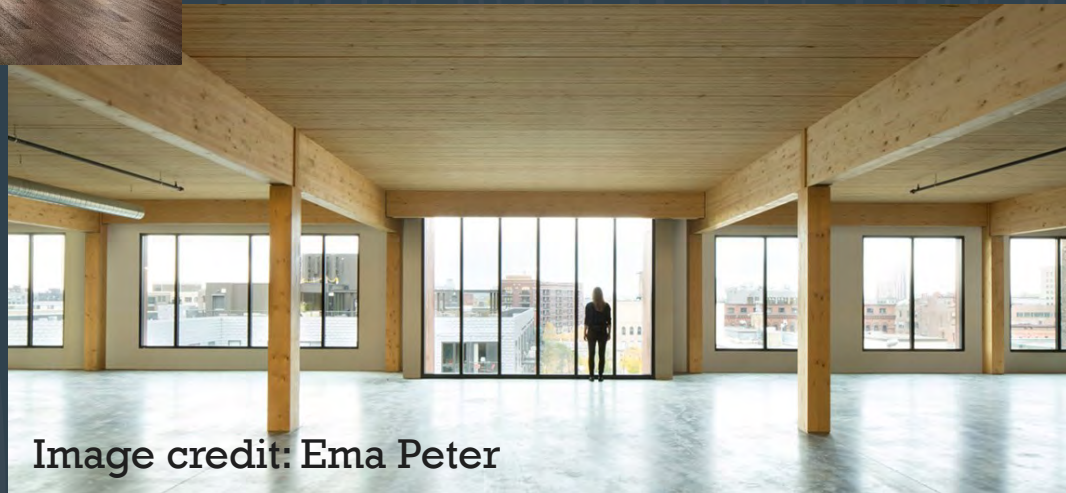


Image credit: Ema Peter

Type IV: 6 stories



Image: Christian Columbres Photography

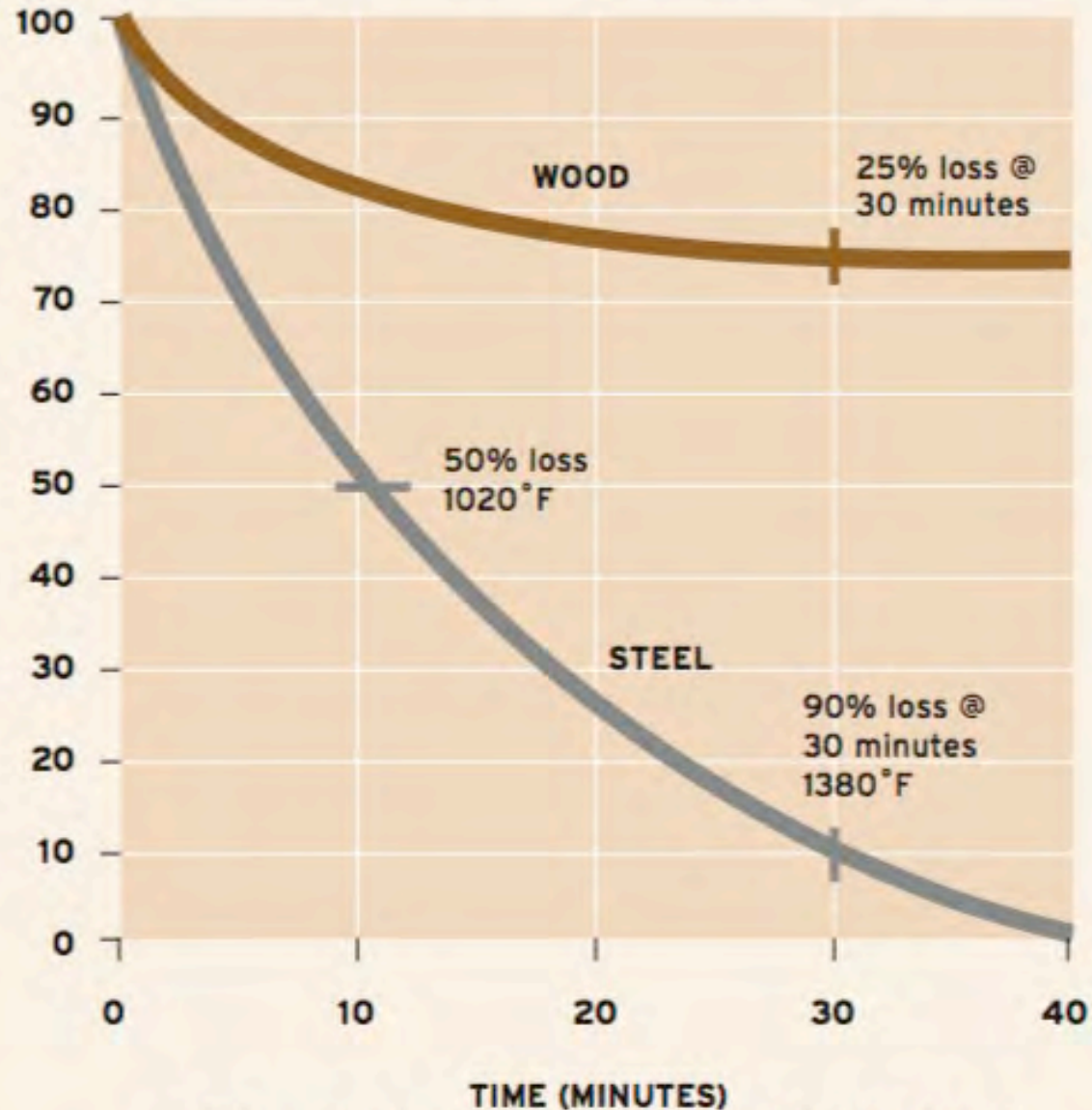
Type V: 4 stories



# Fire resistance



## COMPARATIVE STRENGTH LOSS OF WOOD VERSUS STEEL



Results from test sponsored by National Forest Products Association at the Southwest Research Institute

Source: Aitc

# Mass timber design

Fire resistance

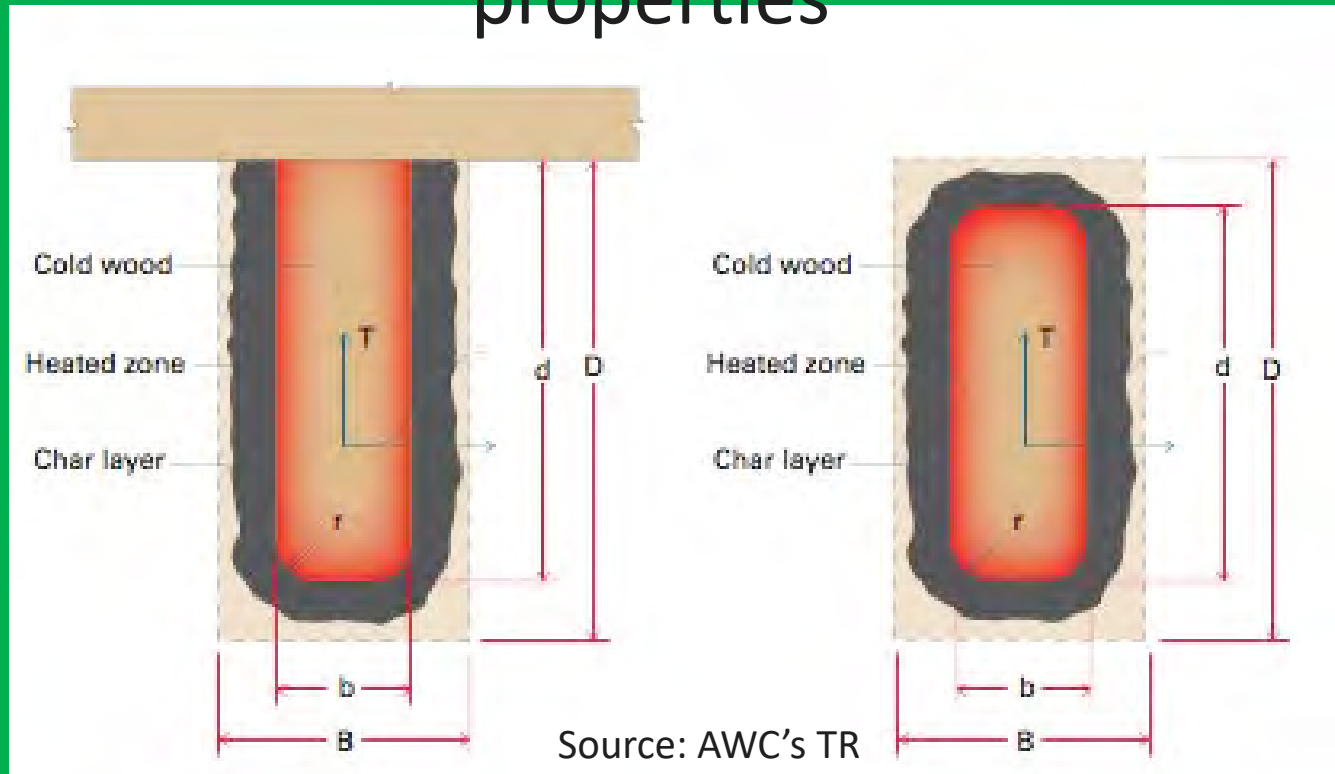
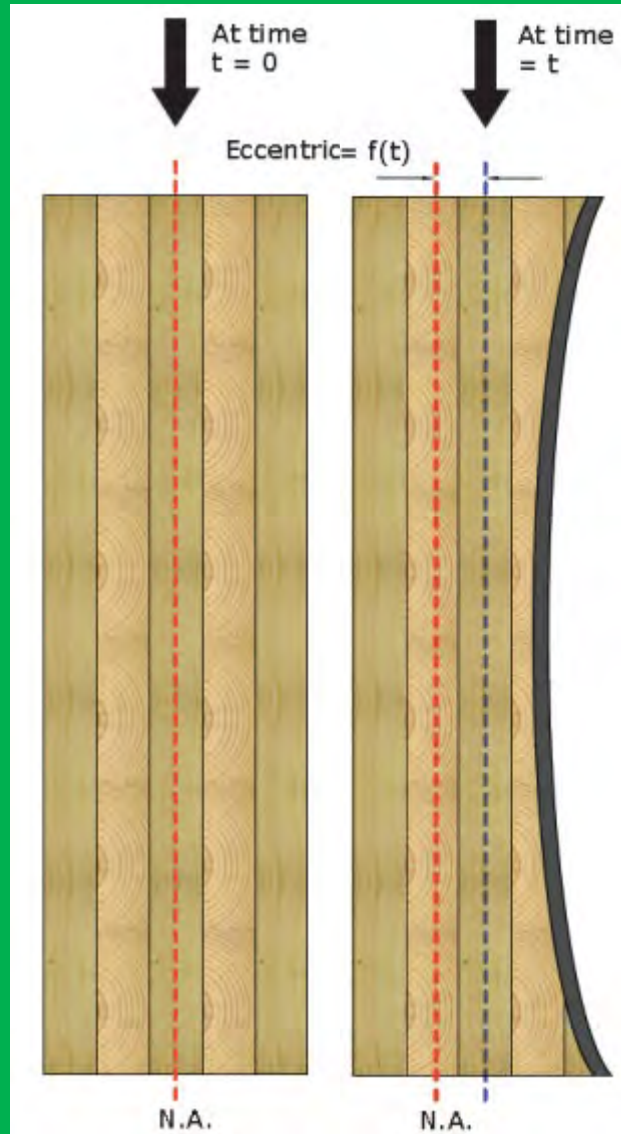




# Mass timber design

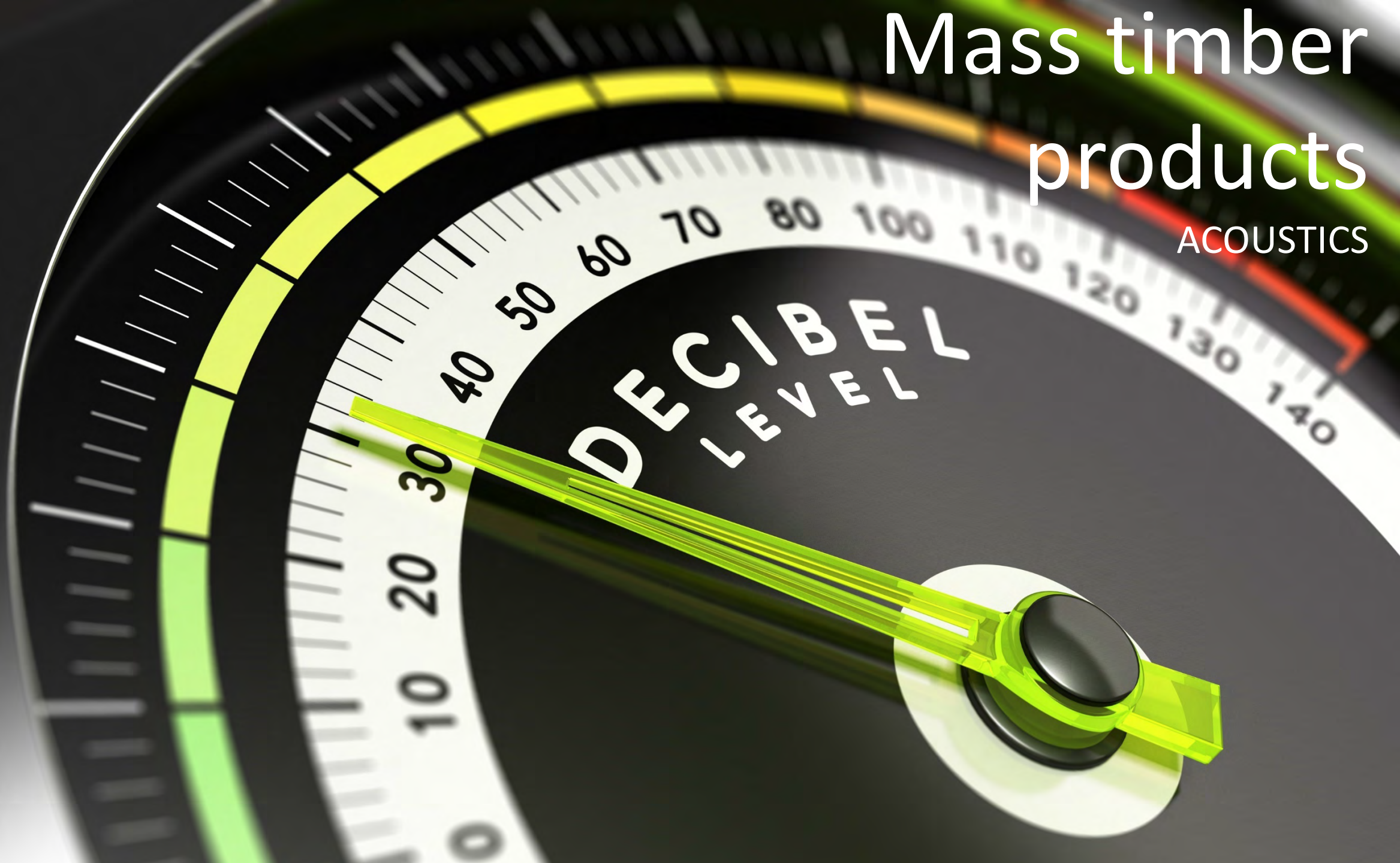
Fire resistance

Similar to heavy timber, mass timber products have inherent fire resistance properties



# Mass timber products

ACOUSTICS





# Mass timber design

Acoustics



Lightweight concrete topping or other similar materials can provide improved acoustical performance, increased durability

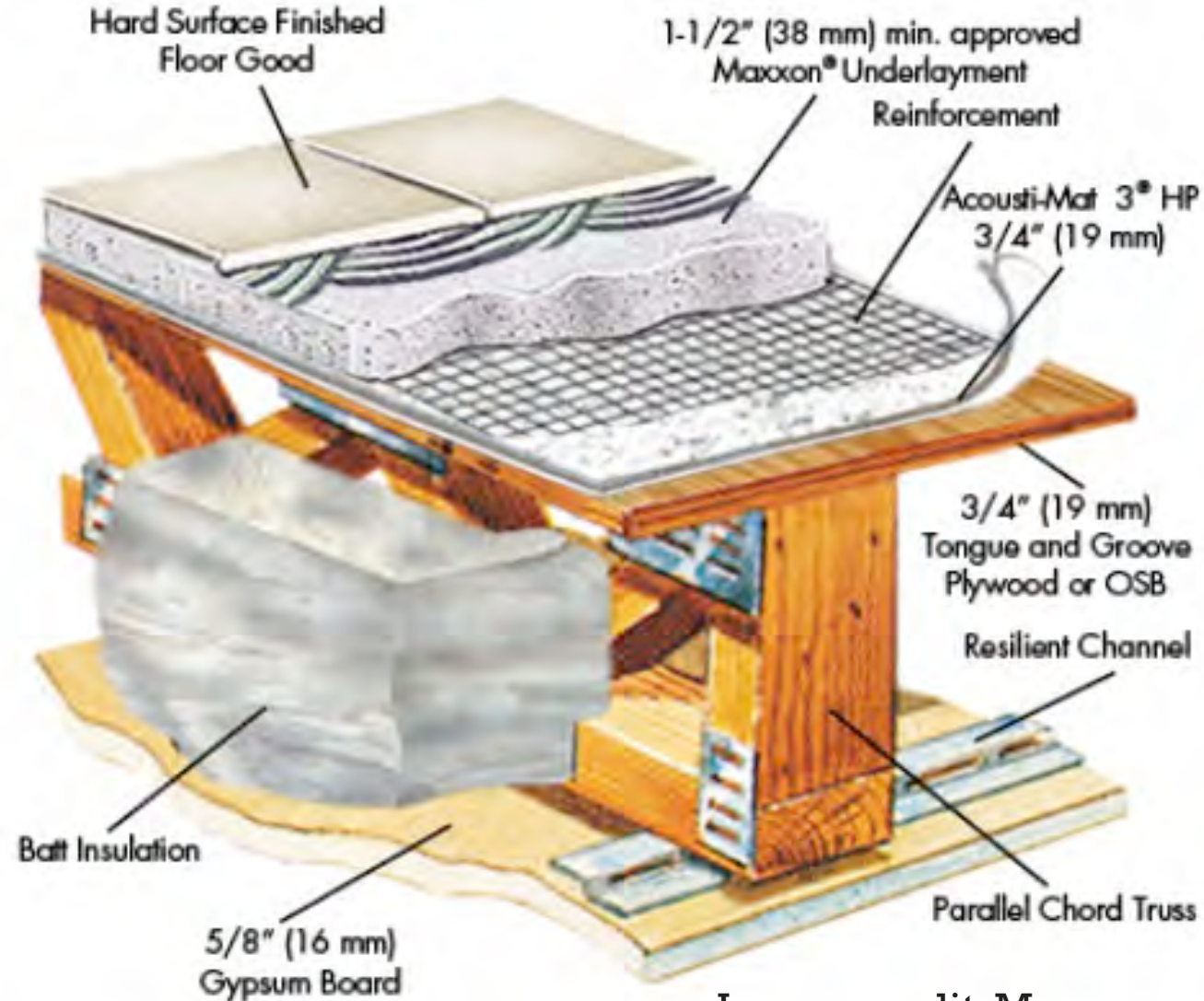


Image credit: Maxxon



# Mass timber design

Acoustics

Acoustical mat - typically installed between subfloor and topping or flooring



Image credit: Pliteq





# Mass timber design

Acoustics

## Common mass timber floor assembly:

- Finish floor (if applicable)
- Underlayment (if finish floor)
- 1.5'' to 3'' thick concrete/gypcrete topping
- Acoustical mat
- WSP (if applicable)
- Mass timber floor panels



Image credit: AcoustiTECH

# Mass timber design

Acoustics



## Options without concrete topping:

- Gypsum/cement board (Fermacell, Permabase, etc.)
- Proprietary products



Image credit: AcoustiTECH



# Mass timber Costs

Mass timber construction costs vary with project location, size, spans, finish level and many other variables

Product manufacturers are the best source of pricing information



# Questions?



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# Mass timber Costs

factors relevant to the cost conversation:

- Cure time: mass timber has none. can be worked on immediately after being placed
- Light-weight:
- Crane size: mass timber is lighter than traditional materials<sup>7</sup>.  
Smaller crane = potential savings
- Smaller seismic forces & foundations = potential savings
- Construction speed: estimated to be 25% faster<sup>11</sup>. Sooner completion = sooner occupancy = sooner revenue
- Others: less construction traffic<sup>11</sup>, prefabricated & precise – goes together smoothly
- Other items that affect cost: Shipping distance, sealers/sanding requirements, amount of custom cnc work

Source 7: Structurlam

Source 11: Fast + Epp

Photo Credit: Structurlam



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