Mass Timber Boot Camp: Fundamentals of Design and Construction

March 31, 2026

Presented by WoodWorks

Founders Hall, Foster School of Business, University of Washington / LMN Architects / Magnusson Klemencic Associates / Photo Tim Griffith

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

AIA Approved Continuing Education

Course Description

This seminar offers a thorough introduction to mass timber construction, tailored for architects, engineers, and construction professionals who are new to mass timber or still developing their expertise. The course will define mass timber, the types of products available, design strategies, and best practices for successful implementation. Technical topics will include structural performance, fire safety, occupant comfort, and key considerations during construction. Additionally, participants will receive a primer on how to implement mass timber from a code perspective and what construction types under the International Building Code (IBC) can be utilized.

Learning Objectives

1. Learn what mass timber products are available and understand their benefits, including structural versatility, prefabrication, lighter carbon footprint, aesthetic differentiation, and reduced labor costs.

2. Learn to navigate the International Building Code (IBC) provisions that permit mass timber construction and understand the specific requirements for building height, floor area, fire-resistance ratings, and the protection of exposed wood surfaces.

3. Highlight best practices for managing vibration and acoustics in mass timber structures, including floor system design, connections, and the integration of sound insulation materials to meet occupant comfort standards.

4. Discuss methods for protecting mass timber during construction and throughout the building's lifespan, including moisture control measures, detailing, weather protection, and sealing techniques to prevent water intrusion and ensure long-term durability.

Mass Timber Construction: Products, Performance & Design

Presented by:
Michael Muller, PE, SE

Photo: Structurlam

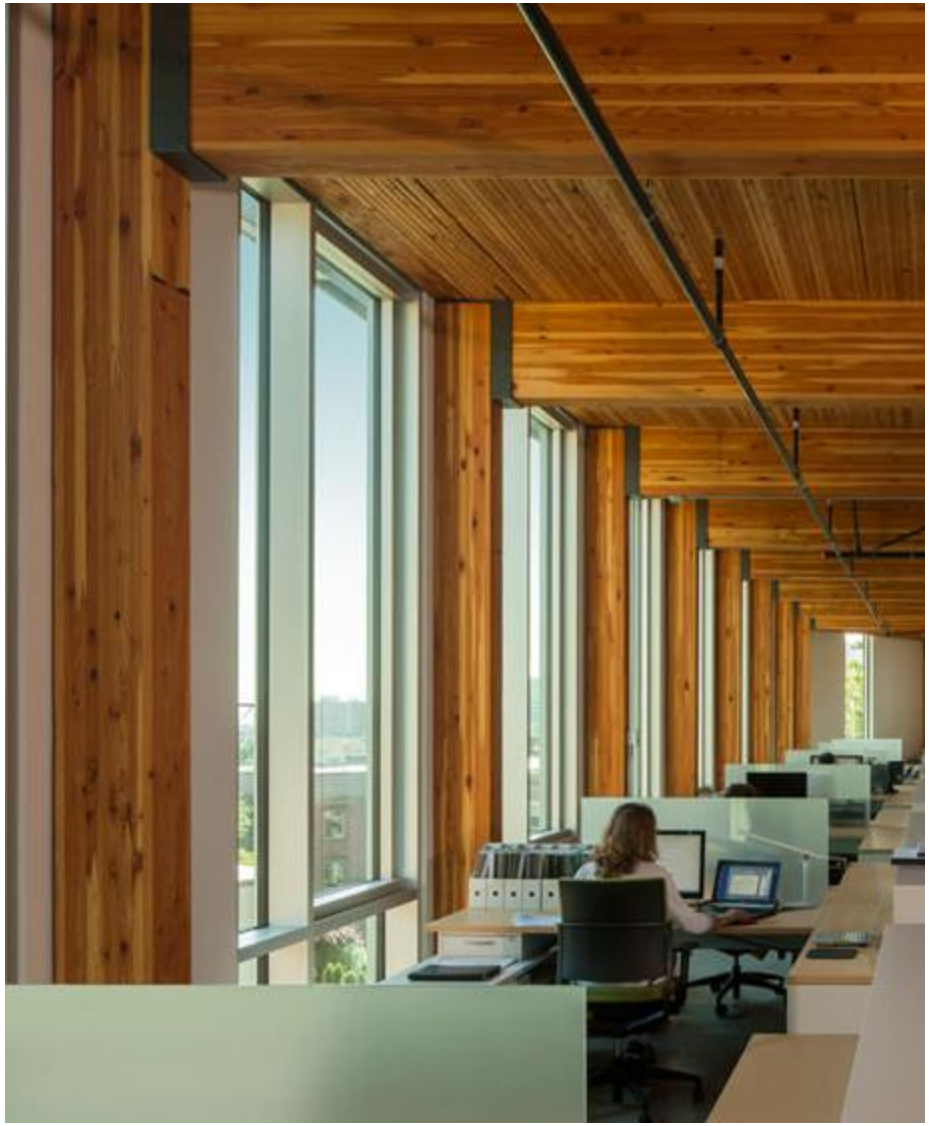
Mass Timber – What is it?

- Large panelized solid wood formed from small wood members
  - CLT, NLT, Glulam, Etc.

- Floor, roof and wall framing

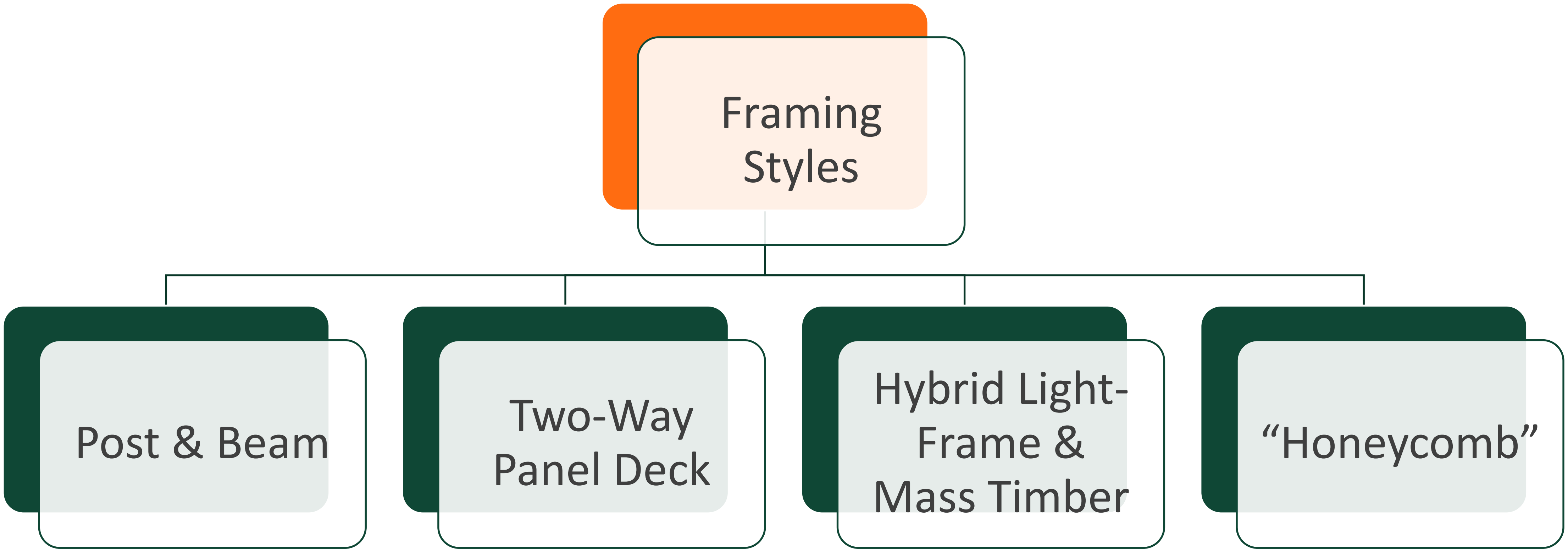
Light-Frame Wood
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

Mass Timber Framing Systems



Post and Beam

T3 Minneapolis
Minneapolis, MN
Image Credit: Blaine Brownell

Two-Way Panels

Brock Commons
Vancouver, BC
Images: Acton Ostry Architects

Hybrid Light-Frame & Mass Timber

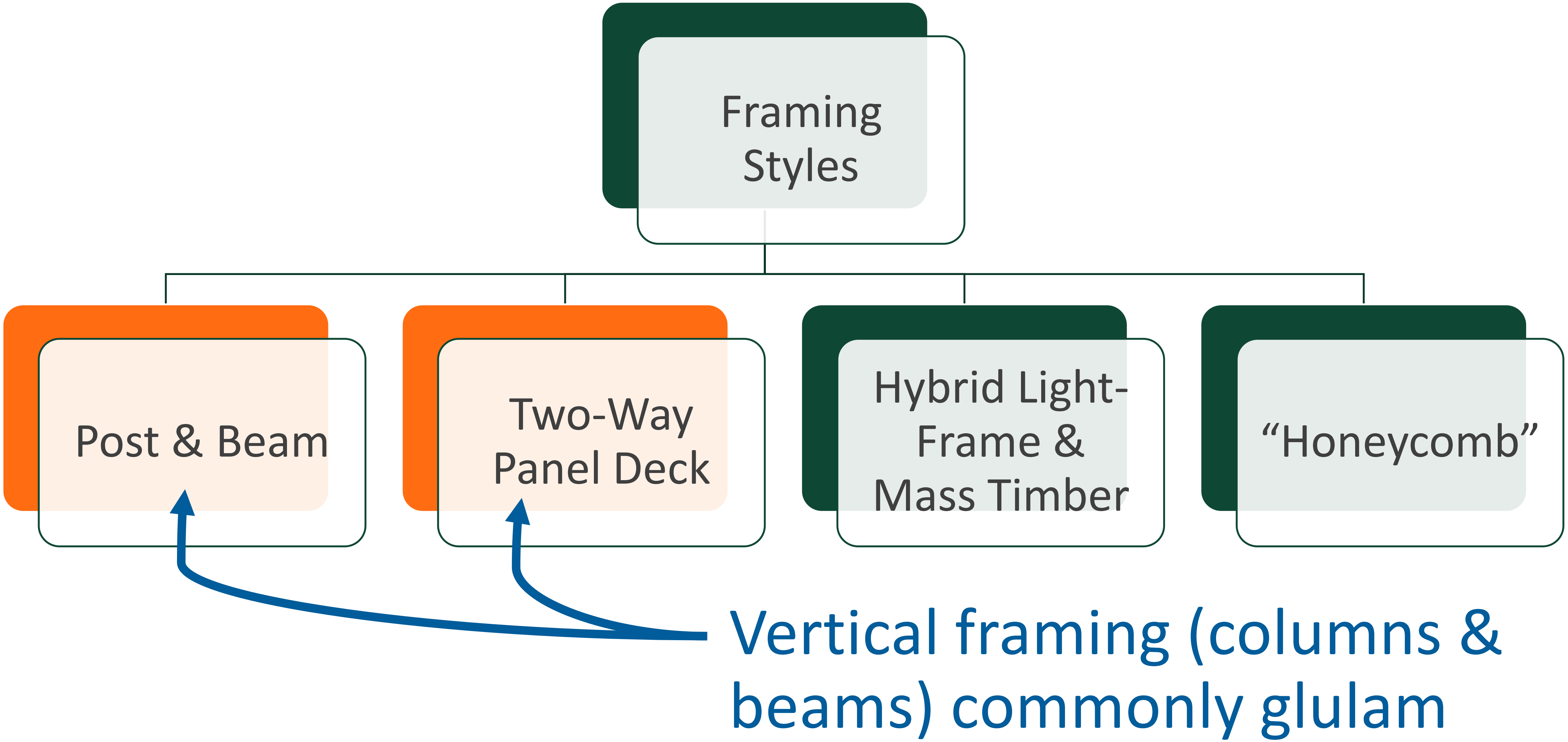
Carbon 12
Portland, OR
Image: WoodWorks

Virtuoso
Vancouver, BC
Image: Seagate Structures

Honeycomb

Candlewood Suites on
Redstone Arsenal
Huntsville, AL
Image Credit: LendLease

Mass Timber Framing Systems



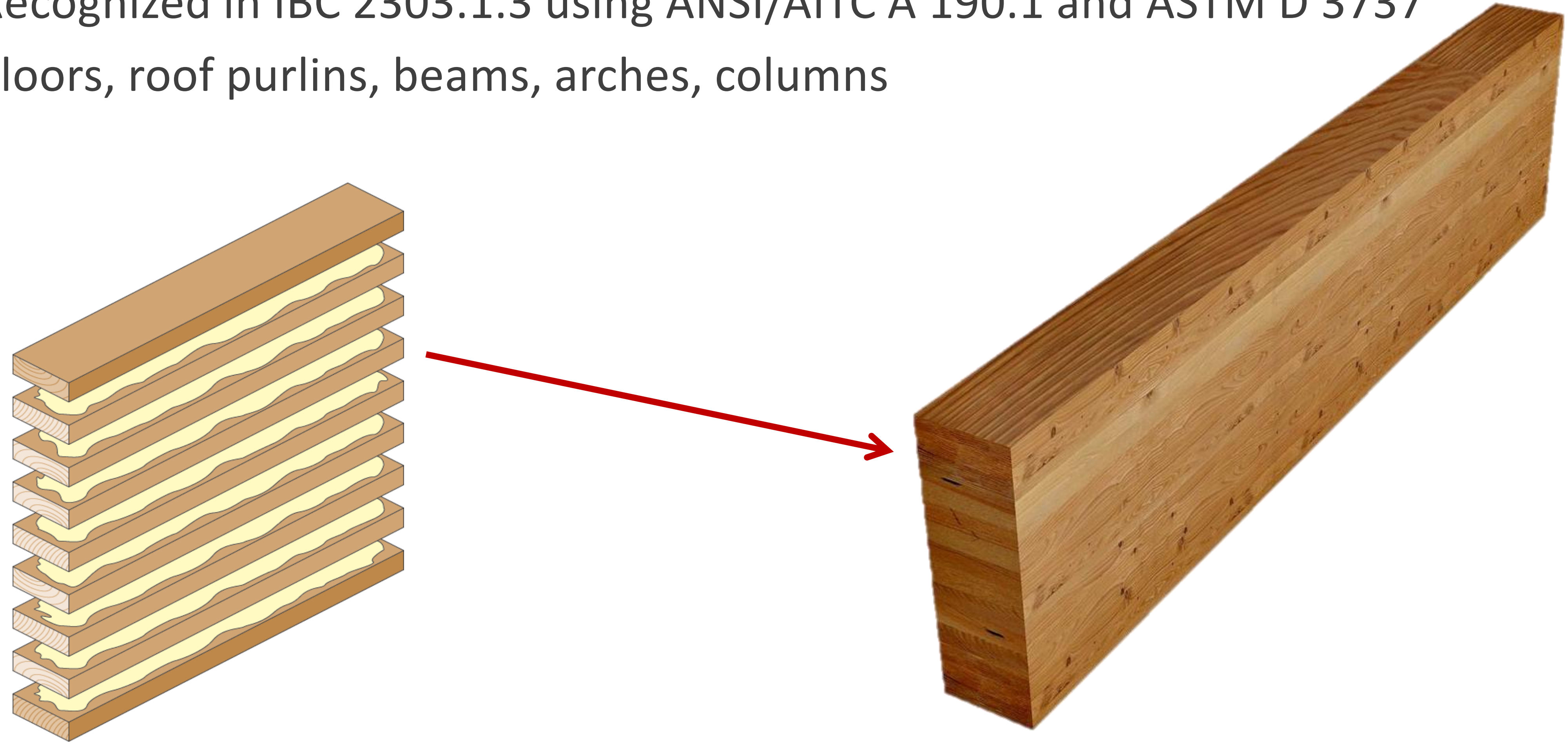
Glulam


Oregon State University – Cascades-
Edward J. Hall, SRG Partnership, catena
consulting engineers, Photo Swinerton

Glulam

Glulam = structural composite of lumber and adhesives

- Recognized in IBC 2303.1.3 using ANSI/AITC A 190.1 and ASTM D 3737
- Floors, roof purlins, beams, arches, columns



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

- Based on number of lams: 6” to 60”+
- Western species lams: Typically 1-1/2” thick
- Southern pine lams: Typically 1-3/8” thick

Typical Species

- Douglas-Fir, Southern Pine, Spruce
- Also available in Cedar & others

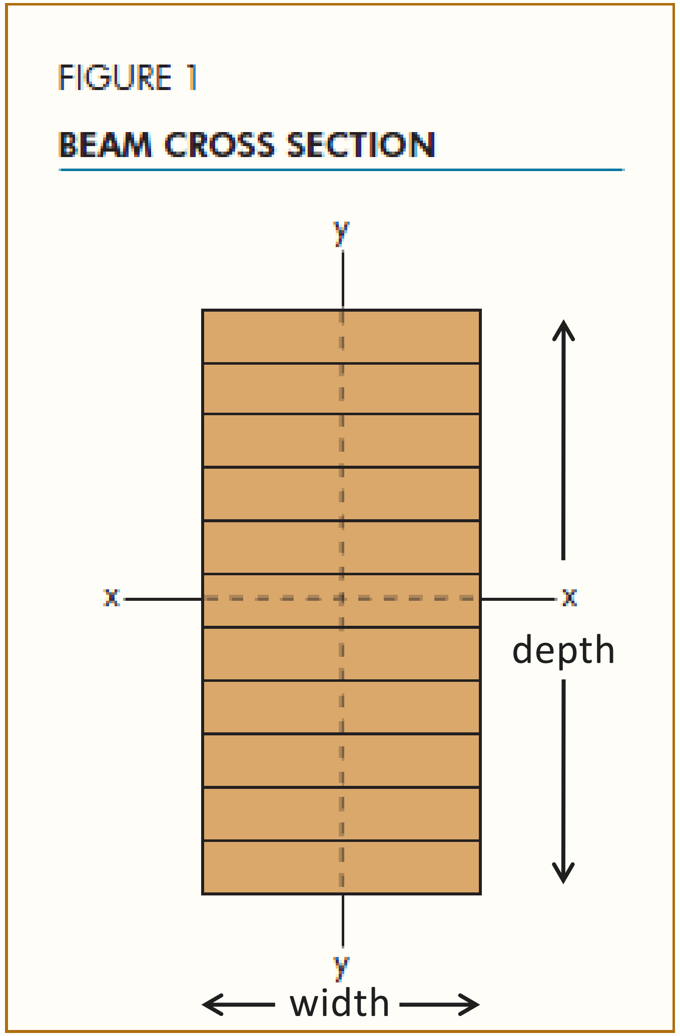
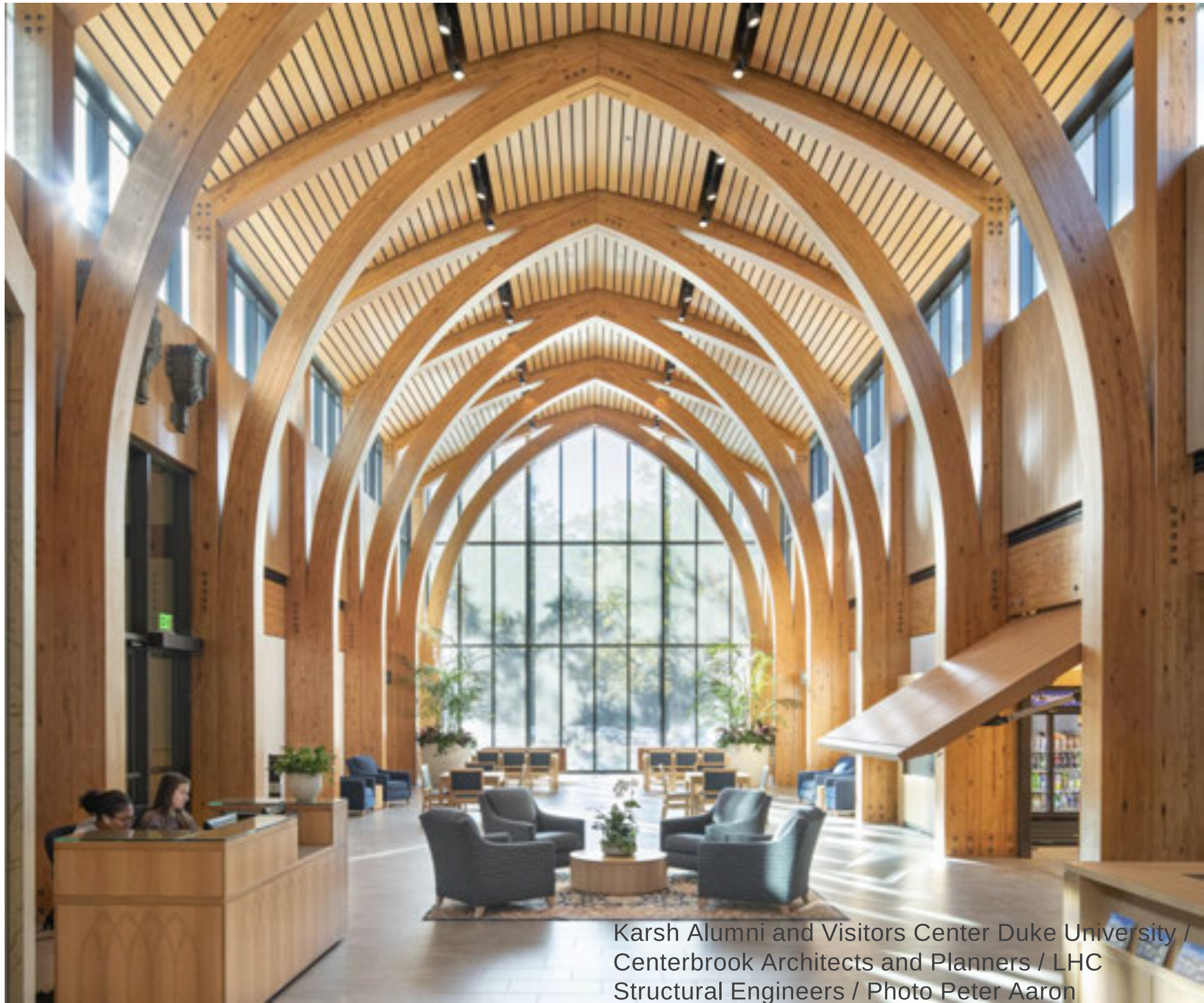


Image: APA Glulam Product Guide

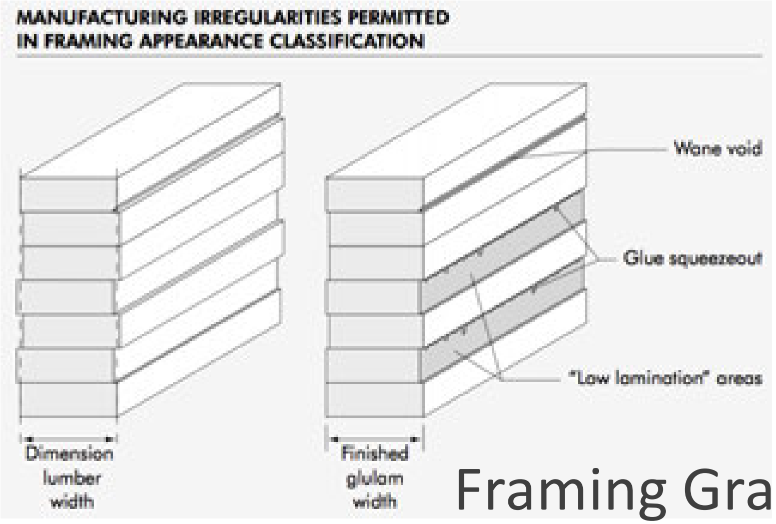
Glulam Specs

- Preservative treated (PT) readily available
- Fire retardant treated (FRT) may be available
- Can be cambered, curved, tapered
- Various Appearance Grades



Karsh Alumni and Visitors Center Duke University / Centerbrook Architects and Planners / LHC Structural Engineers / Photo Peter Aaron

Glulam Appearance Grades



Framing Grade

Images: American Laminators

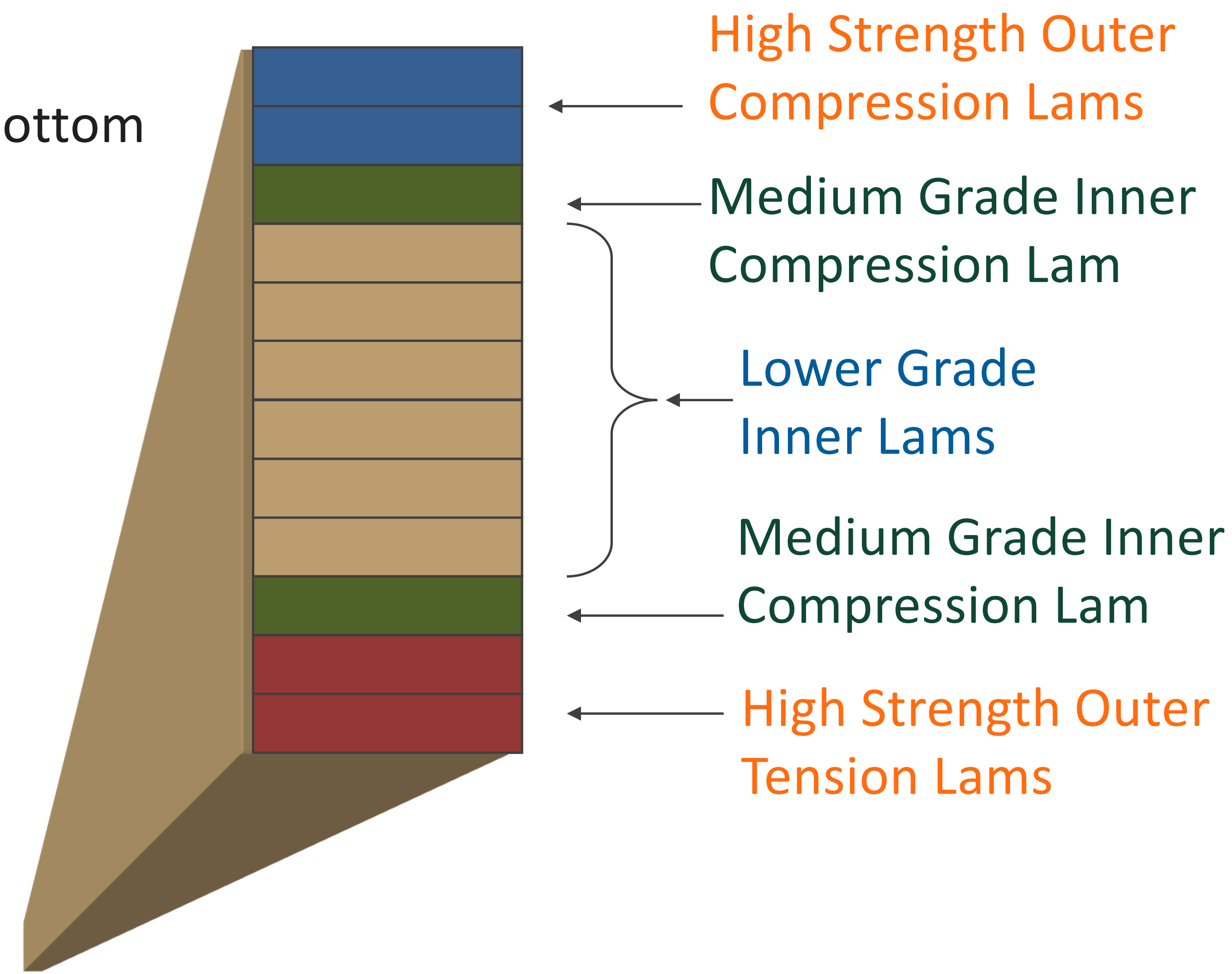
Glulam Layup

Lamination strengths vary:

» Higher strength at top and bottom

» Lower strength in center

Image: APA



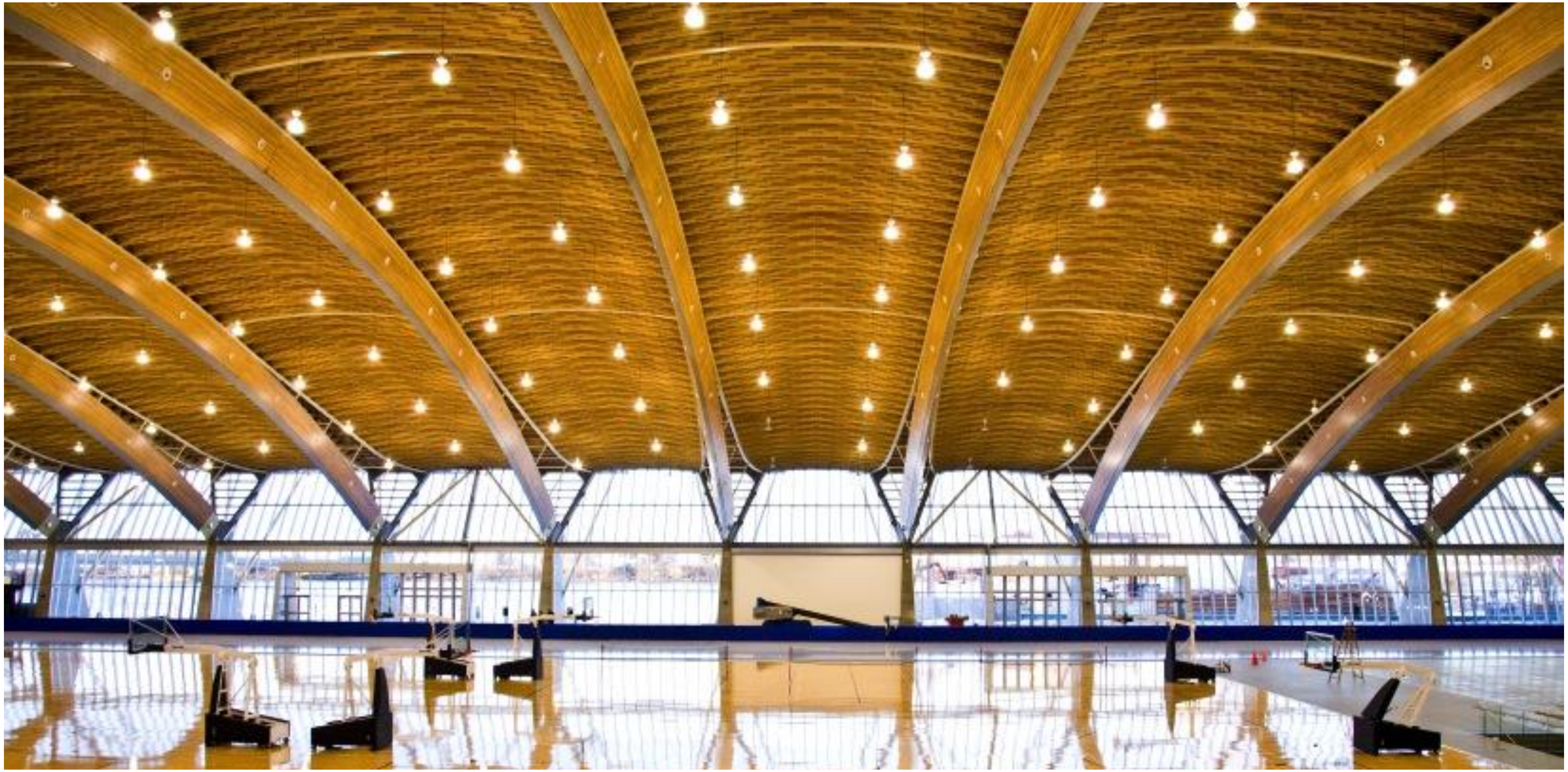
Glulam Built-Up Sections

Built-Up Sections:

- Available from some manufacturers
- Widths of 24”+ available

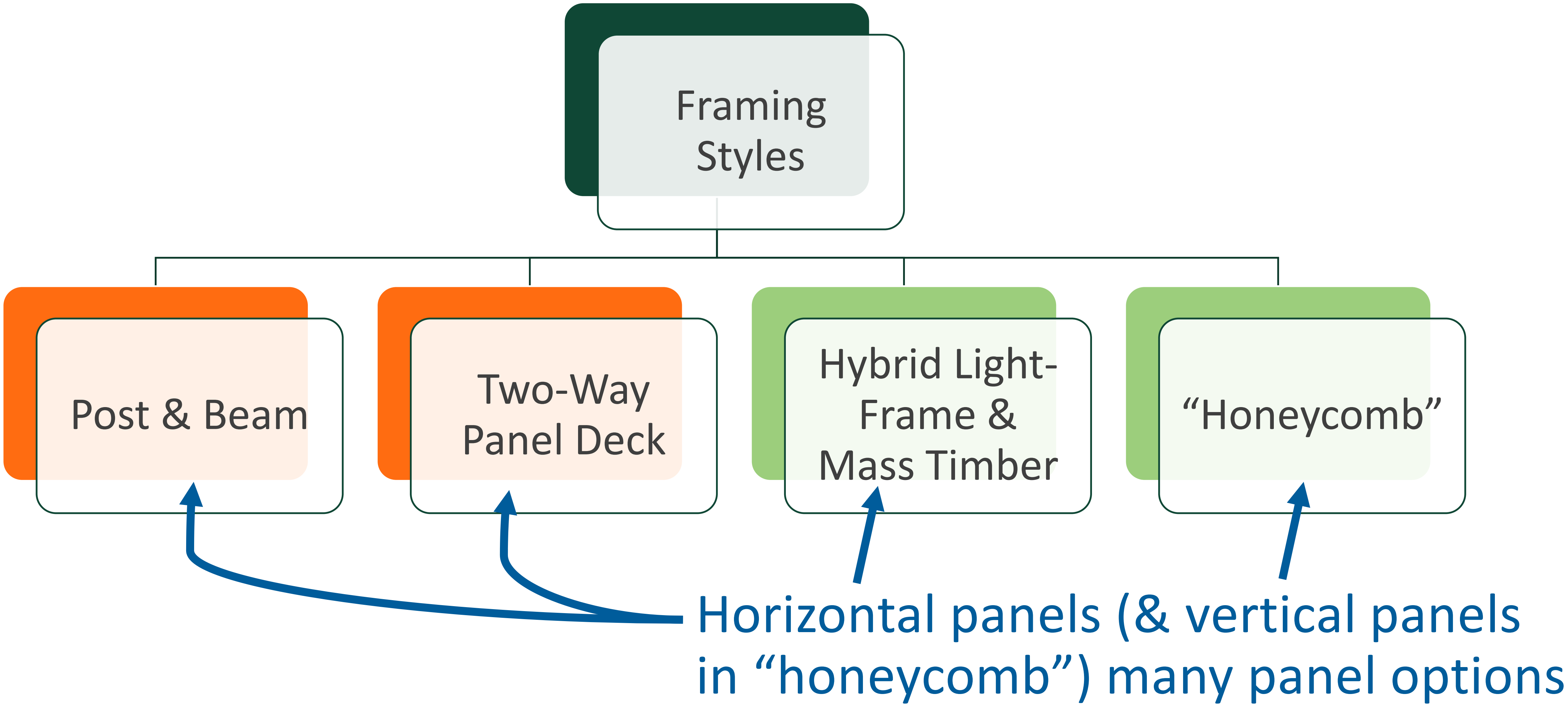
Photo: Unalam

Flexibility of Spans and Shapes



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

Mass Timber Framing Systems



Nail-Laminated Timber (NLT)

Photo: Think Wood

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Glue-Laminated Timber (GLT) Plank orientation

Photo: StructureCraft

Photo: Ema Peter

Photo: StructureCraft

Photo: Manasc Isaac Architects/Fast + Epp

Cross-Laminated Timber (CLT)
Solid sawn laminations

Photo: LendLease

Cross-Laminated Timber (CLT)
SCL laminations

Photo: Freres Lumber

Photo: LEVER Architecture

Nail Laminated Timber

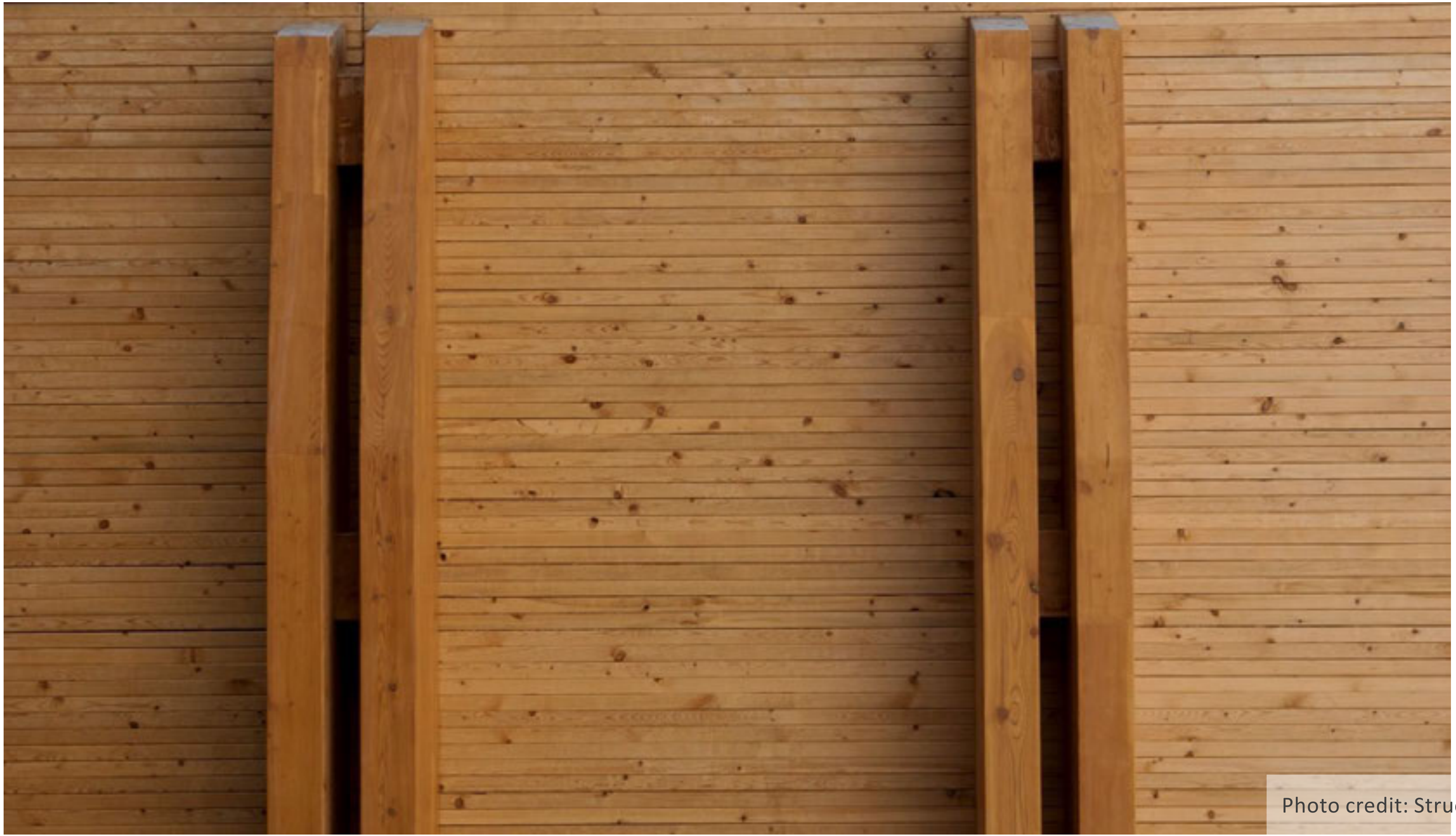


Photo credit: StructureCraft Builders

Nail Laminated Timber (NLT) Panels

What is it?

- Mechanically laminated to create solid timber panel
- Dimension lumber on edge
  - Nominal 2x, 3x, or 4x thickness
  - 4 in. to 12 in. width
- Laminations fastened with nails

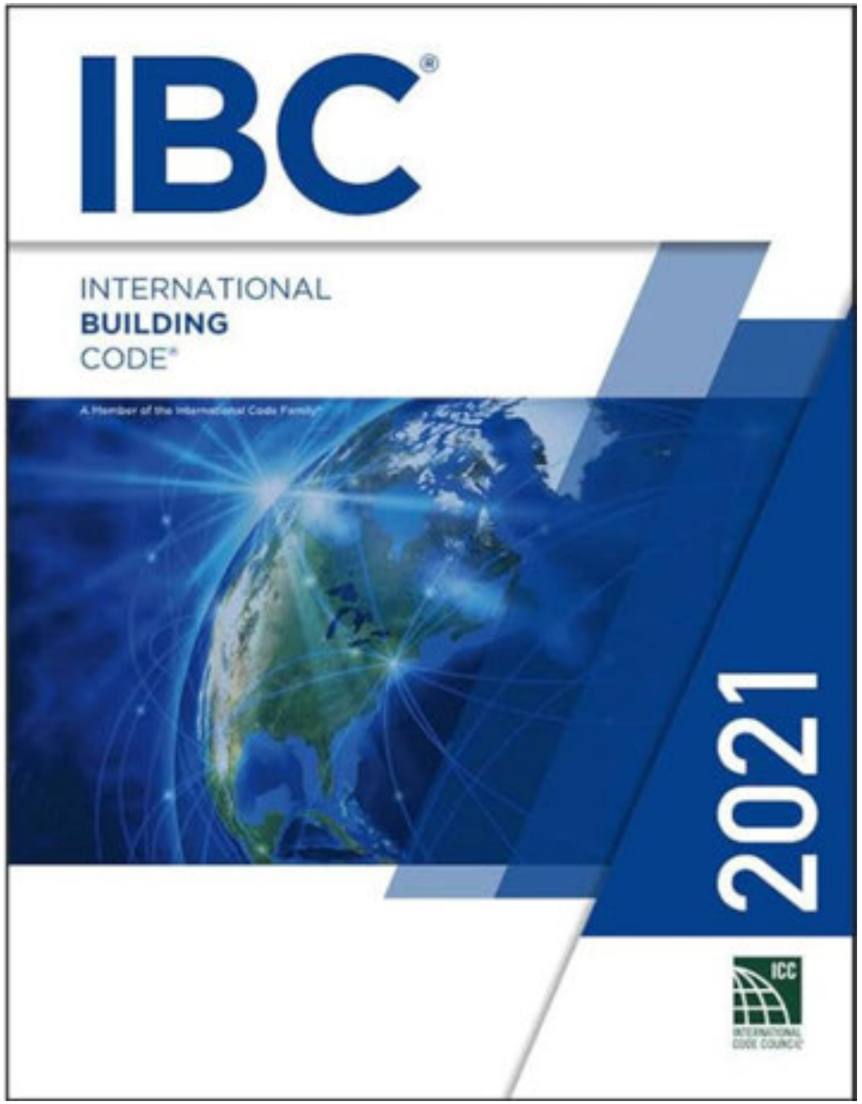
Image: Think Wood

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



Nail Laminated Timber (NLT) Panels

When is it used?

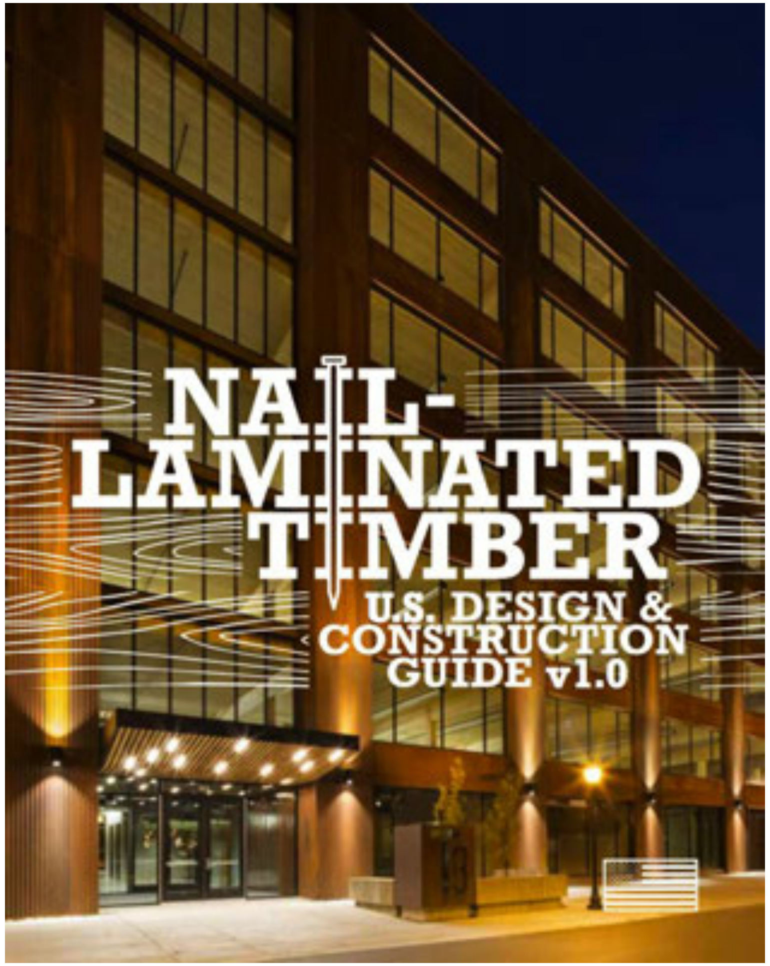
- Floor and roof panels
- Diaphragms (with Plywood/ OSB added to one face)
- Walls, shafts, etc.

Photo credit: StructureCraft Builders

Nail Laminated Timber (NLT) Panels

Content includes:

- Architecture
- Fire
- Structure
- Enclosure
- Supply and Fabrication
- Construction and Installation
- Erection engineering
- Free download at www.thinkwood.com/nltguide



Nail Laminated Timber (NLT) Panels

NLT shrinkage/ expansion design:

» Leave one ply out per 8’-10’ wide panel

Nail Laminated Timber (NLT) Panels

Construction options:

» On-site/ in-place

» Prefabricated offsite

Dowel Laminated Timber (DLT)

Photo credit: StructureCraft Builders

Dowel Laminated Timber (DLT) Panels

What is it?

- Similar to NLT
  - Dowels instead of Nails connecting lams
- Lams usually finger jointed
- Common in Europe
- Not recognized in IBC

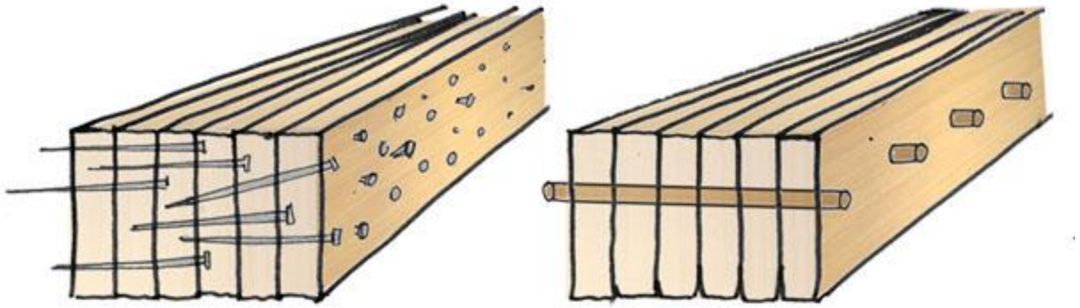


Photo credit: StructureCraft

Dowel Laminated Timber (DLT) Panels

- Resources:
  - Timber Framers Guild (for dowel design)
  - DLT Design Guide

Credit: StructureCraft

Dowel Laminated Timber Profile Options

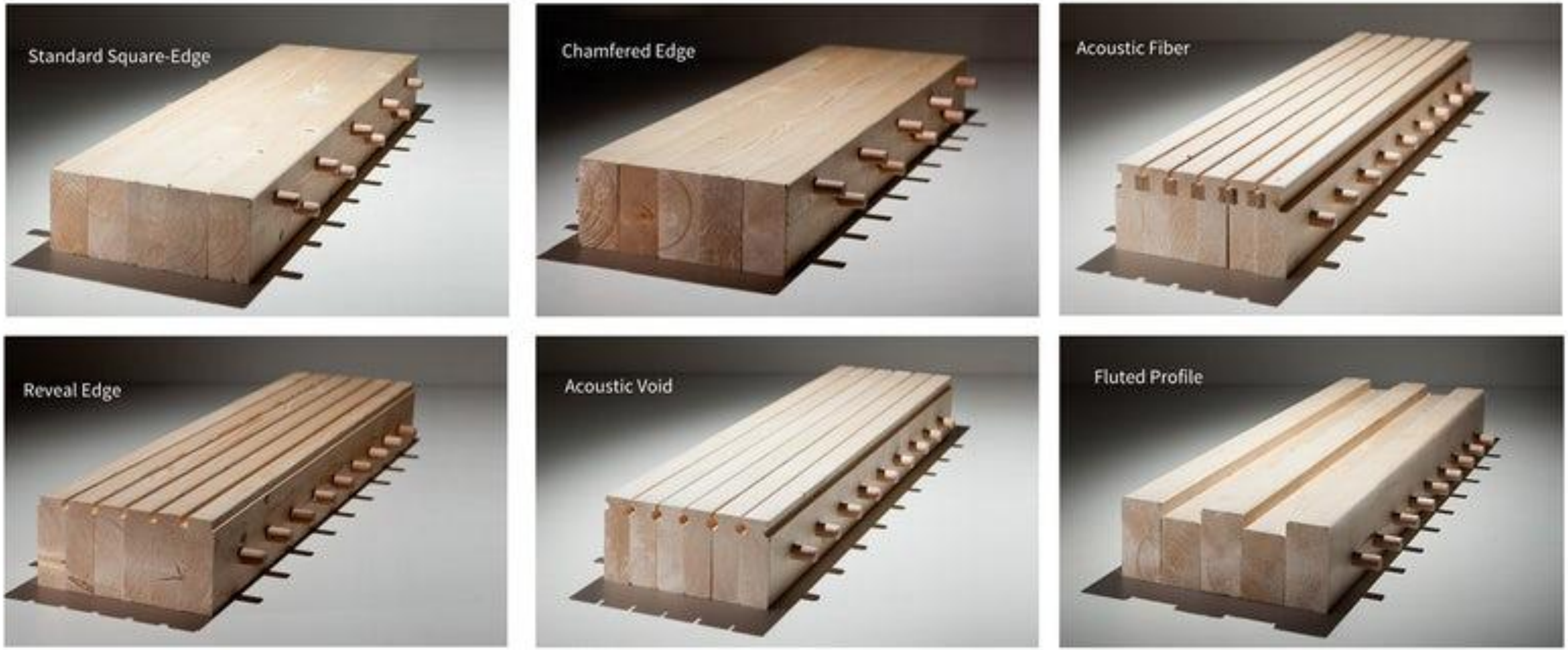


Photo credit: StructureCraft

Glue Laminated Timber (GLT) Panels

Photo credit: Structure Fusion

Photo credit: Unalam

Glue Laminated Timber (GLT) Panels

What is it?

- Similar to glulam beams on their side
- Same code references and manufacturing standards as glulam beams and columns
- Watch design stresses and layups
  - Spec uniform layup (all lams same species & grade)

Image source: StructureCraft

Image source: Manasc Isaac Architects / Fast + Epp

Glue Laminated Timber (GLT) Panels

» Design values for bending in NDS Supplement

» Layup combinations optimized for beams, not GLT deckings

Image source: StructureCraft

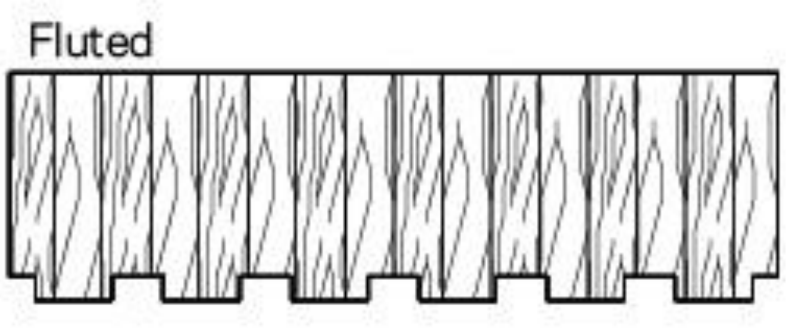
Use with Table 5A Adjustment Factors

		Bending About X-X Axis (Loaded Perpendicular to Wide Faces of Laminations)							Bending About Y-Y Axis (Loaded Parallel to Wide Faces of Laminations)				
		Bending		Compression Perpendicular to Grain		Shear Parallel to Grain	Modulus of Elasticity		Bending	Compression Perpendicular to Grain	Shear Parallel to Grain	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				For Deflection Calculations	For Stability Calculations
Combination Symbol	Species Outer/ Core	F_{bx}^{+} (psi)	F_{bx}^{-} (psi)	$F_{c\perp x}$ (psi)		$F_{vx}^{(2)}$ (psi)	E_x (10^6 psi)	$E_{x\,min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp y}$ (psi)	$F_{vy}^{(2)(3)}$ (psi)	E_y (10^6 psi)	$E_{y\,min}$ (10^6 psi)
24F-1.8E		**2400**	**1450**	**650**		**265**	**1.8**	**0.95**	**1450**	**560**	**230**	**1.6**	**0.85**
24F-V4	DF/DF	2400	1850	650	650	265	1.8	0.95	1450	560	230	1.6	0.85
24F-V8	DF/DF	2400	2400	650	650	265	1.8	0.95	1550	560	230	1.6	0.85
24F-E4	DF/DF	2400	1450	650	650	265	1.8	0.95	1400	560	230	1.7	0.90
24F-E13	DF/DF	2400	2400	650	650	265	1.8	0.95	1750	560	230	1.7	0.90
24F-E18	DF/DF	2400	2400	650	650	265	1.8	0.95	1550	560	230	1.7	0.90
24F-V3	SP/SP	2400	2000	740	740	300	1.8	0.95	1700	650	260	1.6	0.85
24F-V8	SP/SP	2400	2400	740	740	300	1.8	0.95	1700	650	260	1.6	0.85
24F-E1	SP/SP	2400	1450	805	650	300	1.8	0.95	1550	650	260	1.7	0.90
24F-E4	SP/SP	2400	2400	805	805	300	1.9	1.00	1850	650	260	1.8	0.95

Glue Laminated Timber (GLT) Panels

Similar design considerations as NLT:

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

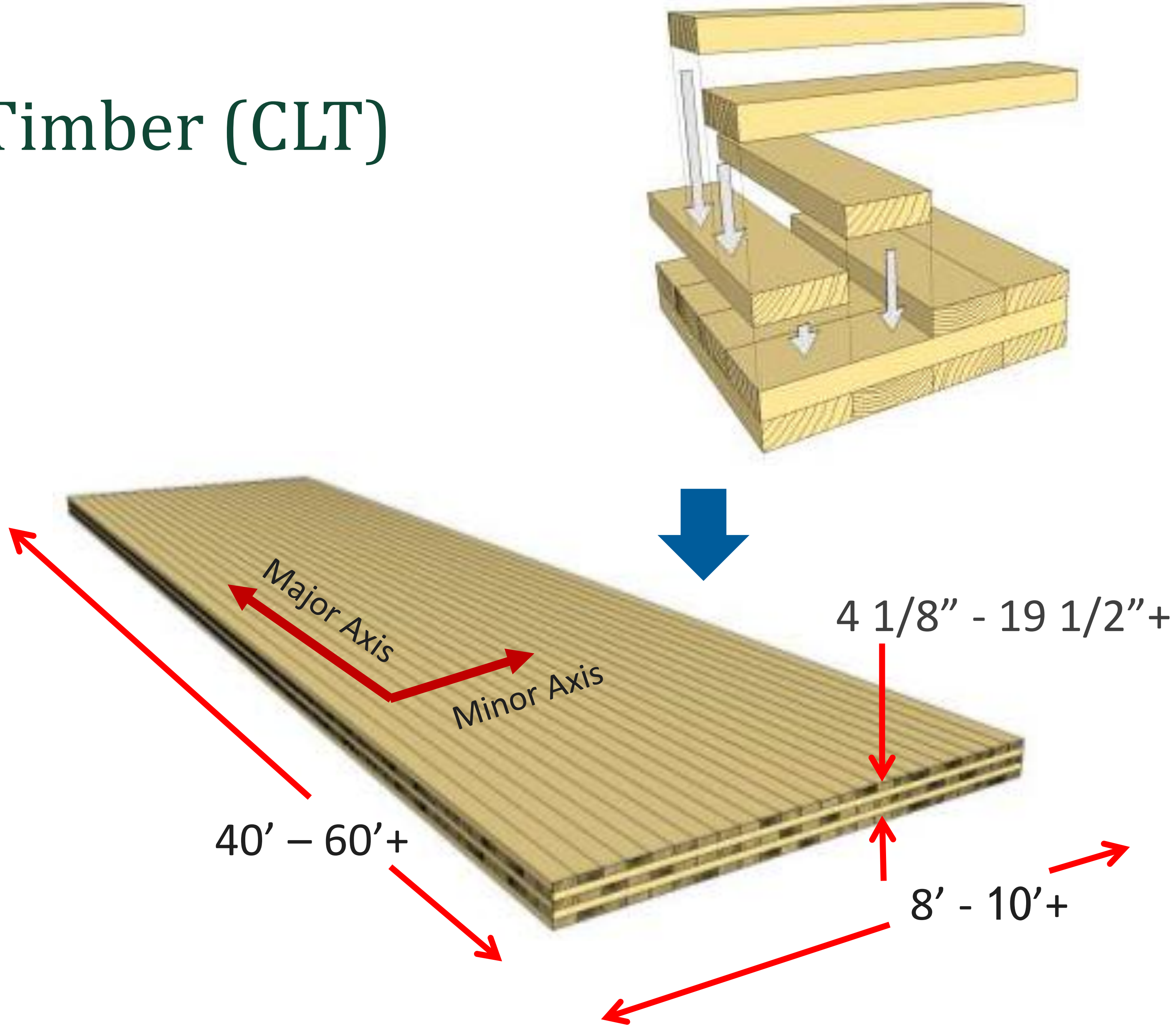


Cross Laminated Timber (CLT)

Cross Laminated Timber (CLT)

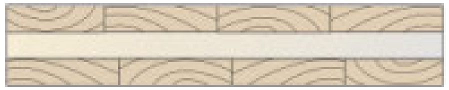
What is it?

» Solid wood panel
» Solid sawn lams
» 3+ layers
» 90° cross-lams



Cross Laminated Timber (CLT) Common Layups

3-ply 3-layer



5-ply 5-layer

7-ply 7-layer

9-ply 9-layer

7-ply 5-layer

9-ply 7-layer

Cross Laminated Timber (CLT) Panel Fabrication

SPRINGER

SPRINGER®

THE WOOD-MECHANISING COMPANY

Cross Laminated Timber (CLT) Prefabrication

- Panels planed, sanded, cut to size
- Openings cut with CNC routers
- 3rd party inspection at factory
- Custom designed and engineered
- Panels delivered/ installed in predetermined sequence


Image Source: Structurlam Products LP

Photo Credit:
Sissi Slotover-Smutny

Cross Laminated Timber (CLT)

- Since 2015 IBC, CLT defined in Chapter 2 Definitions:

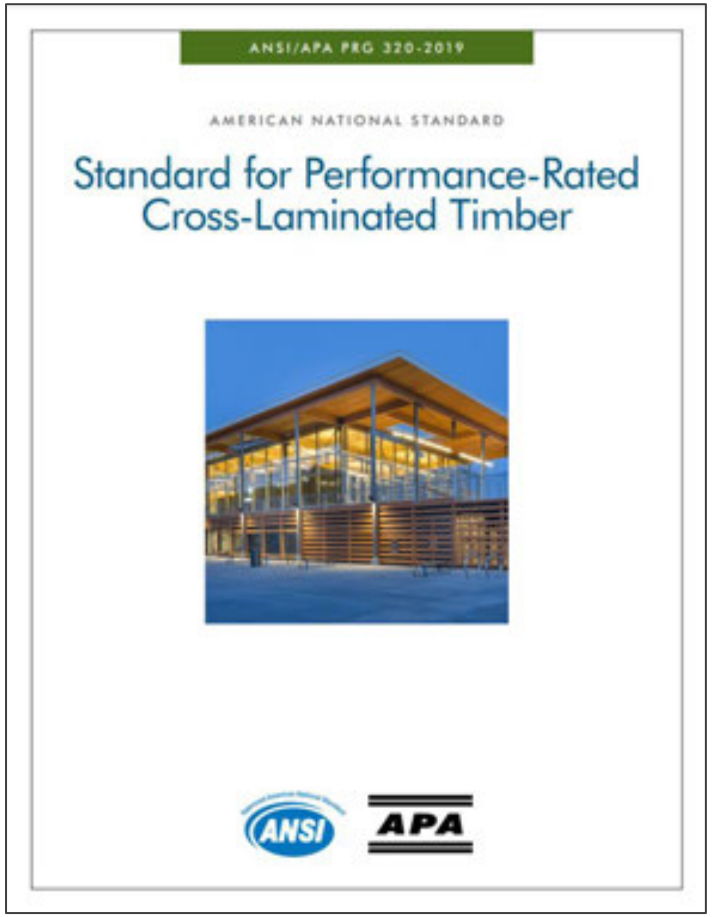
[BS] CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

- And referenced in Chapter 23:

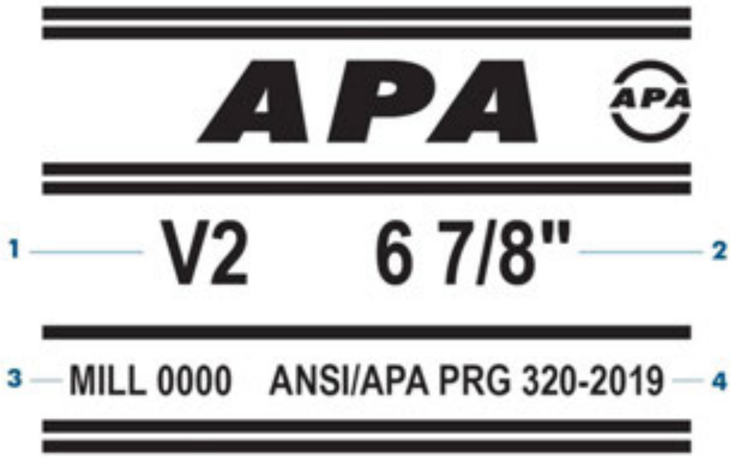
2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

Cross Laminated Timber (CLT)

» ANSI / APA PRG 320 Standard



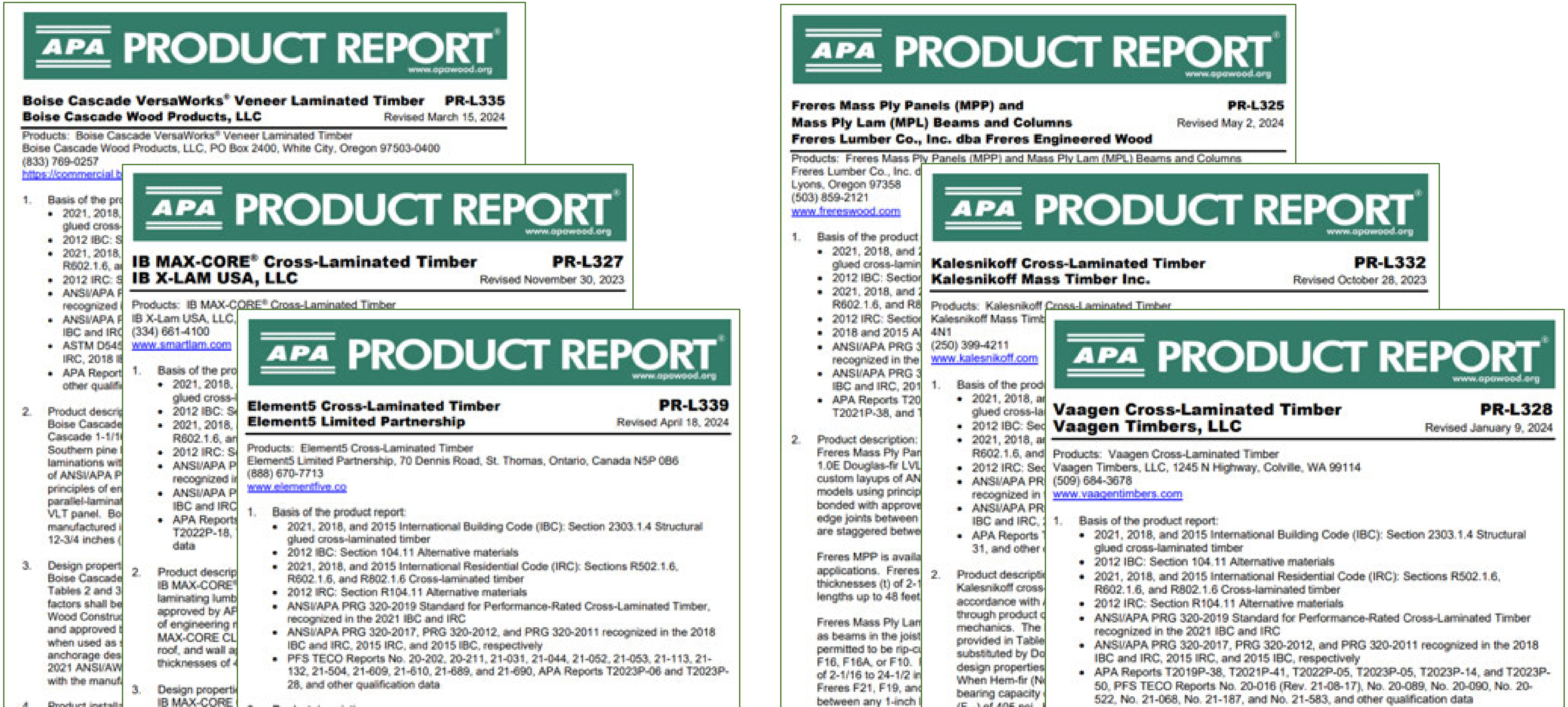
CLT Trademark Example:



1. Grade qualified in accordance with ANSI/APA PRG 320.
2. Product thickness.
3. APA mill number.
4. Referenced product standard.

Source: Structure Magazine, April 2022

Cross Laminated Timber (CLT) Product Reports



APA PRODUCT REPORT
www.apawood.org

Boise Cascade VersaWorks® Veneer Laminated Timber PR-L335
Boise Cascade Wood Products, LLC Revised March 15, 2024

Products: Boise Cascade VersaWorks® Veneer Laminated Timber
Boise Cascade Wood Products, LLC, PO Box 2400, White City, Oregon 97503-0400
(833) 769-0257

APA PRODUCT REPORT
www.apawood.org

IB MAX-CORE® Cross-Laminated Timber PR-L327
IB X-LAM USA, LLC Revised November 30, 2023

Products: IB MAX-CORE® Cross-Laminated Timber
(334) 661-4100
www.smartlam.com

APA PRODUCT REPORT
www.apawood.org

Element5 Cross-Laminated Timber PR-L339
Element5 Limited Partnership Revised April 18, 2024

Products: Element5 Cross-Laminated Timber
Element5 Limited Partnership, 70 Dennis Road, St. Thomas, Ontario, Canada N5P 0B6
(888) 670-7713
www.elementfive.co

1. Basis of the product report:
   - 2021, 2018, and 2015 International Building Code (IBC): Section 2303.1.4 Structural glued cross-laminated timber
   - 2012 IBC: Section 104.11 Alternative materials
   - 2021, 2018, and 2015 International Residential Code (IRC): Sections R502.1.6, R602.1.6, and R802.1.6 Cross-laminated timber
   - 2012 IRC: Section R104.11 Alternative materials
   - ANSI/APA PRG 320-2019 Standard for Performance-Rated Cross-Laminated Timber, recognized in the 2021 IBC and IRC
   - ANSI/APA PRG 320-2017, PRG 320-2012, and PRG 320-2011 recognized in the 2018 IBC and IRC, 2015 IRC, and 2015 IBC, respectively
   - PFS TECO Reports No. 20-202, 20-211, 21-031, 21-044, 21-052, 21-053, 21-113, 21-132, 21-504, 21-609, 21-610, 21-689, and 21-690, APA Reports T2023P-06 and T2023P-28, and other qualification data

APA PRODUCT REPORT
www.apawood.org

Freres Mass Ply Panels (MPP) and Mass Ply Lam (MPL) Beams and Columns PR-L325
Freres Lumber Co., Inc. dba Freres Engineered Wood Revised May 2, 2024

Products: Freres Mass Ply Panels (MPP) and Mass Ply Lam (MPL) Beams and Columns
Lyons, Oregon 97358
(503) 859-2121
www.frereswood.com

APA PRODUCT REPORT
www.apawood.org

Kalesnikoff Cross-Laminated Timber PR-L332
Kalesnikoff Mass Timber Inc. Revised October 28, 2023

Products: Kalesnikoff Cross-Laminated Timber
(250) 399-4211
www.kalesnikoff.com

APA PRODUCT REPORT
www.apawood.org

Vaagen Cross-Laminated Timber PR-L328
Vaagen Timbers, LLC Revised January 9, 2024

Products: Vaagen Cross-Laminated Timber
Vaagen Timbers, LLC, 1245 N Highway, Colville, WA 99114
(509) 684-3678
www.vaagentimbers.com

1. Basis of the product report:
   - 2021, 2018, and 2015 International Building Code (IBC): Section 2303.1.4 Structural glued cross-laminated timber
   - 2012 IBC: Section 104.11 Alternative materials
   - 2021, 2018, and 2015 International Residential Code (IRC): Sections R502.1.6, R602.1.6, and R802.1.6 Cross-laminated timber
   - 2012 IRC: Section R104.11 Alternative materials
   - ANSI/APA PRG 320-2019 Standard for Performance-Rated Cross-Laminated Timber recognized in the 2021 IBC and IRC
   - ANSI/APA PRG 320-2017, PRG 320-2012, and PRG 320-2011 recognized in the 2018 IBC and IRC, 2015 IRC, and 2015 IBC, respectively
   - APA Reports T2019P-38, T2021P-41, T2022P-05, T2023P-05, T2023P-14, and T2023P-50, PFS TECO Reports No. 20-016 (Rev. 21-08-17), No. 20-089, No. 20-090, No. 20-522, No. 21-068, No. 21-187, and No. 21-583, and other qualification data

Mass Plywood Panels (MPP)

Mass Plywood Panels (MPP)

What is it?

- » Thicknesses in 1” Increments
- » Structural properties in APA PR-L325

MPP

Table 1. ASD Reference Design Values[a,b,c] for Freres MPP (For Use in the U.S.)

MPP Layup	Layup ID	Thickness, t_p (in.)	Major Strength Direction: $(F_bS)_{eff,f,0}$ (lbf-ft/ft)	Major Strength Direction: $(EI)_{eff,f,0}$ (10^6 lbf-in.^{2}/ft)	Major Strength Direction: $(GA)_{eff,f,0}$ (10^6 lbf/ft)	Major Strength Direction: $V_{s,0}$ (lbf/ft)	Minor Strength Direction: $(F_bS)_{eff,f,90}$ (lbf-ft/ft)	Minor Strength Direction: $(EI)_{eff,f,90}$ (10^6 lbf-in.^{2}/ft)	Minor Strength Direction: $(GA)_{eff,f,90}$ (10^6 lbf/ft)	Minor Strength Direction: $V_{s,90}$ (lbf/ft)
F16	F16-2	2	1,110	16	0.82	2,190	210	2.8	0.17	695
	F16-3	3	1,870	51	1.23	2,190	355	9.0	0.26	695
	F16-4	4	3,325	122	1.64	2,925	630	21	0.34	930
	F16-5	5	5,200	238	2.05	3,650	985	42	0.43	1,160
	F16-6	6	7,500	410	2.46	4,375	1,420	72	0.69	1,390
	F16-7	7	10,200	652	2.66	5,100	1,930	114	0.81	1,630
	F16-8	8	13,325	973	3.04	5,825	2,525	170	0.91	1,860
	F16-9	9	16,850	1,385	3.42	6,575	3,200	242	1.04	2,090
	F16-10	10	20,825	1,900	3.80	7,300	3,950	333	1.15	2,320
	F16-11	11	25,175	2,529	4.18	8,025	4,775	443	1.27	2,550
	F16-12	12	29,975	3,283	4.56	8,750	5,675	575	1.38	2,775

For SI: 1 in. = 25.4 mm; 1 ft = 304.8 mm; 1 lbf = 4.448N

(a) Tabulated values are allowable design values.

(b) Tabulated values are limited to MPP manufactured with 1-inch-thick Freres 1.6E Douglas-fir LVL.

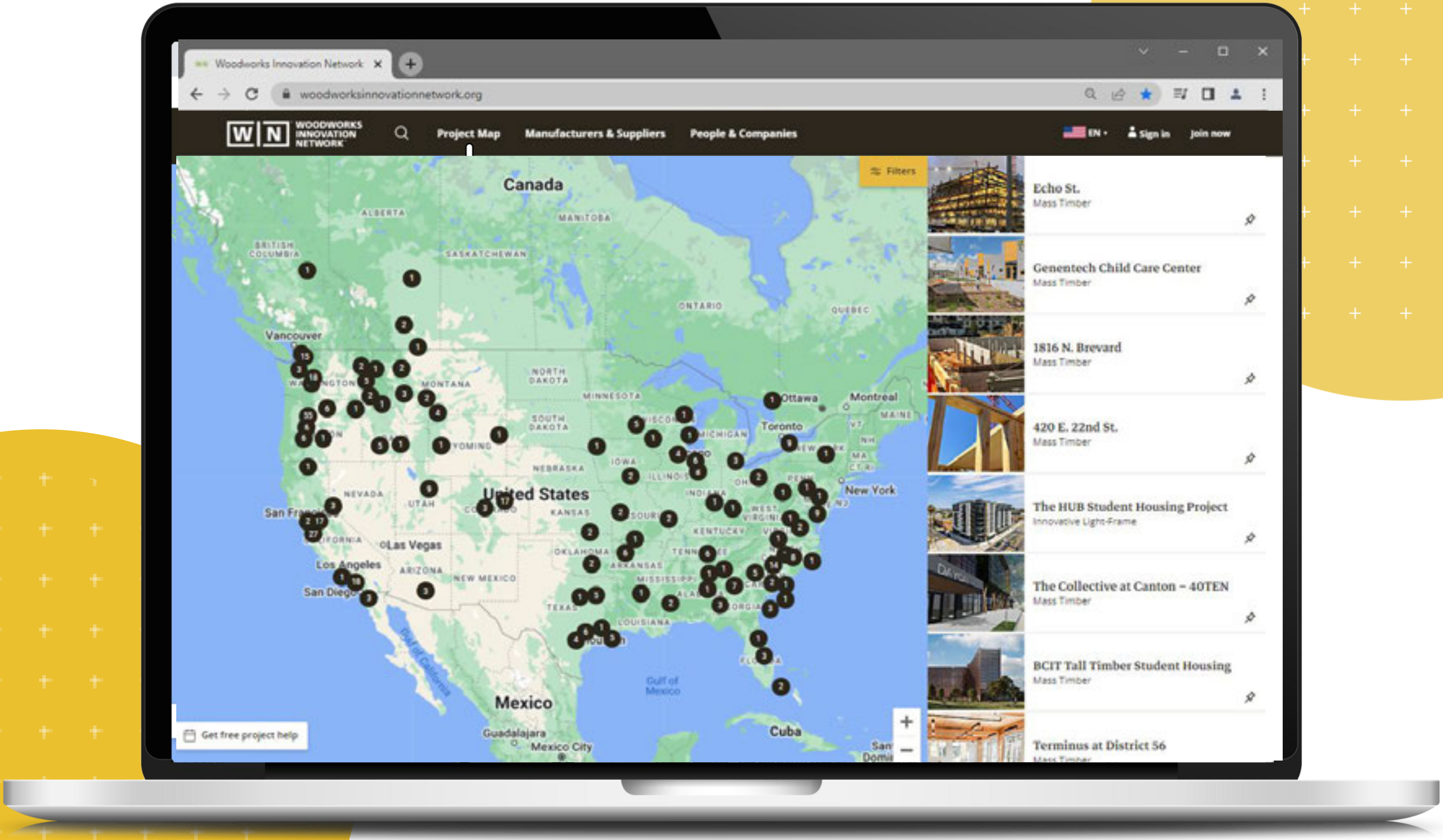
(c) Deflection under a specified uniformly distributed load, w, acting perpendicular to the face of a single-span panel may be calculated as a sum of the deflections due to moment and shear effects using the effective bending stiffness, $(EI)_{eff}$, and the effective in-plane (planar) shear rigidity, $(GA)_{eff}$, as follows:

$$\delta = \frac{22.5wL^4}{(EI)_{eff}} + \frac{3wL^2}{2(GA)_{eff}} \qquad [1]$$

where: δ = Estimated deflection, inches; w = uniform load, plf;
L = span, feet; $(EI)_{eff}$ = tabulated effective bending stiffness, 10^6 lbf-in.^{2}/ft; and
$(GA)_{eff}$ = tabulated effective in-plane (planar) shear rigidity, 10^6 lbf/ft

WOODWORKS INNOVATION NETWORK.ORG

111 East Grand / Neumann Monson Architects
photo Mike Sinclair


Woodworks Innovation Network
woodworksinnovationnetwork.org
WOODWORKS INNOVATION NETWORK
Project Map
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Ottawa
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Toronto
New York
Las Vegas
Los Angeles
San Diego
Echo St.
Mass Timber
Genentech Child Care Center
Mass Timber
1816 N. Brevard
Mass Timber
420 E. 22nd St.
Mass Timber
The HUB Student Housing Project
Innovative Light-Frame
The Collective at Canton – 40TEN
Mass Timber
BCIT Tall Timber Student Housing
Mass Timber
Terminus at District 56
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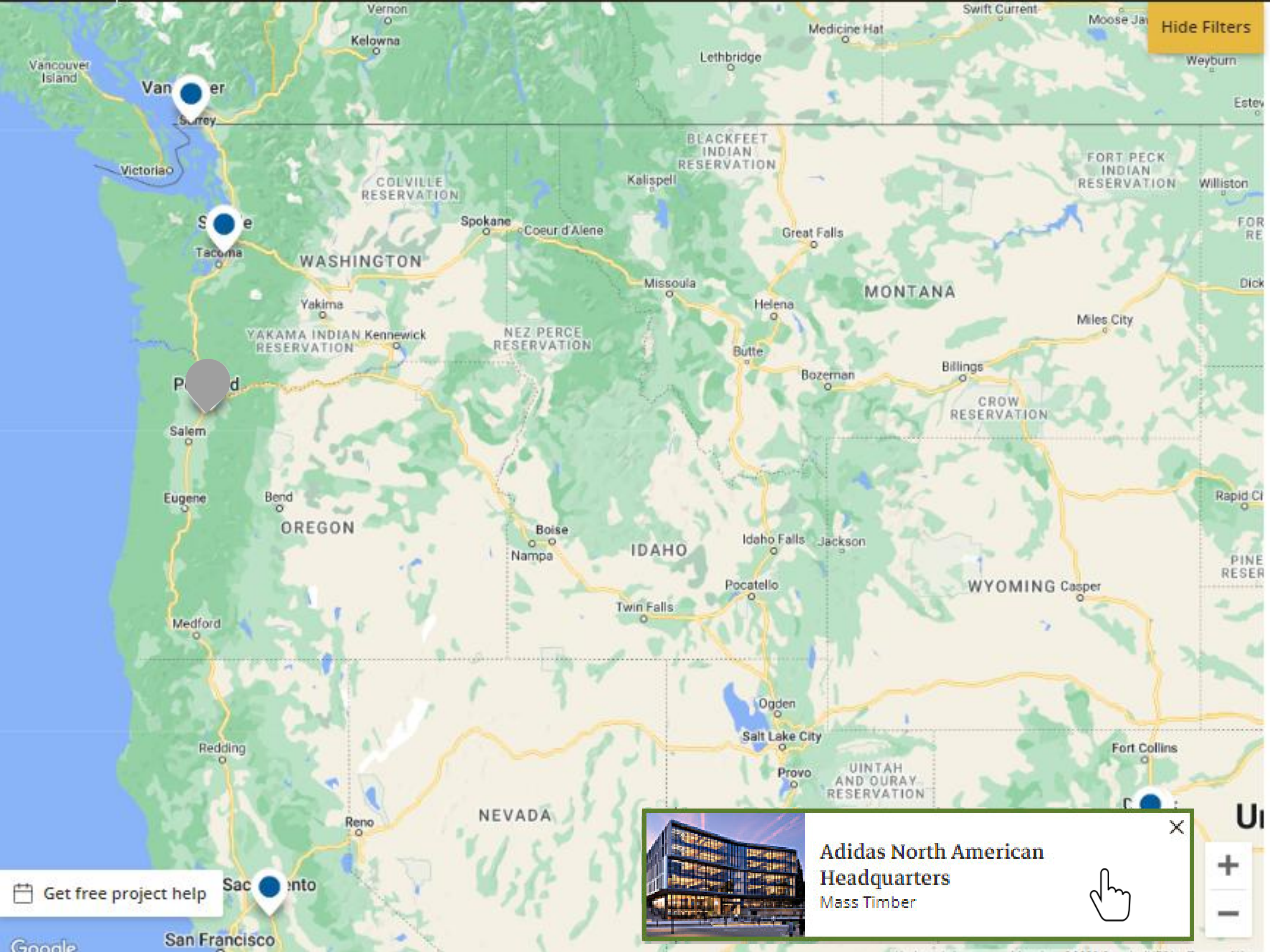


- [ ] Structural Composite Lumber (e.g. LVL and LSL) 0
- [ ] Timber-Frame / Post and Beam 2
- [ ] Wood structural panels 0
- [ ] Wood-Concrete Composite Systems 0

Other Properties

- [ ] Wood Design Award Winner 2
- [ ] Affordable Housing 1
- [ ] Business Case Study Available 0
- [ ] Spec Office 1
- [ ] Technical Case Study Available 1

Number of Stories

1 — 12

Year Built

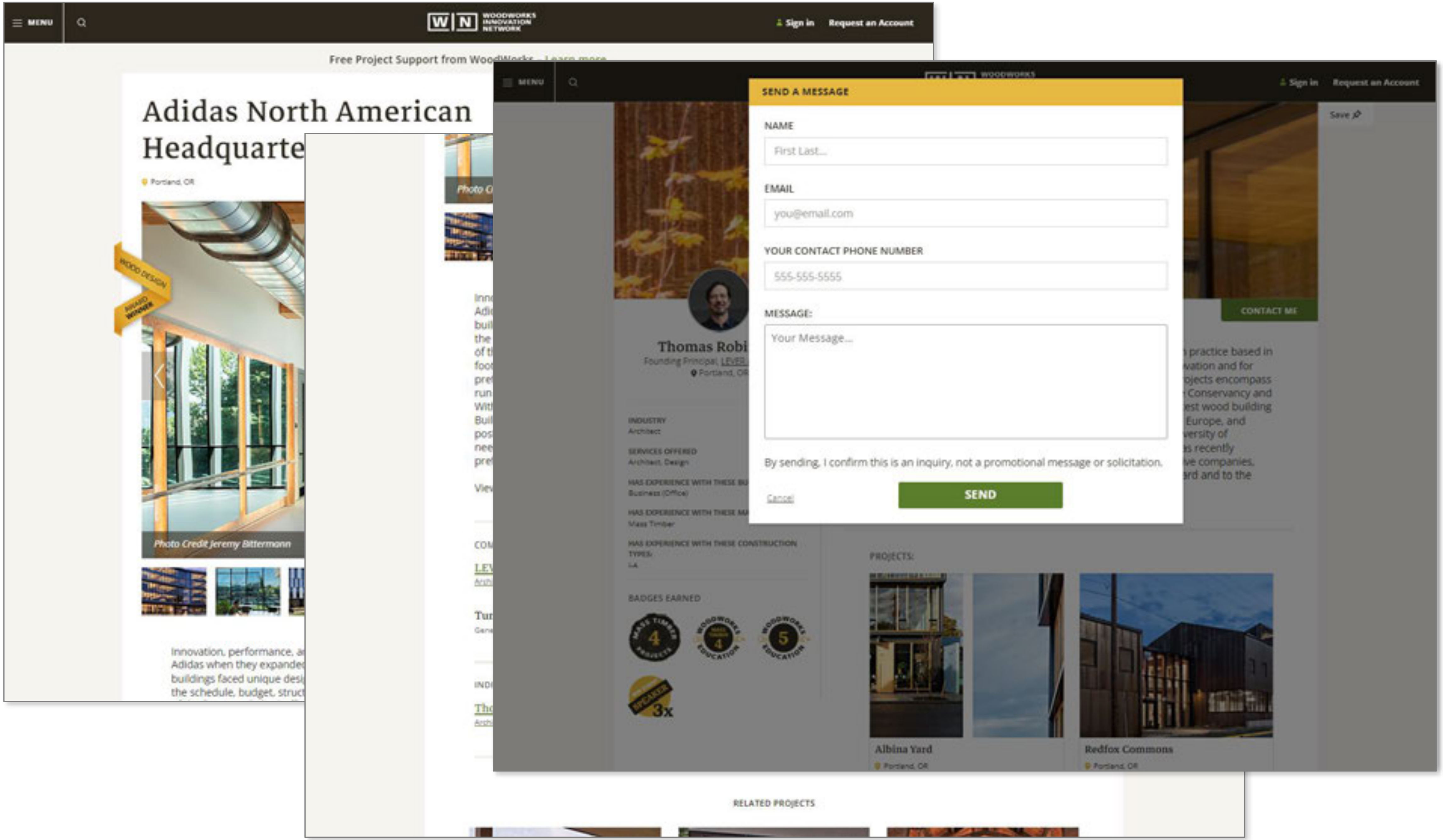
Select...

Construction Types

- [ ] I-A 0
- [ ] I-B 0
- [ ] II-A 0
- [ ] II-B 0
- [ ] III-A 3
- [ ] III-B 1
- [ ] IV-A 0
- [ ] IV-B 1
- [ ] IV-C 0
- [ ] IV-HT 2
- [ ] Unknown 0
- [ ] V-A 0
- [ ] V-B 1

Square Footage

- [ ] < 10,000 18
- [ ] 10,000 - 50,000 72
- [ ] 50,000 - 200,000 74
- [x] 200,000 + 8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buildings faced unique desi
the schedule, budget, struc
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PROJECTS:
Albina Yard
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Redfox Commons
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Early Design Decisions: Priming Mass Timber Projects for Success

WOODWORKS WOOD PRODUCTS COUNCIL ™

Jason Bahr, P.E.


Photo: Structurlam

Outline

- Key Early Design Decisions
- Construction Types
- Fire Design
- Structural Grid
- Connections
- Penetrations & Firestopping
- MEP Layout and Integration
- Lateral Systems
- Acoustics

Key Early Design Decisions

What is the Single Most Important Early Design Decision on a Mass Timber Project? Is it:

Construction Type	MEP Layout
Fire-Resistance Ratings	Acoustics
Member Sizes	Concealed Spaces
Grids & Spans	Connections
Exposed Timber (where & how much)	Penetrations

The Answer is…They All Need to Be Weighed (Plus Others)

Key Early Design Decisions

One *potential* design route:

1. **Building size & occupancy informs construction type & grid**

2. **Construction type informs fire resistance ratings**

3. **Grid & fire resistance ratings inform timber member sizes & MEP layout**

But that's not all…

Key Early Design Decisions

Other impactful decisions:

- **Acoustics informs member sizes (and vice versa)**
- **Fire-resistance ratings inform connections & penetrations**
- **MEP layout informs use of concealed spaces**

Miller Hull Partnership, photo: John Sta

Key Early Design Decisions

Other impactful decisions:

- **Manufacturer capabilities** inform member sizes, grids & connections
- **Lateral system** informs connections, construction sequencing

And more…

Platte Fifteen, Oz Architecture, KL&A Engineers & Builders, Arch Angle Media

Key Early Design Decisions

Early = Efficient

Realize Efficiency in:

» Cost reduction
» Material use (optimize fiber use, minimize waste)
» Construction speed
» Trade coordination
» Minimize RFIs

Commit to a mass timber design from the start

Outline

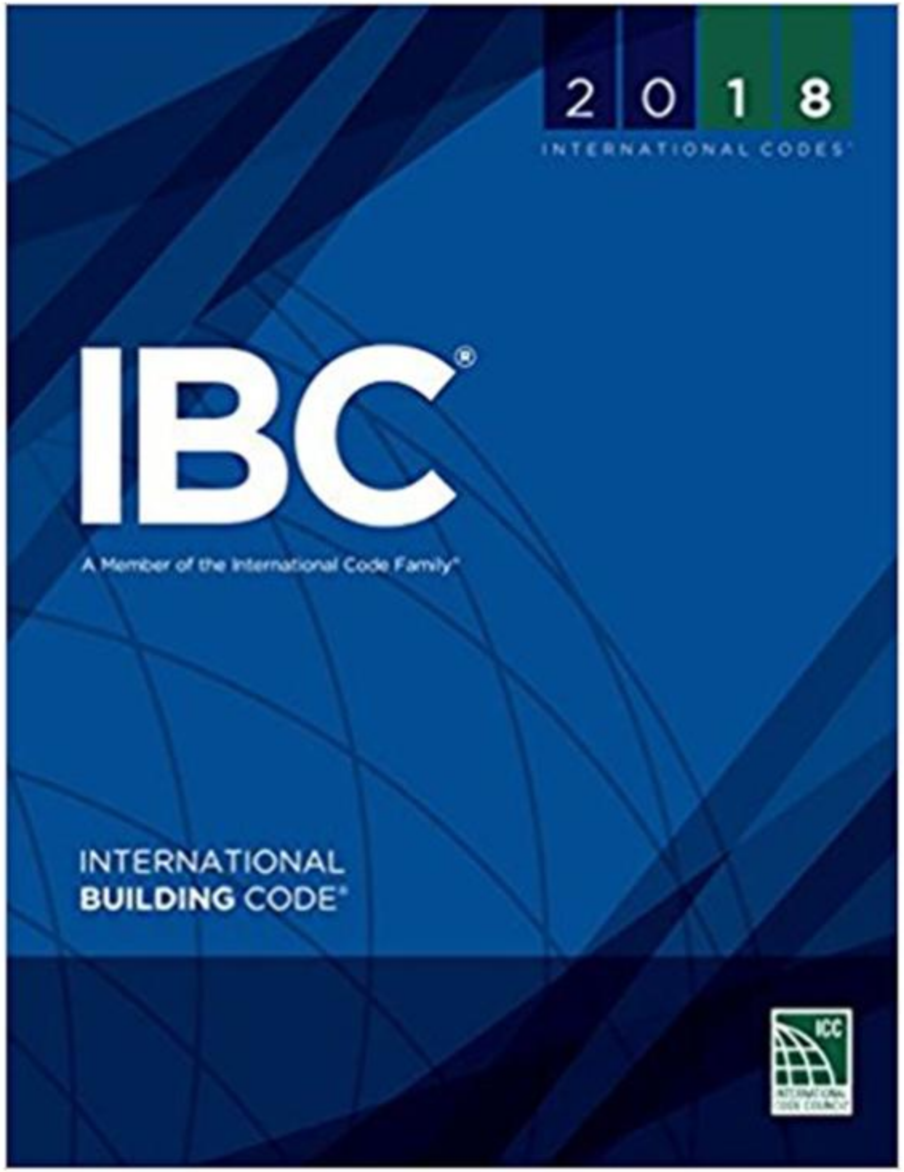
- » Key Early Design Decisions
- Construction Types
- » Fire Design
- » Structural Grid
- » Connections
- » Penetrations & Firestopping
- » MEP Layout and Integration
- » Lateral Systems
- » Acoustics

Construction Types

When does the code allow mass timber to be used?

IBC defines mass timber systems in IBC Chapter 2 and notes their acceptance and manufacturing standards in IBC Chapter 23

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



Construction Types

IBC defines 5 construction types: I, II, III, IV, 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 including several for mass timber

Construction Types

Where does the code allow MT to be used?

Type IB & II: Roof Decking

Image: DeStafano & Chamberlain, Inc, Robert Benson Photography

Image: StructureCraft Builders

Construction Types

All wood-framed building options:

<u>Type III</u>

Exterior walls non-combustible (may be FRTW)

Interior elements any allowed by code, including mass timber

<u>Type V</u>

All building elements are any allowed by code, including mass timber

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

<u>Type IV (Heavy Timber)</u>

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

Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces except in 2021 IBC)

Construction Types

Where does the code allow MT to be used?

Type III: Interior elements (floors, roofs, partitions/shafts) and exterior walls if FRT

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

Construction Types

Where does the code allow MT to be used?

Type IV: Any exposed interior elements & roofs, must meet min. sizes; exterior walls if CLT or FRT. Concealed space limitations (varies by code version)

Image: Perkins + Will

Construction Types

Type IV construction permits exposed heavy/mass timber elements of min. sizes.

Minimum Width by Depth in Inches

Framing		Solid Sawn (nominal)	Glulam (actual)	SCL (actual)
Floor	Columns	8 x 8	$6^3/_4$ x 8¼	7 x 7½
	Beams	6 x 10	5 x 10½	5¼ x 9½
Roof	Columns	6 x 8	5 x 8¼	5¼ x 7½
	Beams*	4 x 6	3 X $6^7/_8$	3½ X 5½

*3" nominal width allowed where sprinklered

See IBC 2018 2304.11 or IBC 2015 602.4 for Details

Photo: WoodWorks

Construction Types

Type IV min. sizes:

<u>Floor Panels/Decking:</u>

- » 4” thick CLT (actual thickness)
- » 4” NLT/DLT/GLT (nominal thickness)
- » 3” thick (nominal) decking covered with: 1” decking or 15/32” WSP or ½” particleboard

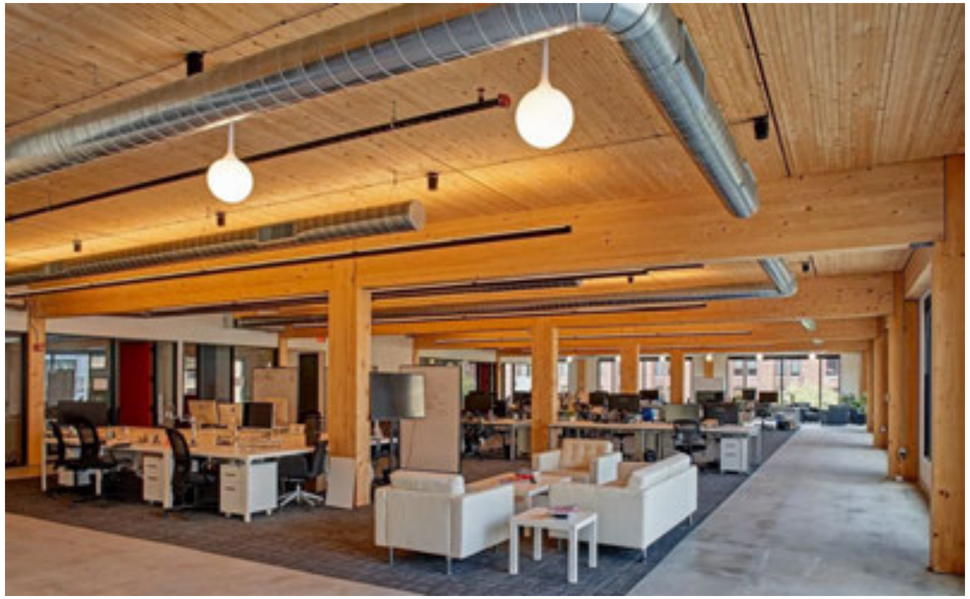


Photo: StructureCraft

Photo: Aitor Sanchez/ Ewing Cole

Photo: WoodWorks

Construction Types

Concealed spaces solutions paper

Richard McLain, PE, SE
Senior Technical Director – Tall Wood
WoodWorks – Wood Products Council

Concealed Spaces in Mass Timber and Heavy Timber Structures

Concealed spaces, such as those created by a dropped ceiling in a floor/ceiling assembly or by a stud wall assembly, have unique requirements in the International Building Code (IBC) to address the potential of fire spread in non-visible areas of a building. Section 718 of the 2018 IBC includes prescriptive requirements for protection and/or compartmentalization of concealed spaces through the use of draft stopping, fire blocking, sprinklers and other means. For information on these requirements, see the WoodWorks Q&A, *Are sprinklers required in concealed spaces such as floor and roof cavities in multi-family wood-frame buildings?*[1]

For mass timber building elements, the choice of construction type can have a significant impact on concealed space requirements. Because mass timber products such as cross-laminated timber (CLT) are prescriptively recognized for Type IV construction, there is a common misperception that exposed mass timber building elements cannot be used or exposed in other construction types. This is not the case.

In addition to Type IV buildings, structural mass timber elements—including CLT, glue-laminated timber (glulam), nail-laminated timber (NLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—can be utilized and exposed in the following construction types, whether or not a fire-resistance rating is required:

- **Type III** – Floors, roofs and interior walls may be any material permitted by code, including mass timber; exterior walls are required to be noncombustible or fire retardant-treated wood.
- **Type V** – Floors, roofs, interior walls and exterior walls (i.e., the entire structure) may be constructed of mass timber.
- **Types I and II** – Mass timber may be used in select circumstances such as roof construction—including the primary frame in the 2021 IBC—in Types I-B, II-A or II-B; exterior columns and arches when 20 feet or more of horizontal separation is provided; and balconies, canopies and similar projections.

INTRO, Cleveland | Cleveland, Ohio
Harbor Bay Real Estate Advisors
HPA Architecture

The John W. Olver Design Building at UMass Amherst includes exposed wood structure in some areas and dropped ceilings in others. Architect: Leers Weinzapfel Associates

https://www.woodworks.org/wp-content/uploads/wood_solution_paper-Concealed_Spaces_Timber_Structures.pdf

Construction Types

Where does the code allow MT to be used?

Type V: All interior elements, roofs & exterior walls

Image: Christian Columbres Photography

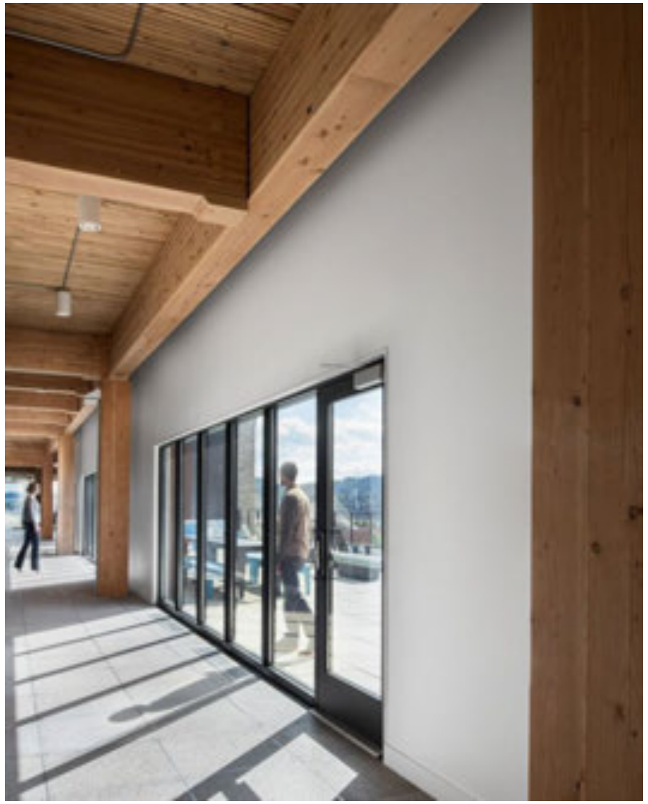
Construction Types

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

Type III: 6 stories

Type IV: 6 stories

Credit: Ema Peter

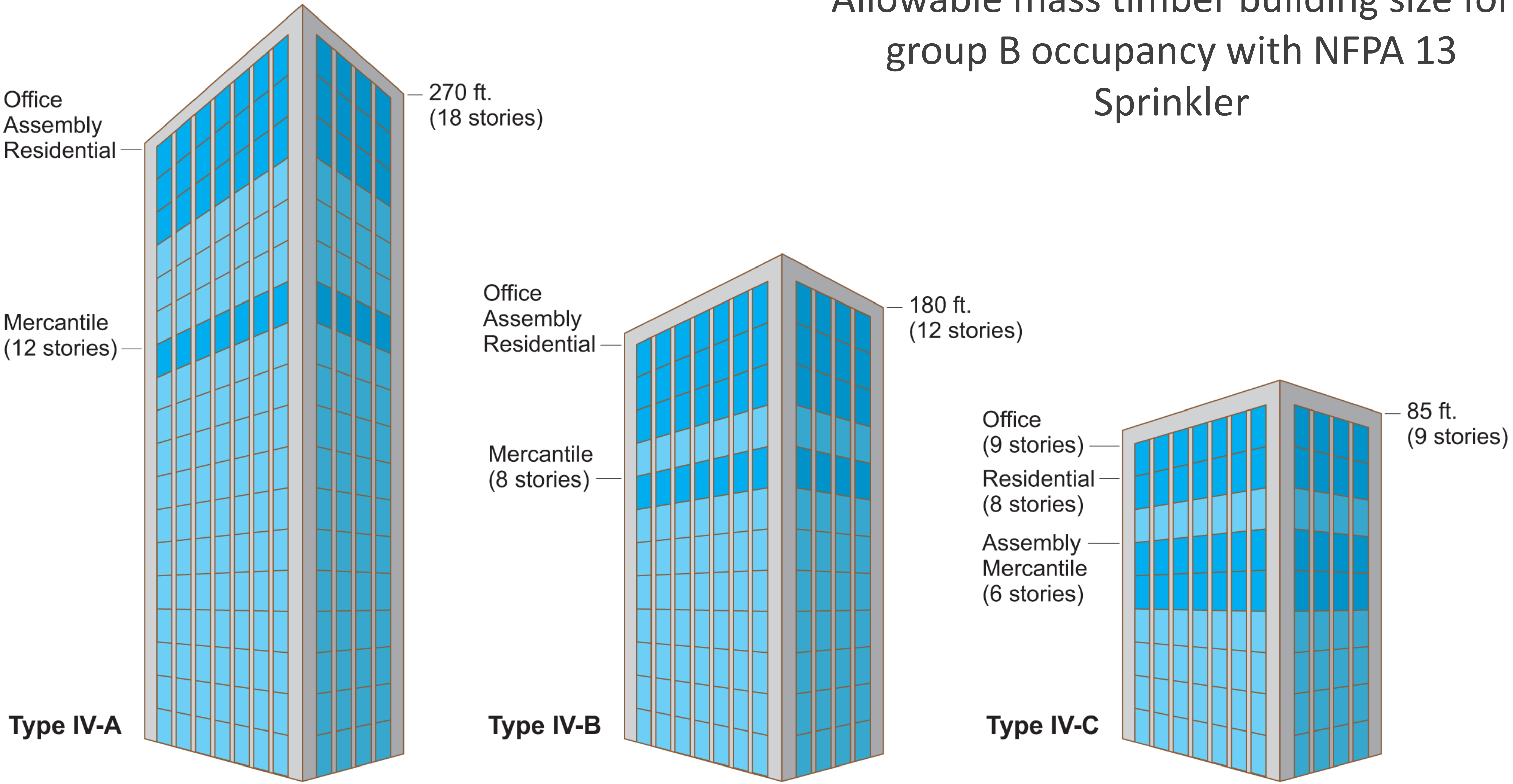


Credit: Christian Columbres Photography

Type V: 4 stories

Construction Types

New Options in 2021 IBC
Allowable mass timber building size for group B occupancy with NFPA 13 Sprinkler



Outline

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- Fire Design
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- Connections
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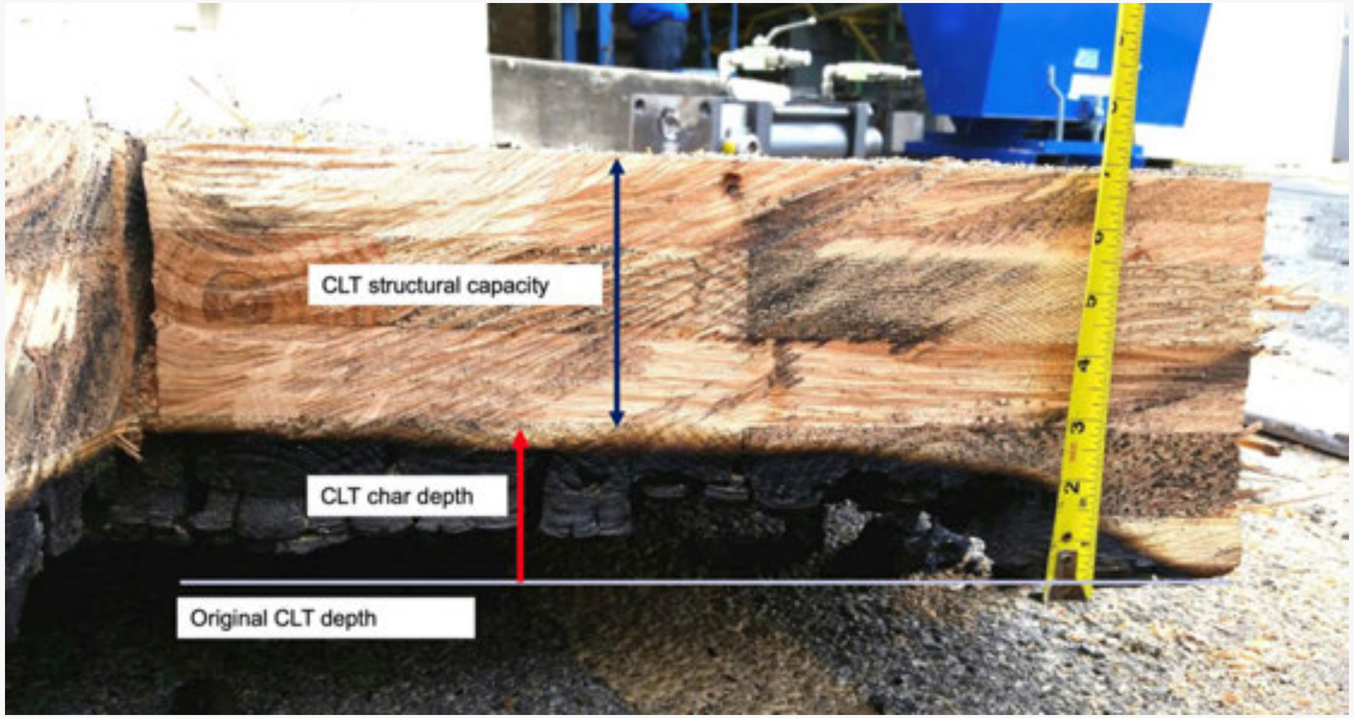
- MEP Layout and Integration
- Lateral Systems
- Acoustics



Key Early Design Decisions

Construction type influences FRR

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	$1^1/_2$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

Source: 2018 IBC

Key Early Design Decisions

Construction type influences FRR

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1½[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	1½	1	1	HT	1[b,c]	0

Source: 2021 IBC

Construction type influences FRR

- » Type IV-HT Construction (minimum sizes)
- » Other than type IV-HT: Demonstrated fire resistance

Method of demonstrating FRR (calculations or testing) can impact member sizing


Fire Testing Laboratory

ACCREDITED Testing Laboratory

TEST REPORT

Page 1 of 53

for

American Wood Council

222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

Standard Methods of
Fire Tests of Building Construction and Materials
ASTM E 119 – 11a

Test Report No: WP-1950
Assignment No: K-1269
Subject Material: Cross-Laminated Timber and Gypsum Board Wall Assembly (Load-Bearing)
Test Date: October 4, 2012
Report Date: October 15, 2012

Prepared by:
Michael J. Rigg
Test Engineer

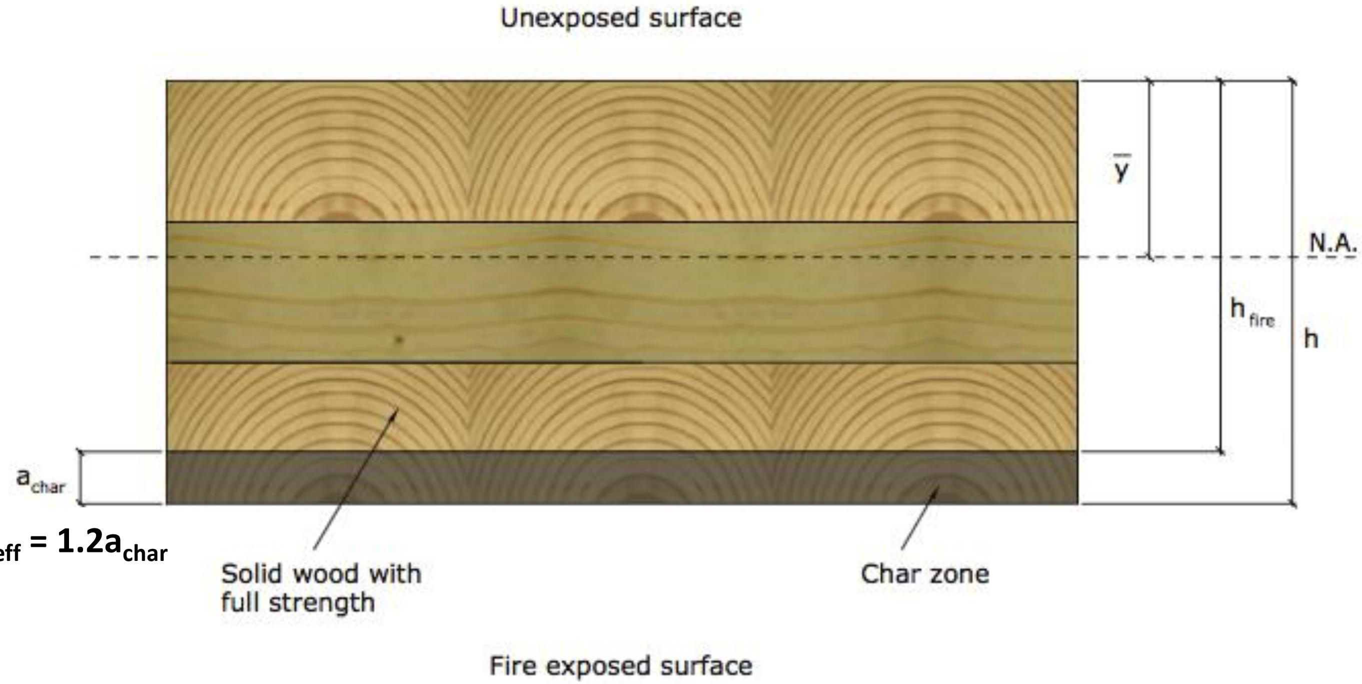
Reviewed by:
Robert J. Menchetti
Director, Laboratory Facilities and Testing Services

Construction type influences FRR

Which Method of Demonstrating FRR of MT is Being Used?

- » Calculations in Accordance with IBC 722 ⟶ NDS Chapter 16
- » Tests in Accordance with ASTM E119

Credit: Urban One

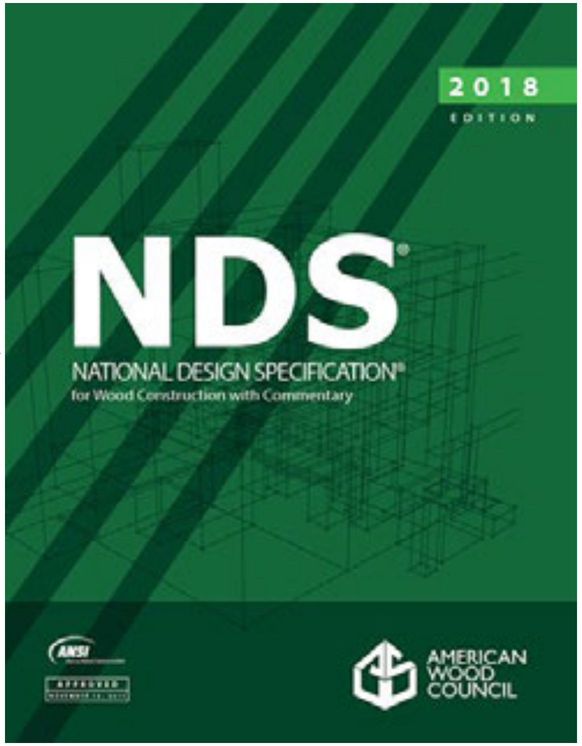


$a_{eff} = 1.2a_{char}$

FRR Design of MT

Calculated FRR of Exposed MT:

IBC to NDS code compliance path



Code Path for Exposed Wood Fire-Resistance Calculations

IBC 703.3
Methods for determining fire resistance

- Prescriptive designs per IBC 721.1
- ***Calculations in accordance with IBC 722***
- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Alternate protection methods as allowed by 104.11

IBC 722
Calculated Fire Resistance

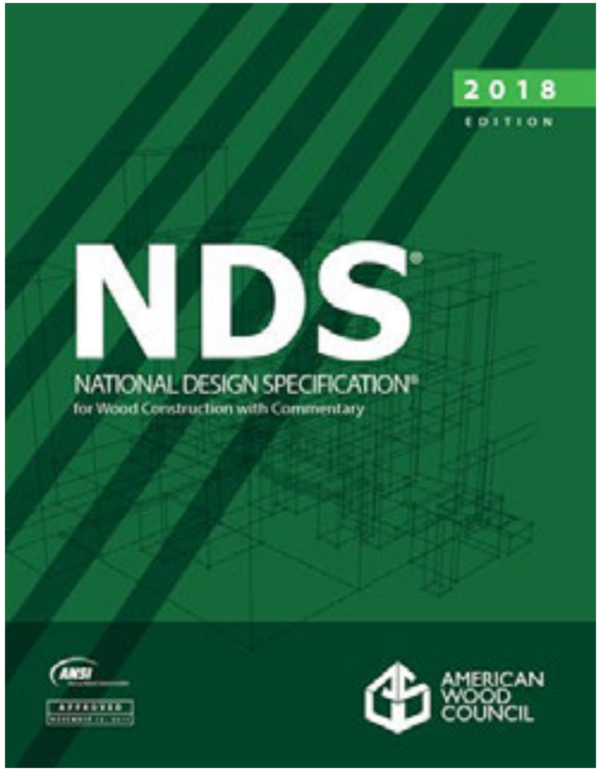
"The calculated *fire resistance* of exposed wood members and wood decking shall be permitted in accordance with **Chapter 16 of ANSI/AWC National Design Specification for Wood Construction (NDS)**

NDS Chapter 16
Fire Design of Wood Members

- Limited to calculating fire resistance up to 2 hours
- Char depth varies based on exposure time (i.e., fire-resistance rating), product type and lamination thickness. Equations and tables are provided.
- TR 10 and NDS commentary are helpful in implementing permitted calculations.

FRR Design of MT

NDS Chapter 16 includes calculation of fire resistance of NLT, CLT, Glulam, Solid Sawn and SCL wood products



NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION 149

FIRE DESIGN OF WOOD MEMBERS

16

Credit: FPInnovations

Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

FRR Design of MT

Nominal char rate of 1.5”/HR is recognized in NDS. Effective char depth calculated to account for duration, structural reduction in heat-affected zone

Credit: ARUP

Table 16.2.1A Char Depth and Effective Char Depth (for β_n = 1.5 in./hr.)

Required Fire Resistance (hr.)	Char Depth, a_{char} (in.)	Effective Char Depth, a_{eff} (in.)
1-Hour	1.5	1.8
1½-Hour	2.1	2.5
2-Hour	2.6	3.2

Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

WoodWorks Inventory of Fire Tested MT Assemblies

Table 1: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies

WoodWorks™ WOOD PRODUCTS COUNCIL

CLT Panel	Manufacturer	CLT Grade or Major x Minor Grade	Ceiling Protection	Panel Connection in Test	Floor Topping	Load Rating	Fire Resistance Achieved (Hours)	Source	Testing Lab
3-ply CLT (114mm 4.488 in)	Nordic	SPF 1650 Fb 1.5EMSR x SPF #3	2 layers 1/2" Type X gypsum	Half-Lap	None	Reduced 36% Moment Capacity	1	1 (Test 1)	NRC Fire Laboratory
3-ply CLT (105mm 4.133 in)	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Reduced 75% Moment Capacity	1	1 (Test 5)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	2	NRC Fire Laboratory March 2016
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer of 5/8" Type X gypsum under Z-channels and furring strips with 3 5/8" fiberglass batts	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	5	NRC Fire Laboratory Nov 2014
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat	Reduced 50% Moment Capactiy	1.5	3	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" normal gypsum	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat or proprietary sound board	Reduced 50% Moment Capactiy	2	4	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" Type X Gyp under Resilient Channel under 7 7/8" I-Joists with 3 1/2" Mineral Wool beween Joists	Half-Lap	None	Loaded, See Manufacturer	2	21	Intertek 8/24/2012
5-ply CLT (175mm 6.875")	Structurlam	E1 M5 MSR 2100 x SPF #2	None	Topside Spline	1-1/2" Maxxon Cyp-Crete 2000 over Maxxon Reinforcing Mesh	Loaded, See Manufacturer	2.5	6	Intertek, 2/22/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap & Topside Spline	2" gypsum topping	Loaded, See Manufacturer	2	7	SwRI (May 2016)
5-ply CLT (175mm 6.875")	Nordic	SPF 1950 Fb MSR x SPF #3	None	Half-Lap	None	Reduced 59% Moment Capacity	1.5	1 (Test 3)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Unreduced 101% Moment Capacity	2	1 (Test 6)	NRC Fire Laboratory
7-ply CLT (245mm 9.65")	Structurlam	SPF #1/#2 x SPF #1/#2	None	Half-Lap	None	Unreduced 101% Moment Capacity	2.5	1 (Test 7)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	SmartLam	SL-V4	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 4)	Western Fire Center 10/26/2016
5-ply CLT (175mm 6.875")	SmartLam	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 5)	Western Fire Center 10/28/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 6)	Western Fire Center 11/01/2016
5-ply CLT (160mm 6.3")	KLH	CV3M1	None	Half-Lap & Topside spline	None	Loaded, See Manufacturer	1	18	SwRI

FRR Design of MT

Method of demonstrating FRR (calculations or testing) can impact member sizing

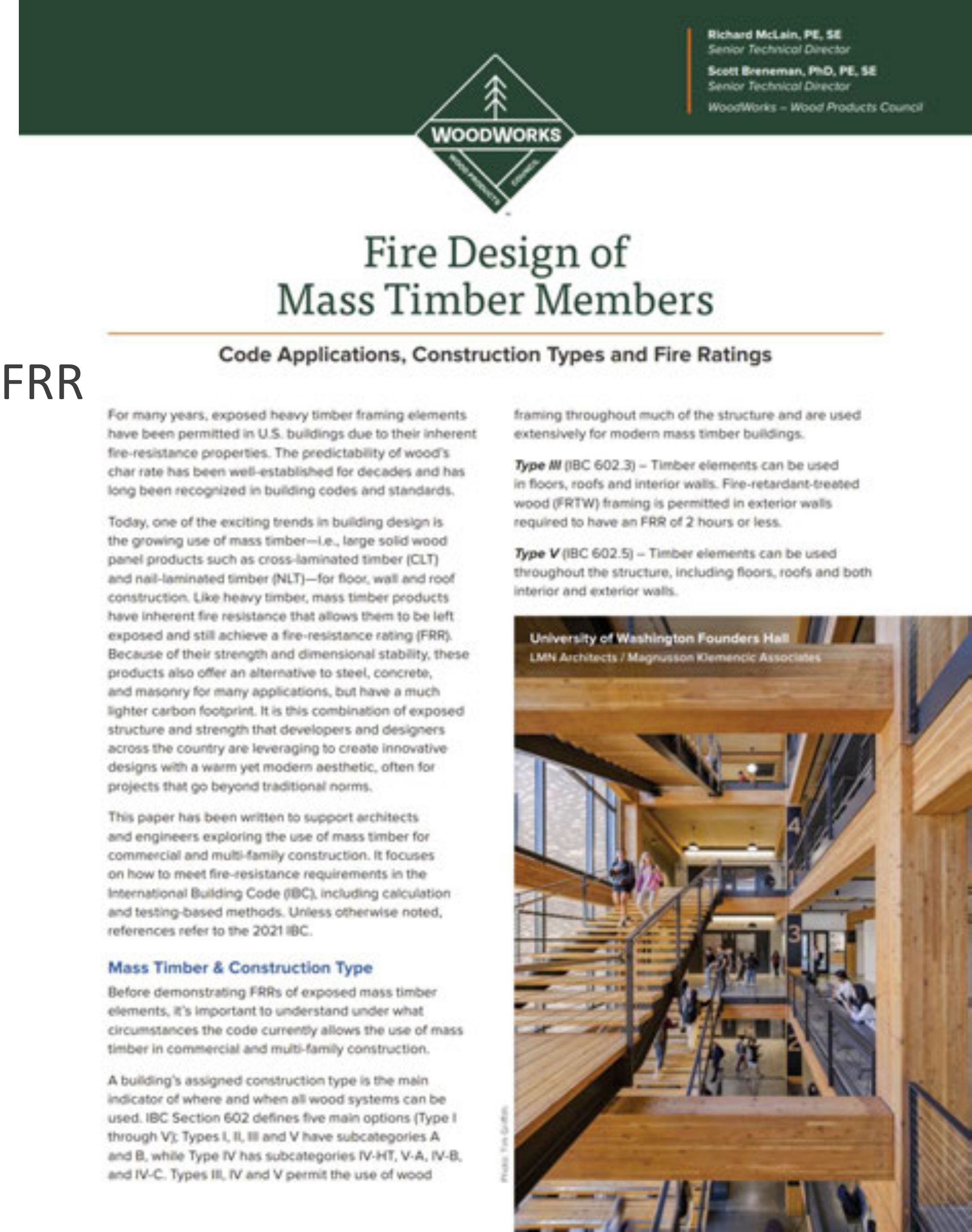
Each has unique benefits:

- Testing:
  - Can result in higher FRR for some assemblies when compared to calculations (i.e. 2-hr FRR with 5-ply CLT panel).
  - Seen as more acceptable by some building officials
- Calculations:
  - Can provide more design flexibility
  - Allows for project span and loading specific analysis

FRR Design of MT

Mass Timber Fire Design Resource

- Code compliance options for demonstrating FRR
- Free download at woodworks.org



Richard McLain, PE, SE
Senior Technical Director
Scott Breneman, PhD, PE, SE
Senior Technical Director
WoodWorks – Wood Products Council

WOODWORKS

Fire Design of Mass Timber Members

Code Applications, Construction Types and Fire Ratings

For many years, exposed heavy timber framing elements have been permitted in U.S. buildings due to their inherent fire-resistance properties. The predictability of wood's char rate has been well-established for decades and has long been recognized in building codes and standards.

Today, one of the exciting trends in building design is the growing use of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction. Like heavy timber, mass timber products have inherent fire resistance that allows them to be left exposed and still achieve a fire-resistance rating (FRR). Because of their strength and dimensional stability, these products also offer an alternative to steel, concrete, and masonry for many applications, but have a much lighter carbon footprint. It is this combination of exposed structure and strength that developers and designers across the country are leveraging to create innovative designs with a warm yet modern aesthetic, often for projects that go beyond traditional norms.

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing-based methods. Unless otherwise noted, references refer to the 2021 IBC.

Mass Timber & Construction Type

Before demonstrating FRRs of exposed mass timber elements, it's important to understand under what circumstances the code currently allows the use of mass timber in commercial and multi-family construction.

A building's assigned construction type is the main indicator of where and when all wood systems can be used. IBC Section 602 defines five main options (Type I through V); Types I, II, III and V have subcategories A and B, while Type IV has subcategories IV-HT, V-A, IV-B, and IV-C. Types III, IV and V permit the use of wood framing throughout much of the structure and are used extensively for modern mass timber buildings.

Type III (IBC 602.3) – Timber elements can be used in floors, roofs and interior walls. Fire-retardant-treated wood (FRTW) framing is permitted in exterior walls required to have an FRR of 2 hours or less.

Type V (IBC 602.5) – Timber elements can be used throughout the structure, including floors, roofs and both interior and exterior walls.

University of Washington Founders Hall
LMN Architects / Magnusson Klemencic Associates

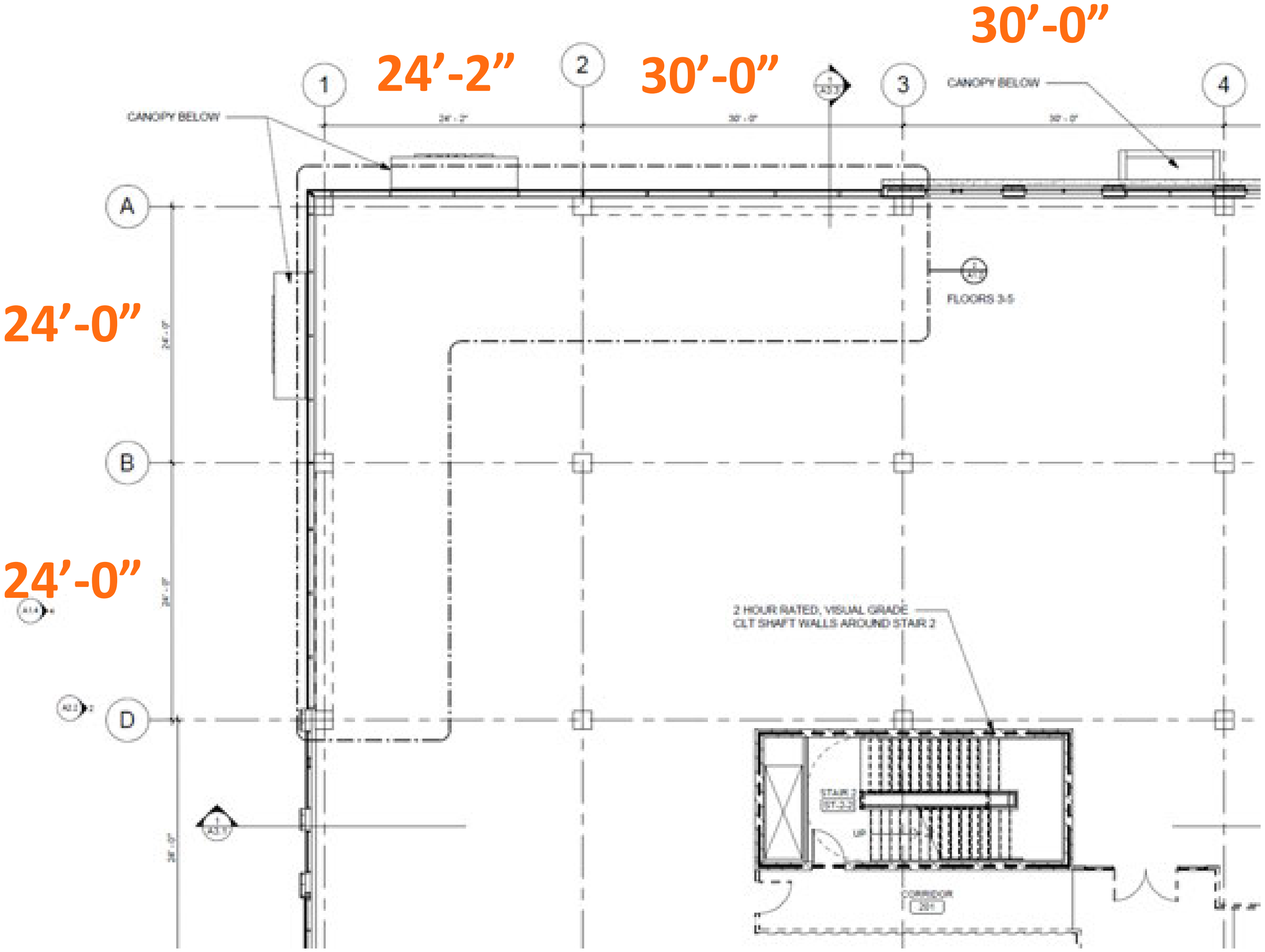
Outline

- Key Early Design Decisions
- Construction Types
- Fire Design
- **Structural Grid**
- Connections
- Penetrations & Firestopping
- MEP Layout and Integration
- Lateral Systems
- Acoustics

Structural Grid

Grids & Spans

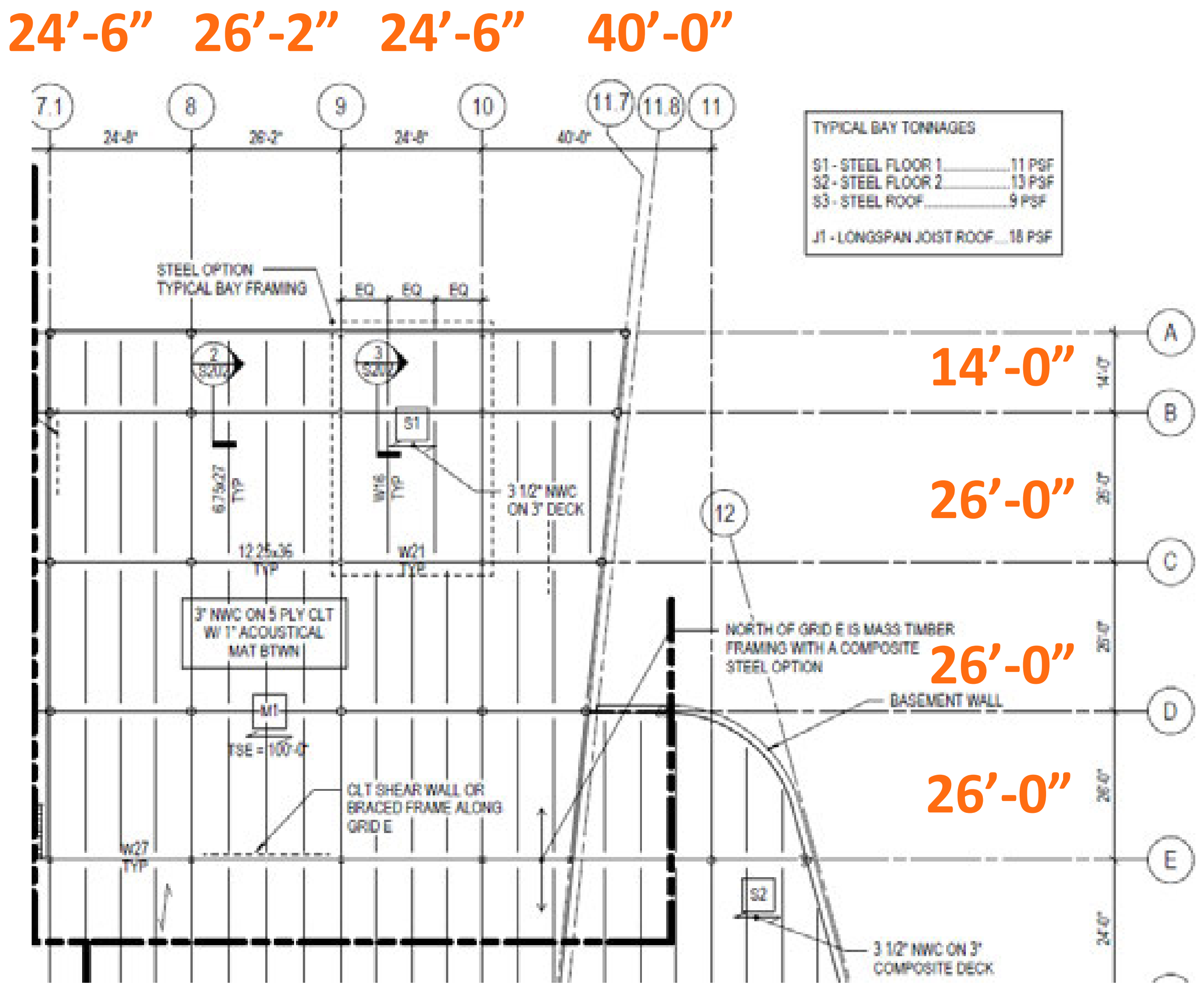
» Consider Efficient Layouts
» Repetition & Scale
» Manufacturer Panel Sizing
» Transportation



Structural Grid

Grids & Spans

- » Consider Efficient Layouts
- » Repetition & Scale
- » Manufacturer Panel Sizing
- » Transportation



Structural Grid

Member Sizes

- Impact of FRR on Sizing
- Impact of Sizing on Efficient Spans
- Consider connections – can drive member sizing

0 HR FRR: Consider 3-ply Panel

- Efficient Spans of 10-12 ft
- Grids of 20x20 (1 purlin) to 30x30 (2 purlins) may be efficient

Albina Yard, Portland, OR
20x20 Grid, 1 purlin per bay
3-ply CLT
Image: Lever Architecture

Structural Grid

Member Sizes

- Impact of FRR on Sizing
- Impact of Sizing on Efficient Spans
- Consider connections – can drive member sizing

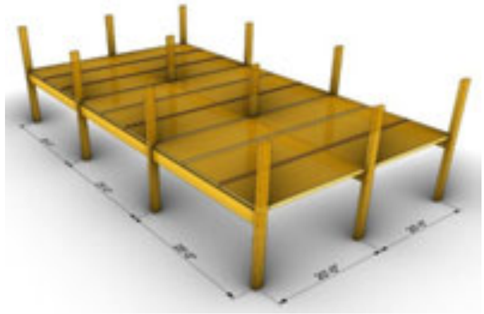
1 or 2 HR FRR: Likely 5-ply Panel

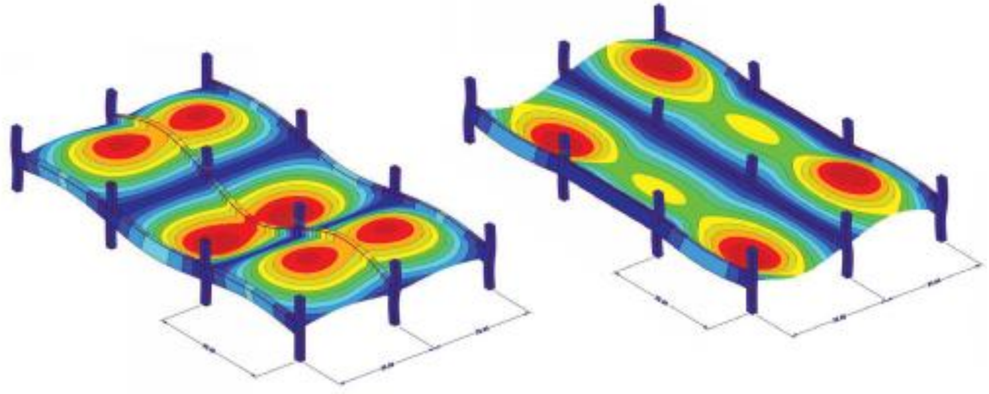
- Efficient spans of 14-17 ft
- Grids of 15x30 (no purlins) to 30x30 (1 purlin) may be efficient

First Tech Credit Union, Hillsboro, OR
12x32 Grid, One-Way Beams
5-ply (5.5”) CLT
Image: Swinerton

New Mass Timber Floor Vibration Guide

- Worked office, lab and residential Examples
- Covers simple and complex methods for bearing wall and frame supported floor systems





Outline

- » Key Early Design Decisions
- » Construction Types
- » Fire Design
- » Structural Grid
- ❯ Connections
- » Penetrations & Firestopping
- » MEP Layout and Integration
- » Lateral Systems
- » Acoustics

Connections

Many ways to demonstrate connection fire protection:

calculations, prescriptive NC, test results, others as approved by AHJ


Photo: John Stamets


Photo: Josh Partee

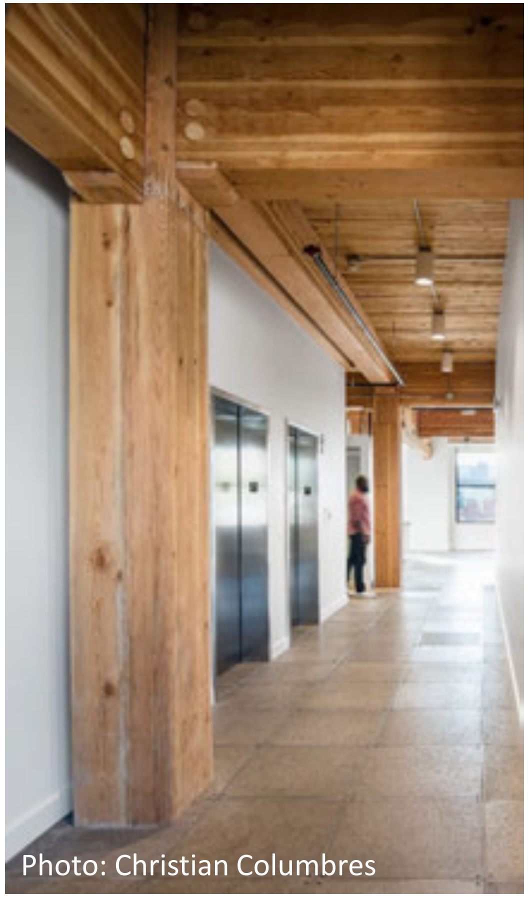


Photo: Christian Columbres

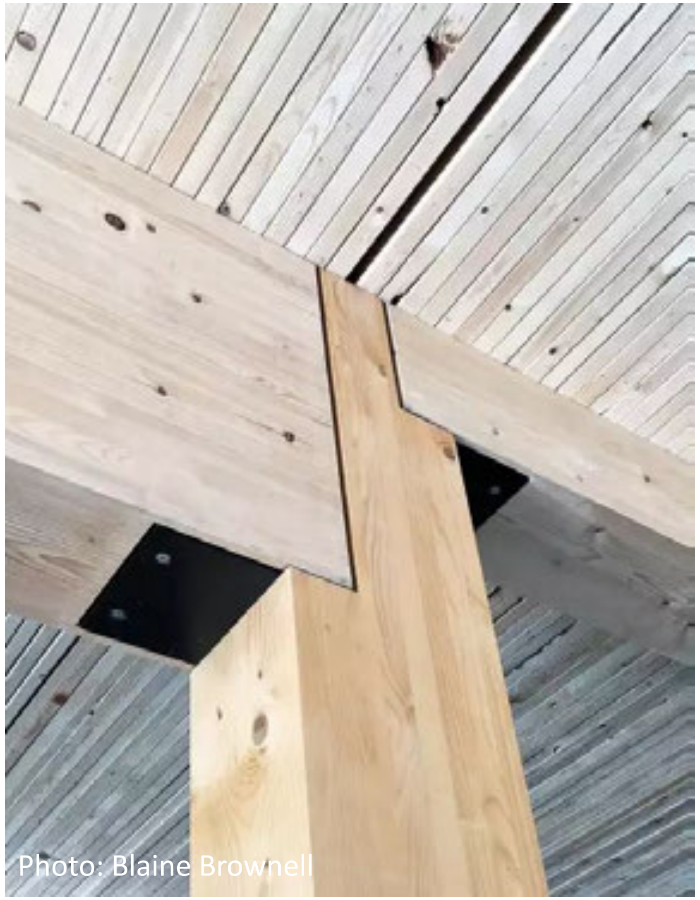
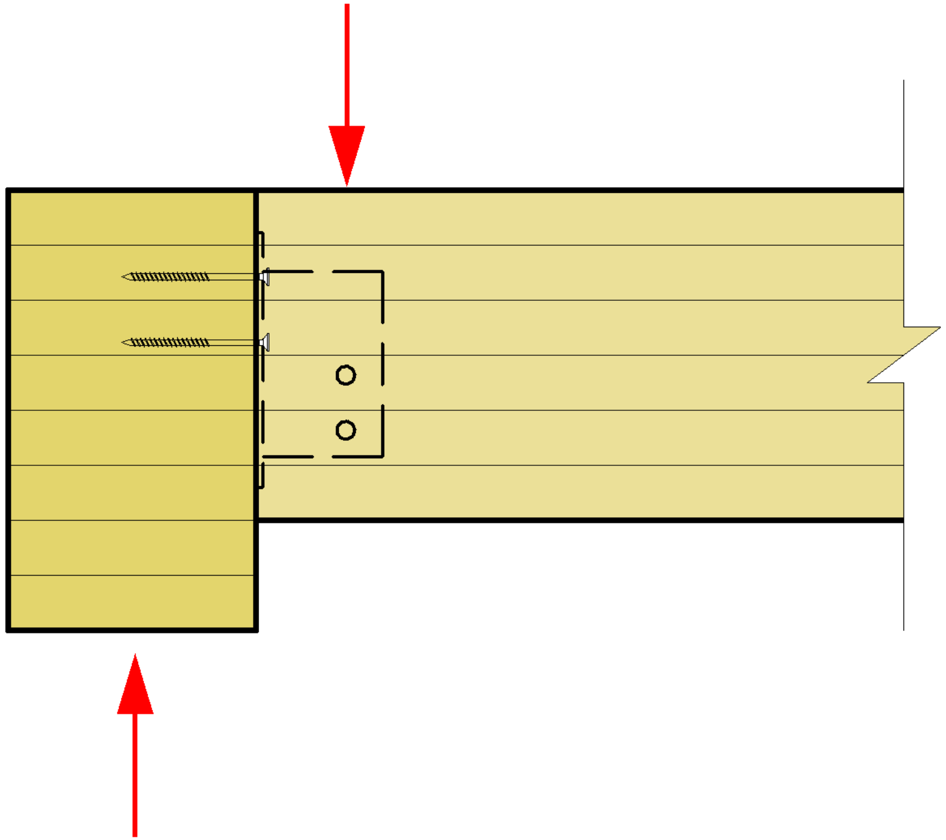


Photo: Blaine Brownell

Connections

Steel hangers/hardware fully concealed within a timber-to-timber connection is a common method of fire protection



Connections

Connection FRR and beam reactions could impact required beam/column sizes

Photos: Simpson Strong-Tie

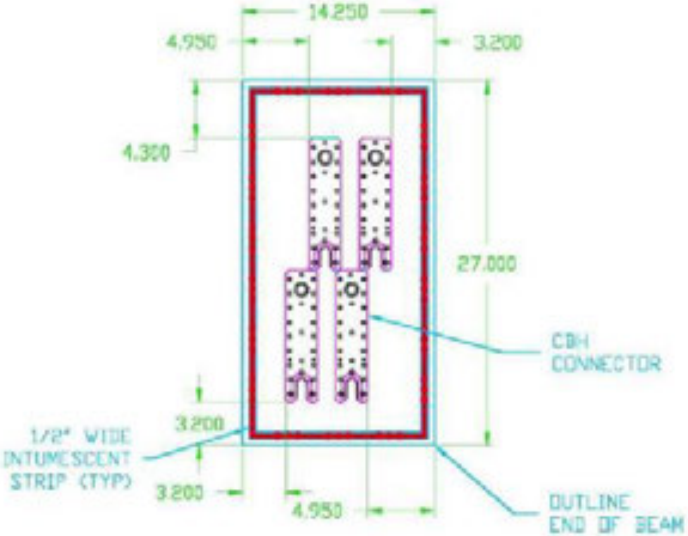


Photo: LEVER Architecture

Connections

Member to member bearing also commonly used, can avoid some/all steel hardware at connection

Connections

Member to member bearing also commonly used, can avoid some/all steel hardware at connection

Style of connection also impacts and is impacted by grid layout and MEP integration

Connections

Other connection design considerations:

- » Structural capacity
- » Shrinkage
- » Constructability
- » Aesthetics
- » Cost

Credit: Alex Schreyer

Mass Timber Connections Index

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

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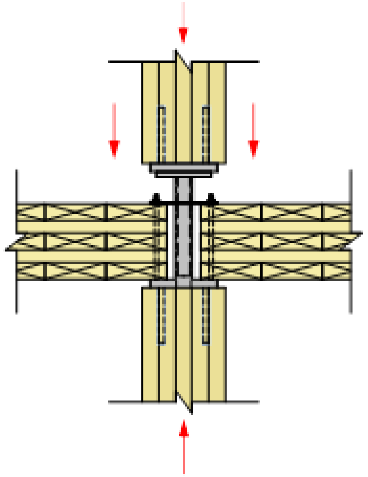
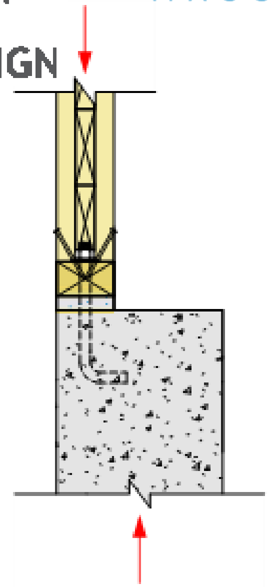
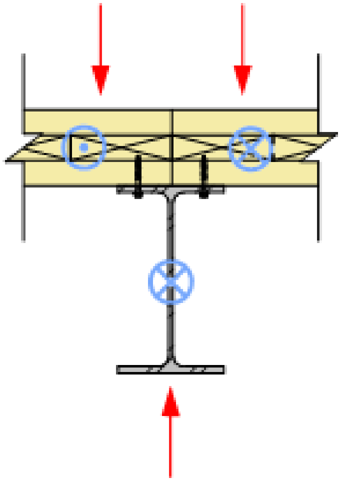
Engineers & Builders

OZ
ARCHITECTURE
URBAN DESIGN
INTERIOR DESIGN

SWINERTON
MASS TIMBER







Outline

» Key Early Design Decisions
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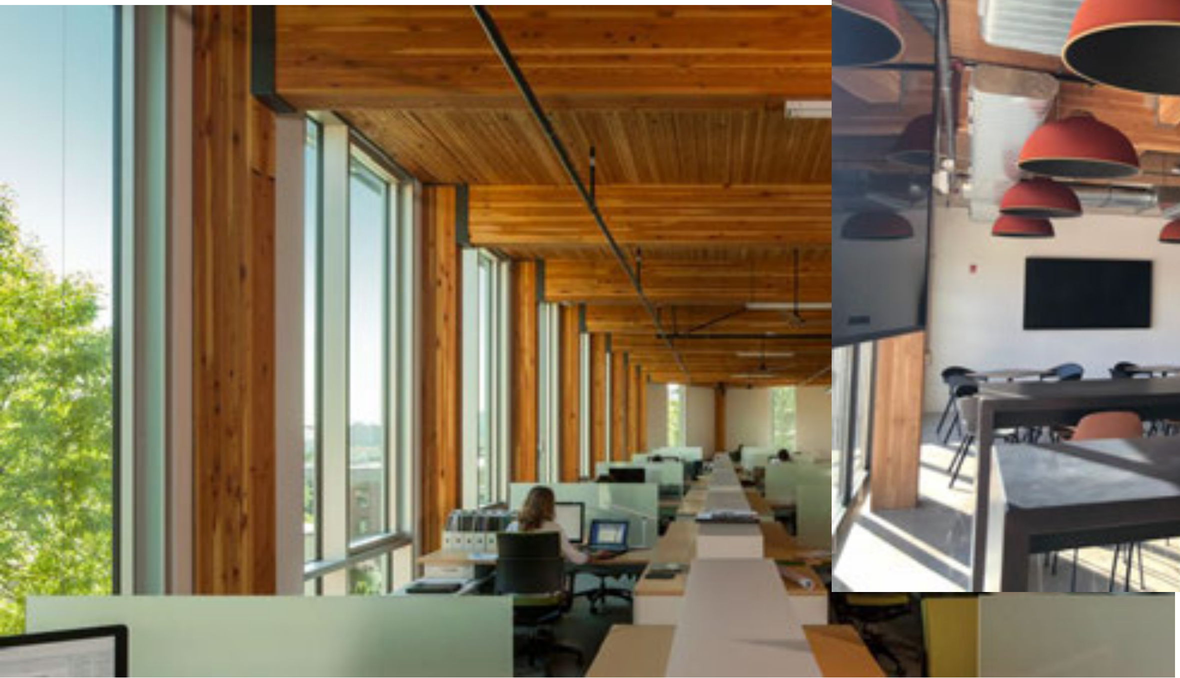
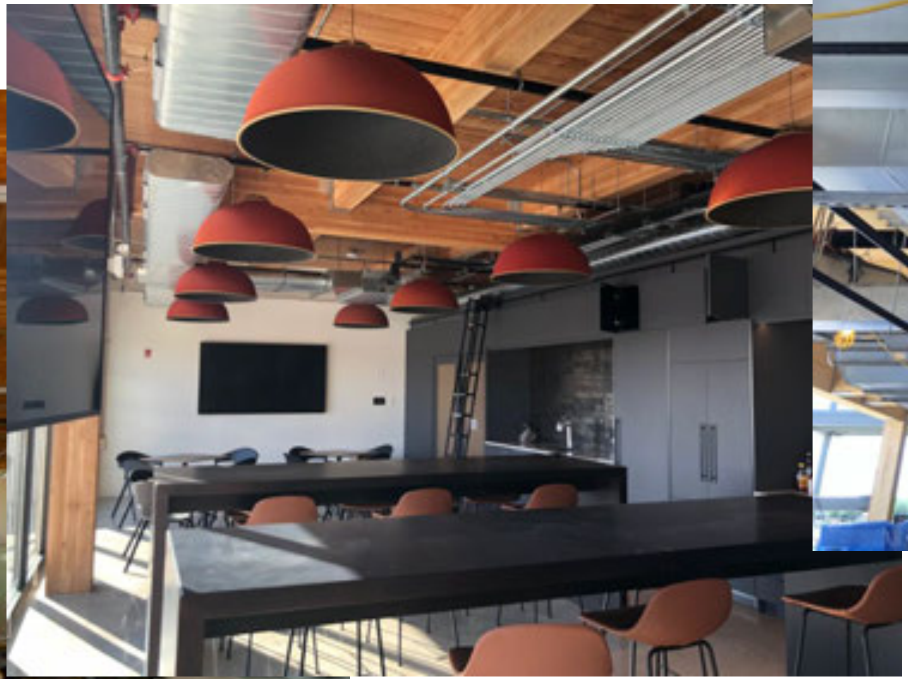
» Lateral Systems
» Acoustics

MEP Layout & Integration

Set Realistic Owner Expectations About Aesthetics

- MEP fully exposed with MT structure, or limited exposure?
- Also consider acoustic impacts of MEPF routing





MEP Layout & Integration

Key considerations:

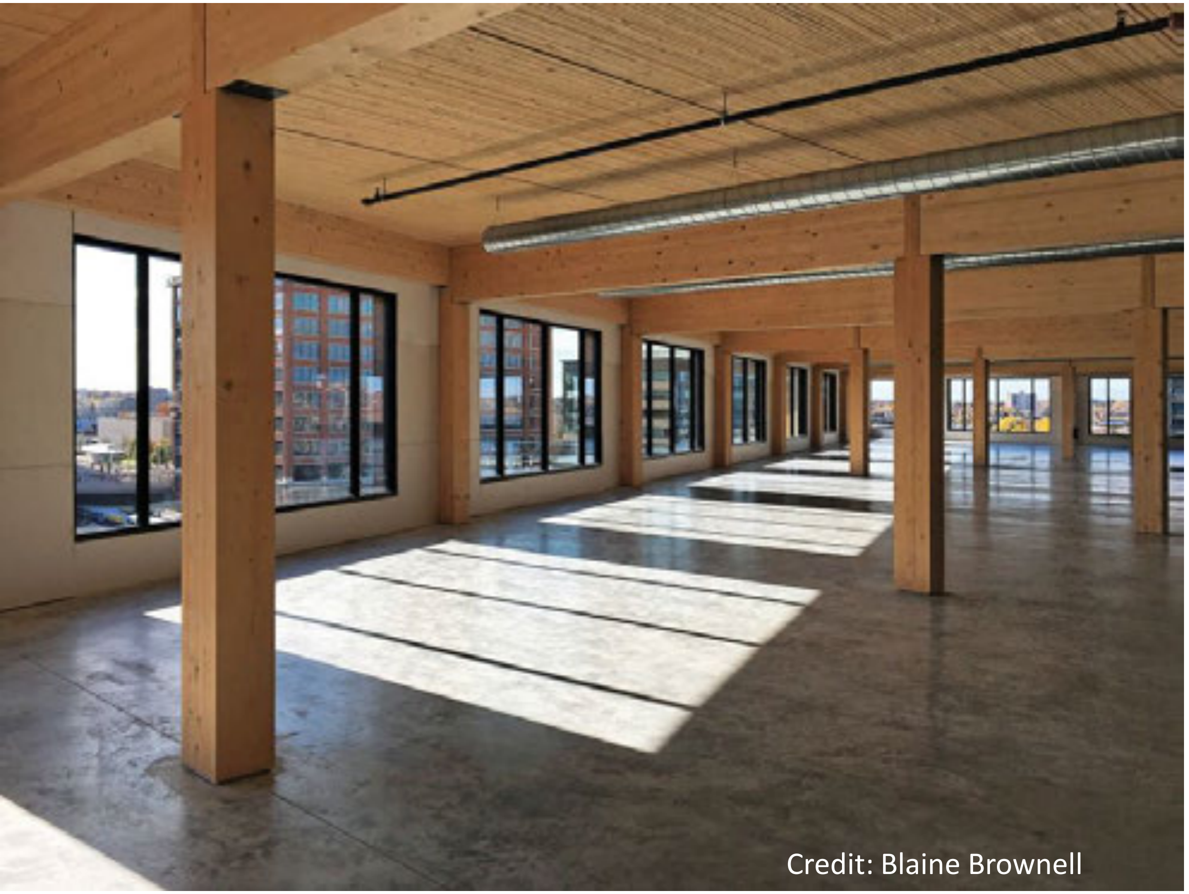
- Level of exposure desired
- Floor to floor, structure depth & desired head height
- Building occupancy and configuration (i.e. central core vs. double loaded corridor)
- Grid layout and beam orientations
- Need for future tenant reconfiguration
- Impact on fire & structural design: concealed spaces, penetrations

Credit: WoodWorks

MEP Layout & Integration

Smaller grid bays at central core (more head height)

- » Main MEP trunk lines around core, smaller branches in exterior bays

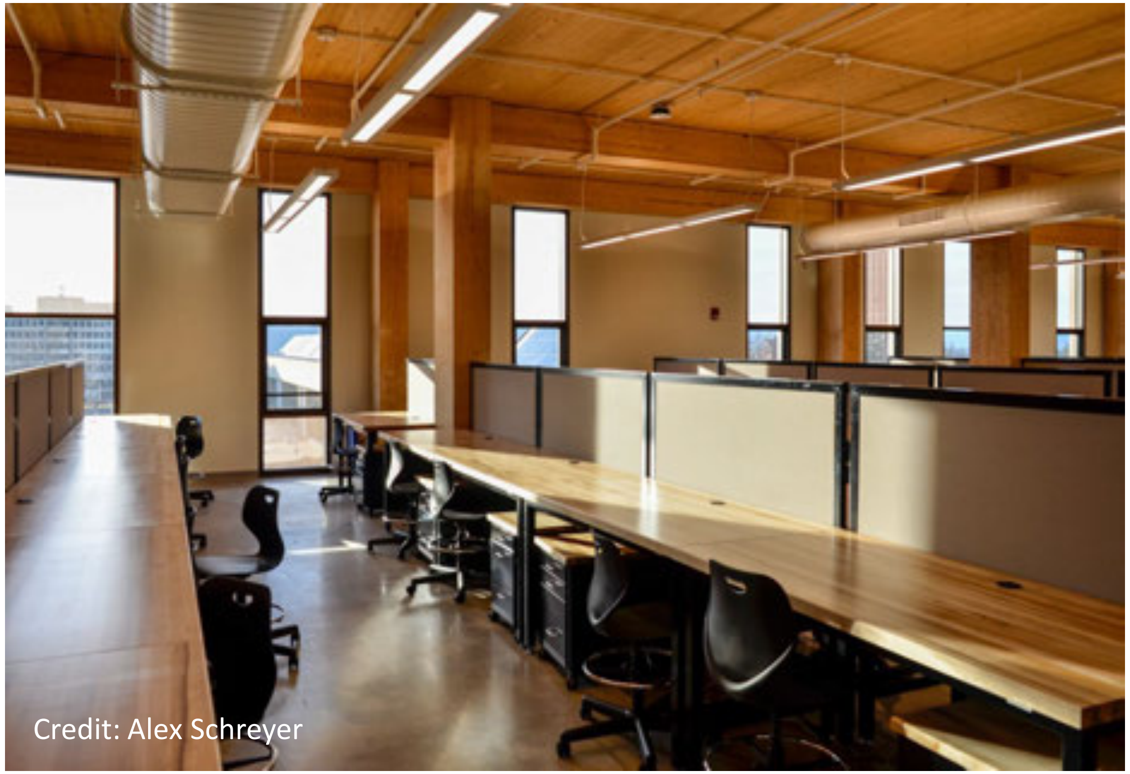

Credit: Blaine Brownell


Credit: WoodWorks

MEP Layout & Integration

Dropped below MT framing

- Can simplify coordination (fewer penetrations)
- Bigger impact on head height


Credit: Alex Schreyer


Credit: WoodWorks

MEP Layout & Integration

In penetrations through MT framing

» Requires more coordination (penetrations)

» Bigger impact on structural capacity of penetrated members

» Minimal impact on head height

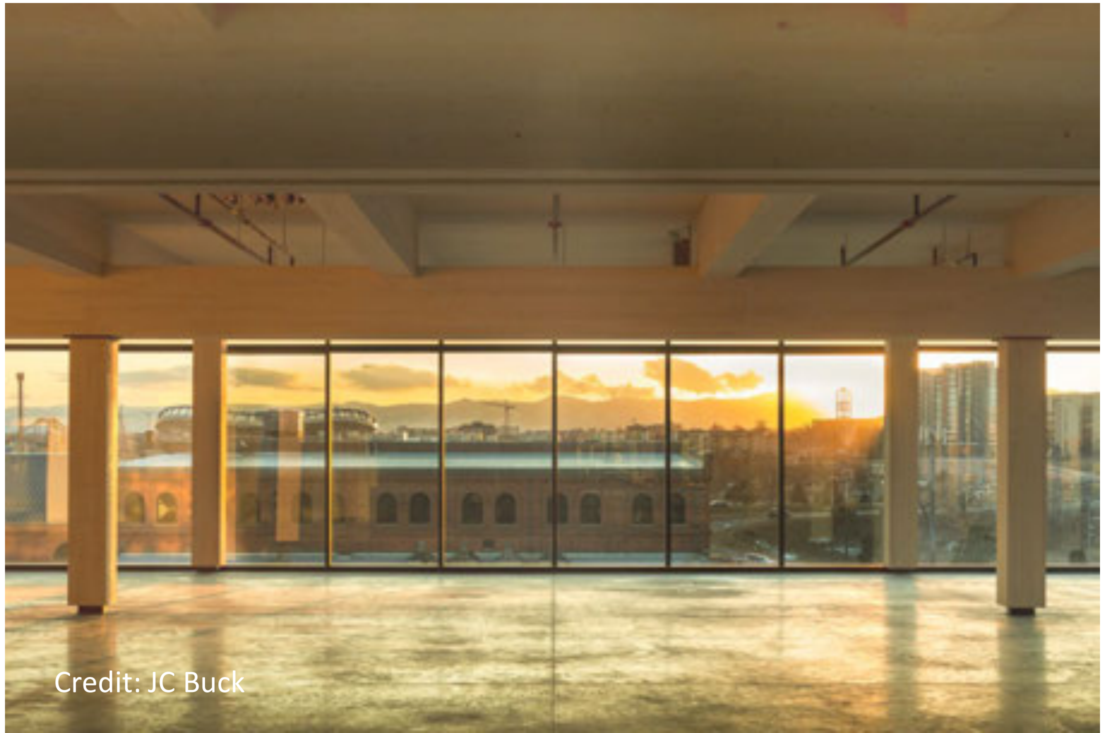
Credit: WoodWorks

Credit: WoodWorks

MEP Layout & Integration

In chases above beams and below panels

- Fewer penetrations
- Bigger impact on head height (overall structure depth is greater)
- FRR impacts: top of beam exposure


Credit: JC Buck


Credit: KL&A Engineers & Builders

MEP Layout & Integration

In raised access floor (RAF) above MT

- Aesthetics (minimal exposed MEP)
- Acoustic impacts (usually thinner topping req'd)

RAF

NON-RAF

Credit: BOKA Powell

MEP Layout & Integration

In raised access floor (RAF) above MT

- Impact on head height
- Concealed space code provisions

Outline

- Key Early Design Decisions
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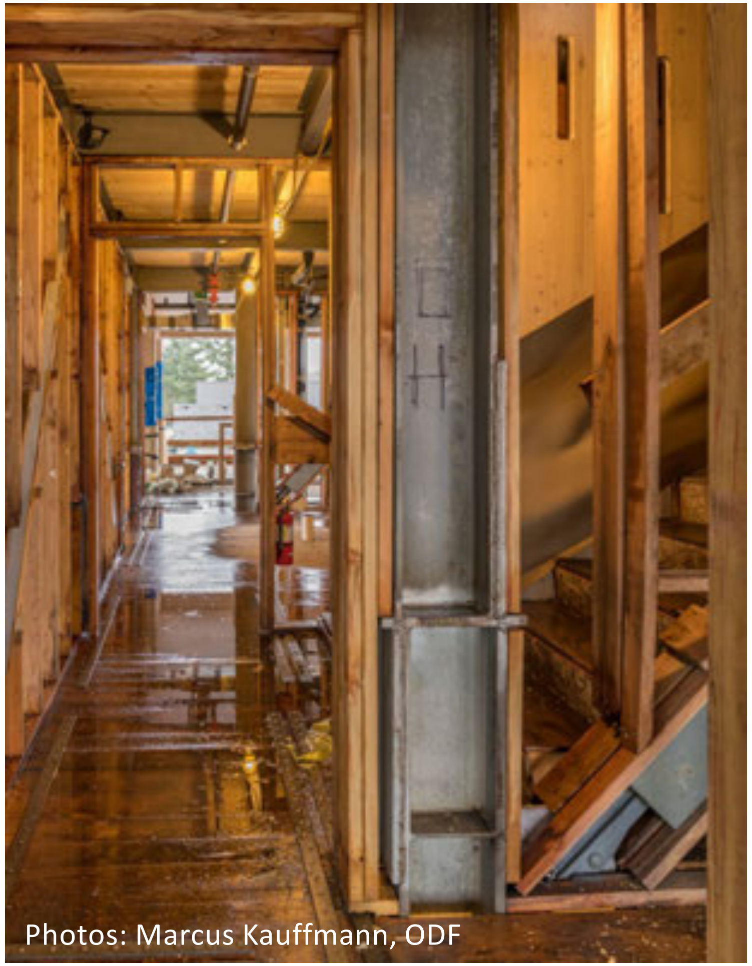
- Fire Design
- Structural Grid
- Connections
- Penetrations & Firestopping
- MEP Layout and Integration
- **Lateral Systems**
- Acoustics

Lateral System Choices

Concrete Shear walls

Lateral System Choices

Steel Braced Frame



Photos: Marcus Kauffmann, ODF

Lateral System Choices

Wood-Frame Shear walls

Credit: KL&A Engineers & Builders

Lateral System Choices

MT Shear walls

Lateral System Choices

MT Rocking Shear walls

Photo: WoodWorks

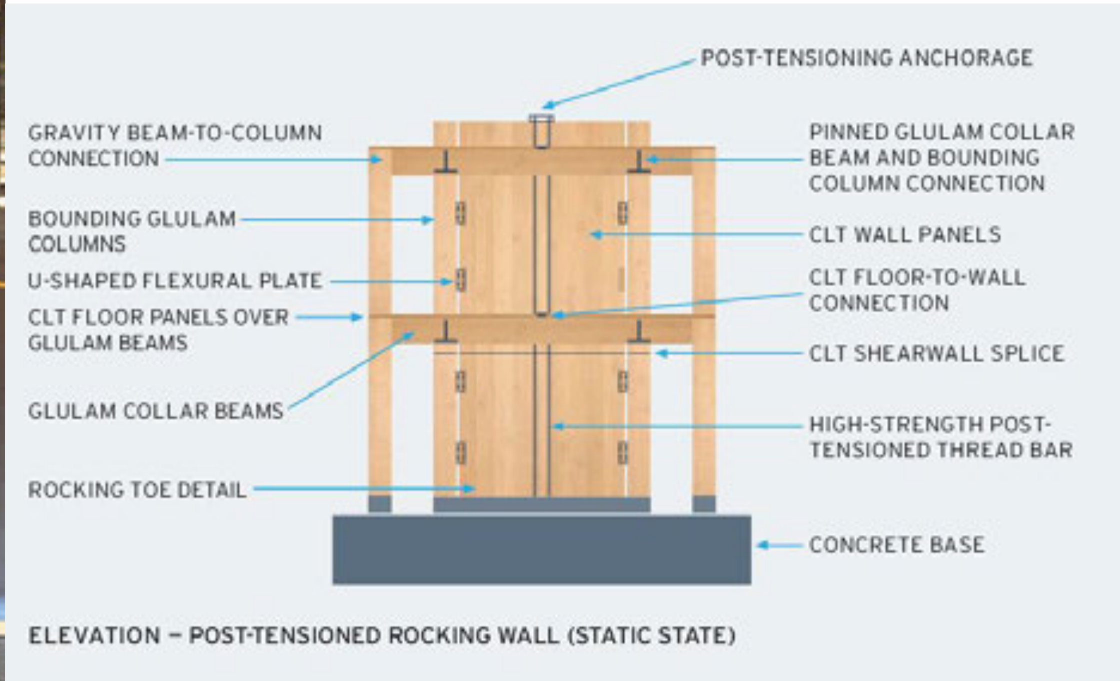


Image: KPFF

Lateral System Choices

Timber Braced Frame

Credit: Alex Schreyer

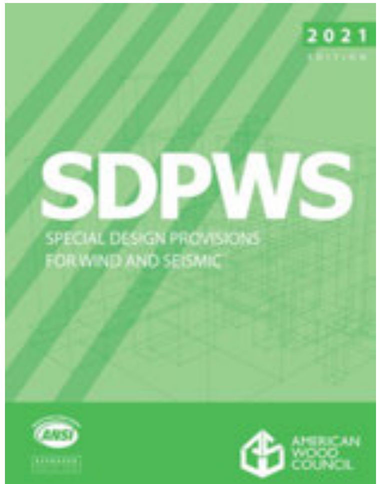
Lateral System Choices

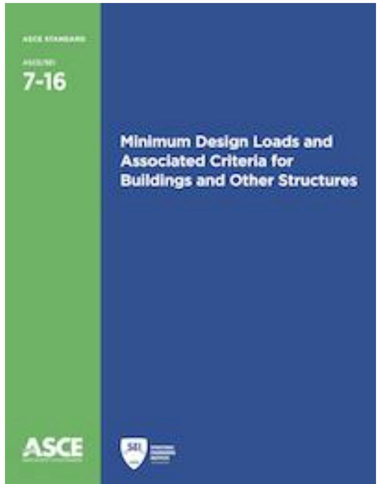
<u>Prescriptive Code Compliance</u>

- Concrete Shear walls ✓
- Steel Braced Frames ✓
- Light Wood-Frame Shear walls ✓
- CLT Shear walls ✓
- CLT Rocking Walls ✗
- Timber Braced Frames ✗

2021 SDPWS
ASCE 7-22


Photo: WoodWorks





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Acoustics & Sound Control

Consider Impacts of:

- Timber & Topping Thickness
- Panel Layout
- Gapped Panels
- Connections & Penetrations
- MEP Layout & Type

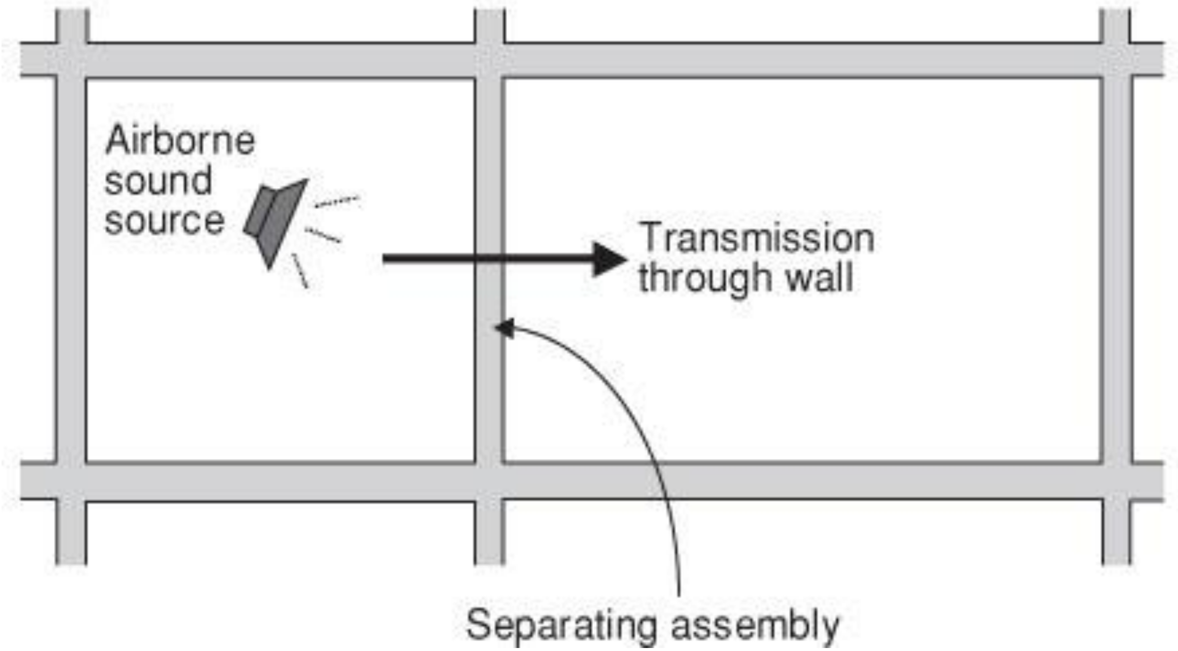
Credit: Rothoblaas

Acoustics & Sound Control

<u>Air-Borne Sound:</u>

Sound Transmission Class (STC)

- Measures how effectively an assembly isolates air-borne sound and reduces the level that passes from one side to the other
- Applies to walls and floor/ceiling assemblies



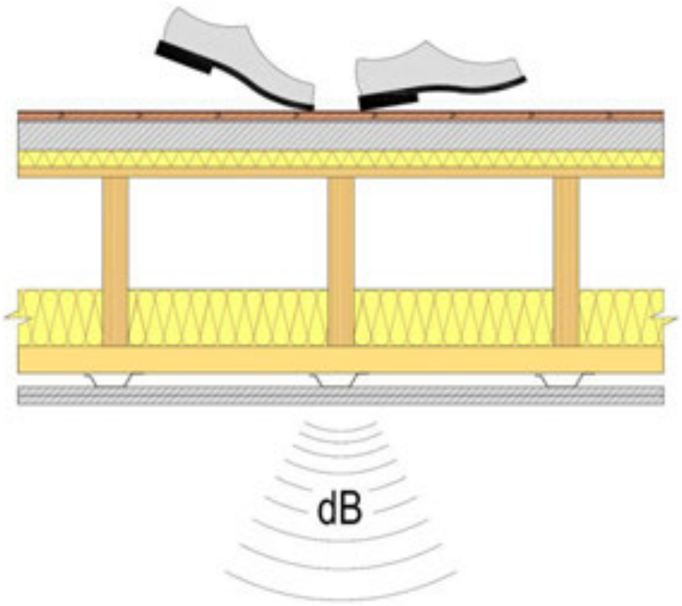
Acoustics & Sound Control

Structure-Borne Sound:

Impact Insulation Class (IIC)

» Evaluates how effectively an assembly blocks impact sound from passing through it

» Only applies to floor/ceiling assemblies



Acoustics & Sound Control

Code requirements only address residential occupancies:

For unit to unit or unit to public or service areas:

Min. STC of 50 (45 if field tested):

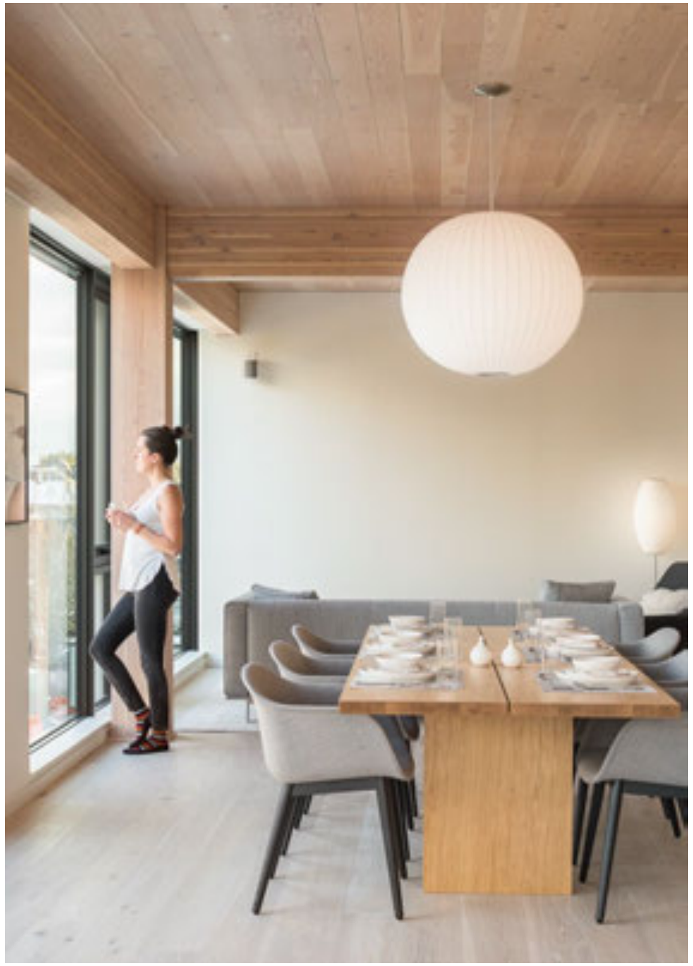
» Walls, Partitions, and Floor/Ceiling Assemblies

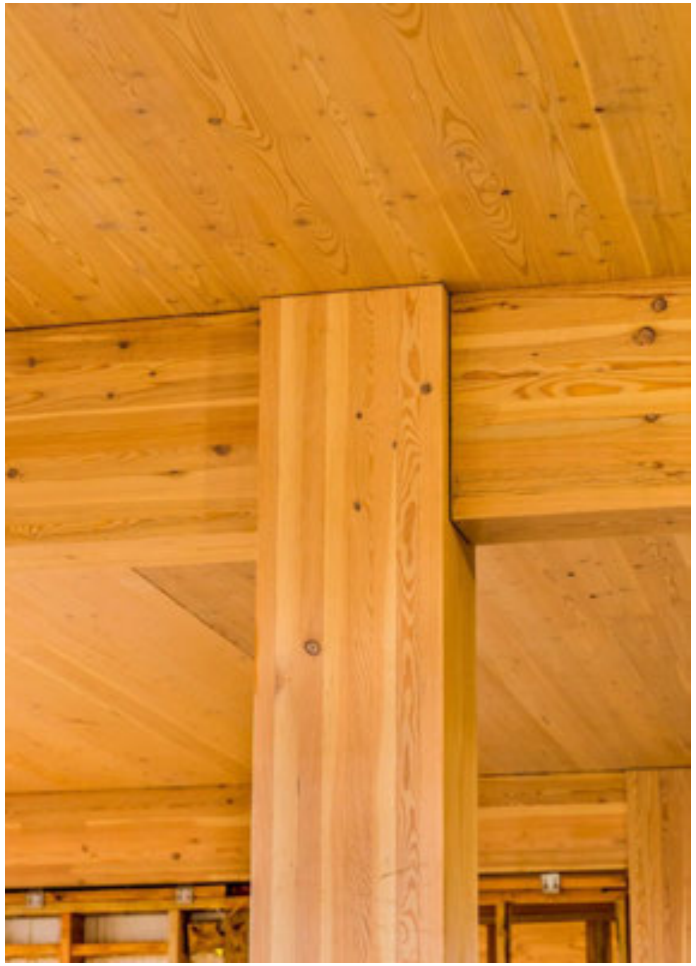
Min. IIC of 50 (45 if field tested) for:

» Floor/Ceiling Assemblies

Acoustics & Sound Control

MT: Structure Often is Finish





Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: Kaiser + PATH

Acoustics & Sound Control

But by Itself, Not Adequate for Acoustics

Photo: Corey Gaffer courtesy Perkins + Will

Acoustics & Sound Control

TABLE 1:

Examples of Acoustically-Tested Mass Timber Panels

Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall[4]	3.07"	33	N/A
5-ply CLT wall[4]	6.875"	38	N/A
5-ply CLT floor[5]	5.1875"	39	22
5-ply CLT floor[4]	6.875"	41	25
7-ply CLT floor[4]	9.65"	44	30
2x4 NLT wall[6]	3-1/2" bare NLT 4-1/4" with 3/4" plywood	24 bare NLT 29 with 3/4" plywood	N/A
2x6 NLT wall[6]	5-1/2" bare NLT 6-1/4" with 3/4" plywood	22 bare NLT 31 with 3/4" plywood	N/A
2x6 NLT floor + 1/2" plywood[2]	6" with 1/2" plywood	34	33

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks[7]

Acoustics & Sound Control

Regardless of the structural materials used in a wall or floor ceiling assembly, there are 3 effective methods of improving acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers

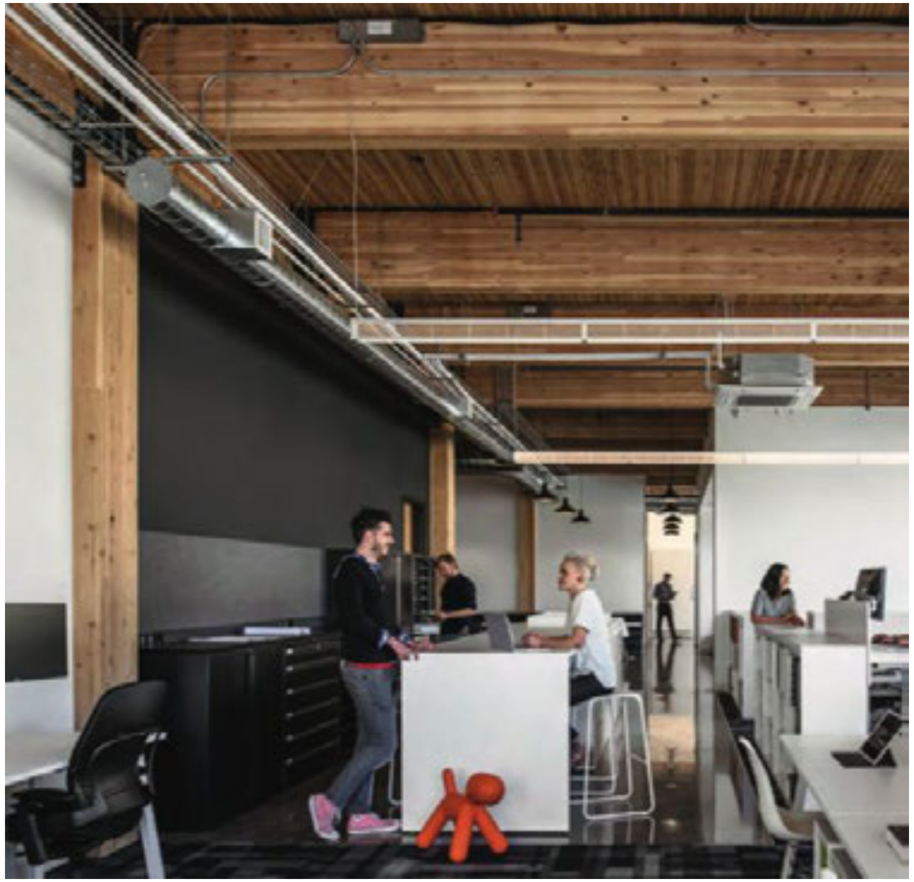


Image credit: Christian Columbres

Acoustics & Sound Control

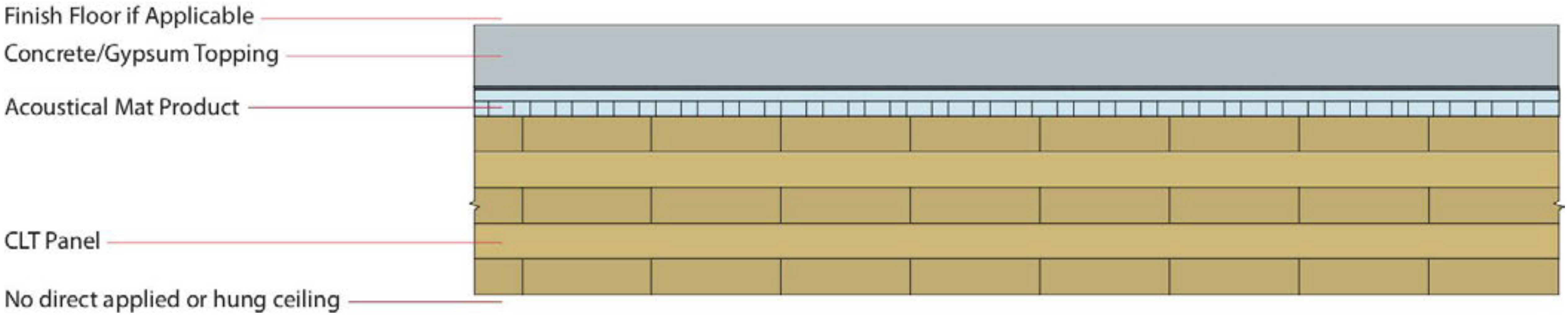
<u>Concrete Slab:</u>
6” Thick
80 PSF ⟷ 18 PSF
STC 53 ⟷ STC 41

<u>CLT Slab:</u>
6-7/8” Thick
18 PSF
STC 41

Acoustics & Sound Control

There are three main ways to improve an assembly's acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers



Acoustics & Sound Control

There are three main ways to improve an assembly's acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers

Acoustical Mat:

- » Typically roll out or board products
- » Thicknesses vary: Usually ¼" to 1"+

Credit: Maxxon

Acoustics & Sound Control

Acoustical floor underlayments

Photo: AcoustiTECH[10]

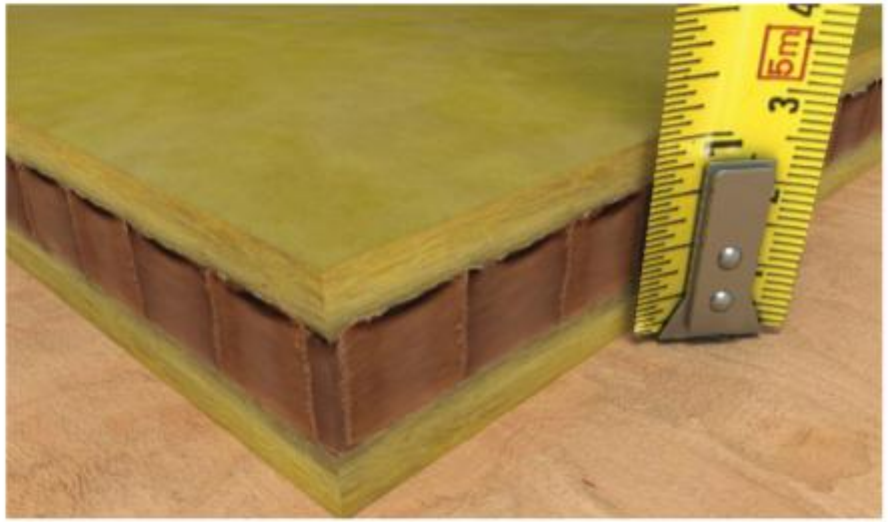


Photo: Kinetics Noise Control, Inc.,[11]

Photo: Maxxon Corporation

Photo: Pliteq Inc.,[12]

Acoustics & Sound Control

Common mass timber floor assembly:

- Finish floor (if applicable)
- Underlayment (if finish floor)
- 1.5” to 4” thick concrete/gypcrete topping
- Acoustical mat
- WSP (if applicable)
- Mass timber floor panels

Credit: AcoustiTECH

Acoustics & Sound Control

Solutions Paper

http://www.woodworks.org/wp-content/uploads/wood_solution_paper-MASS-TIMBER-ACOUSTICS.pdf

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Acoustics and Mass Timber: Room-to-Room Noise Control

T3 Minneapolis

The growing availability and code acceptance of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction has given designers a low-carbon alternative to steel, concrete, and masonry for many applications. However, the use of mass timber in multi-family and commercial buildings presents unique acoustic challenges.

While laboratory measurements of the impact and airborne sound isolation of traditional building assemblies such as light wood-frame, steel and concrete are widely available, fewer resources exist that quantify the acoustic performance of mass timber assemblies. Additionally, one of the most desired aspects of mass timber construction is the ability to leave a building's structure exposed as finish, which creates the need for asymmetric assemblies. With careful design and detailing, mass timber buildings can meet the acoustic performance expectations of most building types.

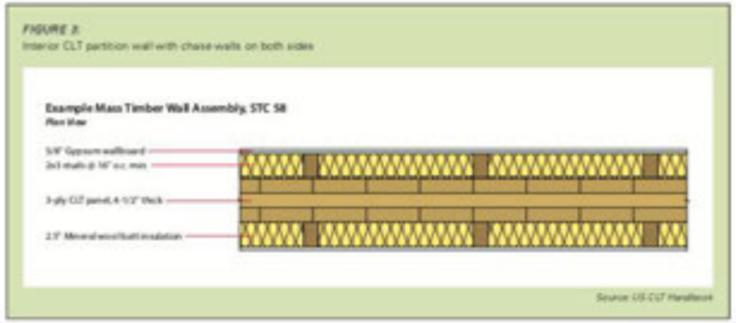

FIGURE 3: Interior CLT partition wall with chase walls on both sides

Example Mass Timber Wall Assembly, STC 58

Source: US CLT Handbook

Mass Timber Assembly Options: Walls

Mass timber panels can also be used for interior and exterior walls—both bearing and non-bearing. For interior walls, the need to conceal services such as electrical and plumbing is an added consideration. Common approaches include building a chase wall in front of the mass timber wall or installing gypsum wallboard on resilient channels that are attached to the mass timber wall. As with bare mass timber floor panels, bare mass timber walls don't typically provide adequate noise control, and chase walls also function as acoustical improvements. For example, a 3-ply CLT wall panel with a thickness of 3.07" has an STC rating of 33. In contrast, Figure 3 shows an interior CLT partition wall with chase walls on both sides. This assembly achieves an STC rating of 58, exceeding the IBC's acoustical requirements for multi-family construction. Other examples are included in the inventory of tested assemblies noted above.

Acoustical Differences between Mass Timber Panel Options

The majority of acoustically-tested mass timber assemblies include CLT. However, tests have also been done on other mass timber panel options such as NLT and dowel-laminated timber (DLT), as well as traditional heavy timber options such as tongue and groove decking. Most tests have concluded that CLT acoustical performance is slightly better than that of other mass timber options, largely because the cross-orientation of laminations in a CLT panel limits sound flanking.

For those interested in comparing similar assemblies and mass timber panel types and thicknesses, the inventory noted above contains tested assemblies using CLT, NLT, glued-laminated timber panels (GLT), and tongue and groove decking.

Improving Performance by Minimizing Flanking

Even when the assemblies in a building are carefully designed and installed for high acoustical performance, consideration of flanking paths—in areas such as assembly intersections, beam-to-column/wall connections, and MEP penetrations—is necessary for a building to meet overall acoustical performance objectives.

One way to minimize flanking paths at these connections and interfaces is to use resilient connection isolation and sealant strips. These products are capable of resisting structural loads in compression between structural members and connections while providing isolation and breaking hard, direct connections between members. In the context of the three methods for improving acoustical performance noted above, these strips act as decouplers. With airtight connections, interfaces and penetrations, there is a much greater chance that the acoustic performance of a mass timber building will meet expectations.

Acoustical isolation strips

Acoustics & Sound Control

Acoustics & Sound Control

Inventory of Acoustically Tested Mass Timber Assemblies

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Following is a list of mass timber assemblies that have been acoustically tested as of April 5, 2024. Sources are noted at the end of this document. For free technical assistance on any questions related to the acoustical design of mass timber assemblies, or free technical assistance related to any aspect of the design, engineering or construction of a commercial or multi-family wood building in the U.S., email help@woodworks.org or contact the WoodWorks Regional Director nearest you: http://www.woodworks.org/project-assistance

Contents:

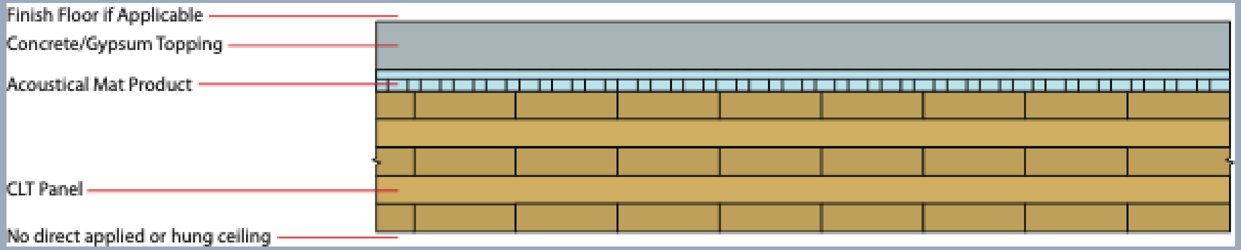
http://bit.ly/mass-timber-assemblies

Acoustics & Sound Control

Inventory of Tested Assemblies

Table 1: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

WoodWorks
WOOD PRODUCTS COUNCIL



CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 5-ply (6.875")	1-1/2" Gyp-Crete®	Maxxon Acousti-Mat® 3/4	None	47[2] ASTC	47[2] AIIC	1
			LVT	-	49[2] AIIC	
			Carpet + Pad	-	75[2] AIIC	
			LVT on Acousti-Top®	-	52[2] AIIC	
			Eng Wood on Acousti-Top®	-	51[2] AIIC	
		Maxxon Acousti-Mat® ¾ Premium	None	49[2] ASTC	45[2] AIIC	
			LVT	-	47[2] AIIC	
			LVT on Acousti-Top®	-	49[2] AIIC	
	1-1/2" Levelrock®	USG SAM N25 Ultra	None	45[6]	39[6]	15
			LVT	48[6]	47[6]	16
			LVT Plus	48[6]	49[6]	58
			Eng Wood	47[6]	47[6]	59
			Carpet + Pad	45[6]	67[6]	60
			Ceramic Tile	50[6]	46[6]	61
			None	45[6]	42[6]	15
			LVT	48[6]	44[6]	16

Keys to Mass Timber Success:

Know Your WHY

Design it as Mass Timber From the Start

Leverage Manufacturer Capabilities

Understand Supply Chain

Optimize Grid

Take Advantage of Prefabrication & Coordination

Expose the Timber

Discuss Early with AHJ

Work with Experienced People

Let WoodWorks Help for Free

Create Your Market Distinction

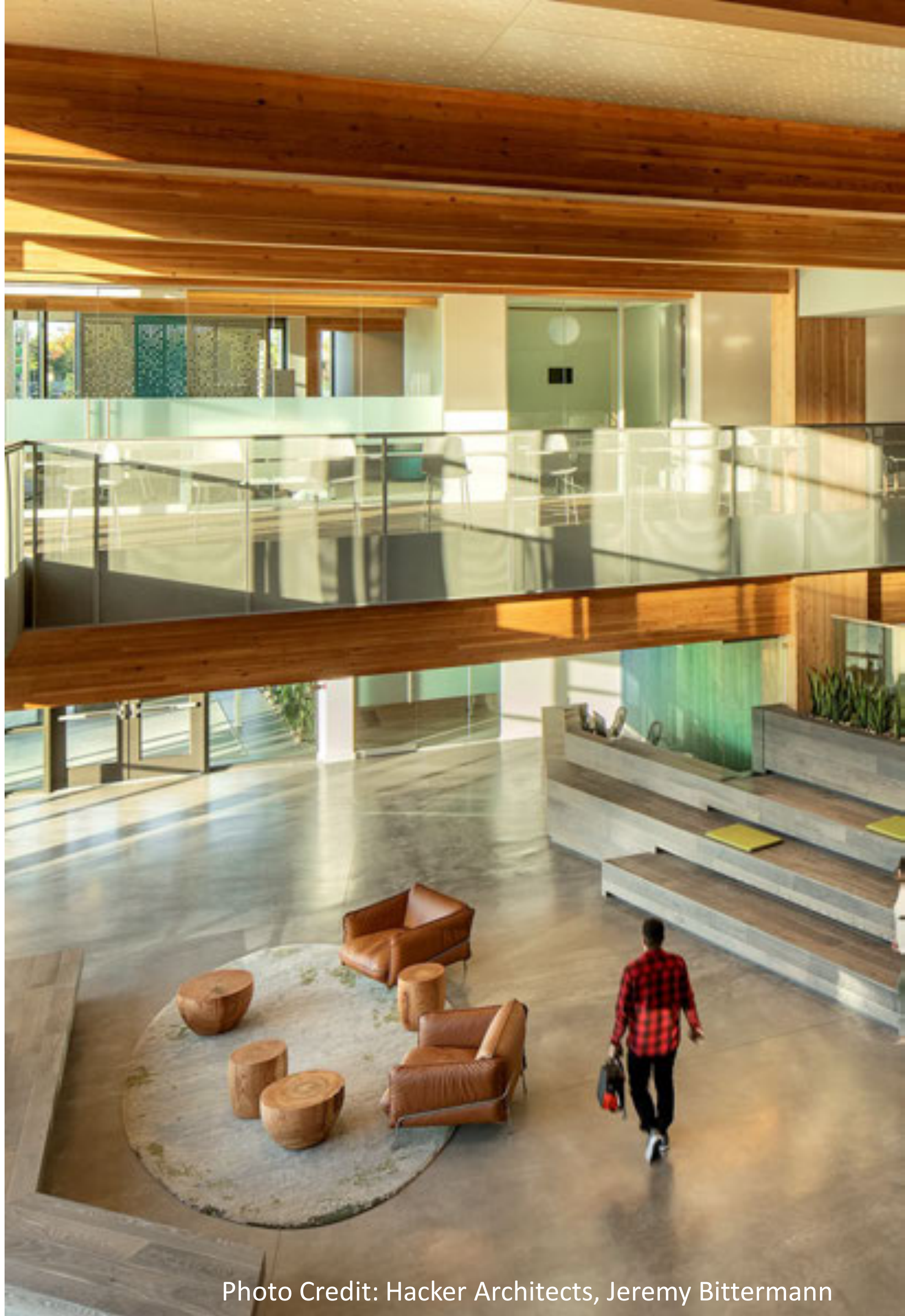


Photo Credit: Hacker Architects, Jeremy Bittermann

Mass Timber Construction: Costing & Construction Management

WOODWORKS
WOOD PRODUCTS COUNCIL

Kate Carrigg, PE

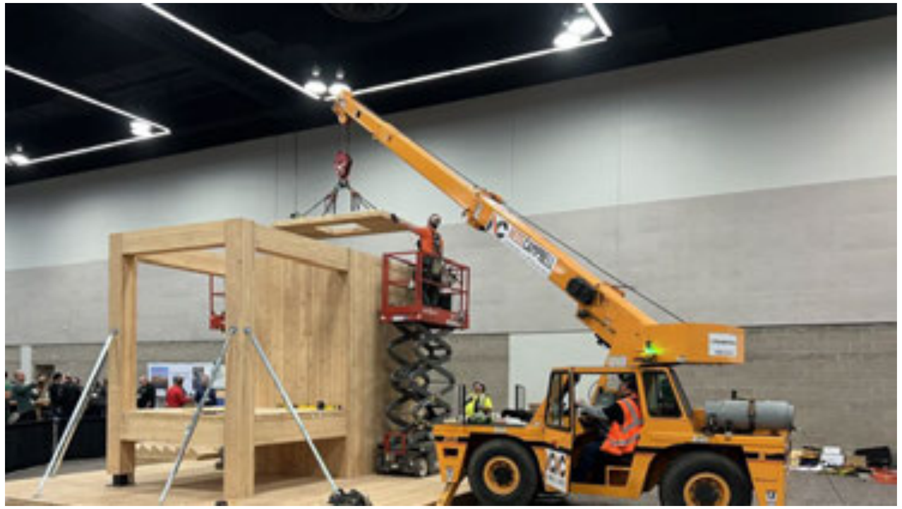
Photo: Structurlam

Construction Management Program

Jason Reynolds, MBA, DBIA

Brandon Brooks, MBA, PMP

Partner Training Centers



WOOD PRODUCTS COUNCIL

- Hardware Manufacturer
- United Brotherhood of Carpenters
- Ironworkers International
- University Partners
- Training Centers

https://www.woodworks.org/

Thesis, LEVER Architecture, Holmes, Swinerton, photo Bryan Aulick

WOODWORKS

How to Successfully Cost Manage a Mass Timber Project

Cost-Estimating Considerations for General Contractors

Apex Plaza
William McDonough + Partners / Hourigan

A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates from the earliest stage of design. However, unlike other materials, there isn't a hundred years of tradition and shared experience to guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking.

This paper is intended to bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. It has been written with an emphasis on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials. Follow these steps to more confidently cost plan your next wood building.

This paper was developed collaboratively with a design and construction professional who specializes in mass timber construction and has worked on multiple projects for general contractors. Costs, percentages and other values are based on their experience and may differ for other projects.

Step 1: Do Your Homework

- Vet Potential Subcontractors
- Determine the Procurement Model
- Procurement Models

Step 2: Establish a Reliable Pre-Design Budget

- Basic Timber Pricing Dynamics
- Provide this Information for Better Supply Pricing
- Insights for Better Budgeting
- Choose Your List of Bidders
- Adjust Budgets for Other Trades Impacted by Timber

Step 3: Manage Project Costs (not covered)

Timber Bidding Package – Bidding Checklist (not covered)

https://www.woodworks.org/resources/how-to-successfully-cost-manage-a-mass-timber-project/

Step 1: Do Your Homework

Factors Influencing Cost Estimation

Design Complexity: High impact on material and labor costs

Material Availability:

- Regional differences in availability and pricing
- Understand which suppliers and subcontractors are appropriate for your project and how best to use them

Procurement Model: Can impact the timber package price by as much as 30%—or more than 5% of total project hard costs

Understanding Cost Impacts of Construction Type

Pre-Design Budget Example

4-story building on college campus

- Mostly Group B occupancy, some assembly (events) space
- NFPA 13 sprinklers throughout
- Floor plate = 7,700 SF
- Total Building Area = 23,100 SF

Impact of Assembly Occupancy Placement:

Owner originally desires events space on top (4th) floor

- Requires Construction Type IIIA

If owner permits moving events space to 1st, 2nd or 3rd floor

- Could use Type IIIB

Understanding Cost Impacts of Construction Type

Pre-Design Budget Example

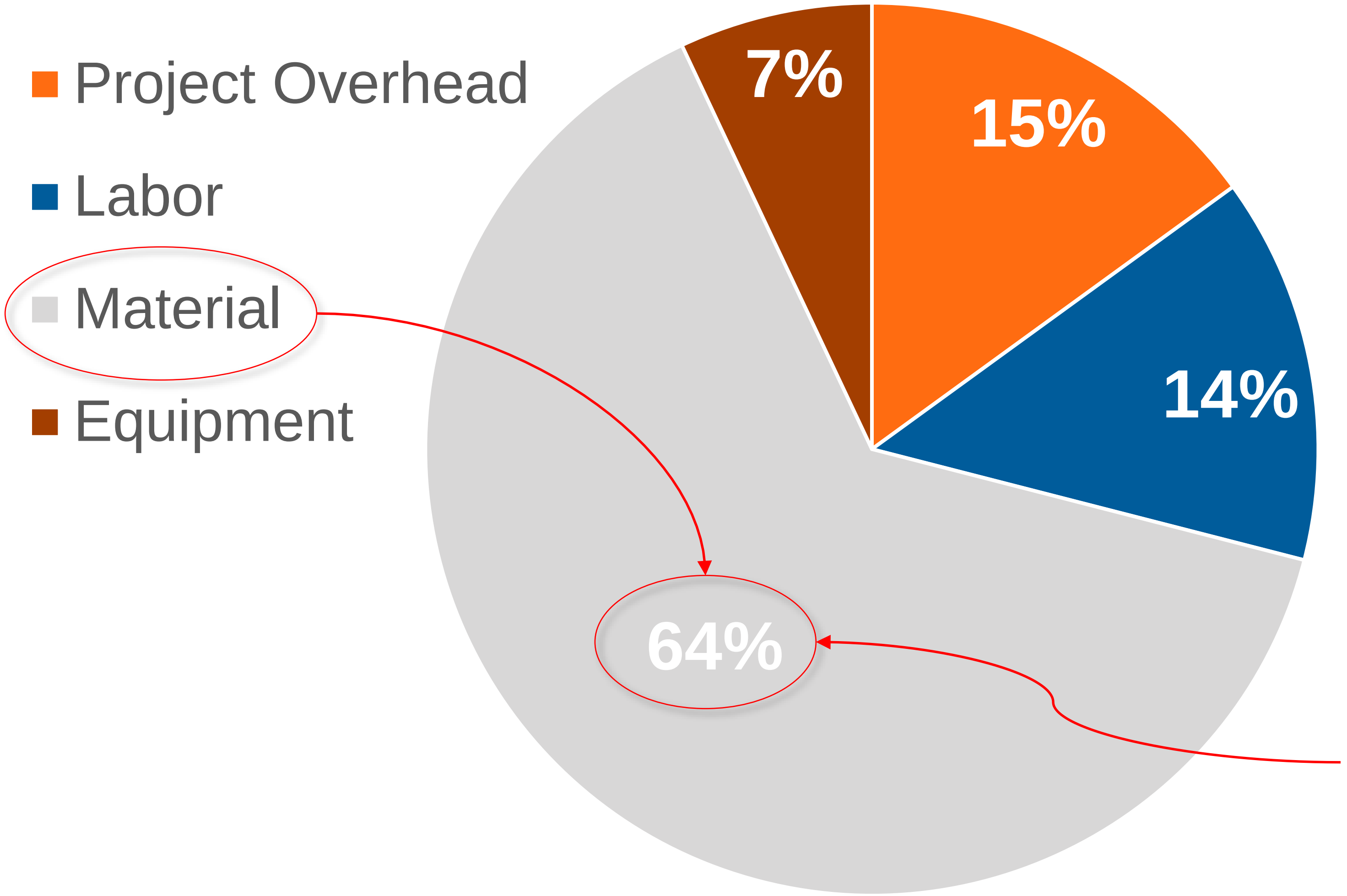
4-story building on college campus

Cost Impact of Assembly Occupancy Placement:

Location of Event Space	4th Floor	1st Floor
Construction Type	III-A	III-B
Assembly Group	A-3	A-3
Fire Resistive Rating	1-Hr	0-Hr
Connections	Concealed	Exposed
CLT Panel Thickness	5-Ply	3-Ply
Superstructure Cost/SF	**$65/SF**	**$53/SF**

The Canyons / Kaiser+Path, Cantena Consulting Engineers / Photo Jeremy Bittermann

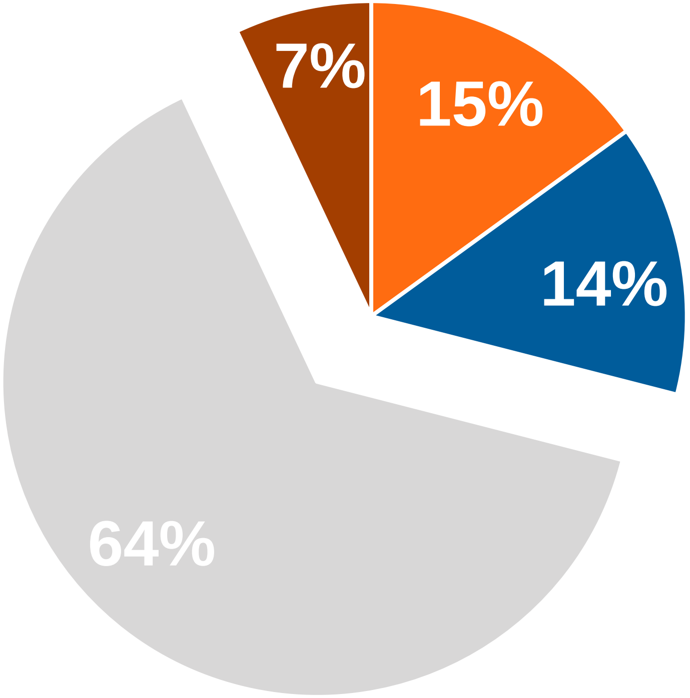
Anatomy of a Turnkey Mass Timber Package



Panels are the biggest part of the biggest piece of the cost pie

Source: Swinerton

Material (Direct Cost)

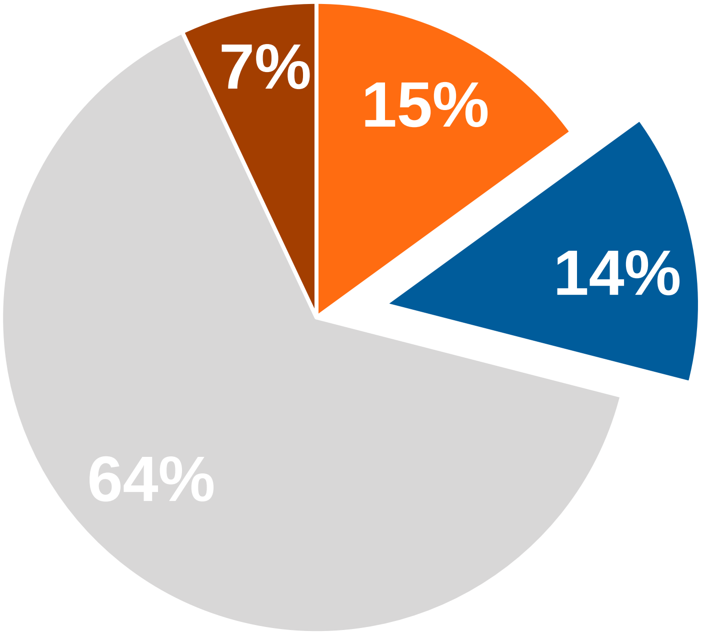


Turnkey Mass Timber Package

or

Source: Swinerton

Labor (Direct Cost)



Turnkey Mass Timber Package

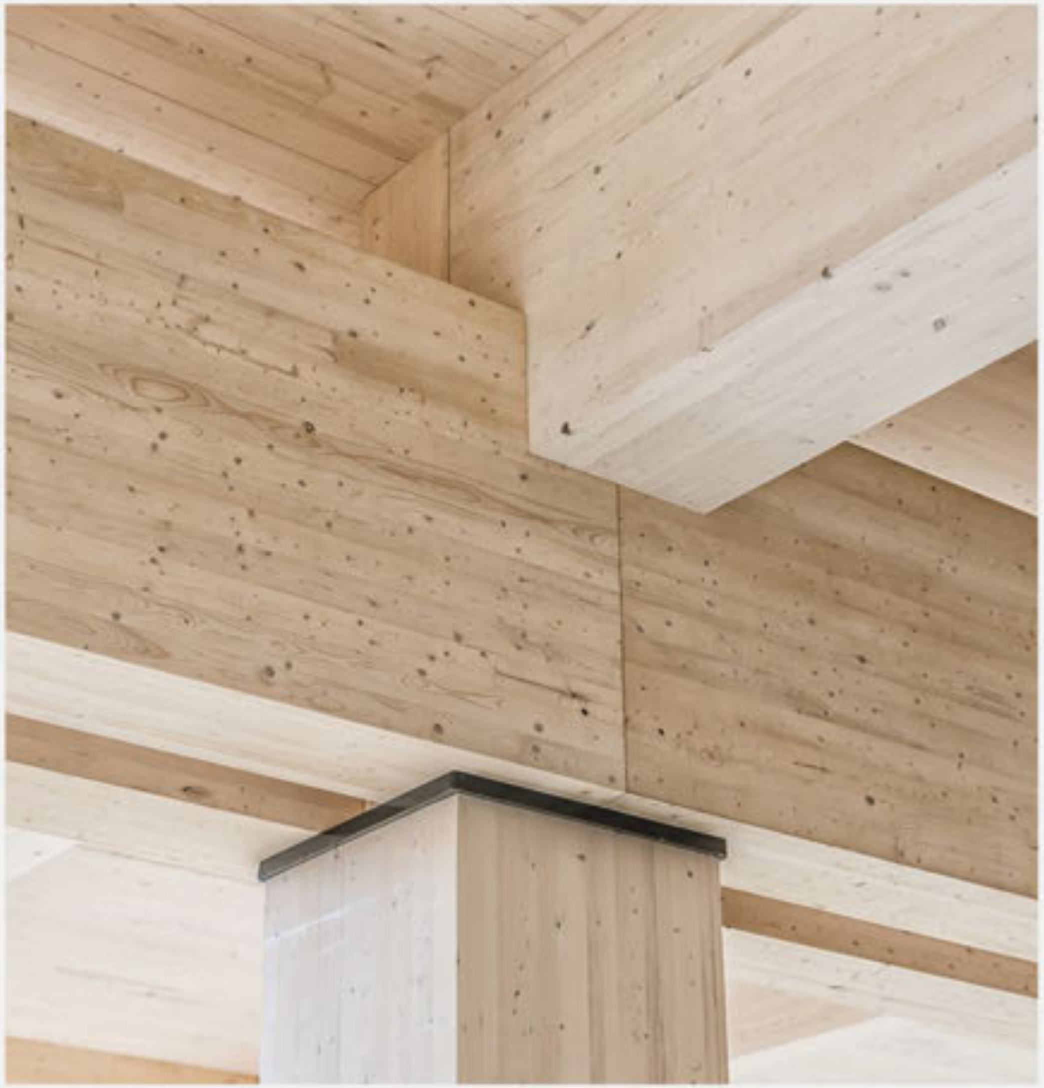
Photo: Swinerton

Source: Swinerton

Fabrication and Connection Considerations

- Factory vs. field
- Tolerances
- Connection classes
- Fire resistance
- Inspections

John W. Olver Design
Building at UMass Amherst
Leers Weinzapfel Associates / Equilibrium Consulting / Simpson Gumpertz & Heger (EOR) / Suffolk Construction
Photo Alex Schreyer



WoodWorks Index of Mass Timber Connections

A compilation of connections used in mass timber construction

Platte Fifteen / OZ Architecture / KL&A Engineers & Builders
Photo Alan Ferrin
https://www.woodworks.org/resources/index-of-mass-timber-connections/

Connection Classes and *Fire Ratings*

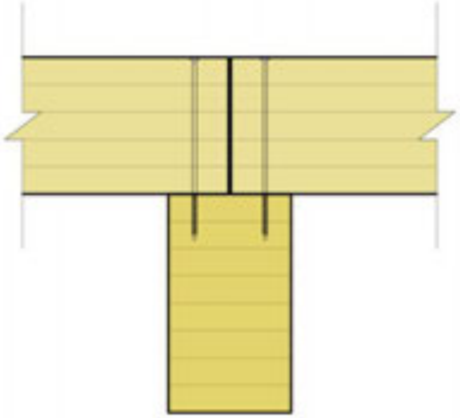
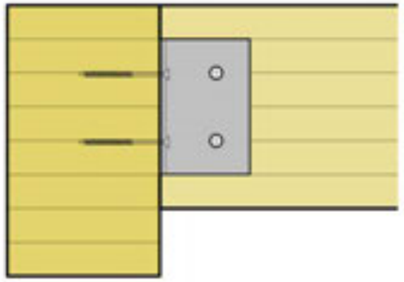
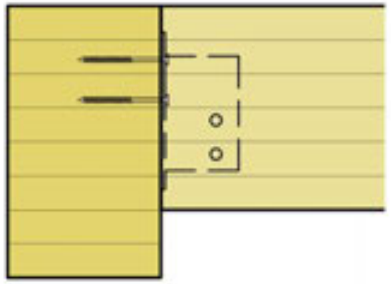
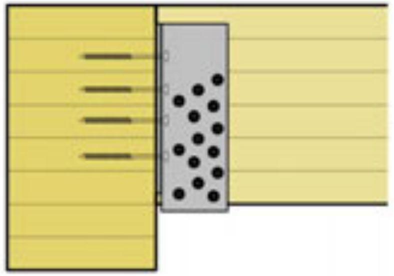
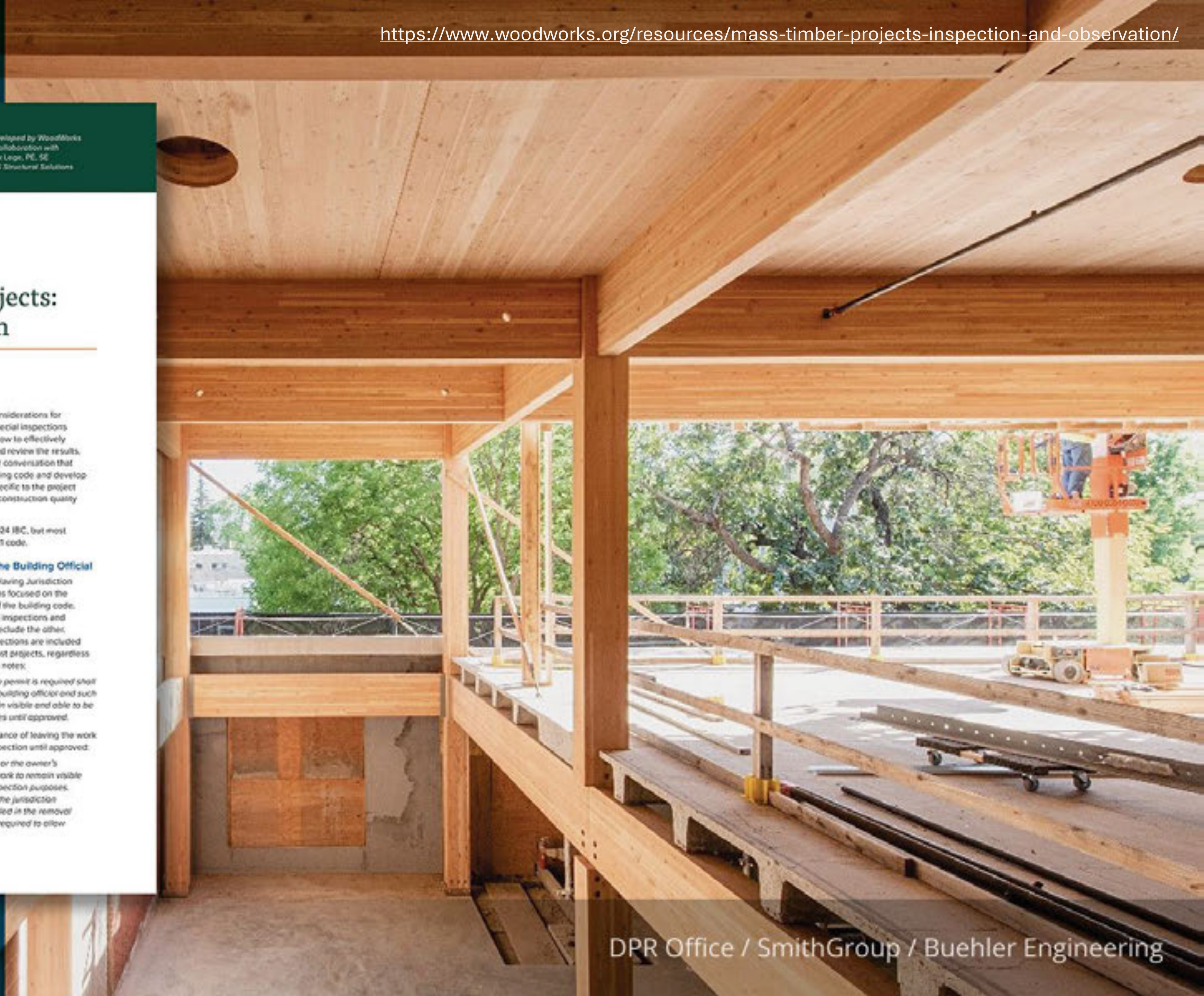
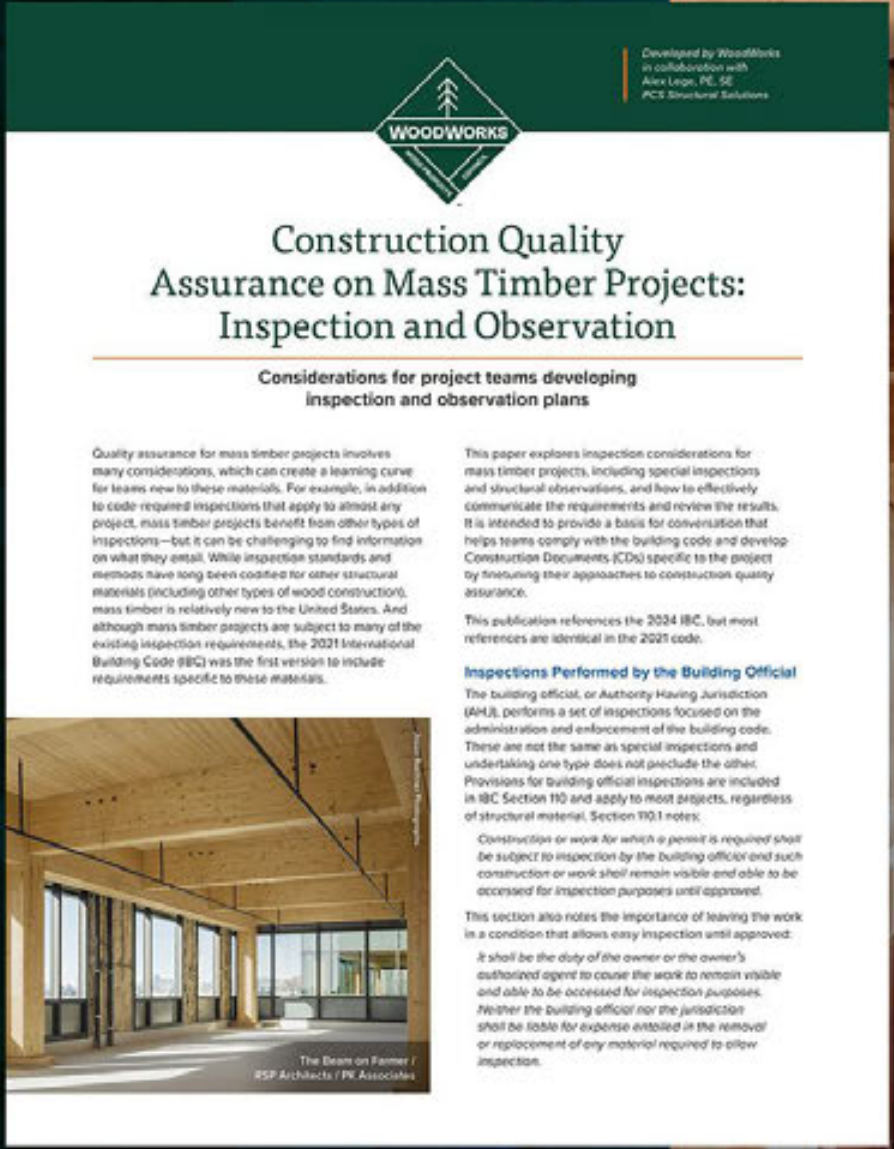
Connection class	**Class 1**	**Class 2**	**Class 3**	**Class 3**
Fire resistance	May be inherently fire resistant according to NDS calculations	Requires additional protection to meet fire-rating requirements	Tested fire-resistance rating (as specified by manufacturer)	Requires additional protection to meet fire-rating requirements
Connection example				
	Beam Bears on Girder*	Beam Connected to Girder with Steel Angles*	Beam Connected to Girder with Concealed Face-Mounted Knife Plate Connector*	Beam Connected to Girder with Proprietary Hanger*

Table 8 in the ***Index***

https://www.woodworks.org/resources/mass-timber-projects-inspection-and-observation/





Developed by WoodWorks in collaboration with Alex Lego, PE, SE PCS Structural Solutions

WOODWORKS

Construction Quality Assurance on Mass Timber Projects: Inspection and Observation

Considerations for project teams developing inspection and observation plans

Quality assurance for mass timber projects involves many considerations, which can create a learning curve for teams new to these materials. For example, in addition to code-required inspections that apply to almost any project, mass timber projects benefit from other types of inspections—but it can be challenging to find information on what they entail. While inspection standards and methods have long been codified for other structural materials (including other types of wood construction), mass timber is relatively new to the United States. And although mass timber projects are subject to many of the existing inspection requirements, the 2021 International Building Code (IBC) was the first version to include requirements specific to these materials.

The Beam on Farmer / RSP Architects / PK Associates

This paper explores inspection considerations for mass timber projects, including special inspections and structural observations, and how to effectively communicate the requirements and review the results. It is intended to provide a basis for conversation that helps teams comply with the building code and develop Construction Documents (CDs) specific to the project by finetuning their approaches to construction quality assurance.

This publication references the 2024 IBC, but most references are identical in the 2021 code.

Inspections Performed by the Building Official

The building official, or Authority Having Jurisdiction (AHJ), performs a set of inspections focused on the administration and enforcement of the building code. These are not the same as special inspections and undertaking one type does not preclude the other. Provisions for building official inspections are included in IBC Section 110 and apply to most projects, regardless of structural material. Section 110.1 notes:

> *Construction or work for which a permit is required shall be subject to inspection by the building official and such construction or work shall remain visible and able to be accessed for inspection purposes until approved.*

This section also notes the importance of leaving the work in a condition that allows easy inspection until approved:

> *It shall be the duty of the owner or the owner's authorized agent to cause the work to remain visible and able to be accessed for inspection purposes. Neither the building official nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.*

Step 1: Do Your Homework

Factors Influencing Cost Estimation

Design Complexity: High impact on material and labor costs

Material Availability:

- Regional differences in availability and pricing
- Understand which suppliers and subcontractors are appropriate for your project and how best to use them

Procurement Model: Can impact the timber package price by as much as 30%—or more than 5% of total project hard costs

Step 1: Do Your Homework

Vet Potential Subcontractors

- Which products do you manufacture vs. which do you supply?
- What services do you typically provide?
- What is the ideal project for your company?
- What is your lead time?

Mass Timber Construction

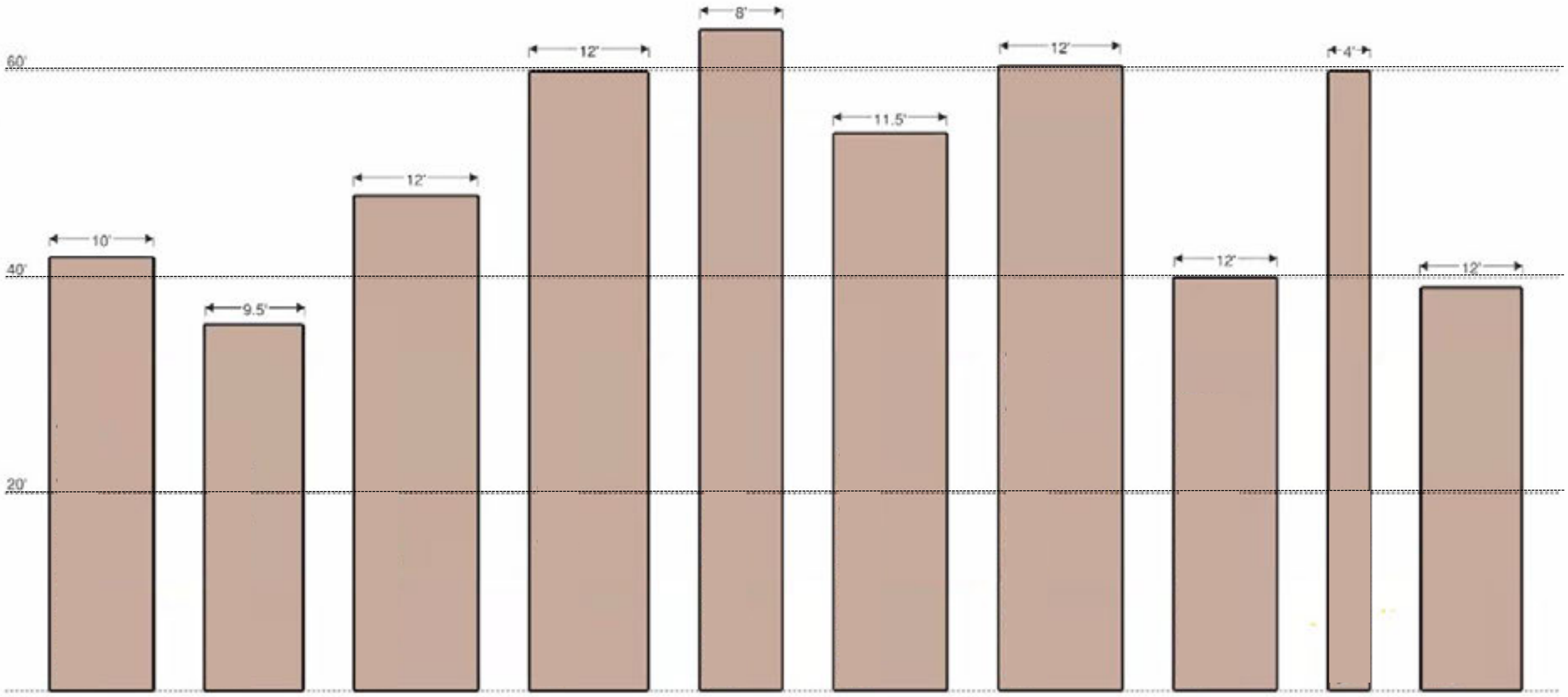
Know your supply chain

- Manufacturers - different species, grades and maximum panel/beam sizes
- Trucking logistics and cost
- Manufacturer specific CNC capabilities
- 3rd party fabricators can have additional CNC capabilities

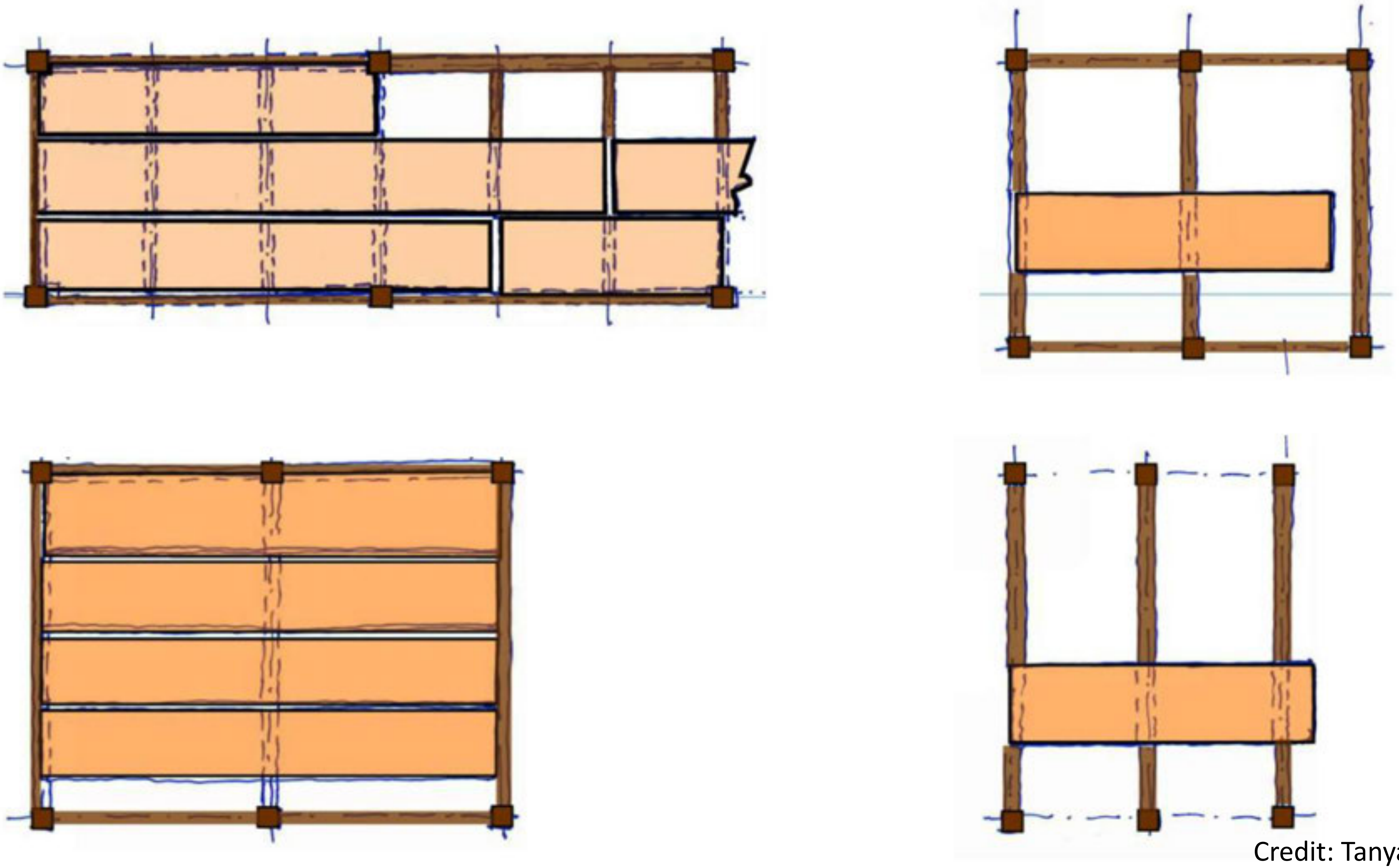
Photo: DR Johnson

Photo: Sauter Timber

Understand Manufacturer's Capabilities



Credit: TimberLab



Credit: Tanya Luthi, Entuitive

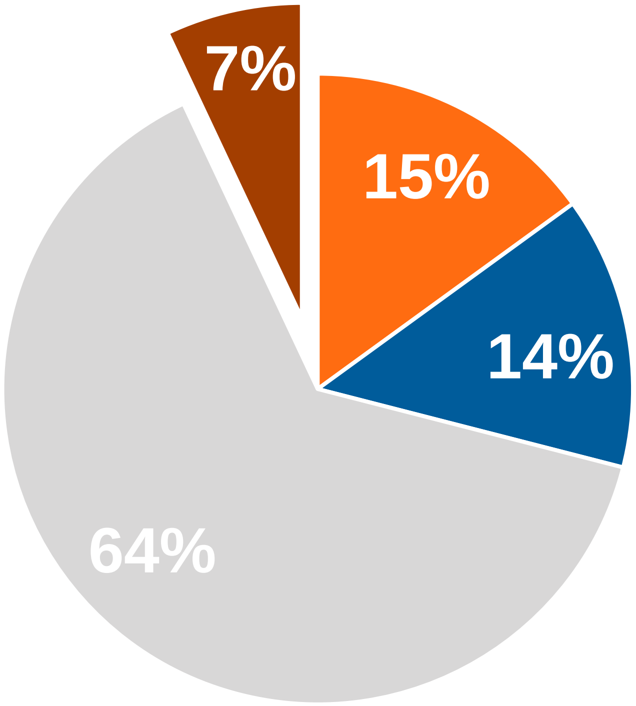
Understand Manufacturer’s Capabilities

Mass Timber Construction

- Staging areas
- Cranes

Photo Credit: Alex Schreyer

Equipment (Direct Cost)



Turnkey Mass Timber Package

Photo: Swinerton

Photo: Alex Schreyer

Source: Swinerton

Step 1: Do Your Homework

Factors Influencing Cost Estimation

Design Complexity: High impact on material and labor costs

Material Availability:

- Regional differences in availability and pricing
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Procurement Model: Can impact the timber package price by as much as 30%—or more than 5% of total project hard costs

Step 1: Do Your Homework
Procurement Models

Installer Furnish and Install

- Single contract between GC and installer; installer supplies material and installation

Manufacturer Furnish and Install

- Single contract between GC and manufacturer; manufacturer subcontracts installer

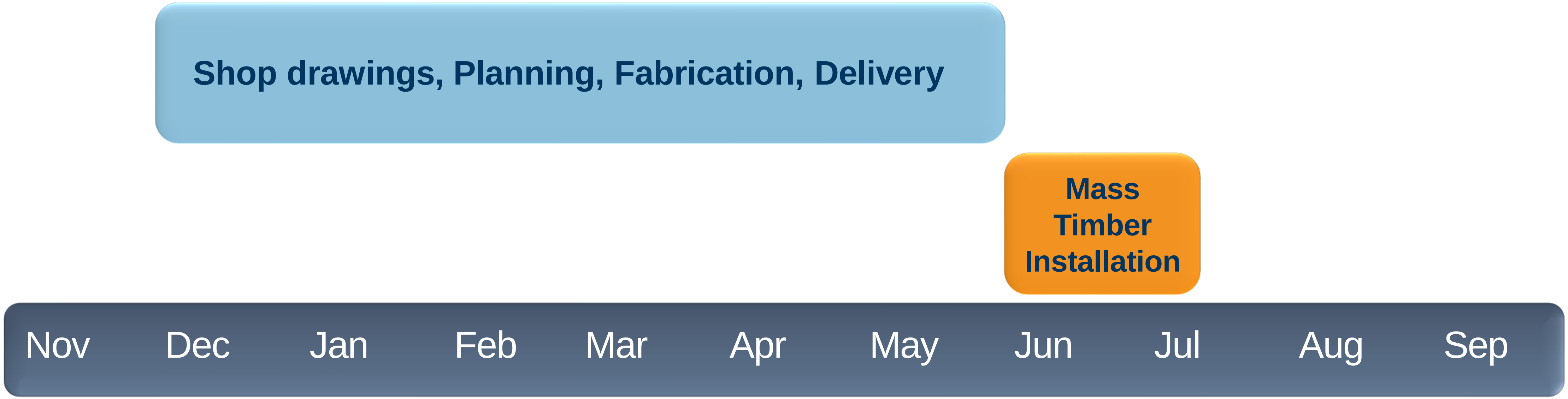
Furnish and Install Separately

- GC procures material direct from manufacturer; separate contract with installer

GC Self-Perform

Design-Build Subcontract

Procurement Logic for Scheduling

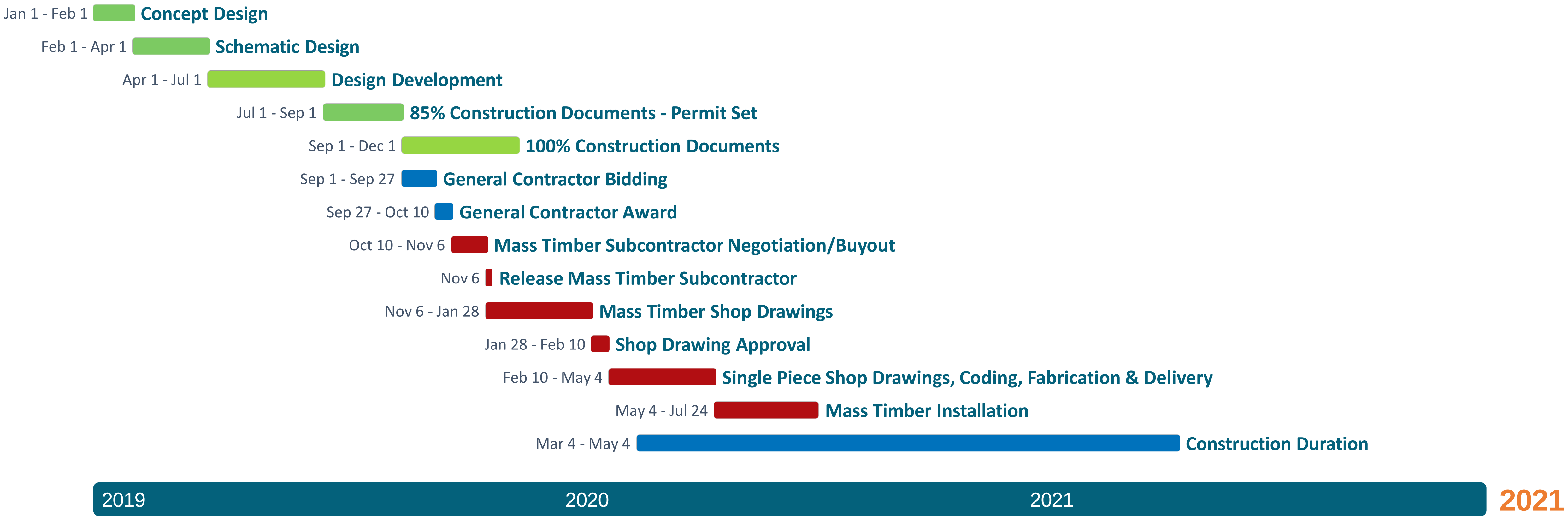


Source: Swinerton

Example 6 Story Type IIIA Project

Procurement Approach Determines Schedule

Example 6 Story Type IIIA Project

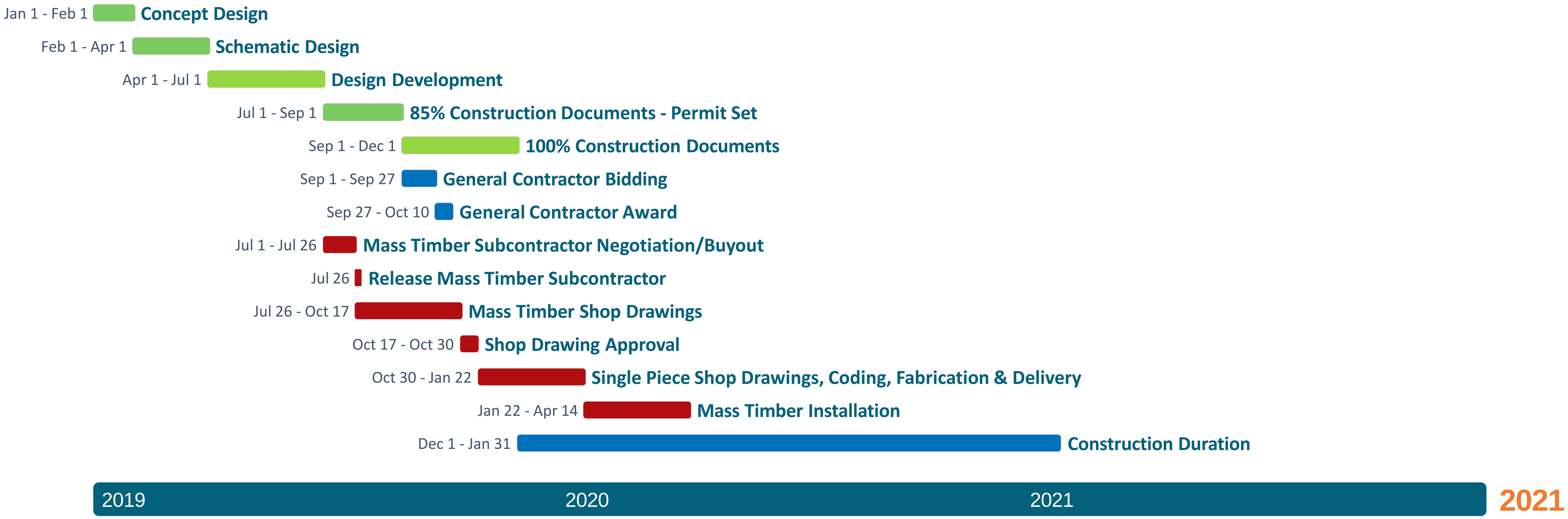


Source: Swinerton

Design-Bid-Build Procurement

Procurement Approach Determines Schedule

Example 6 Story Type IIIA Project



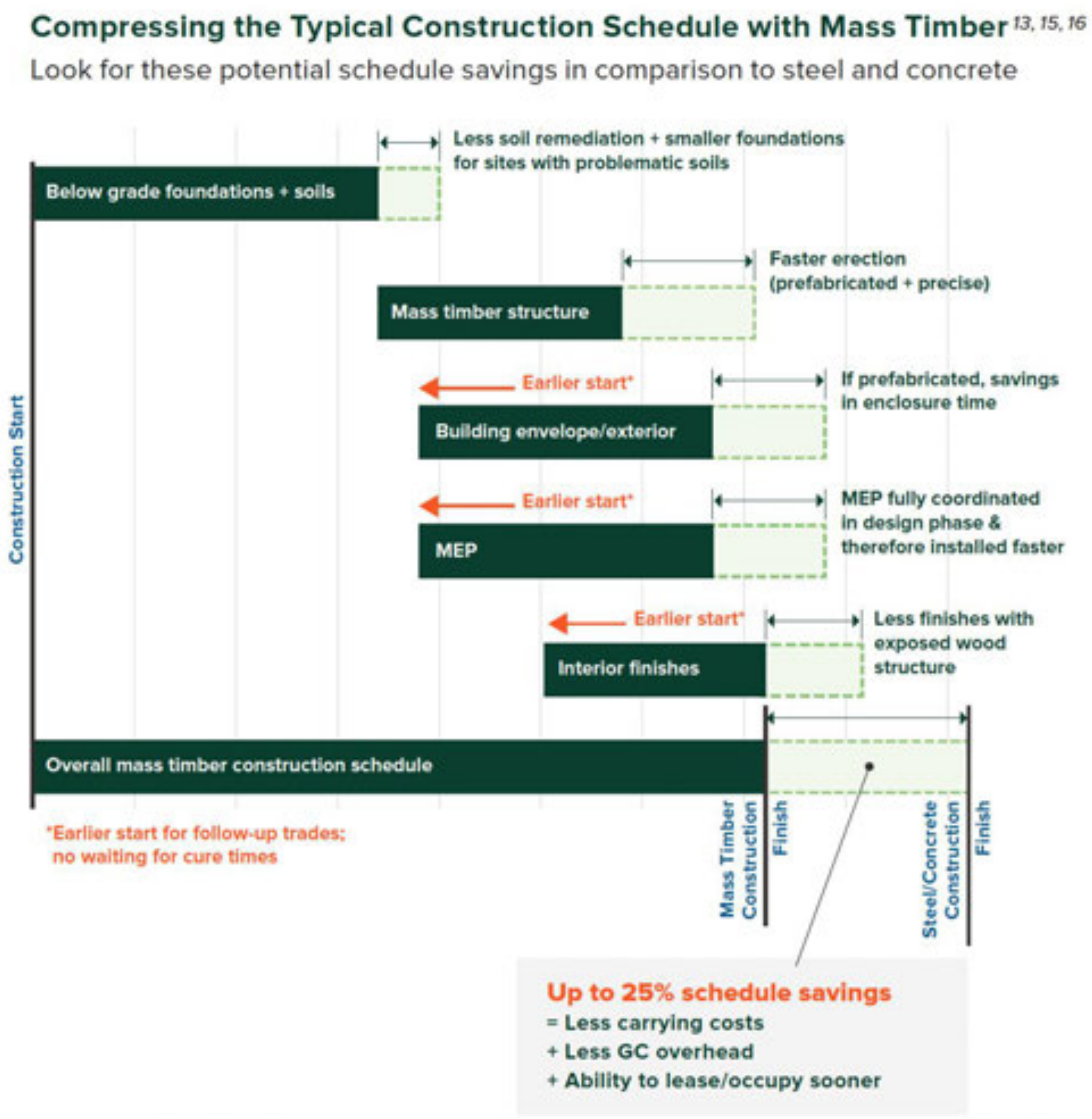
Source: Swinerton

Design-Build/Design-Assist Procurement

Early Move-In for Rough-In Trades.

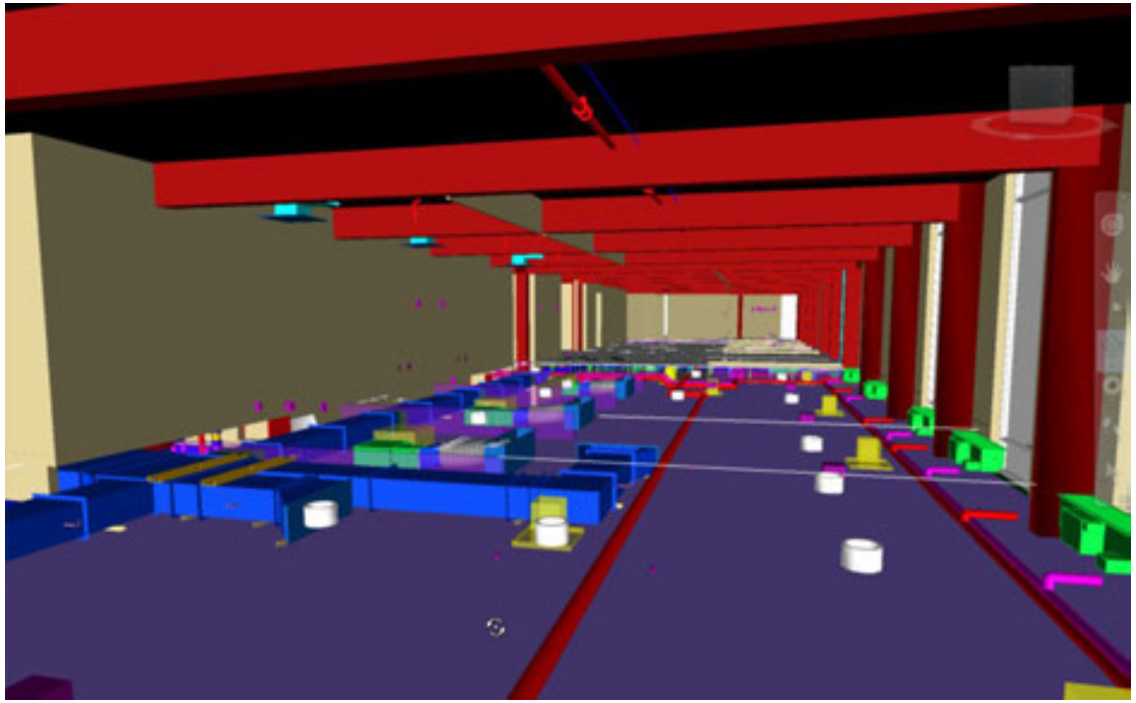
Photos: Swinerton

Procurement Approach Determines Schedule



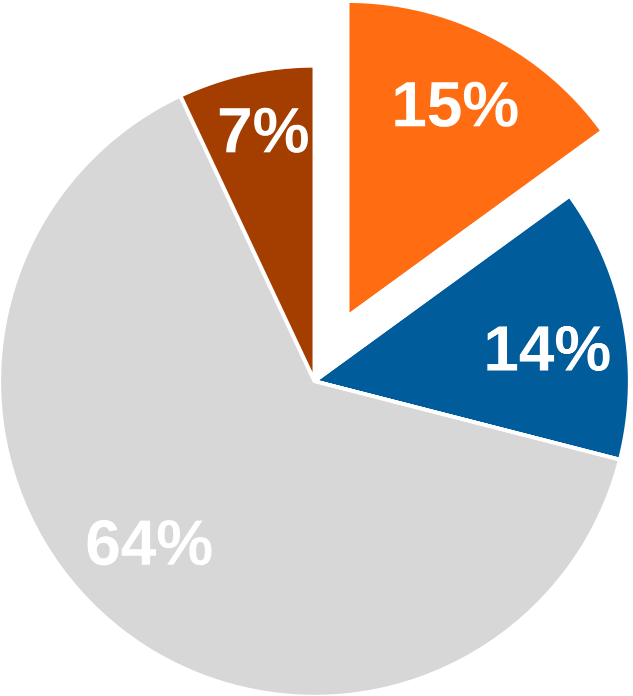
Source: WoodWorks

Embracing BIM for Fabrication



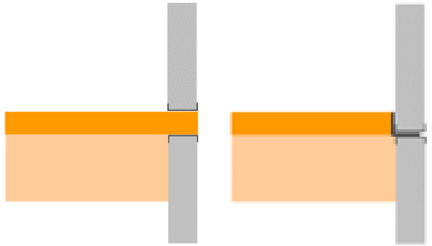
Photos: Swinerton

Project Overhead



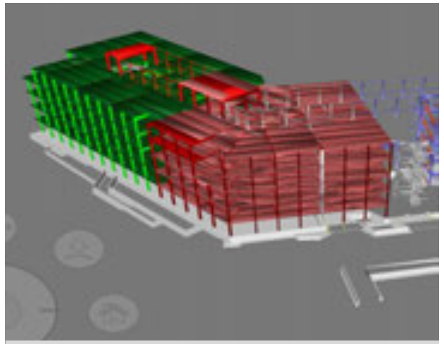
Turnkey Mass Timber Package

Cost Analysis

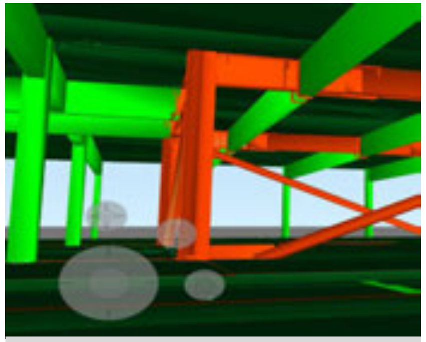


Design Refinement

System Integration



VD&C



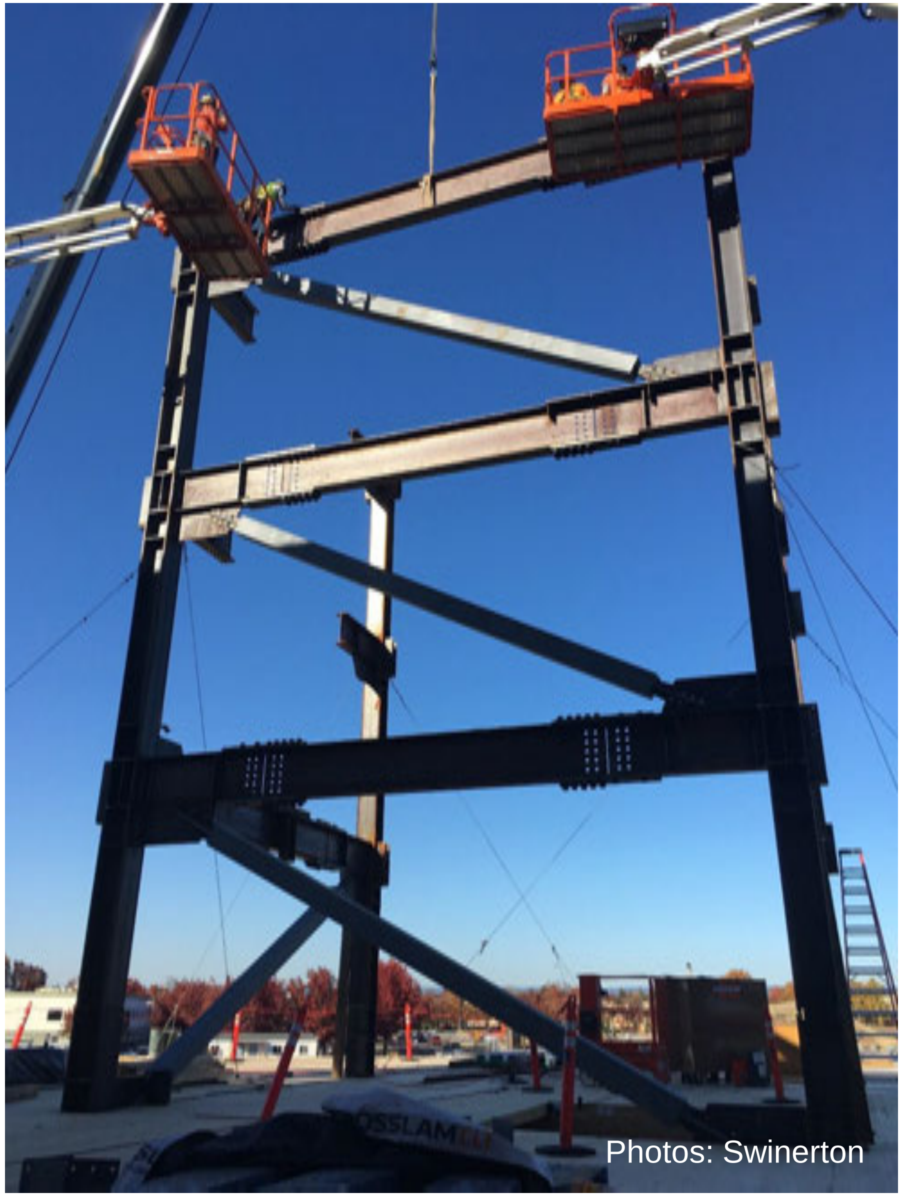
Detail Optimization

Logistics Planning

Photos: Swinerton

Source: Swinerton

Schedule Impacts: Hybrid Structures



Photos: Swinerton

Step 2: Establish a Reliable Pre-Design Budget

Choose Your List of Bidders

- Good to have three or four qualified/interested bidders to cover both supply and installation scopes if not being bid together
- Not every project is the right fit for every supplier or installer and producing a good bid takes time
- It is important to have a flexible specification to meet the design team’s intentions.

Step 2: Establish a Reliable Pre-Design Budget

Provide this Information for Better Supply Pricing

- Components that will be timber
- Grid size and structural typology
- Elements that will be exposed and their fire ratings
- Appearance grade requirements
- Local sourcing and/or forest certification requirements

Step 2: Establish a Reliable Pre-Design Budget

Insights for Better Budgeting

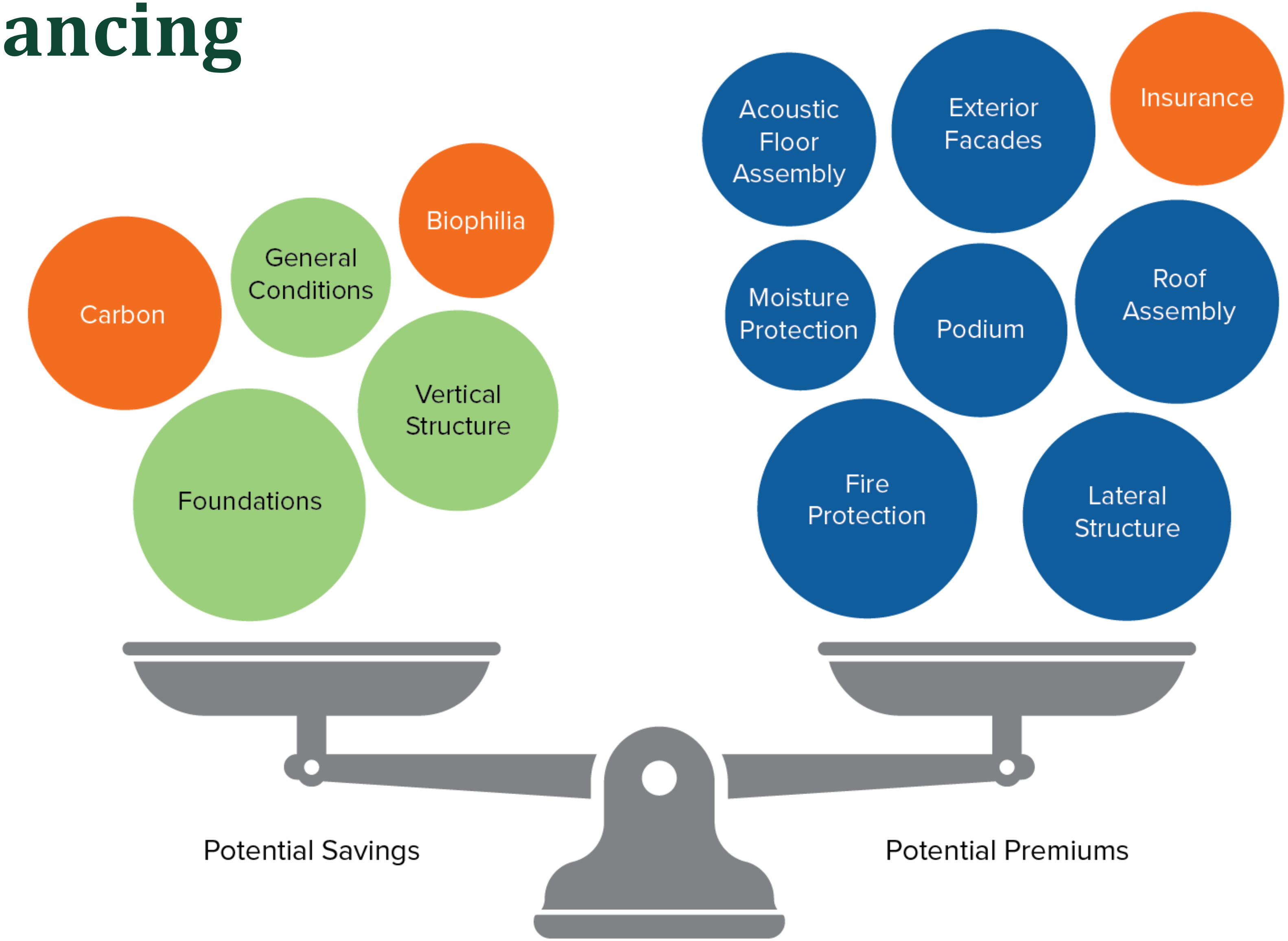
Pricing Breakdown		
Concept/ Schematic Design	Design Development	Bidding
Timber Supply Package	CLT	Floor/roof panels
		Wall panels
		Stair package
		Visual grade
		Temporary sealants
		Factory-applied membranes
		Predrilling/marking
	Glulam	Beams
		Columns
		Blocking/stair package
		Architectural finish
		Certification premium
	Hardware	Connectors
		Preassembly
		Fasteners and splines
		Hardware shipping
	Logistics	CLT shipping
		Glulam shipping
		Temporary storage
	Other	Project management/design assist
		Fabrication model/shop drawings

Important to Ask Manufacturers and Suppliers What is Included (and Excluded) from Costs they Provide

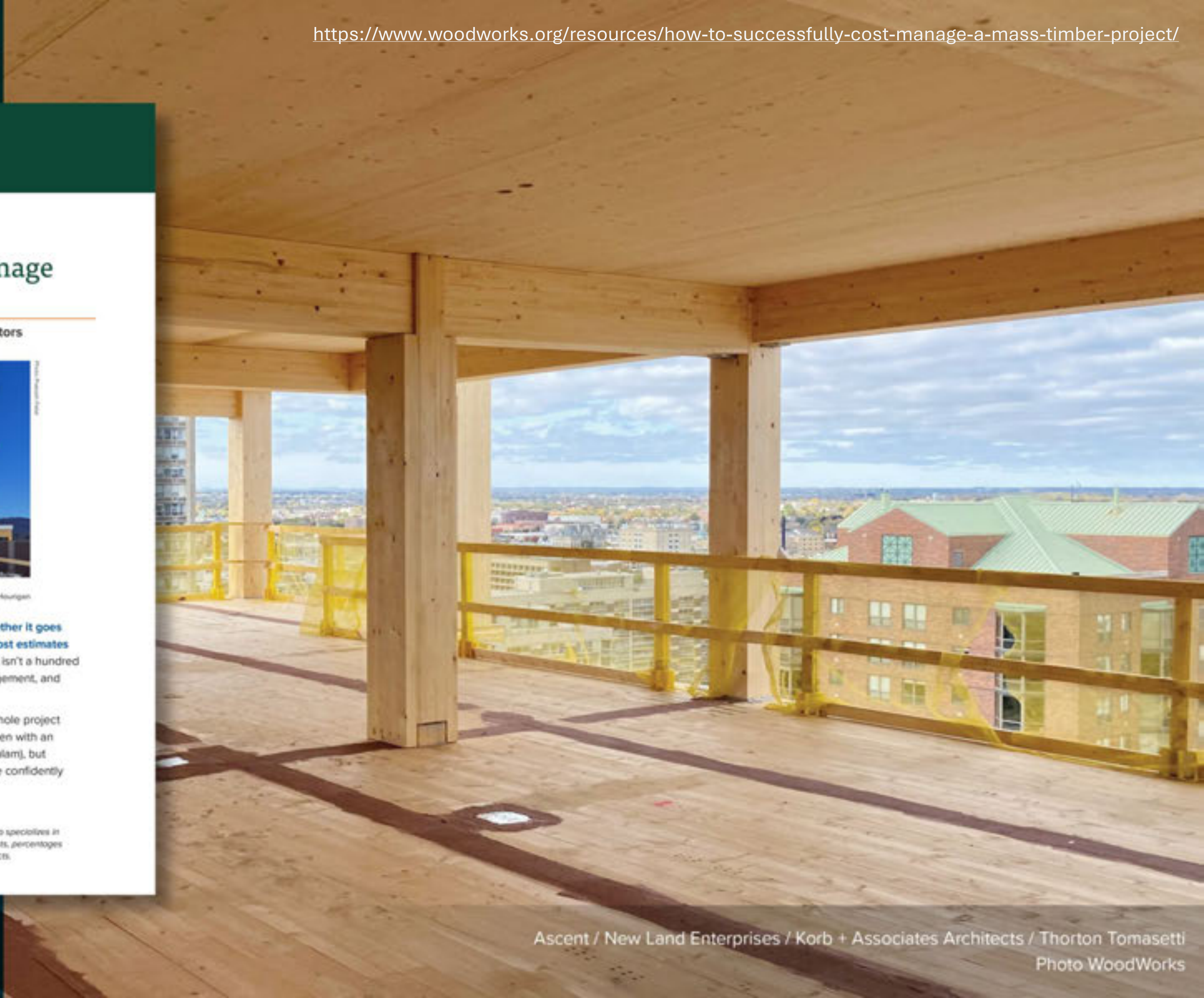
Installation	Labor and equipment	Schedule duration
		Crew size
		On-site moisture management
	Crane	Size
		Duration
	Staging yard	Duration
Taxes		

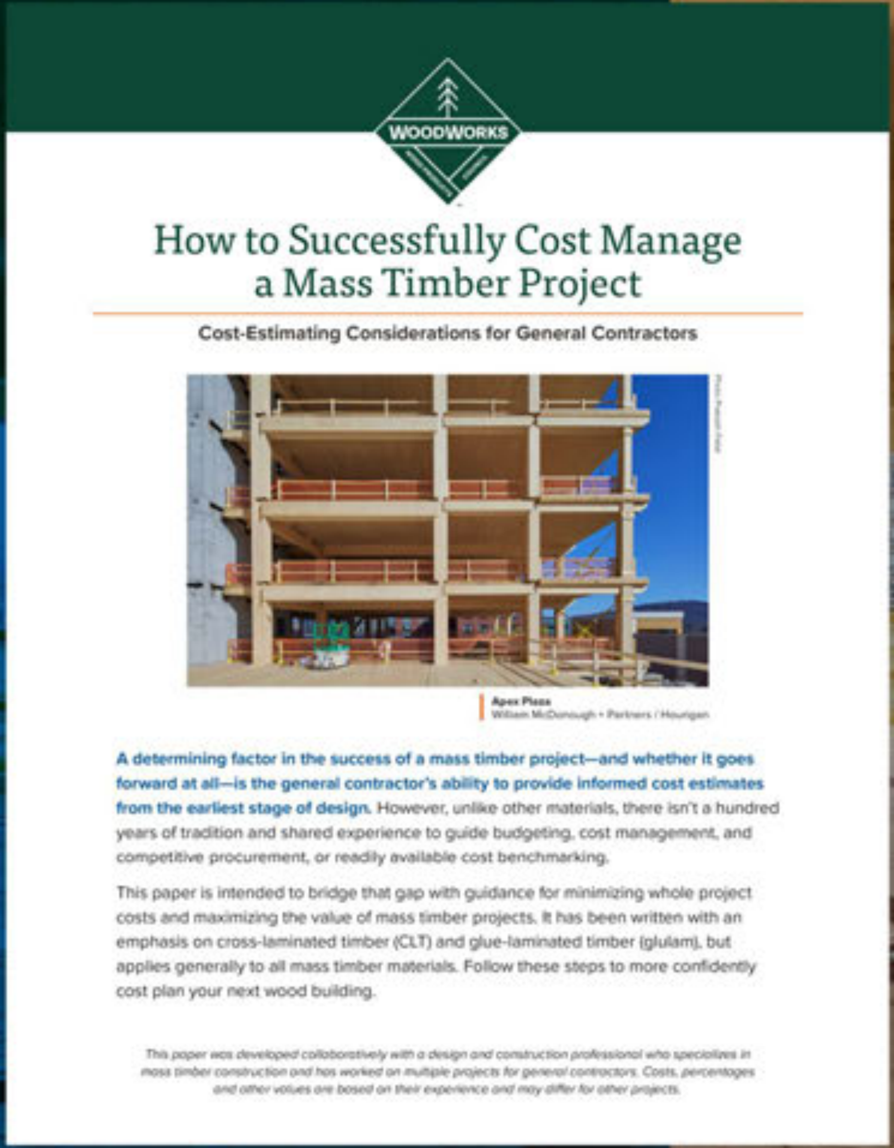
Items in green are not typically included in early pricing; develop separate budgets if needed

Mass Timber Construction Cost Balancing



https://www.woodworks.org/resources/how-to-successfully-cost-manage-a-mass-timber-project/





How to Successfully Cost Manage a Mass Timber Project

Cost-Estimating Considerations for General Contractors

Apex Plaza
William McDonough + Partners / Hourigan

A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates from the earliest stage of design. However, unlike other materials, there isn't a hundred years of tradition and shared experience to guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking.

This paper is intended to bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. It has been written with an emphasis on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials. Follow these steps to more confidently cost plan your next wood building.

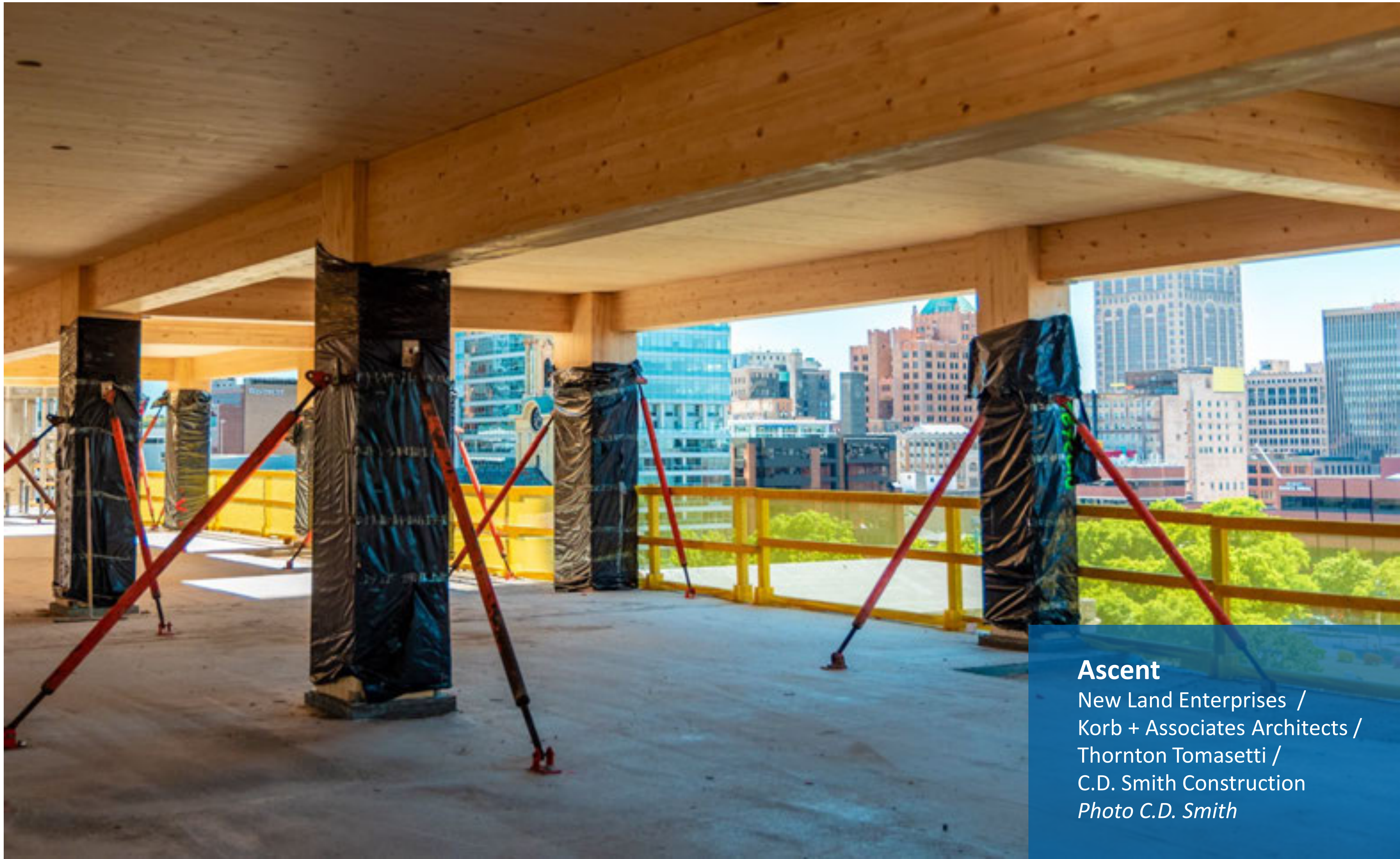
This paper was developed collaboratively with a design and construction professional who specializes in mass timber construction and has worked on multiple projects for general contractors. Costs, percentages and other values are based on their experience and may differ for other projects.

Ascent / New Land Enterprises / Korb + Associates Architects / Thorton Tomasetti
Photo WoodWorks


https://www.woodworks.org/resources/u-s-mass-timber-construction-manual/
WOODWORKS
WOOD PRODUCTS COUNCIL
U.S.
Mass Timber
Construction
Manual
The Soto / Hixon Properties
BOKA Powell
Photo: StructureCraft

Material Protection

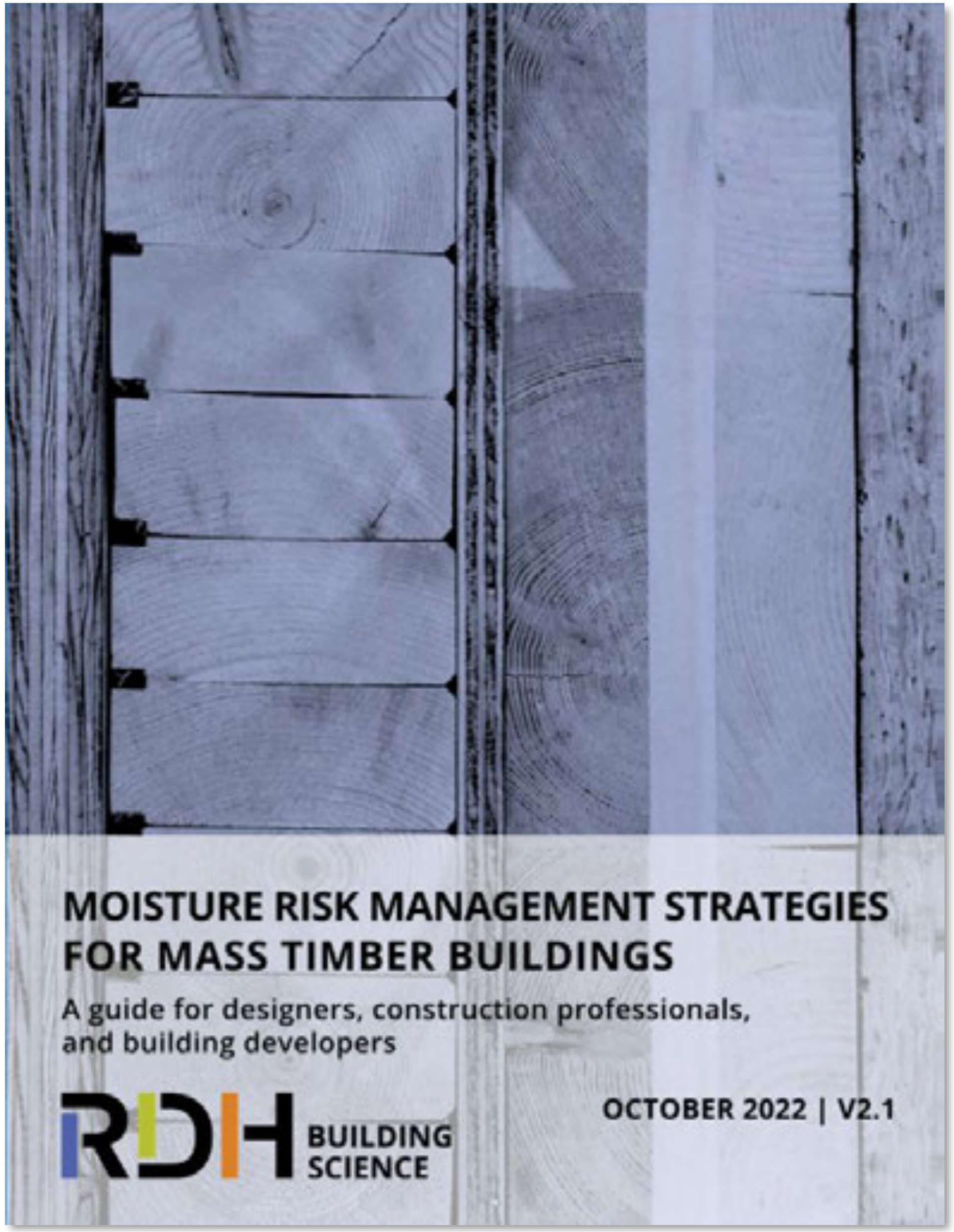
- Moisture
- UV rays
- Damage



Ascent
New Land Enterprises /
Korb + Associates Architects /
Thornton Tomasetti /
C.D. Smith Construction
Photo C.D. Smith

Managing Moisture: Mass Timber Guide

- Start early
- Evaluate risks
  - climate & season
  - water mgmt. during construction
  - exposure duration
  - shipping & storage
- Prepare construction phase moisture management plan



Moisture Management Plan

Planning starts at the earliest stage and is collaborative.

Construction team responsibilities include:

- Construction phase plan; on-site strategies based on risk evaluation
  - Coverings
  - Deflection/diversion
  - Ventilation/drying
- Anticipating and troubleshoots issues
- Monitoring

Type and Extent of Protection

- Decision by architect/contractor
- Appearance requirements
- Extent and cost of protection methods
- Protection in fabrication plant and/or on jobsite
- Capability of fabricator
- Capability of installer/moisture protection subcontractor
- Schedule protection plan
- Protection prior to installation
- Protection during installation
- Protection after installation

Moisture Management Responsibility and Risk

- Responsibility for managing and cost of the plan
- Contractor and/or fabricator
- Conditions to be considered
- Schedule delays and revisions
- Construction weather conditions (worst case)

Monitoring Moisture Before, During and After Construction

- Coordination with concrete topping activities
- Roofing material
- Columns, beams and floor/wall panels

U.S. Mass Timber Construction Manual / WoodWorks

Expert Tips: MT Coatings

- » Protective treatments vs. finishes
  - » Protective undercoat typically applied in shop
  - » Additional coats for protection and beauty

WOODWORKS
WOOD PRODUCTS COUNCIL

Expert Tips

Architectural Finishes and Mass Timber: A Primer

Covers coatings and how to choose them, protective treatments vs. finishes, best practices for protecting wood in situ, and maintenance cycles

Adidas North American Headquarters / LEVER Architecture / photo Jeremy Bittermann

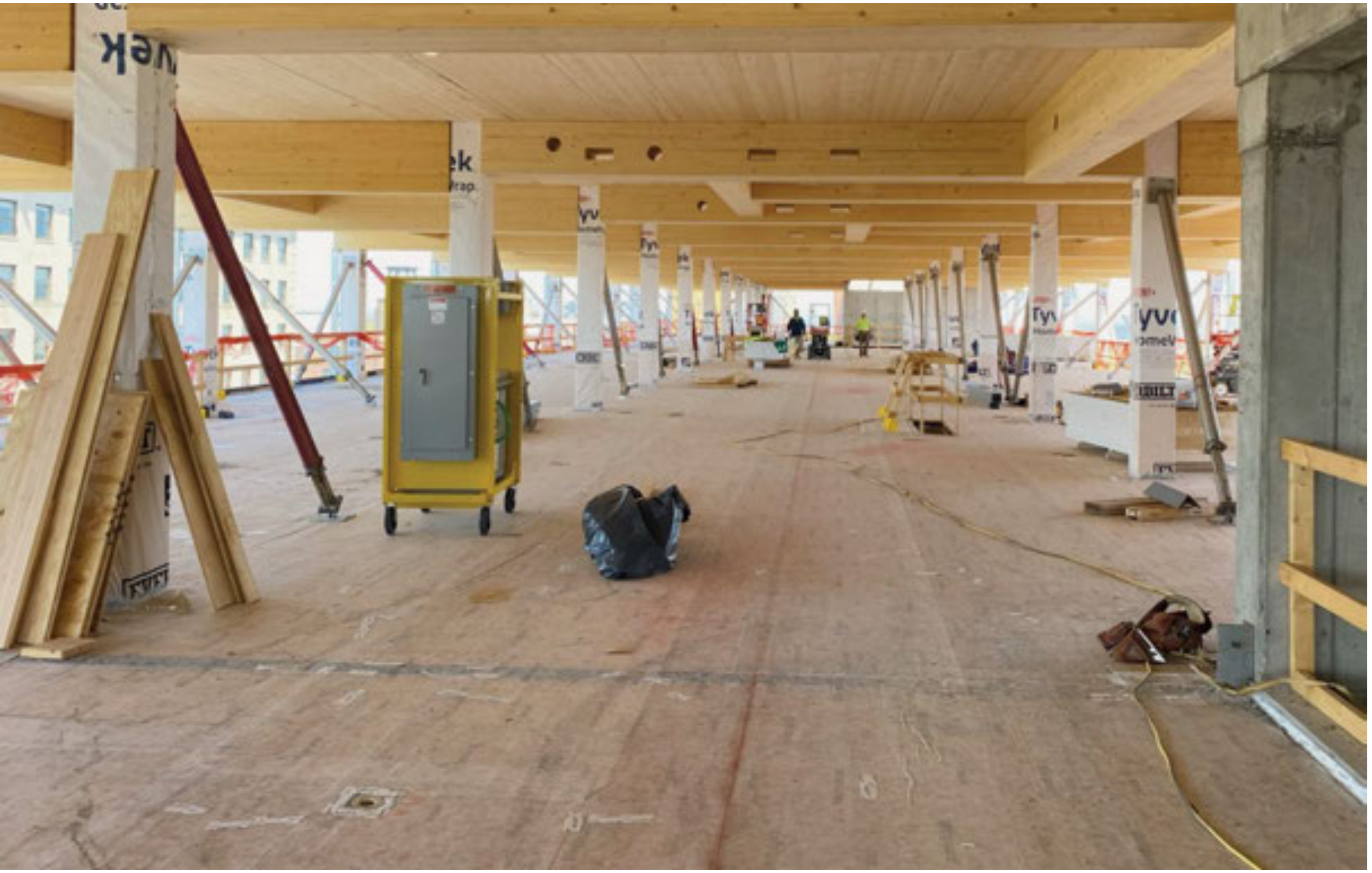
Transportation & Storage

Photos Paul Alberts / Ardor Media / naturallywood.com

Panel Joint Treatment

INTRO
Harbor Bay Ventures / Hartshorne Plunkard Architecture / Forefront Structural Engineers / Fast + Epp / Panzica Construction
Photos WoodWorks

Coverings



INTRO / Photos WoodWorks

Membranes can be spray-applied, sheet product (adhesive or non), or board/sheathing product.

Vaproshield

Deflection & Diversion

From Moisture Risk Management Strategies for Mass Timber Buildings,

Platte Fifteen
Oz Architecture / KL&A Engineers & Builders /
Adolfson & Peterson Construction
Photo WoodWorks

Moisture Monitoring

Monitor the moisture content (MC) of wood materials throughout construction.

- When materials are received
- Regular intervals
- After rainfall
- Before drying in

Product	MC at Manufacture	Desired MC at Project Close-in with Direct-Applied Concrete Toppings
CLT	12% +/- 3%[a]	<16%
GLT	12-16%[b]	<16%
NLT	<19%[c]	<16%
DLT	15-19%[d]	<16%

Sources: [a]PRG-320 standard, [b]ANSI A190.1, [c]Nail-Laminated Timber Design Guide – U.S. Edition, and [d]DLT Design and Profile Guide

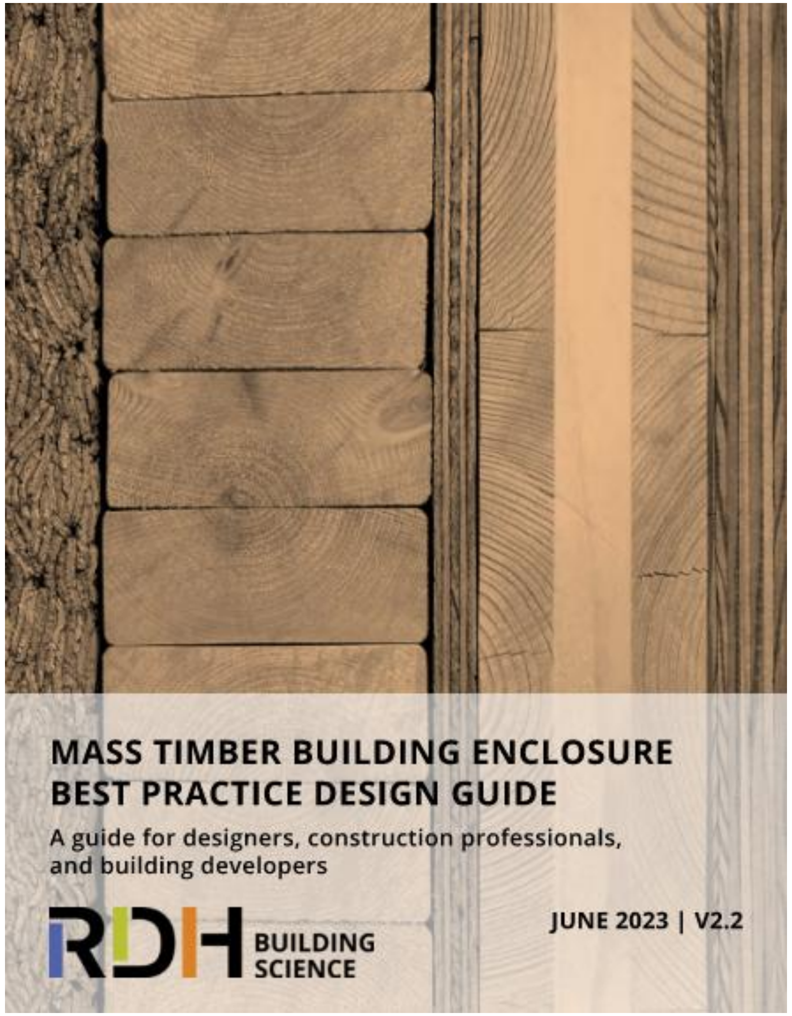
The best way to minimize exposure to moisture is to close in the project quickly.

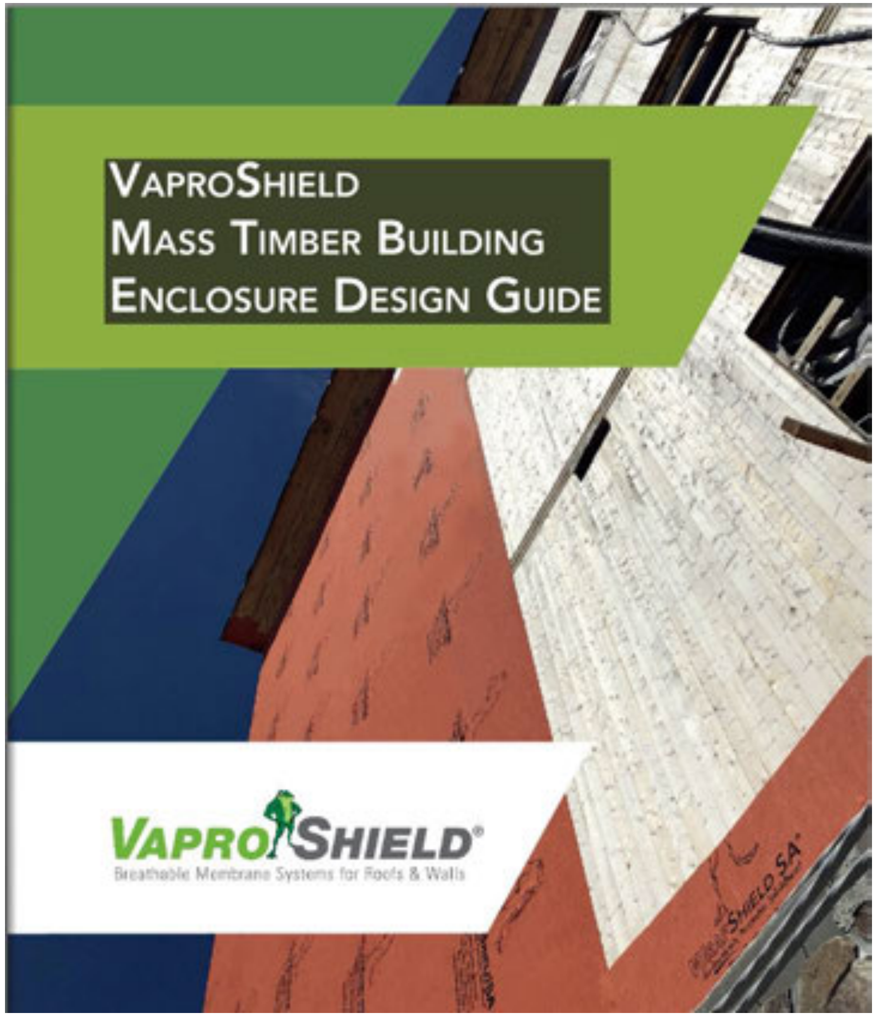
INTRO / Photo Harbor Bay Ventures

Building Envelope: Mass Timber Detailing Guides

WoodWorks provides structural details on our website. However, those don't consider control layers of the building envelope.

These are two great guides with example building envelope details for mass timber.





QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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Funding provided in part by the Softwood Lumber Board