Designing and Building with Mass Timber: Design, Planning and Performance

March 5, 2025

Presented by
Momo Sun, WoodWorks

Image: Nanotronics Smart Factory / Rogers Partners / Silman / Photo Albert Vecerka

PRESENTATION OUTLINE

MASS TIMBER DESIGN

Products
Structural Solution & Connections
Projects and Code Considerations

MASS TIMBER CONSTRUCTION

Planning for Construction
Performing Construction
Workforce Development

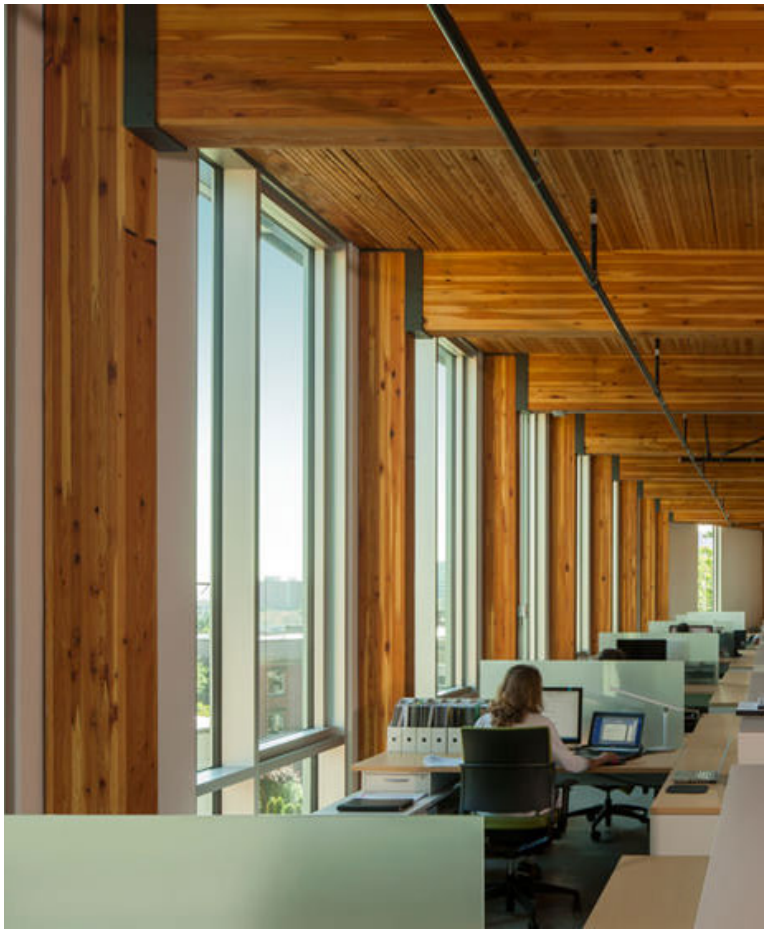
MASS TIMBER OVERVIEW

Photo: PCL Construction

OVERVIEW | TIMBER METHODOLOGIES

Light Wood-Frame
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

OFFICES | MULTI-FAMILY | COMMERCIAL | EDUCATIONAL

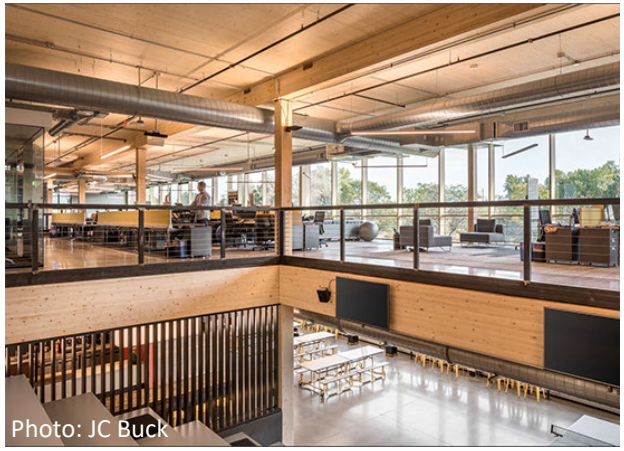


Photo: JC Buck

Photo: William Horne


Photo: LEVER Architecture


Photo: David Sundberg and Gray Organschi Architecture


Photo: ©Albert Vecerka/Esto


Photo: Christian Columbres

MASS TIMBER PRODUCTS

Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)

Plank orientation

Photo: StructureCraft

Photo: StructureCraft

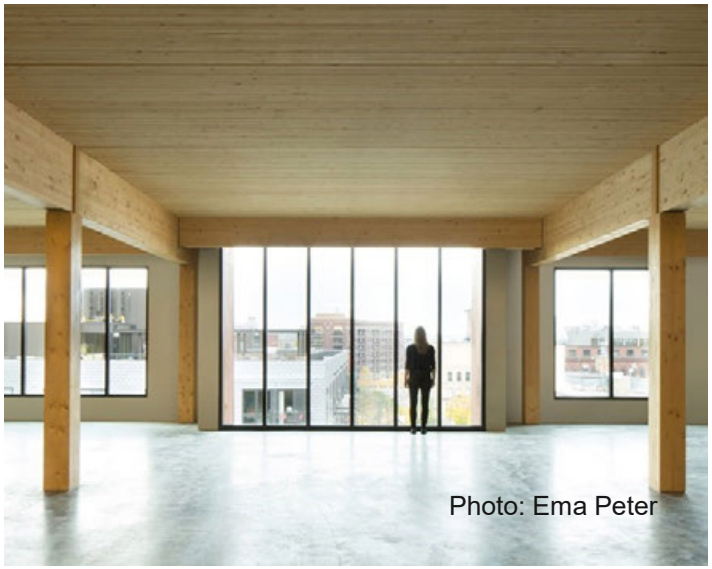


Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

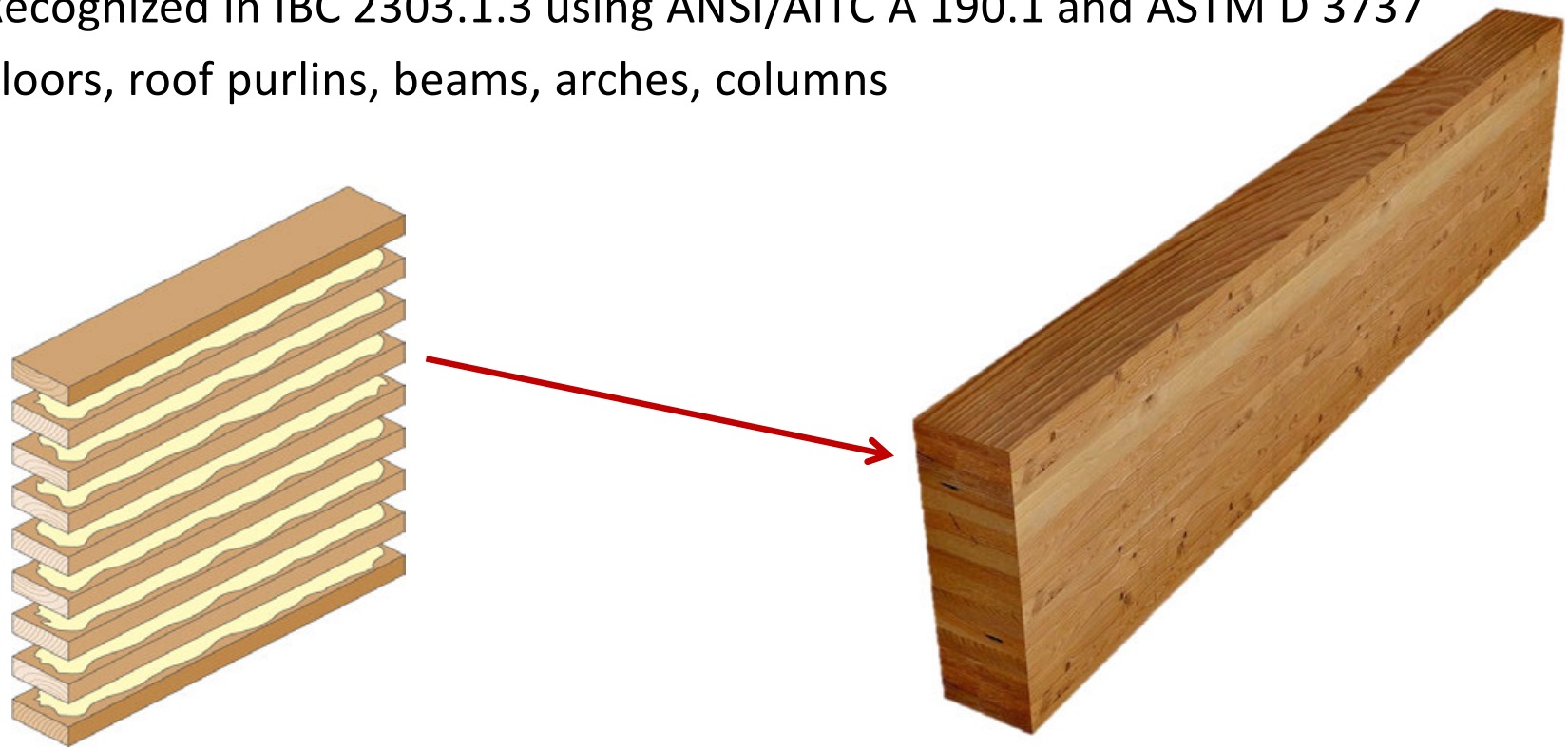
Glulam

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

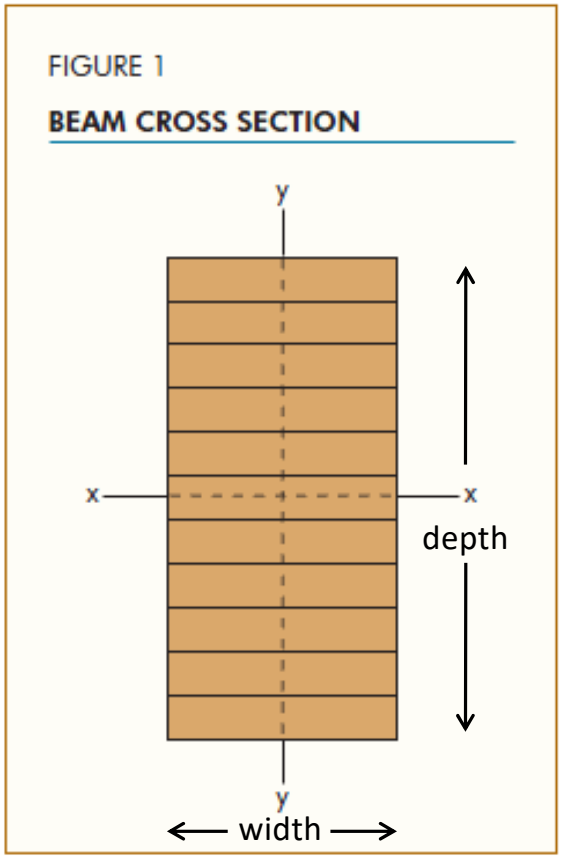
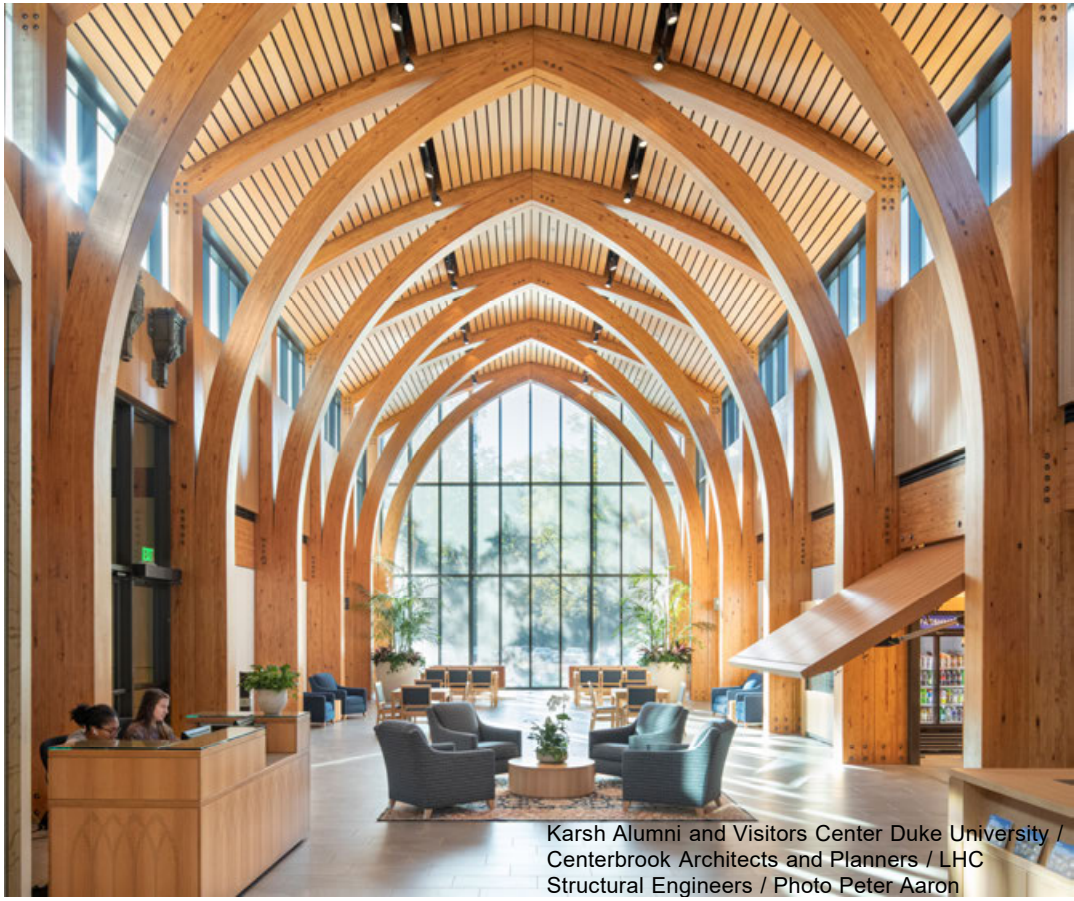


Image: APA Glulam Product Guide

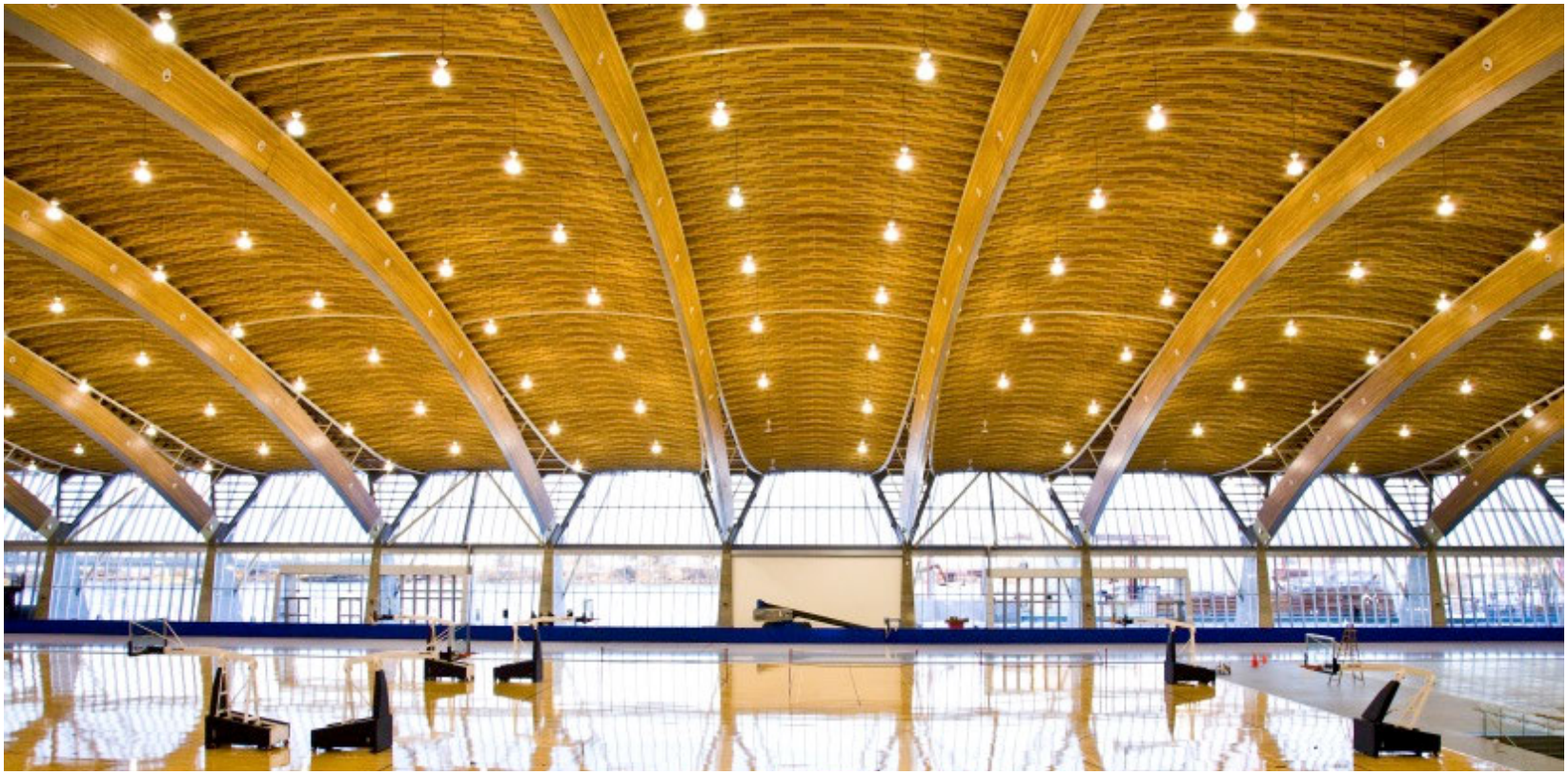
Glulam Specs

- 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

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

Flexibility of Spans and Shapes

Lemay America Auto Museum
Photo Credit: Western Wood Structures

Nail-Laminated Timber (NLT)

Photo: StructureCraft

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

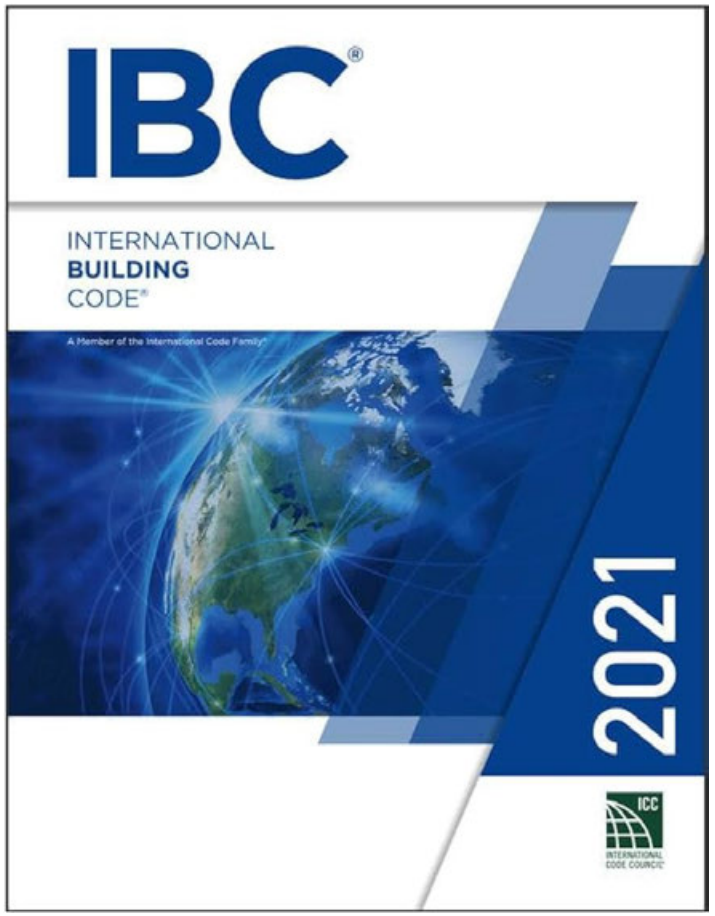
Image: Think Wood

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)

Photo: StructureCraft

Photo: Think Wood

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

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

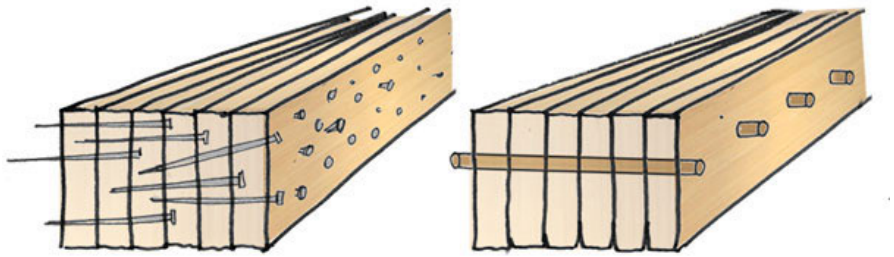


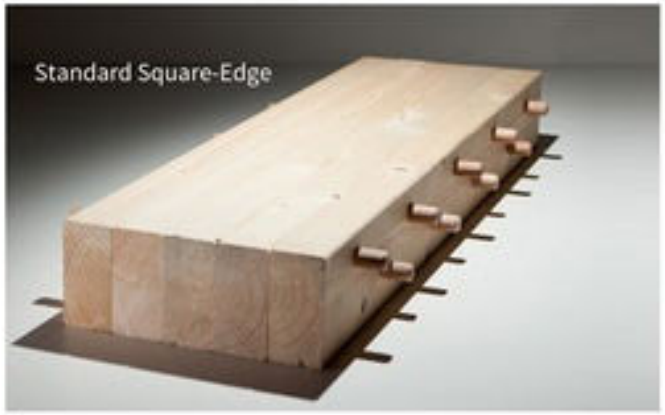
Photo credit: StructureCraft

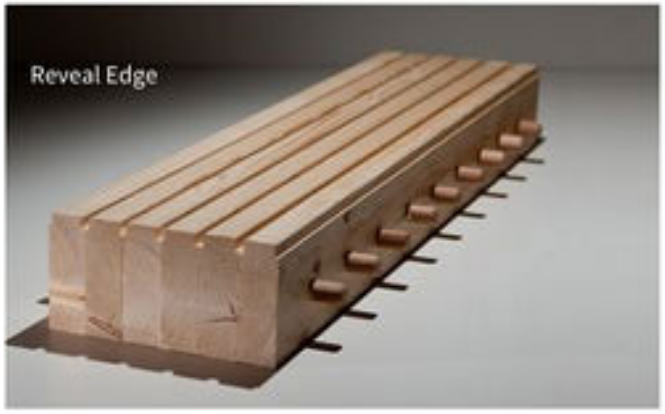
Dowel Laminated Timber (DLT) Panels

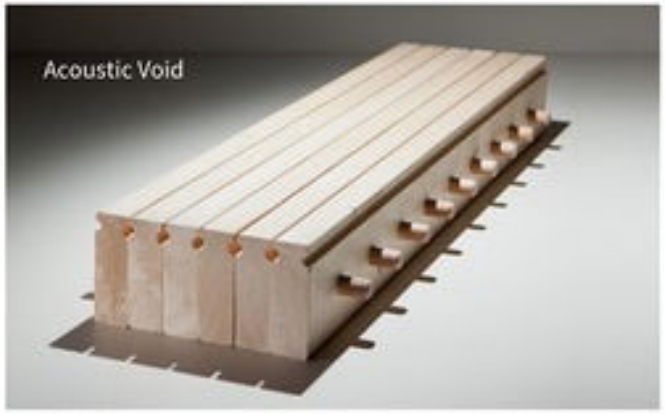
- Resources:
  - Timber Framers Guild (for dowel design)
  - DLT Design Guide

Credit: StructureCraft

Dowel Laminated Timber Profile Options







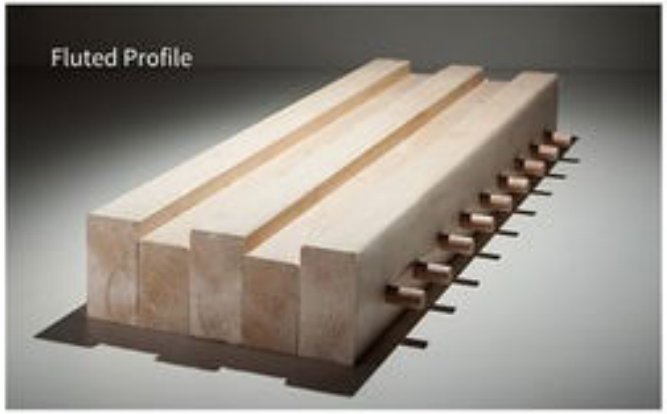


Photo credit: StructureCraft

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

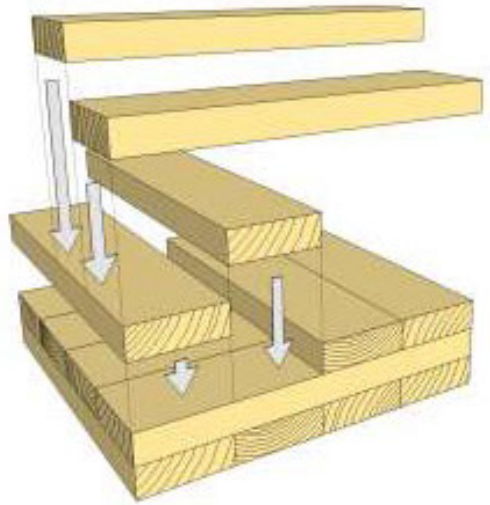
Image source: Manasc Isaac Architects / Fast + Epp

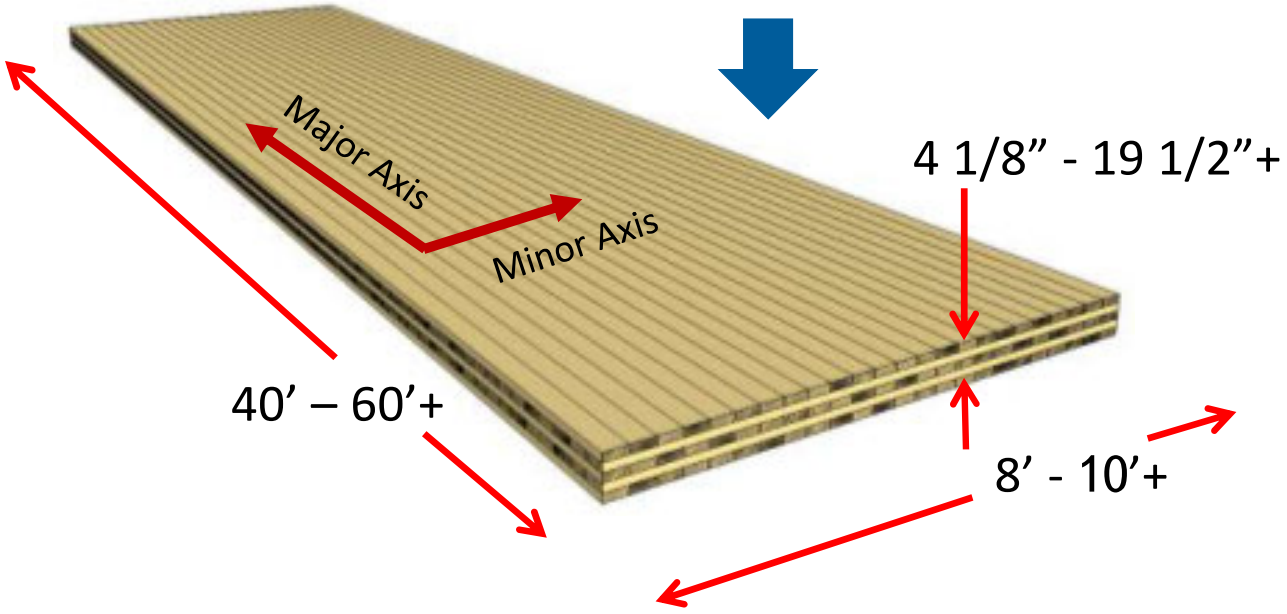
Cross-Laminated Timber (CLT)

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

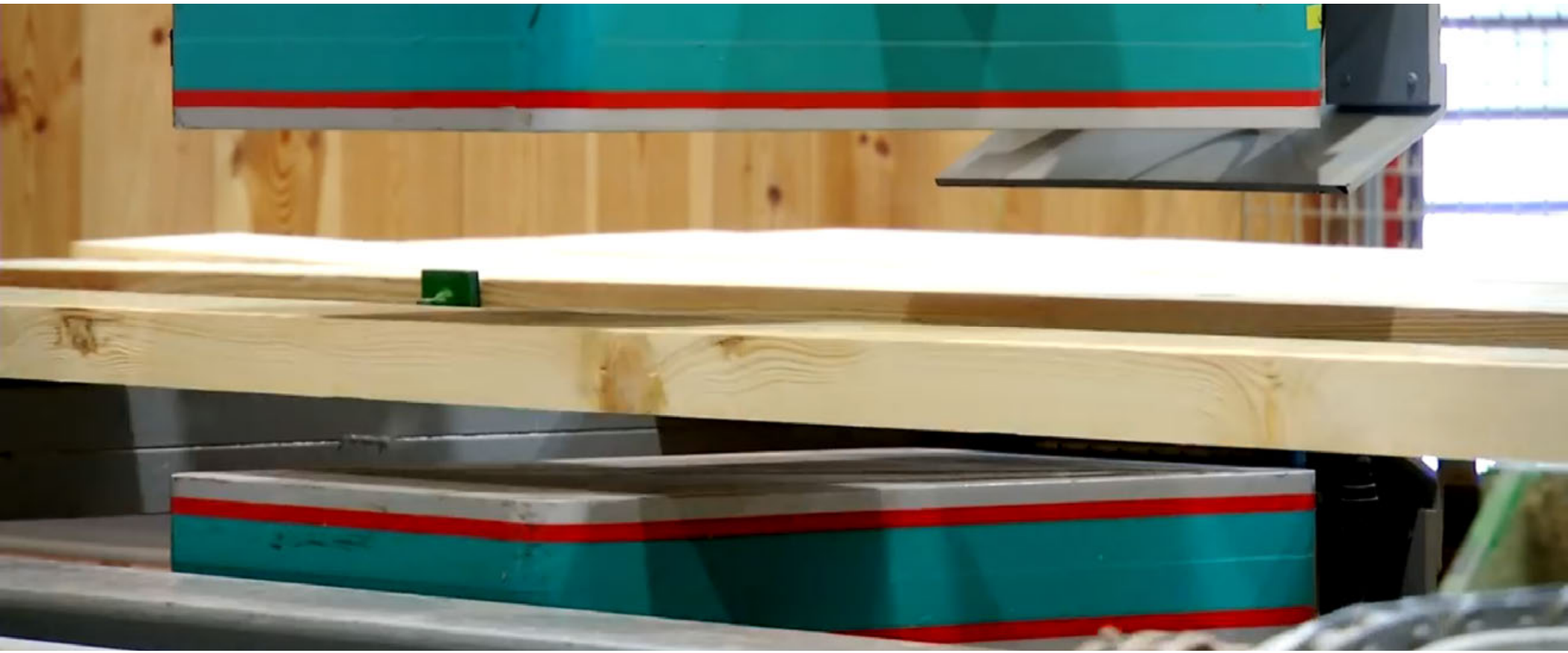
Cross Laminated Timber (CLT)

Photo Credit: DR Johnson

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

Photo Credit:
Sissi Slotover-Smutny



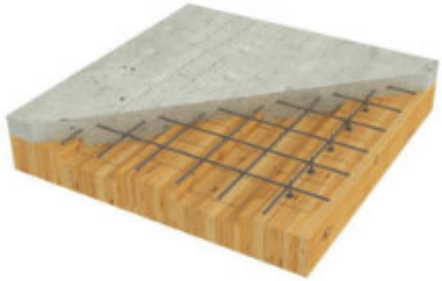
Other Mass Timber Product Options

Glue Laminated Timber
GLT

Laminated Veneer Lumber
LVL

Parallel Strand Lumber
PSL

Laminated Strand Lumber
LSL



Timber-Concrete Composite
TCC

Decking

Photos: StructureCraft

Current State of Mass Timber Projects Over Time

US Market Year-End 2024

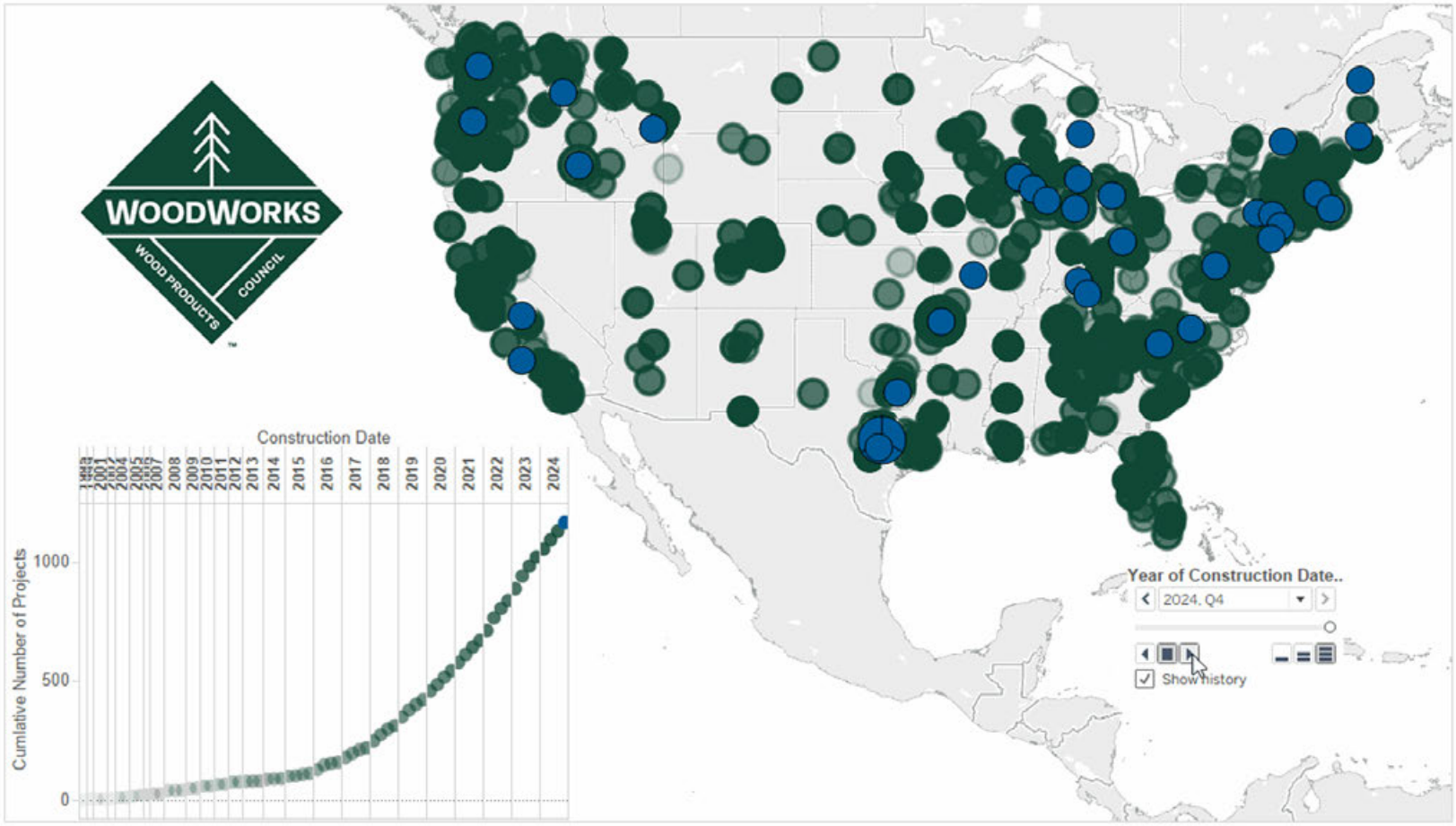


Photo: Ema Peter

STRUCTURAL SOLUTIONS | POST, BEAM + PLATE

Photo: Seagate Structures

STRUCTURAL SOLUTIONS | POST + PLATE

Photo: Lendlease

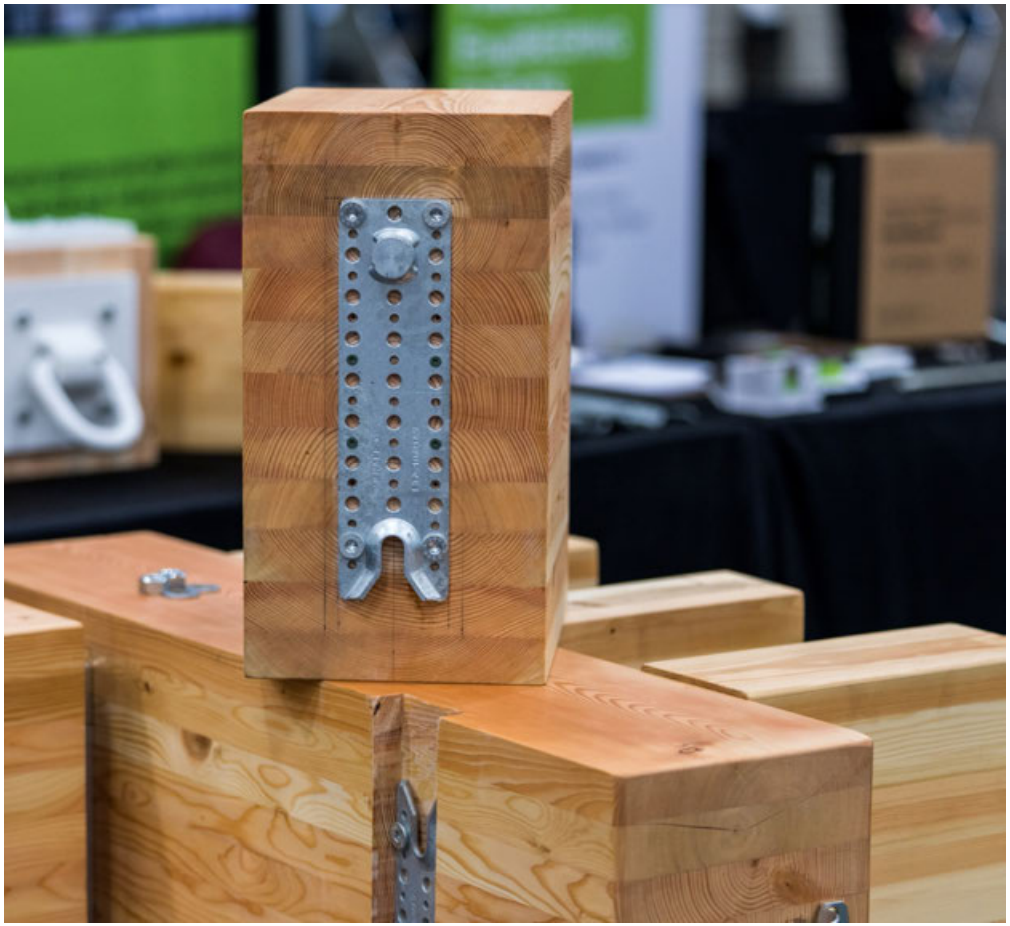
STRUCTURAL SOLUTIONS | HYBRID LIGHT-FRAME + MASS TIMBER

STRUCTURAL SOLUTIONS | HYBRID STEEL + MASS TIMBER

LEVER Architecture, photo Jeremy Bittermann

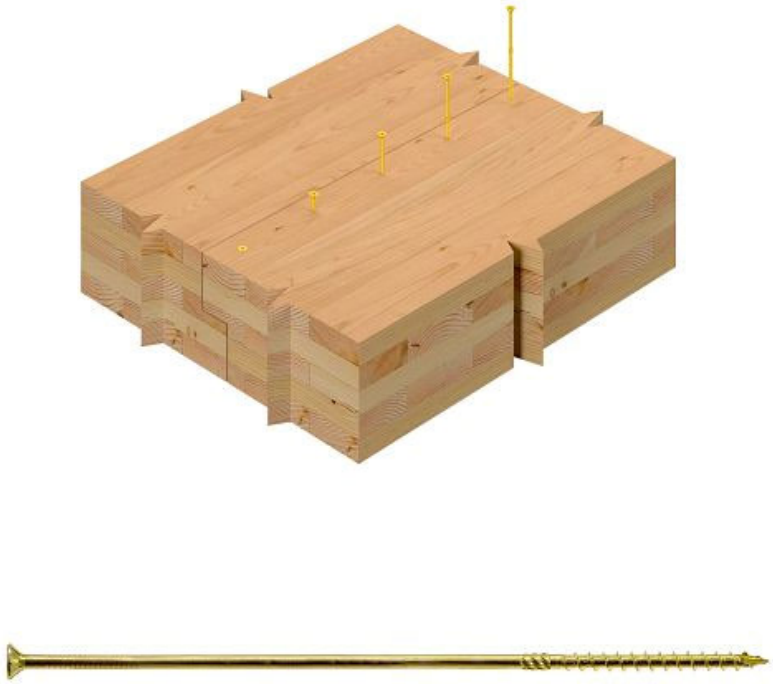
STRUCTURAL SOLUTIONS | HYBRID CONCRETE + MASS TIMBER

OVERVIEW | CONNECTIONS



Concealed Connectors

Photo Marcus Kauffman



Self Tapping Screws

Photo Simpson Strong Tie

Many ways to demonstrate connection fire protection: calculations, prescriptive NC, test results, others as approved by AHJ


Photo: John Stamets


Photo: Josh Partee

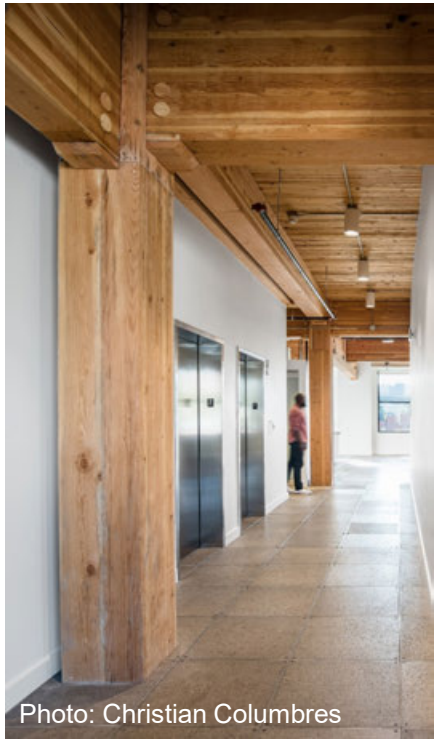


Photo: Christian Columbres

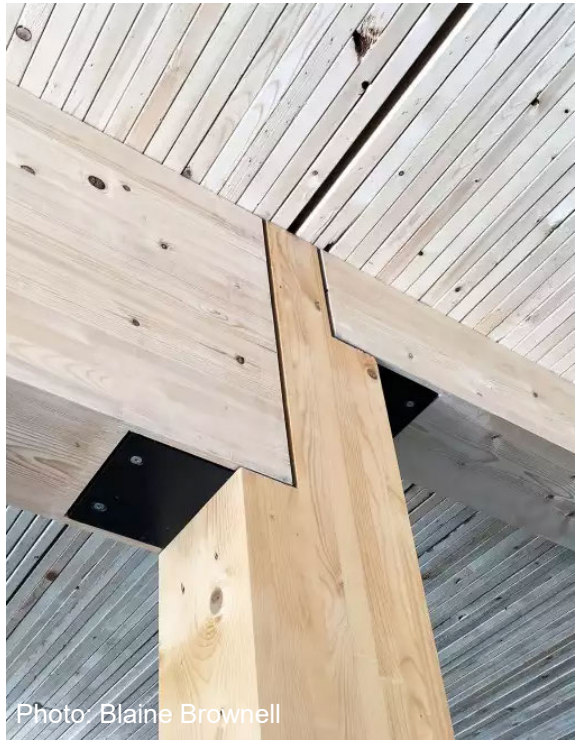


Photo: Blaine Brownell

Beam to Column

Photo: StructureCraft

Photo: Structurlam

Column to Foundation

Photo: Alex Schreyer

Panel to Panel & Supports

Photo: Charles Judd

Photo: Marcus Kauffman

Timber House

Brooklyn, NY

MESH architectures
Silman
Photo: Travis Mark

Timber House

Brooklyn, NY

MESH architectures
Silman
Photo: Travis Mark

24,000 sf, 6 stories

Type III-A

Multi-Family

MT – GLT floors, beams, columns and roof

Completed 2022

WN PROFILE

Evergreen Charter School
Hempstead, NY

Martin Hopp Architect
ODEH Engineers
Rendering: Martin Hopp Architect

Evergreen Charter School

Hempstead, NY

85,000 sf, 5 stories

Type III-A

Educational

W|N PROFILE

Martin Hopp Architect
ODEH Engineers
Rendering: Martin Hopp Architect

Photos: Michael Elkan | Naturally Wood | UBC


INTRO, CLEVELAND
9 Stories | 115 ft
8 Timber Over 1 Podium
512,000 SF
297 Apartments, Mixed-Use
Photo: Harbor Bay Real Estate Advisors, Purple Film | Architect: Hartshorne Plunkard Architecture

INTRO, CLEVELAND

Type IV-B
Variance to expose ~50% ceilings

Photo: Harbor Bay Real Estate Advisors, Image Fiction | Architect: Hartshorne Plunkard Architecture

ASCENT, MILWAUKEE

Photo: Korb & Associates Architects |
Architect: Korb & Associates Architects

493,000 SF

259 APARTMENTS, MIXED-USE

ASCENT, MILWAUKEE

Tallest Mass Timber Building in the World

Photo: CD Smith Construction |
Architect: Korb & Associates Architects


80 M ST, WASHINGTON, DC
3 STORY VERTICAL ADDITION
7 STORY EXISTING BUILDING
Photo: WoodWorks | Architect: Hickok Cole

80 M ST, WASHINGTON, DC

100,000 SF

2 NEW LEVELS OF CLASS A OFFICE SPACE
OCCUPIED PENTHOUSE
17’-0” CEILING HEIGHTS

11 E LENOX, BOSTON, MA

7 STORIES

70 FT

Passive House

Multi-Family

Credit: H + O Structural Engineering

Credit: Monte Frenah Design Studio

11 E LENOX, BOSTON, MA

Credit: H + O Structural Engineering

MASS TIMBER PROJECT CONSIDERATIONS

Photo: Hacker Architects

MASS TIMBER IN THE CODE

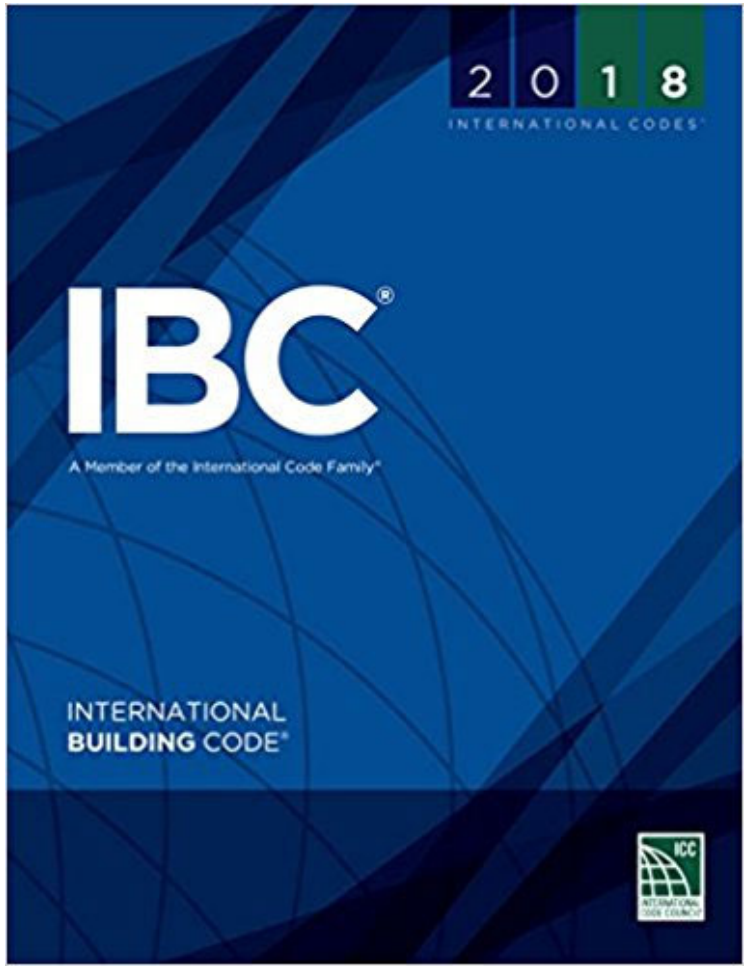
Photo: Freres Lumber

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:

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

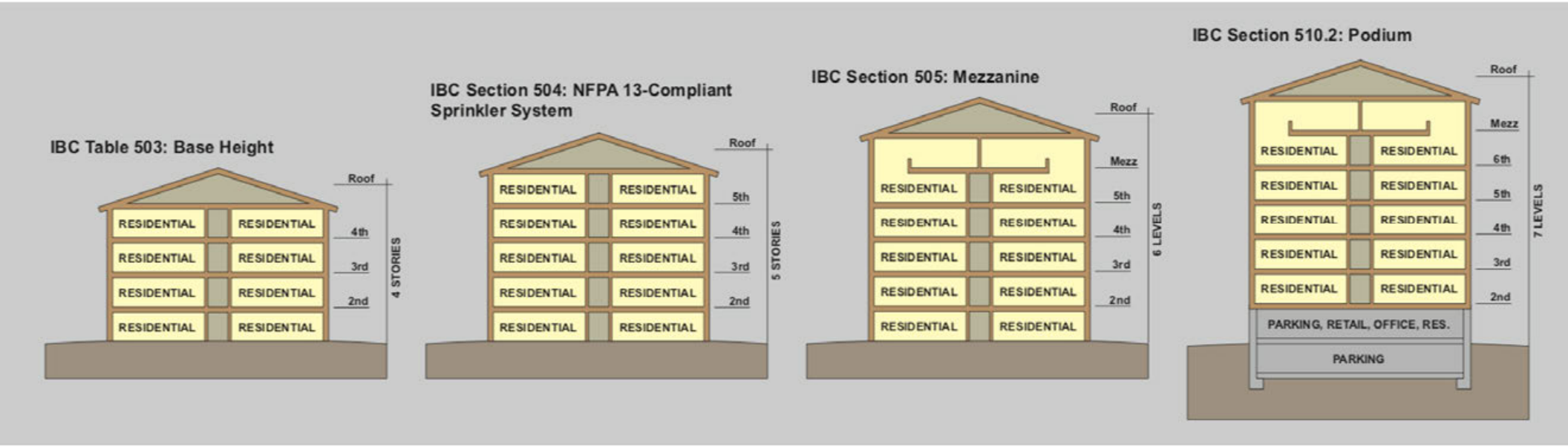
Types III and V are subdivided to A (protected) and B (unprotected)

Type IV (Heavy Timber)

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

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

Mass Timber in Low- to Mid-Rise: 1-6 Stories in Construction Types III, IV or V



Construction Types

Where does the code allow MT to be used?

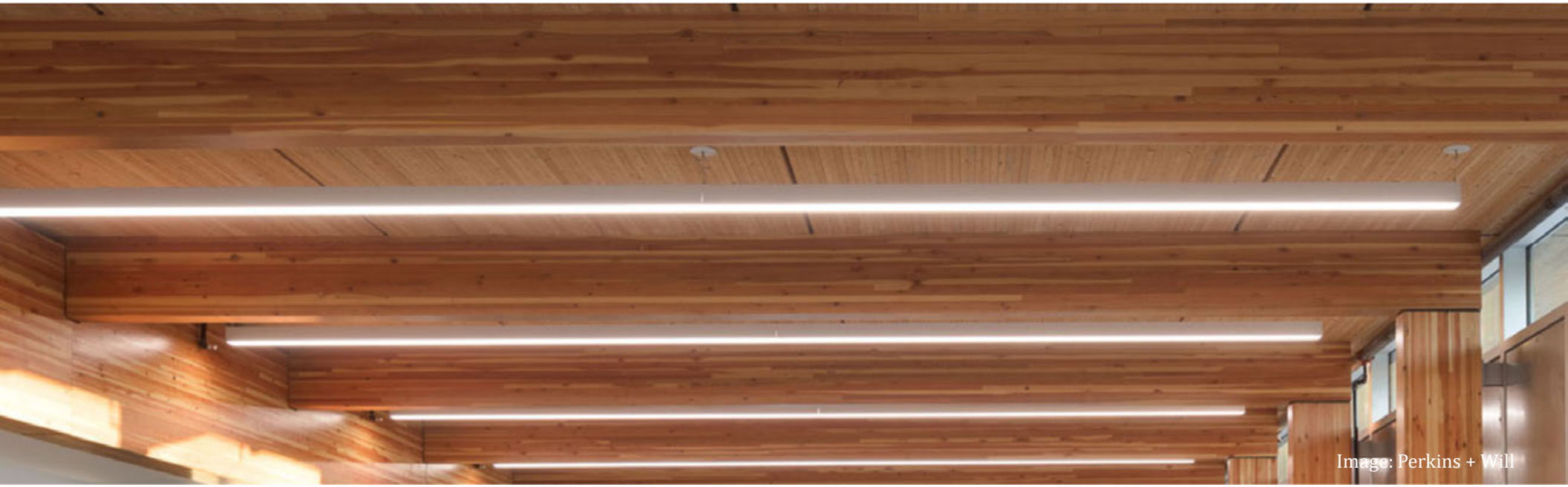
Type III: Interior elements (floors, roofs, partitions/shafts) and exterior walls if FRT

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)



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

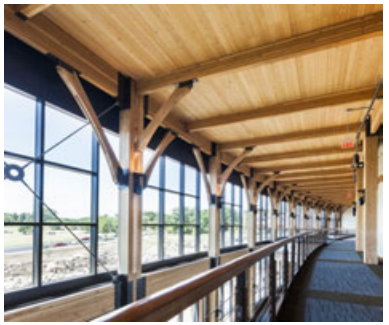


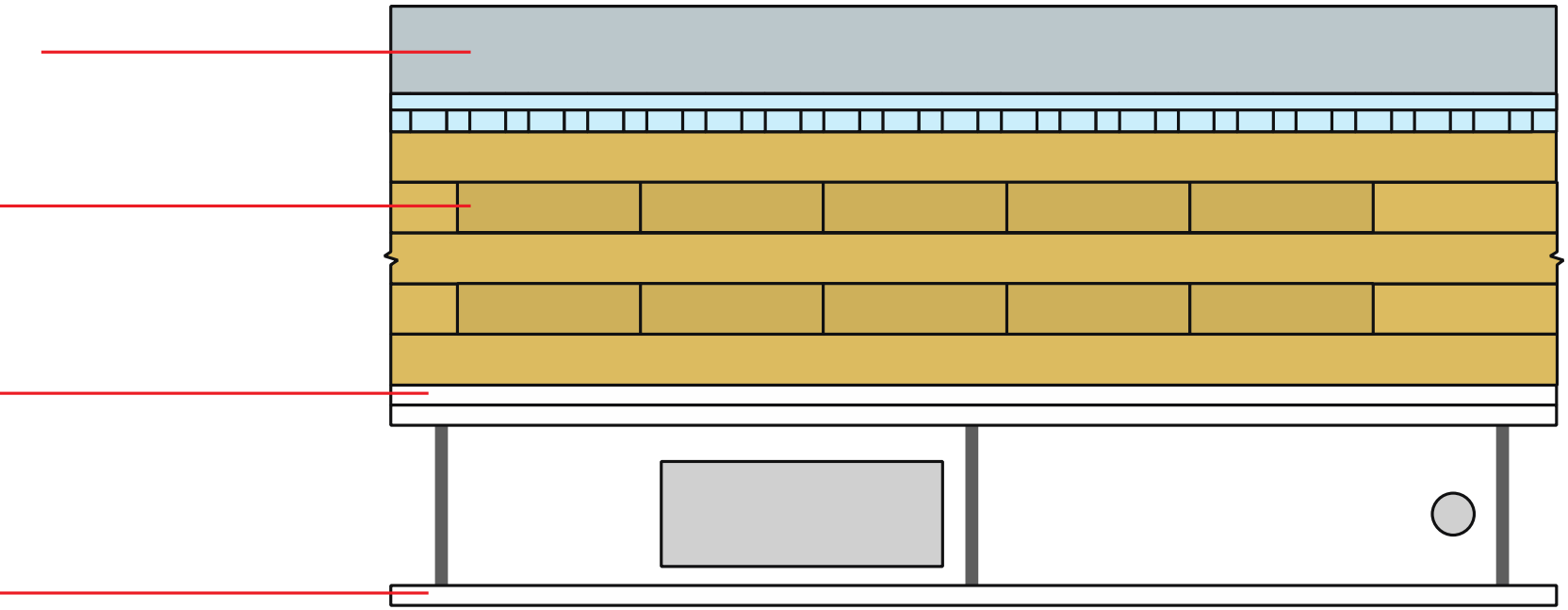
Photo: Aitor Sanchez/ Ewing Cole

Photo: WoodWorks

Construction Types

Type IV concealed spaces

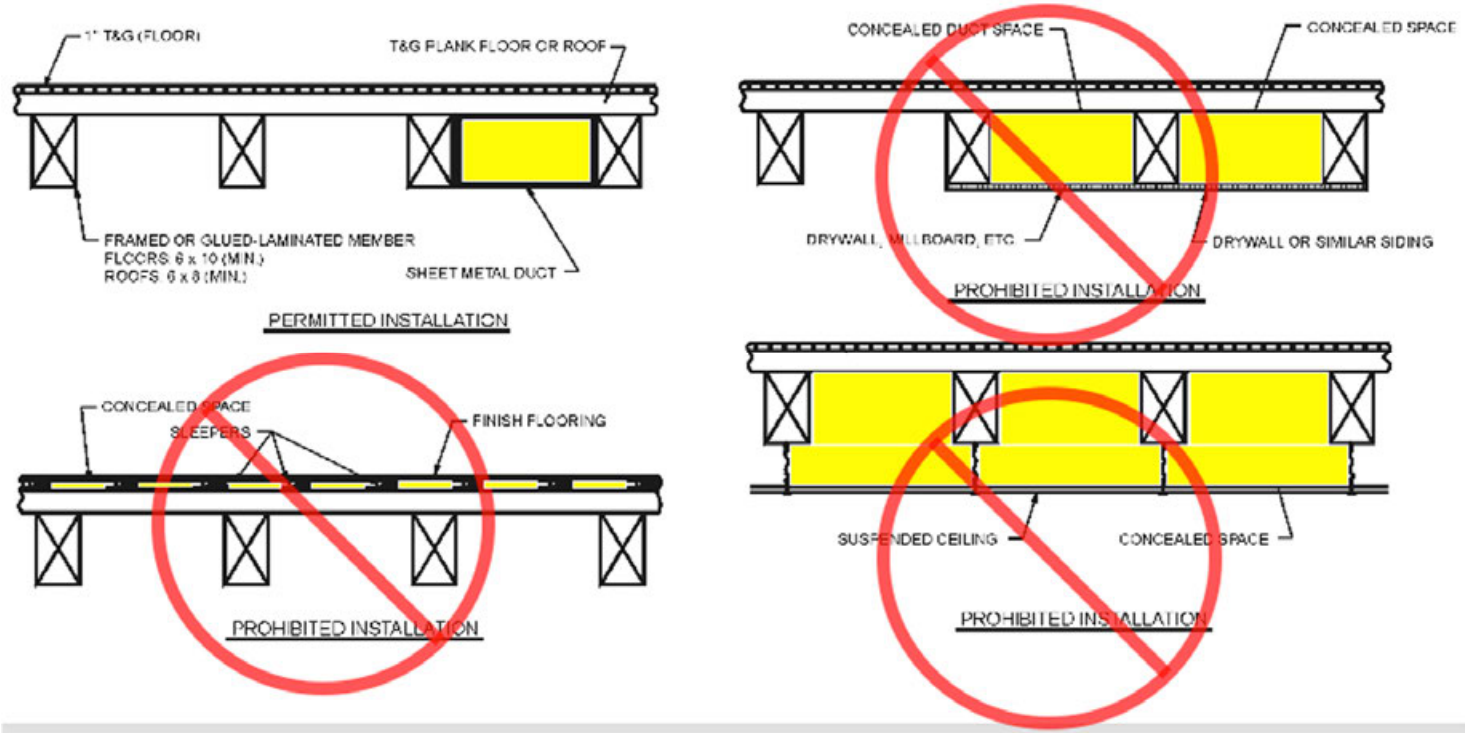
Can I have a dropped ceiling? Raised access floor?



Construction Types

Type IV concealed spaces

Until 2021 IBC, Type IV-HT provisions

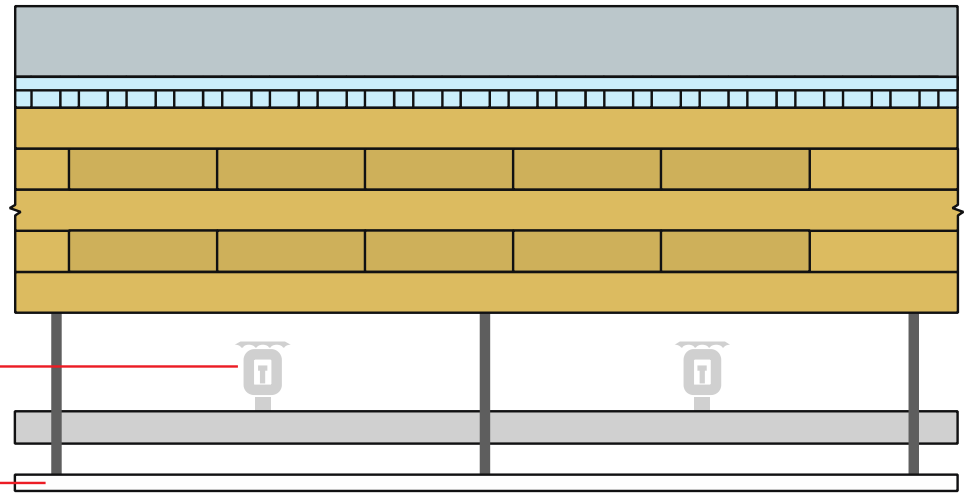


Credit: IBC

Construction Types

Type IV concealed space options within 2021 IBC

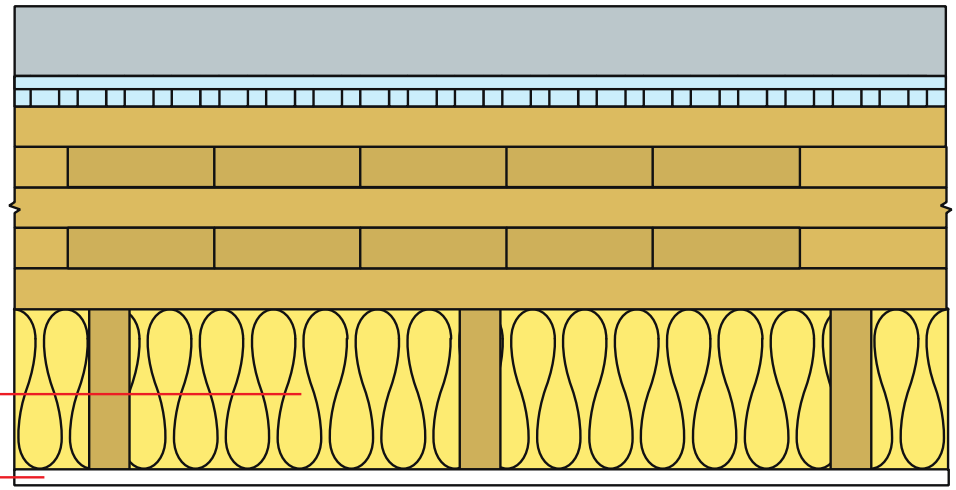
Option 1:



Construction Types

Type IV concealed space options within 2021 IBC

Option 2:



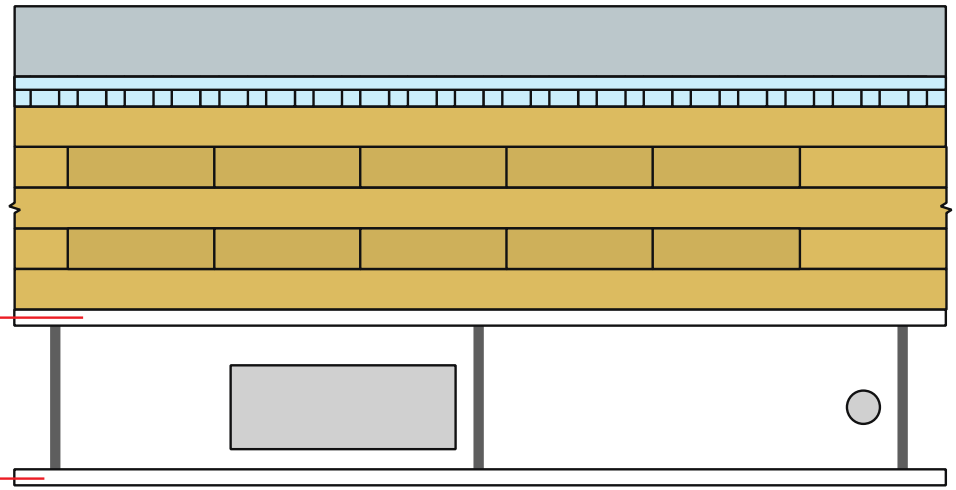
Construction Types

Type IV concealed space options within 2021 IBC

Option 3:

5/8" Type X gypsum on all mass timber surfaces within concealed space

Dropped ceiling



Construction Types

Concealed spaces solutions paper

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

WOODWORKS

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.

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?

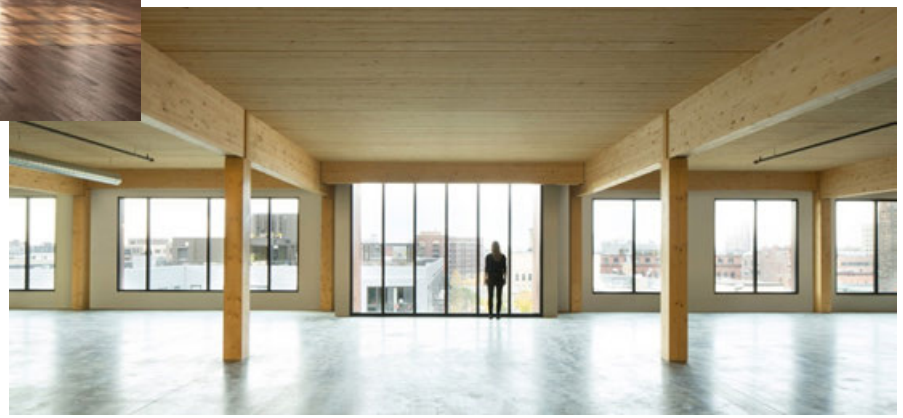
Type V: All interior elements, roofs & exterior walls

Image: Christian Columbres Photography

Construction Types

Type III: 6 stories

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



Type IV: 6 stories

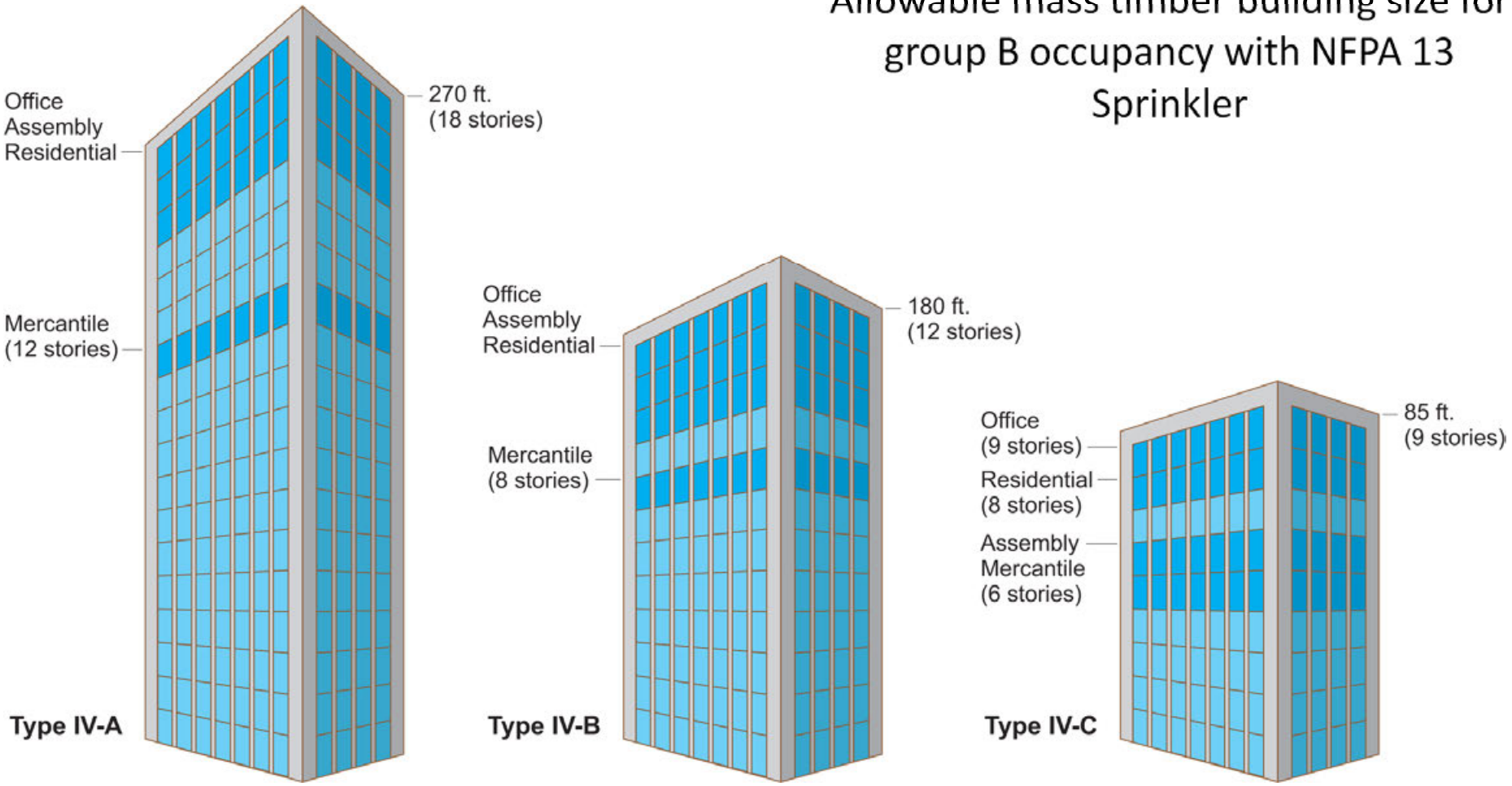
Credit: Ema Peter

Credit: Christian Columbres Photography

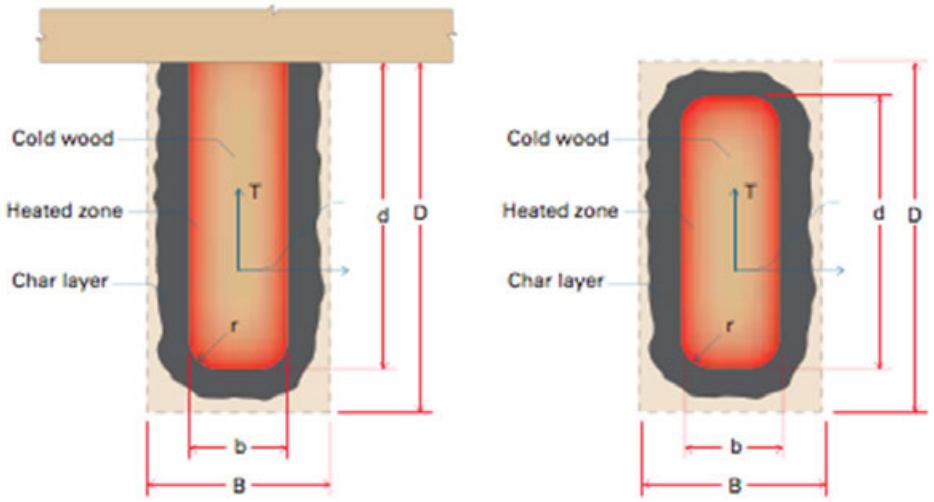
Type V: 4 stories

Construction Types

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



Mass Timber's Fire-Resistive Performance is Well-Tested, Documented and Recognized via Code Acceptance



Source: AWC's TR 10

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

Source: AWC's NDS

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)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

Source: 2018 IBC

Construction type influences FRR – IBC 2021

TABLE 601

FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

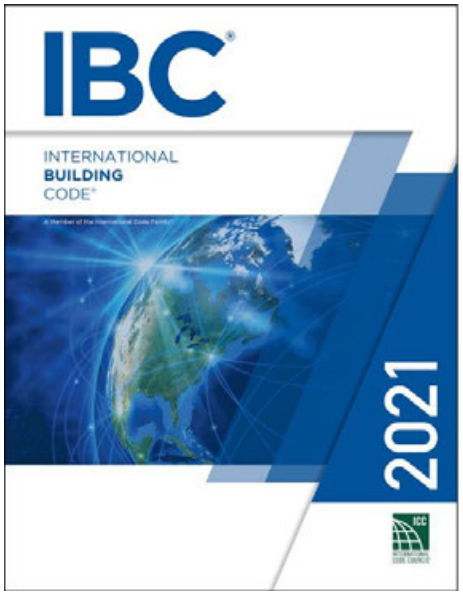
BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a, b]	2[a, b, c]	1[b, c]	0[c]	1[b, c]	0	3[a]	2[a]	2[a]	HT	1[b, c]	0
Bearing walls												
Exterior[e, f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	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



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

WOODWORKS

Demonstrating Fire-Resistance Ratings for Mass Timber Elements in Tall Wood Structures

Changes to the 2021 International Building Code (IBC) have created opportunities for wood buildings that are much larger and taller than prescriptively allowed in past versions of the code. Occupant safety, and the need to ensure fire performance in particular, was a fundamental consideration as the changes were developed and approved. The result is three new construction types—Type IV-A, IV-B and IV-C—which are based on the previous Heavy Timber construction type (renamed Type IV-HT), but with additional fire protection requirements.

One of the main ways to demonstrate that a building will meet the required level of passive fire protection, regardless of structural materials, is through hourly fire-resistance ratings (FRRs) of its elements and assemblies. The IBC defines an FRR as *the period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703.*

FRRs for the new construction types are similar to those required for Type I construction, which is primarily steel and concrete.[1] (See Table 1.) They are found in IBC Table 601, which includes FRR requirements for all construction types and building elements; however, other code

Ascent | Milwaukee, WI
Architect: Korb + Associates Architects
Structural Engineer: Thornton Tomasetti

TABLE 1: FRR Requirements (Hours) for Tall Mass Timber Construction Types and Existing Type I

Building Element	I-A *Unlimited stories, heights and areas**	IV-A *Max. 18 stories, 270 ft, 324,000 sf***	I-B *Max. 12 stories, 180 ft, unlimited areas**	IV-B *Max. 12 stories, 180 ft, 216,000 sf***	IV-C *Max. 9 stories, 85 ft, 135,000 sf***
Primary Frame	3	3	2	2	2
Exterior Bearing Walls	3	3	2	2	2
Interior Bearing Walls	3	3	2	2	2
Roof Construction	1.5	1.5	1	1	1
Primary Frame at Roof	2	2	1	1	1
Floor Construction	2	2	2	2	2

Assumes an NFPA 13 automatic sprinkler system throughout building
*Unlimited building size permitted for most occupancies
**Area limits indicated are per level, assuming no frontage increase; see IBC Tables 504.3, 504.4 and 506.2 for additional details

Source: 2021 IBC Tables 504.3, 504.4, 506.2 and 601

Mass Timber Fire Design Resource

- Code compliance options for demonstrating FRR
- Updated as new tests are completed
- Free download at woodworks.org

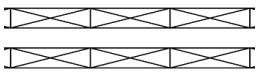
Cost: Construction Type

TABLE 601

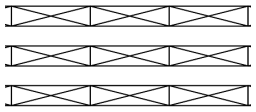
Fire Resistance Rating Requirements for Building Elements (Hours)

Building Element	I-A	I-B	III-A	III-B	IV-A	IV-B	IV-C	IV-HT	V-A	V-B
Primary Structural Frame	3*	2*	1	0	3*	2	2	HT	1	0
Ext. Bearing Walls	3*	2*	2	2	3*	2	2	2	1	0
Int. Bearing Walls	3*	2*	1	0	3*	2	2	1/HT	1	0
Floor Construction	2	2*	1	0	2	2	2	HT	1	0
Roof Construction	1.5*	1*	1	0	1.5	1	1	HT	1	0
Exposed Mass Timber Elements					None	20-40%	Most	All		

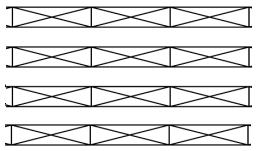
Baseline
0hr & HT



+$10/SF
1hr & maybe 2hr



+$12-15/SF
2hr FRR



Cost Source: Swinerton

*These values can be reduced based on certain conditions in IBC 403.2.1, which do not apply to Type IV buildings.

Cost Impacts of Construction Type

Construction Type Early Decision 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

Cost Impacts of Construction Type

Construction Type Early Decision Example

4-story building on college campus

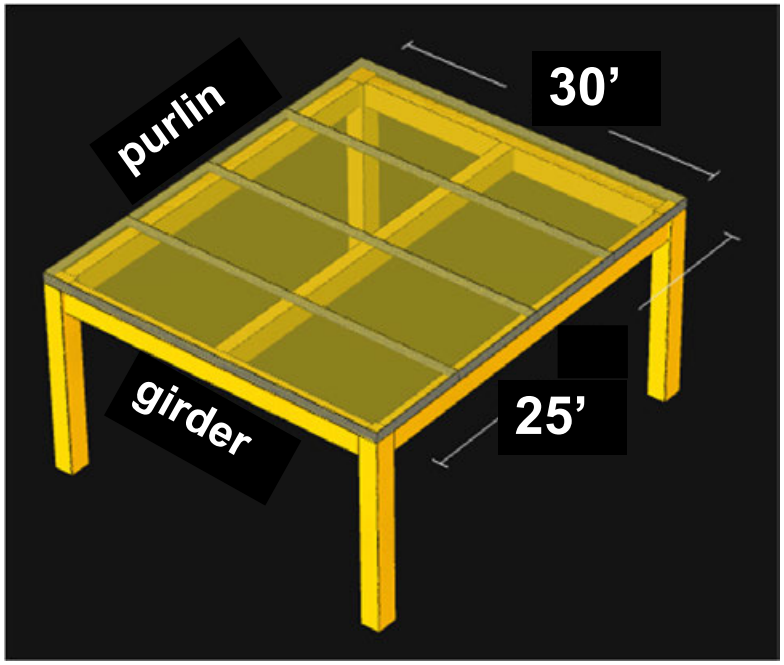
Cost Impact of Assembly Occupancy Placement:

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**

Source: PCL Construction

Cost Implication of Design Choices

Panel volume usually 65-80% of MT package volume



Source: Fast + Epp, Timber Bay Design Tool

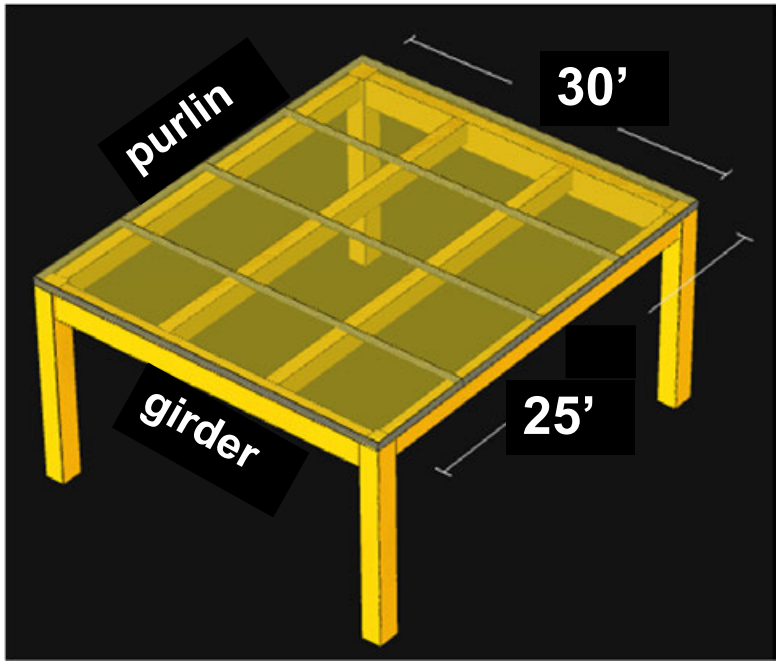
Type IIIA option 1

1-hr FRR
Purlin: 5.5”x28.5”
Girder: 8.75”x33”
Column: 10.5”x10.75”
Floor panel: 5-ply

Glulam volume = 118 CF (22% of MT)
CLT volume = 430 CF (78% of MT)
Total volume = 0.73 CF / SF

Cost Implication of Design Choices

Panel volume usually 65-80% of MT package volume



Source: Fast + Epp, Timber Bay Design Tool

Type IIIA option 2

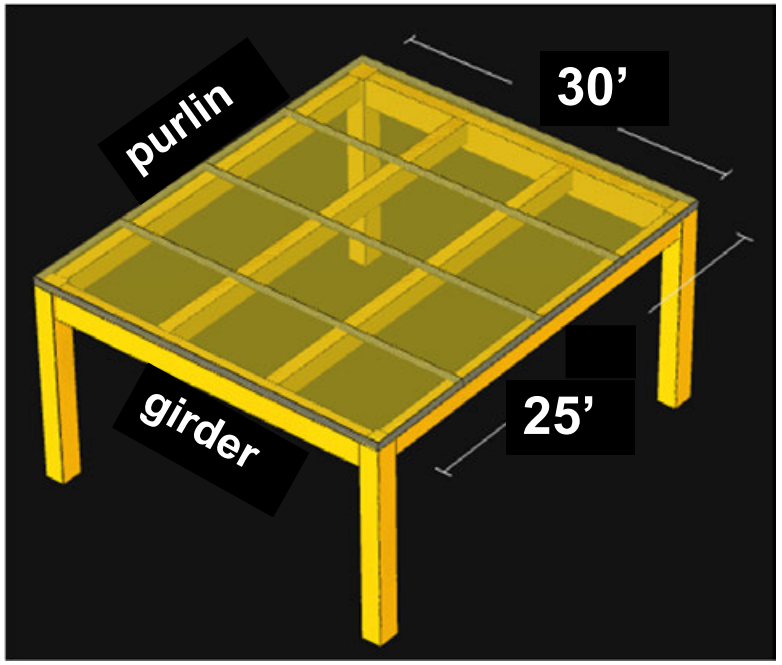
1-hr FRR
Purlin: 5.5”x24”
Girder: 8.75”x33”
Column: 10.5”x10.75”
Floor panel: 5-ply

Glulam volume = 123 CF (22% of MT)
CLT volume = 430 CF (78% of MT)
Total volume = 0.74 CF / SF

Cost considerations: One additional beam (one additional erection pick), 2 more connections

Cost Implication of Design Choices

Panel volume usually 65-80% of MT package volume



Source: Fast + Epp, Timber Bay Design Tool

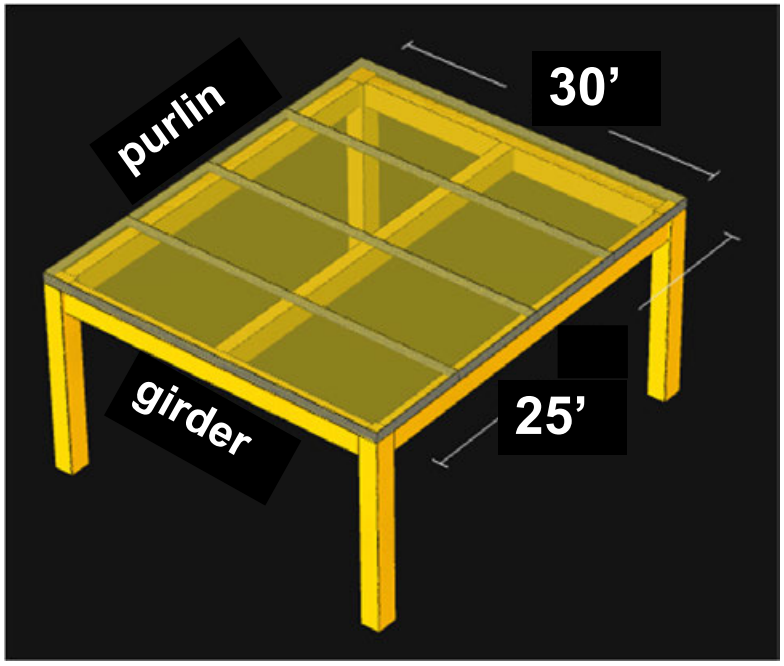
Type IV-HT

0-hr FRR (min sizes per IBC)
Purlin: 5.5”x24” (IBC min = 5”x10.5”)
Girder: 8.75”x33” (IBC min = 5”x10.5”)
Column: 10.5”x10.75” (IBC min = 6.75”x8.25”)
Floor panel: 3-ply (IBC min = 4” CLT)

Glulam volume = 120 CF (32% of MT)
CLT volume = 258 CF (68% of MT)
Total volume = 0.51 CF / SF

Cost Implication of Design Choices

Which is the most efficient option?



Source: Fast + Epp, Timber Bay Design Tool

	Timber Volume Ratio
IIIA – Option 1	0.73 CF / SF
IIIA – Option 2	0.74 CF / SF
IV-HT	0.51 CF / SF

A general rule of thumb for efficient mass timber fiber volume is no higher than 0.75 CF per SF for up to a 1 hour rated structure (higher if 2 hour exposed timber in tall mass timber). Ratios in the 0.85 to 1.0 CF / SF range tend to become cost prohibitive

Expert Tips

Key Design Considerations for Mass Timber Projects

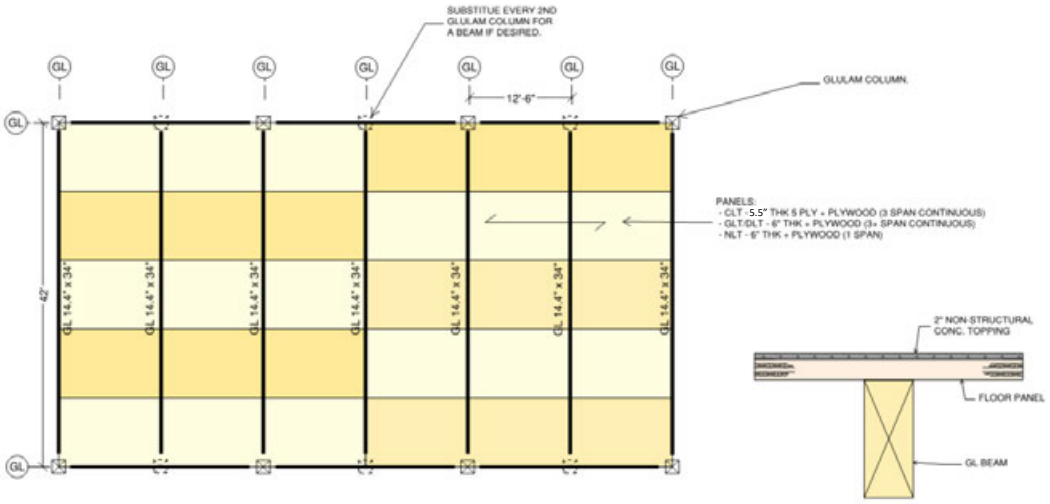
Important considerations related to construction type, fire ratings, panel thickness, member size and occupancy.

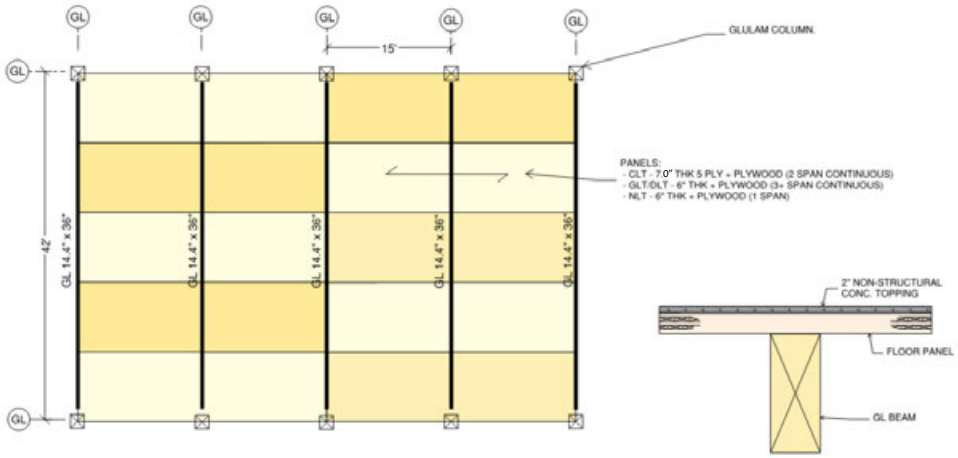
Share

Selecting a Construction Type

For mass timber projects, selection of construction type is one of the more significant design decisions. While it's common to choose construction type based on structural material—i.e., to assume that steel and concrete structures should be Type II, light-frame wood should be Type V, and exposed heavy/mass timber should be Type IV—this approach can lead to additional costs. While Type IV construction can be used for exposed

Cost: Structural System & Grid





Baseline

12’-6” Glulam Spacing

5.5” CLT

$ +5%

15’ Glulam Spacing

7” CLT

Source: Seattle Mass Timber Tower Book

Expert Tips

Creating Efficient Structural Grids in Mass Timber Buildings

Although a mass timber solution may work economically on grids created for other materials, a few modifications can increase efficiencies related to member sizing and manufacturer capabilities.

Share

Mass timber products such as cross-laminated timber (CLT), nail-laminated timber (NLT) and glue-laminated timber (glulam) are at the core of a revolution that is shifting how designers think about construction. At no time has materials selection been such an integral aspect of the building designer's daily responsibilities. In addition to its sustainability and light carbon footprint, mass timber has benefits that include enhanced aesthetics, speed of construction and light weight, all of which can positively impact costs. However, to convince building owners and developers that a mass timber solution is viable, the structural design must also be cost competitive. This requires a full understanding of both material properties and

Value Analysis

$$Value = \frac{\uparrow Function \quad + \uparrow Aesthetics}{\downarrow Cost}$$

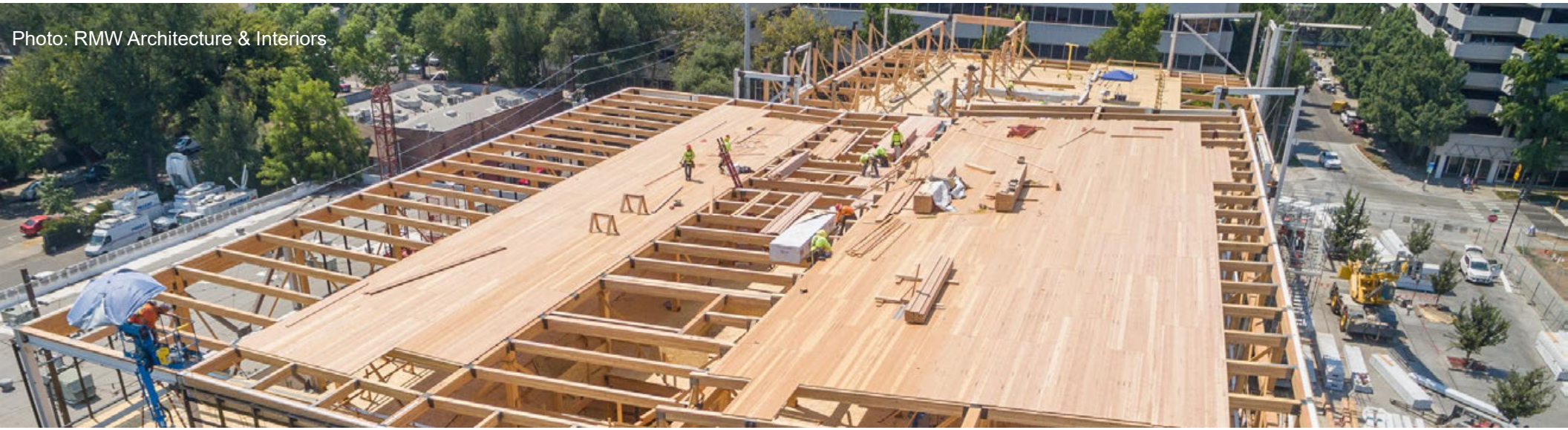


Photo: RMW Architecture & Interiors

Value Analysis

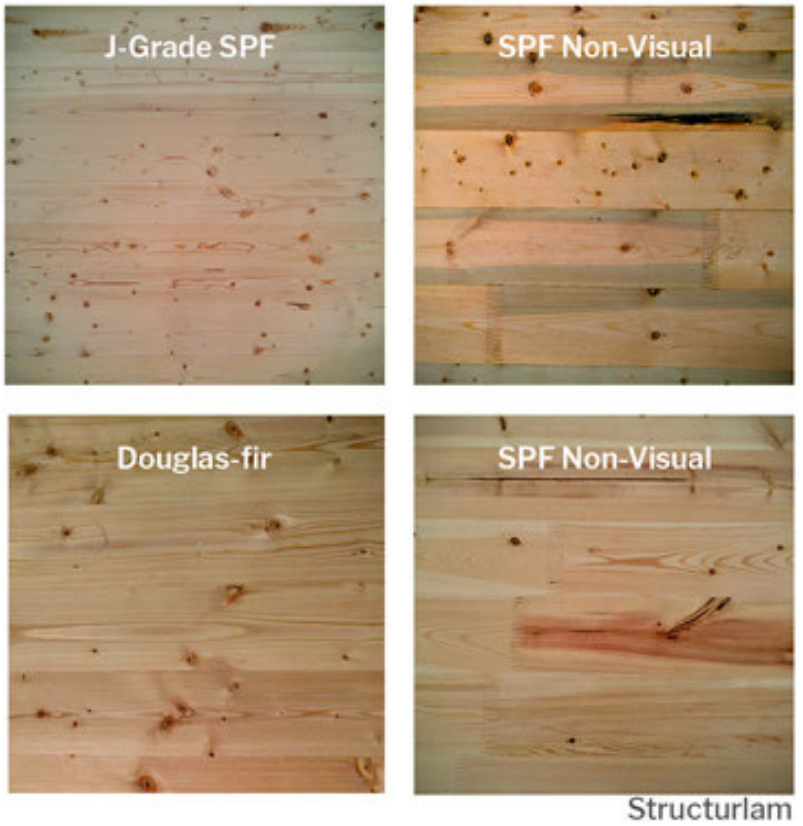
$$Value\ Engineering = \frac{\downarrow Function\ + \downarrow Aesthetics}{\downarrow Cost}$$

Cost Impacts of Finish/ Appearance Grade

Appearance vs. Industrial Grades

Aesthetic Expectations

- Appearance grade more $
- Industrial grade can save $
- Specification of appearance grade varies by product
- CLT, DLT, NLT: aesthetic expectations are agreed upon by building designer and manufacturer/ fabricator (ask for samples & outline in specs)
- Glulam: grades are standardized



Expert Tips

Specifying Appearance Grades for CLT, NLT and Glulam

Information for designers seeking to specify appearance grade for cross-laminated timber (CLT), nail-laminated timber (NLT), or glue-laminated timber (glulam).

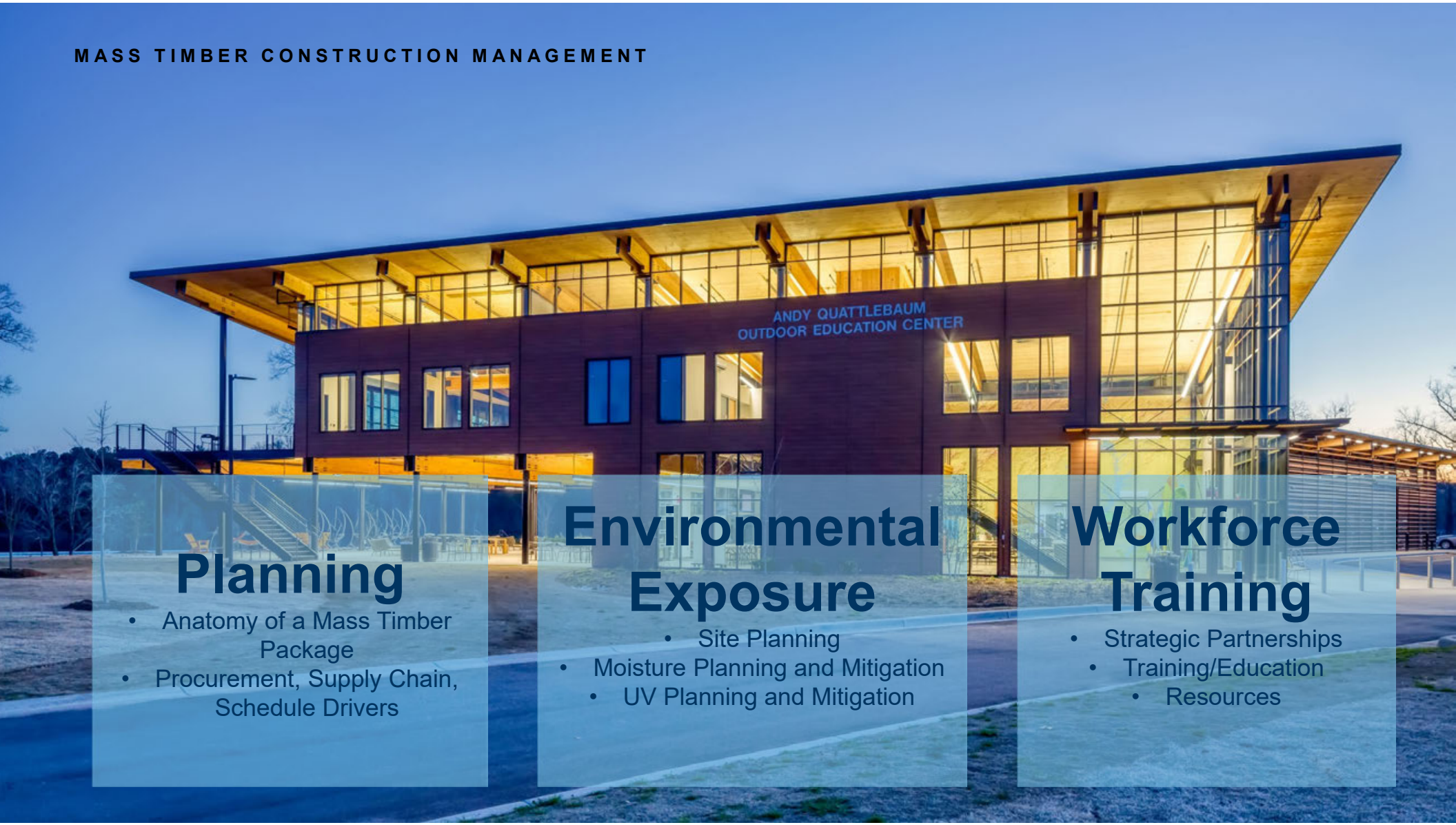
Share

For mass timber, specification of appearance grade varies by product. Aesthetic expectations for cross-laminated timber (CLT) and nail-laminated timber (NLT) are agreed upon between the building designer and manufacturer/fabricator and described in the product specifications, whereas grades for glued-laminated timber (glulam) are standardized.

CLT Appearance Grades

Starting with the 2015 version of the International Building Code (IBC), CLT has been prescriptively

MASS TIMBER CONSTRUCTION MANAGEMENT



Planning

- Anatomy of a Mass Timber Package
- Procurement, Supply Chain, Schedule Drivers

Environmental Exposure

- Site Planning
- Moisture Planning and Mitigation
- UV Planning and Mitigation

Workforce Training

- Strategic Partnerships
- Training/Education
- Resources

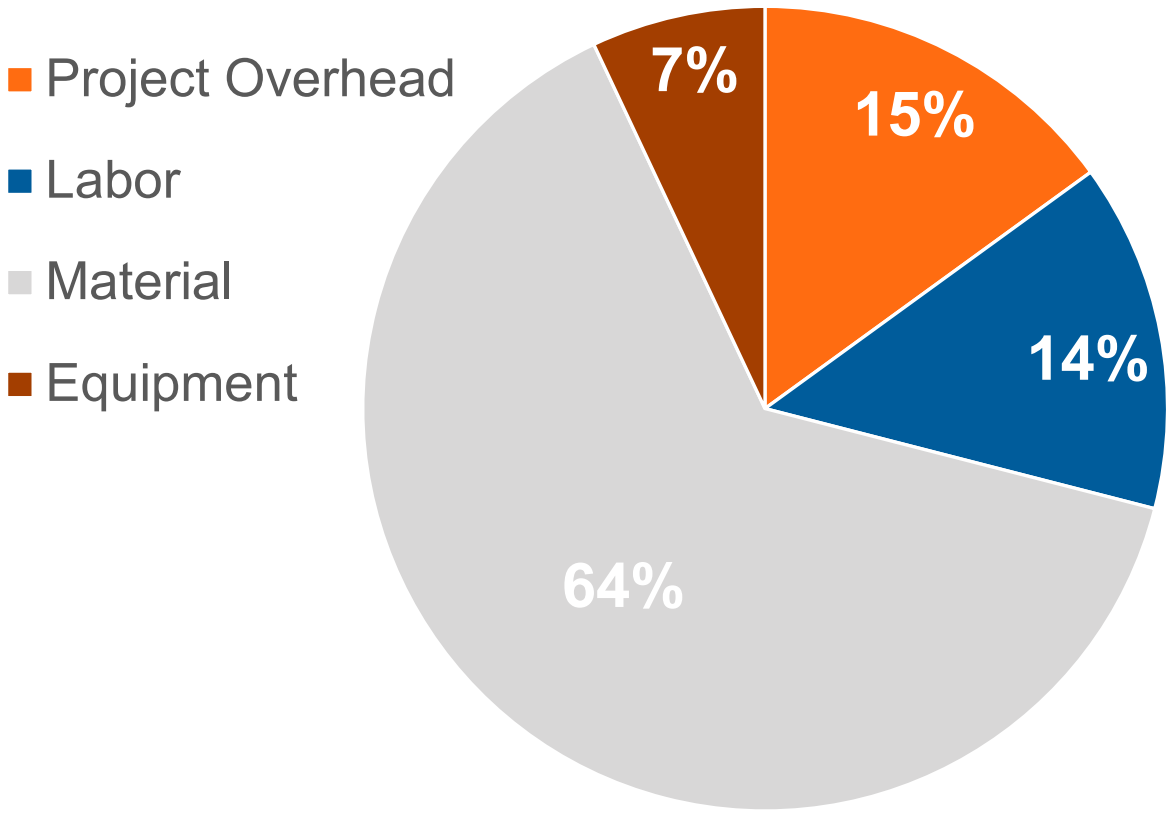
Holistic Costing

$/SF

$/SF

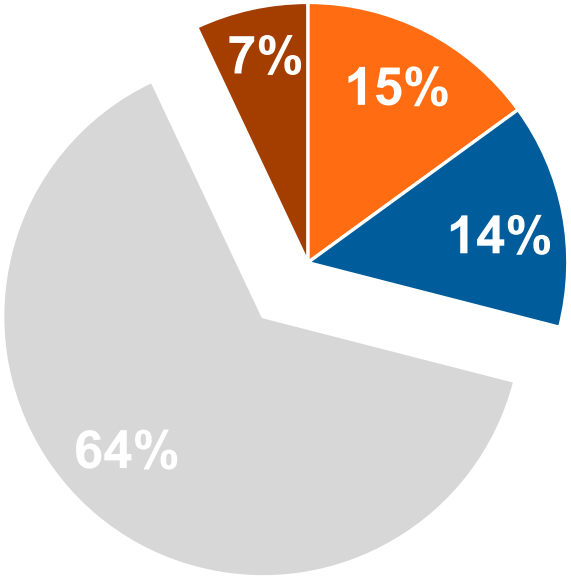
Image: GBD Architects

Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

Material (Direct Cost)

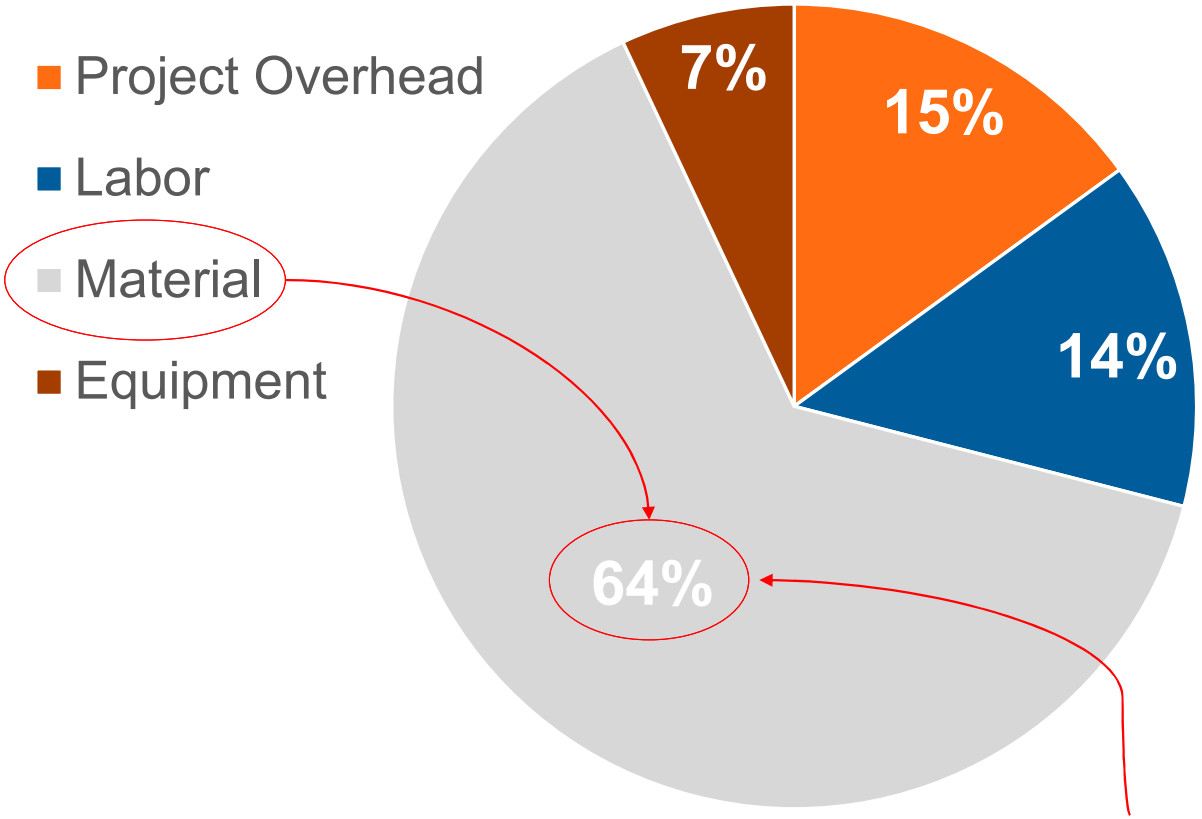


Turnkey Mass Timber Package

or

Source: Swinerton

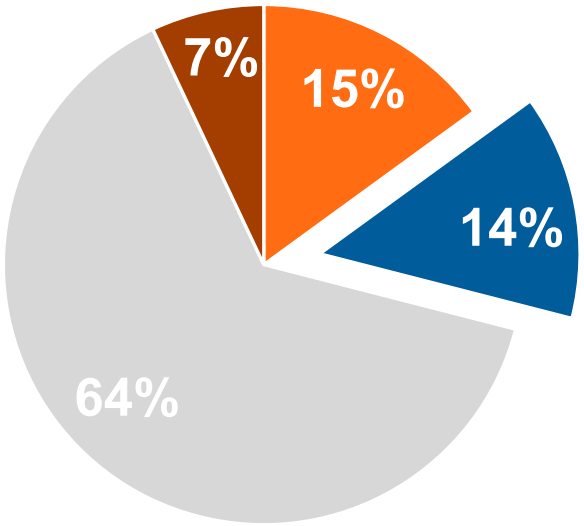
Mass Timber Package Costs



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

Source: Swinerton

Labor (Direct Cost)

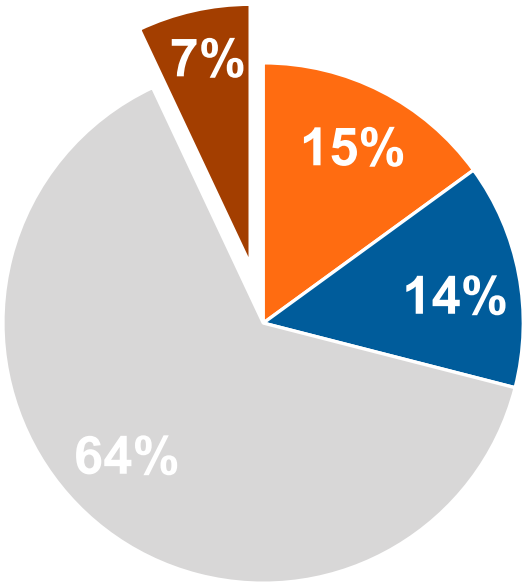


Turnkey Mass Timber Package

Photo: Swinerton

Source: Swinerton

Equipment (Direct Cost)



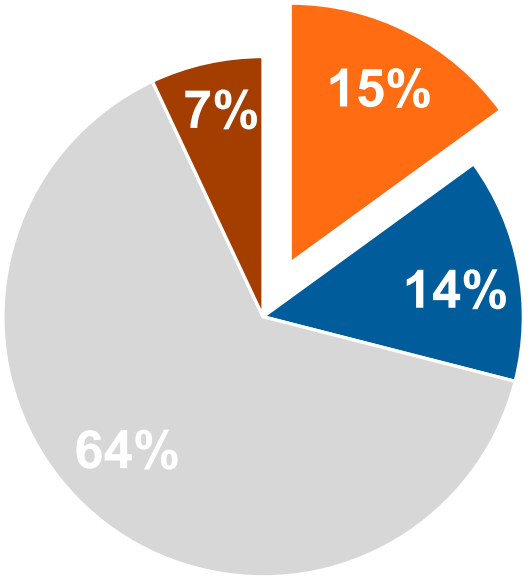
Turnkey Mass Timber Package

Source: Swinerton

Photo: Swinerton

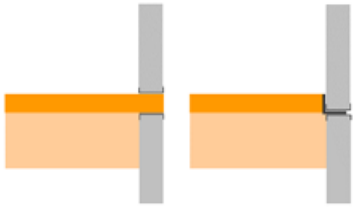
Photo: Alex Schreyer

Project Overhead



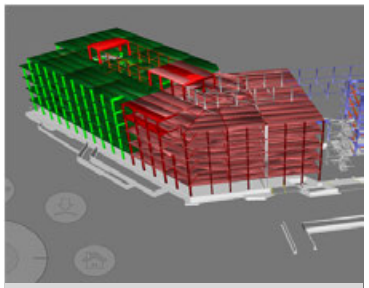
Turnkey Mass Timber Package

Cost Analysis

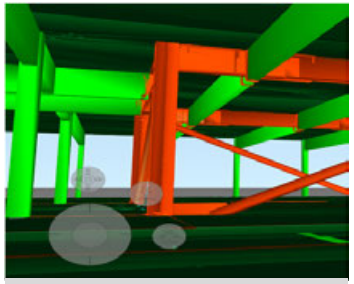


Design Refinement

System Integration



VD&C



Detail Optimization

Logistics Planning

Photos: Swinerton

Source: Swinerton

Total Project Cost Analysis

CONSIDERATIONS:

- Ceiling Treatment
- Floor Topping
- HVAC System & Route
- Foundation Size
- Material Savings
- Perimeter glazing
- Value of Time
- Completion Bonds/Insurance

Credit: Hacker Architects

Insurance Perspective on Mass Timber

- Lack of historic loss data = Unknowns
- Unknowns = Risk
- Risk = Higher Premiums
- Some take a ‘wood is wood’ approach

- Important to understand the significant differences in how mass timber performs in the event of a fire, etc. when compared to light wood-frame and all other building materials

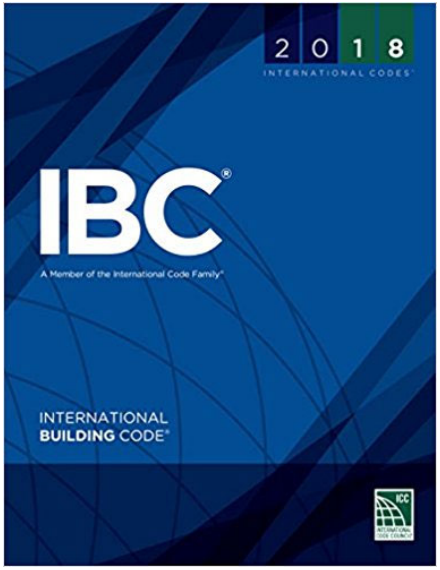
Photo Credit: StructureCraft

Photo Credit: GLI Partners

Insurance vs. Building Codes

- It is important to note the distinct difference between the primary concerns of insurers vs. primary concerns of building codes
- **Insurance** primarily concerned with **property loss**
- **Building codes** primarily concerned with **occupant safety**

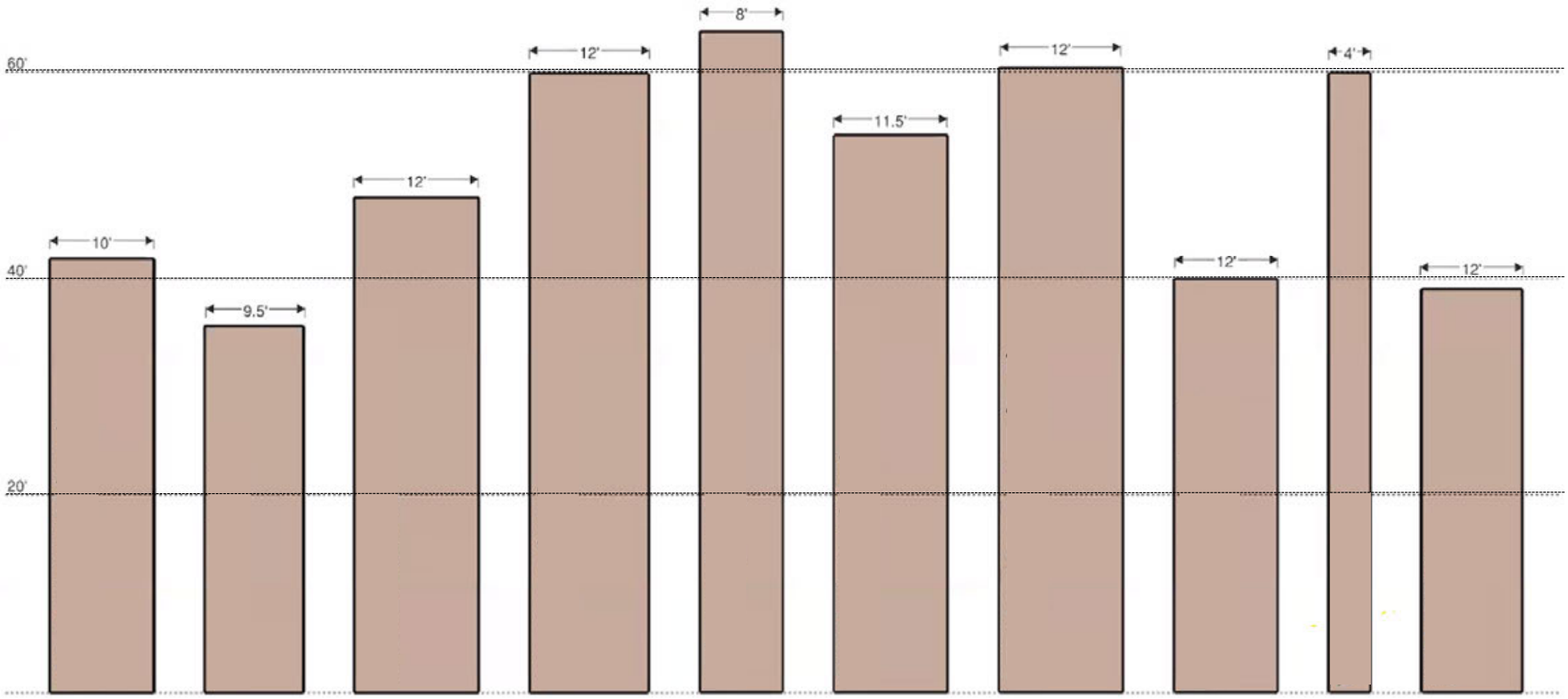
- As such, code acceptance and associated testing may be helpful to insurers in evaluating a new product like mass timber, but it will not address all concerns



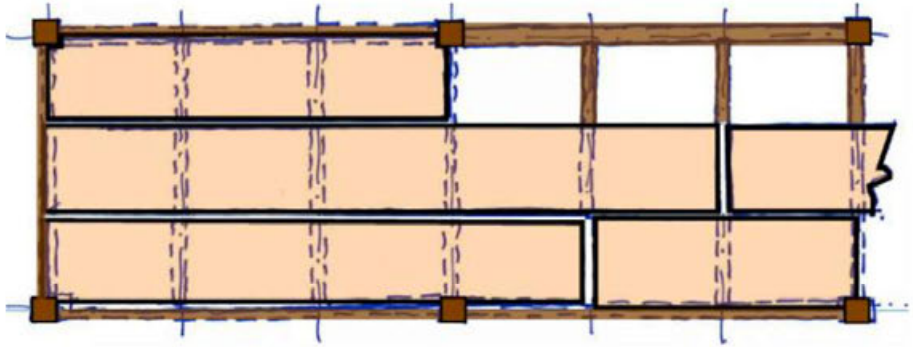
Understand the Supply Chain

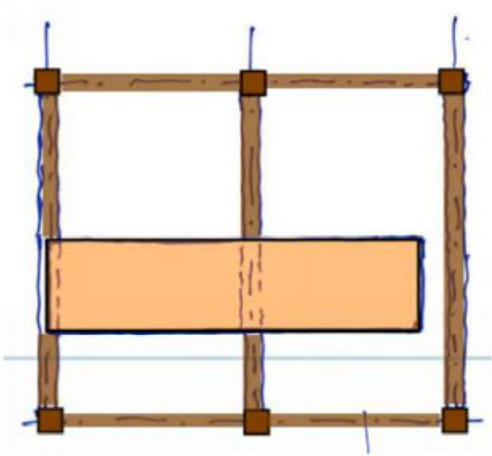
Photo: Swinerton

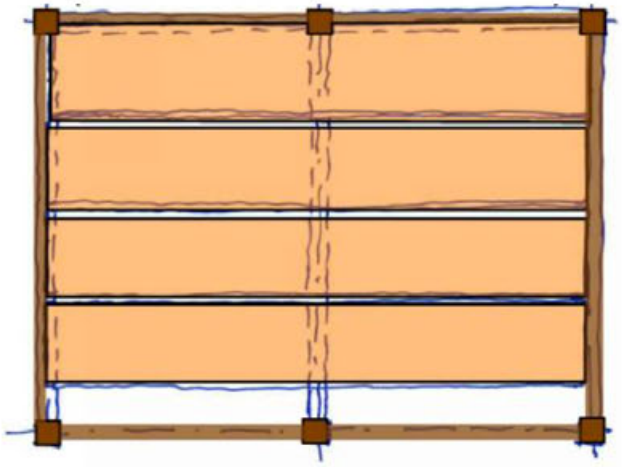
Understand Manufacturer's Capabilities

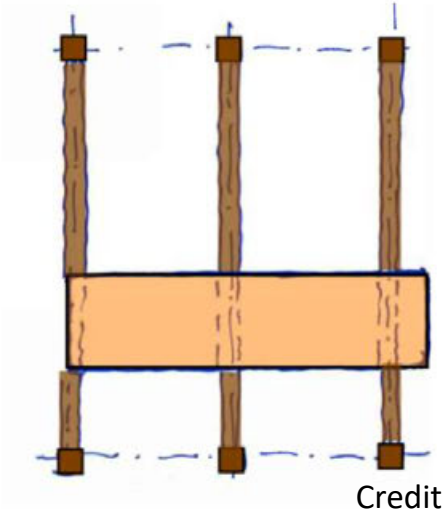


Credit: TimberLab







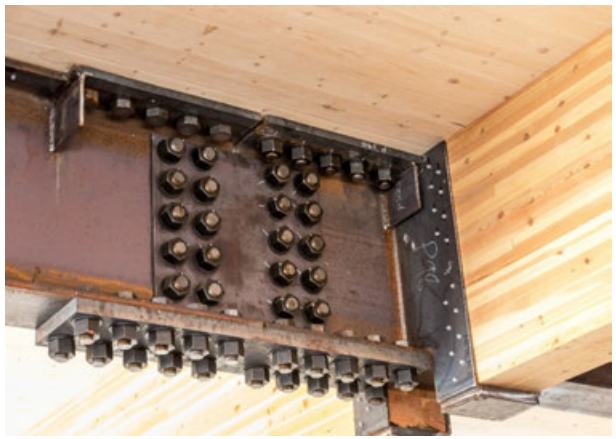


Credit: Tanya Luthi, Entuitive

Understand Manufacturer's Capabilities


Embrace the
Prefab Advantage
Photo: Swinerton

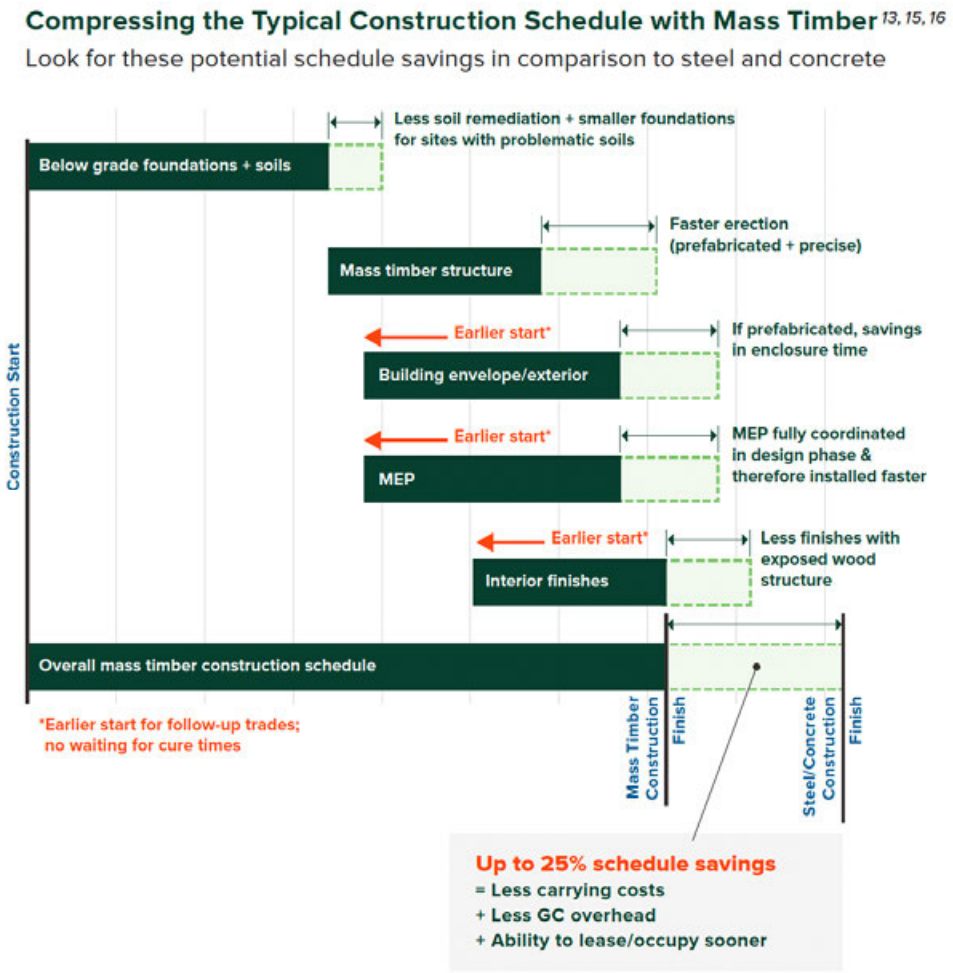
Tolerances: Interface with Other Structural Materials



Schedule Drivers

Photo: Swinerton

Procurement Approach Determines Schedule



Source: WoodWorks

Procurement Logic for Scheduling

Source: Swinerton

Example 6 Story Type IIIA Project

Schedule Comparison

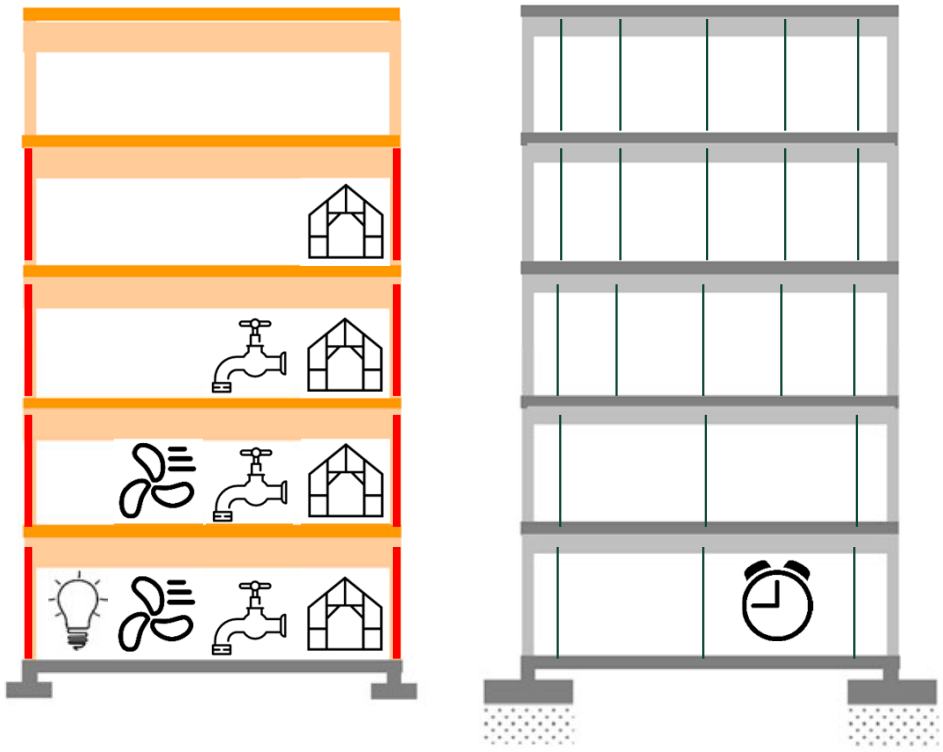
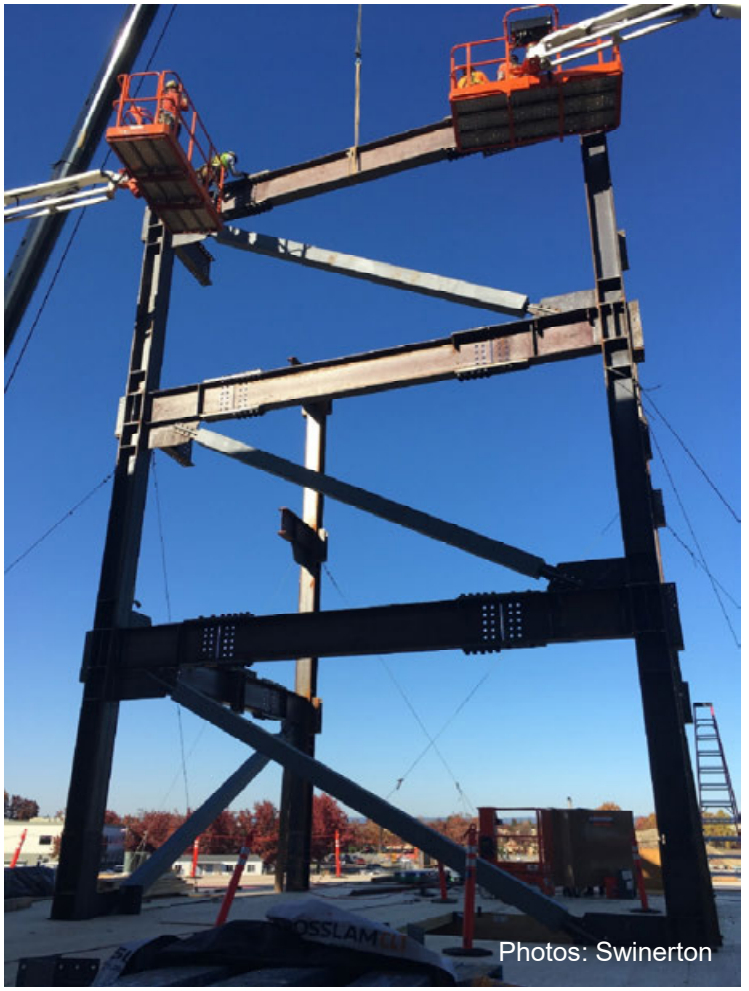


Image: Swinerton

Photo: WoodWorks

Schedule Impacts: Hybrid Structures

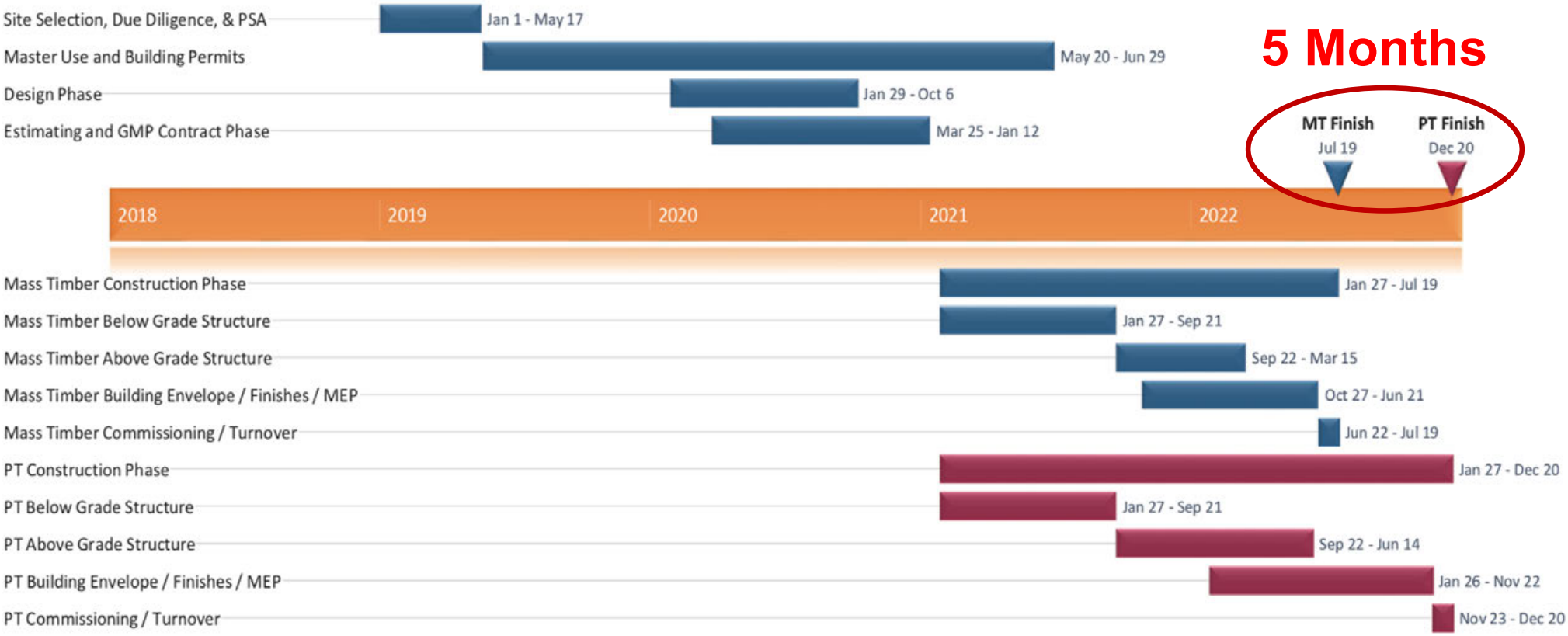


Photos: Swinerton

Look At Schedule Holistically

Photo: StructureCraft Builders

Overall Project Schedule Analysis: 12 Story Type IV-B



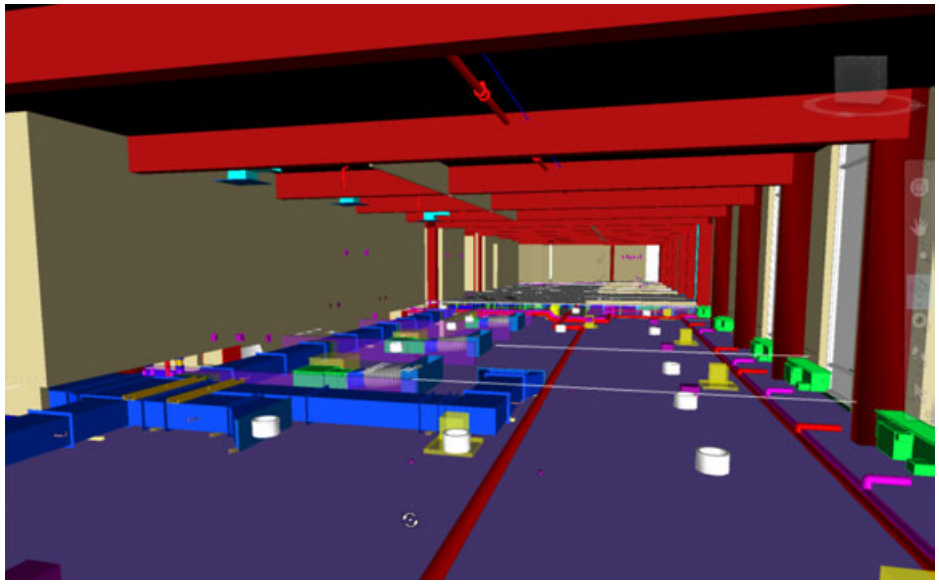
Source: Swinerton

Early Move-In for Rough-In Trades.

Photos: Swinerton

Schedule Impact on Cost | Value of Time

Embracing BIM for Fabrication



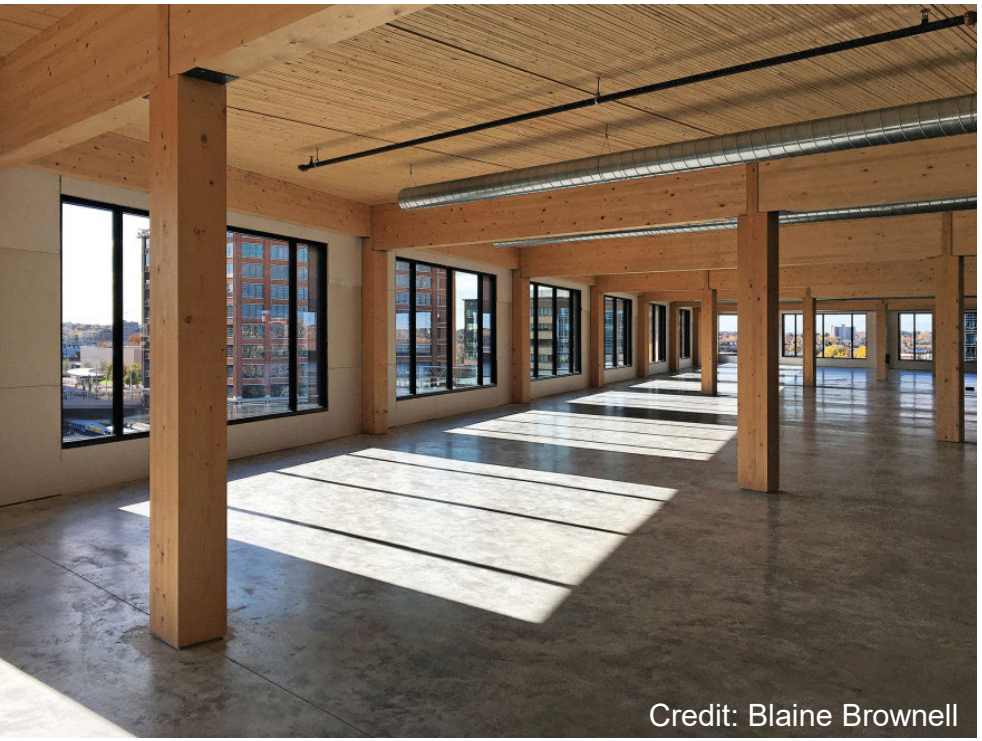
Photos: Swinerton

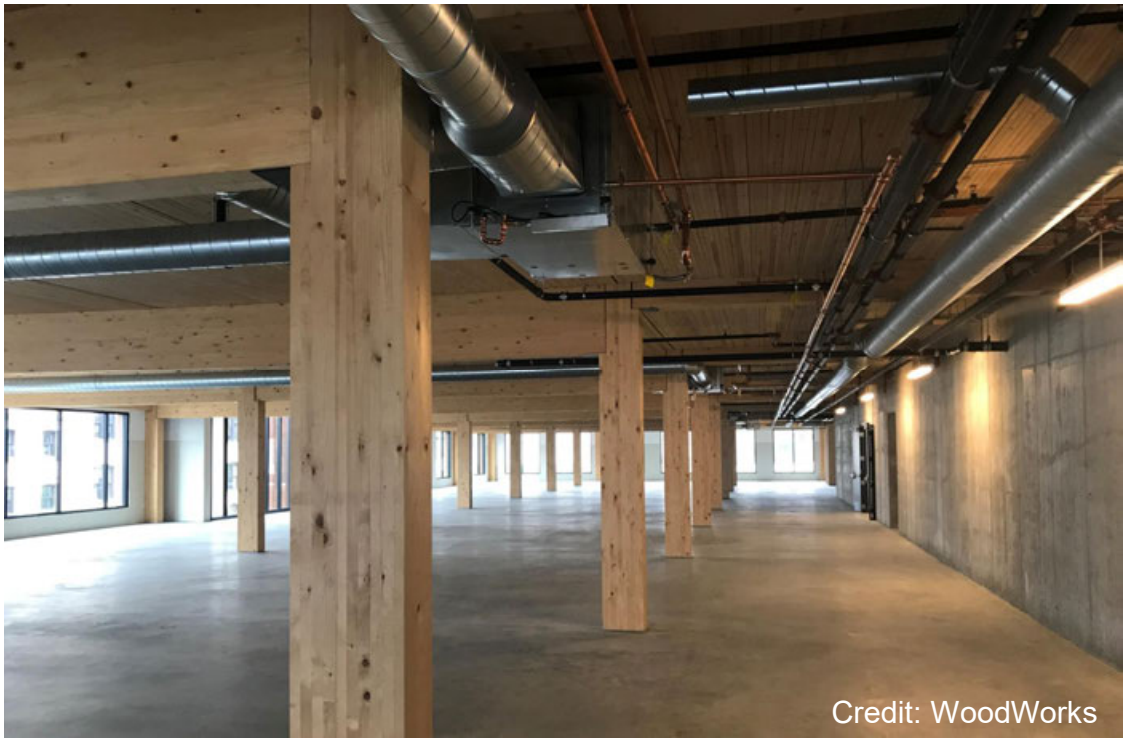
MEP Layout & Integration

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

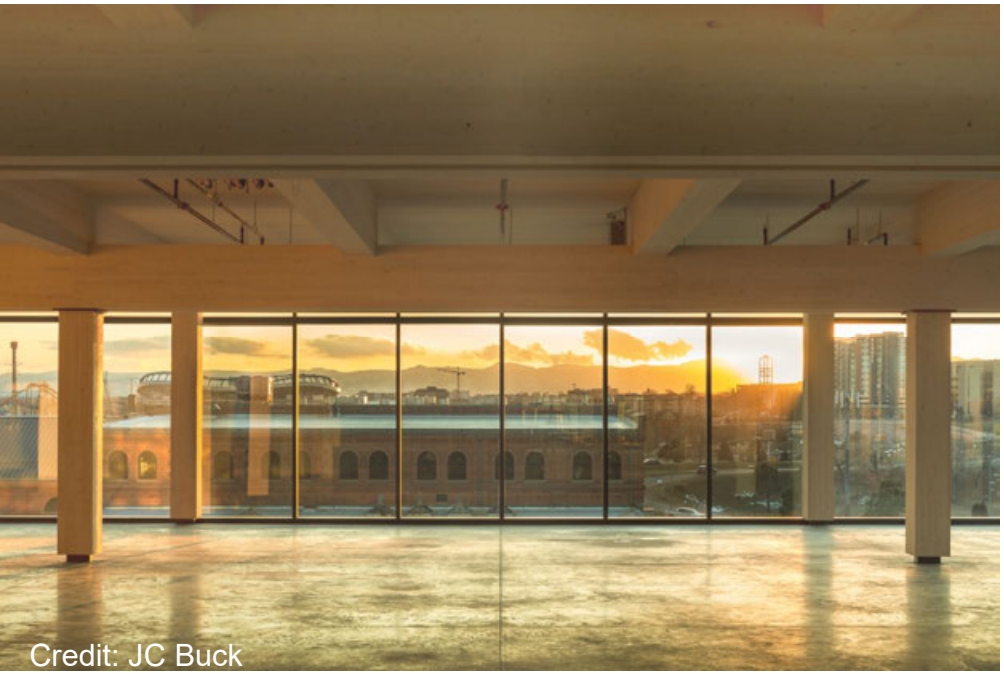
In penetrations through MT framing

- Requires more coordination (penetrations)
- Bigger impact on structural capacity of penetrated members
- Minimal impact on head height

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

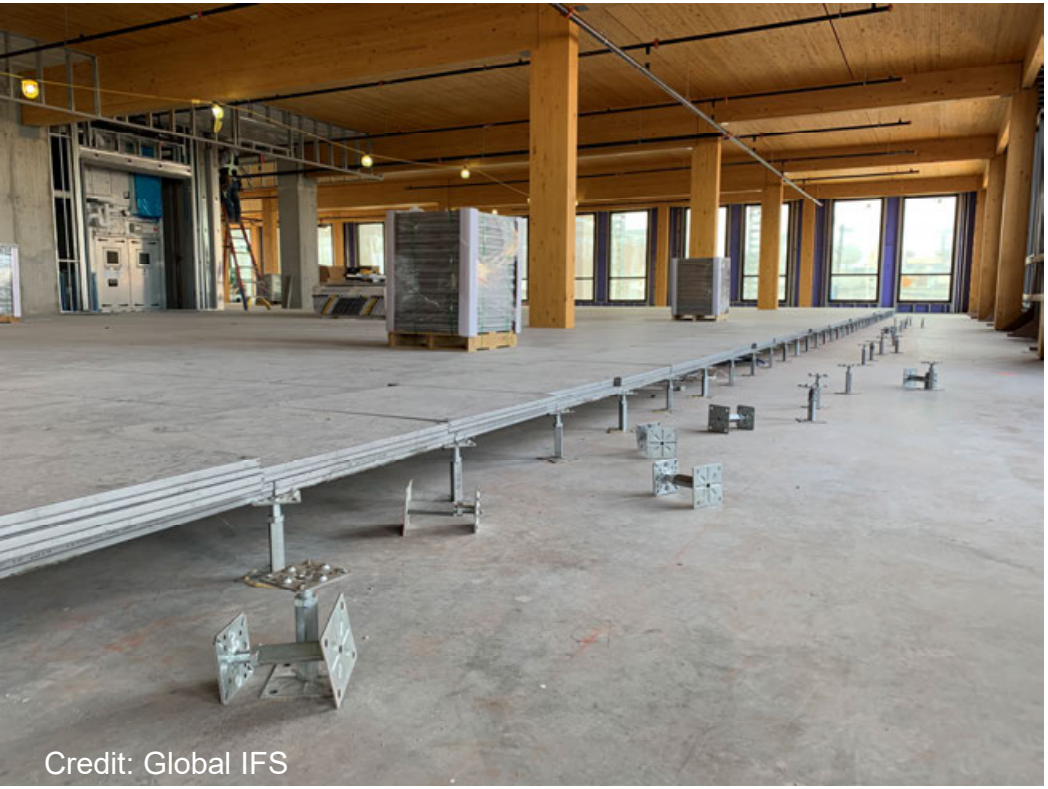

Credit: JC Buck


Credit: KL&A Engineers & Builders

MEP Layout & Integration

In raised access floor (RAF) above MT

- Impact on head height
- Concealed space code provisions



MEP Layout & Integration

In topping slab above MT

- Greater need for coordination prior to slab pour
- Limitations on what can be placed (thickness of topping slab)
- No opportunity for renovations later

Planning for Environmental Exposures

- Plan Early
- Risk Evaluation
- Develop Construction
- Phase Plan
- Execute the Design and Moisture Management Plan
- Monitor

RDH Moisture Management Guide 1st Ed

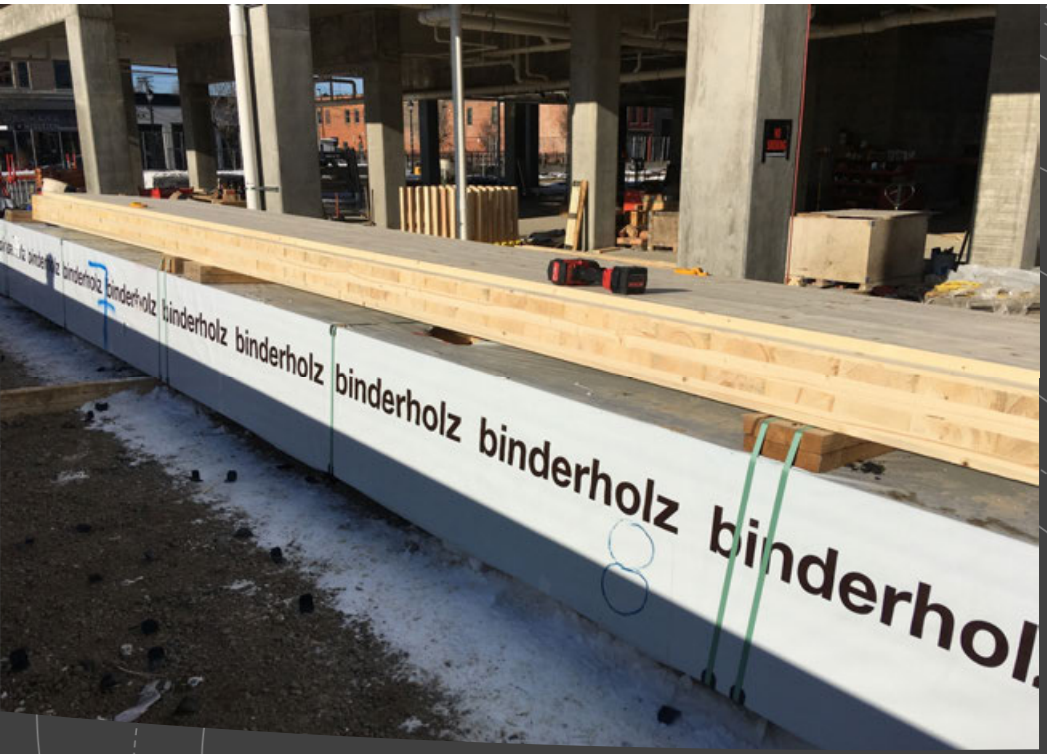
BB0

Photo: Swinerton

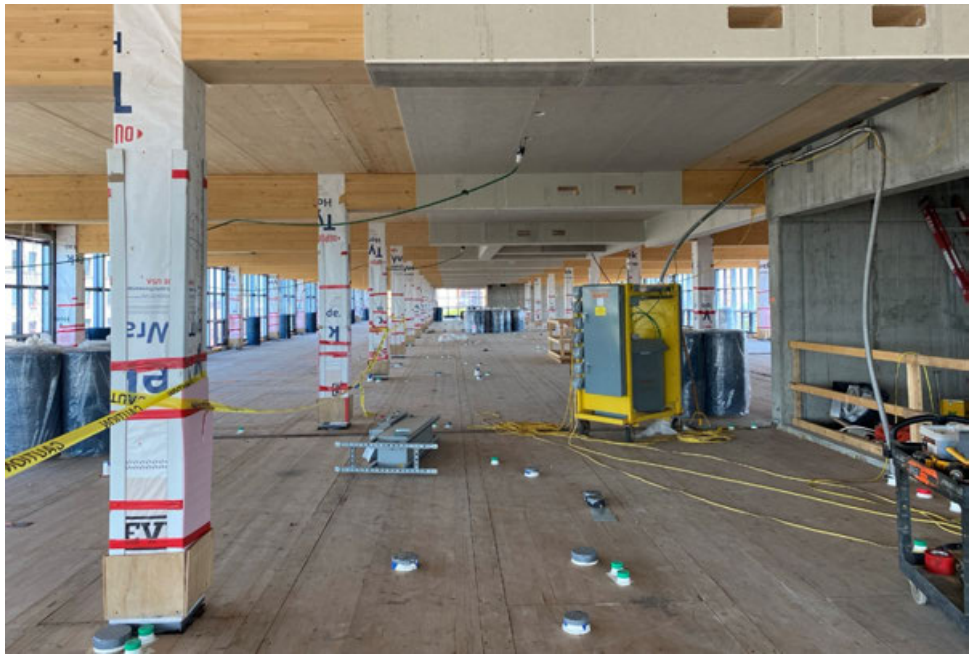
Material Environmental Exposure and Moisture Management

Enroute
Onsite
Post-Install
Other Material

Photo: Alex Schreyer



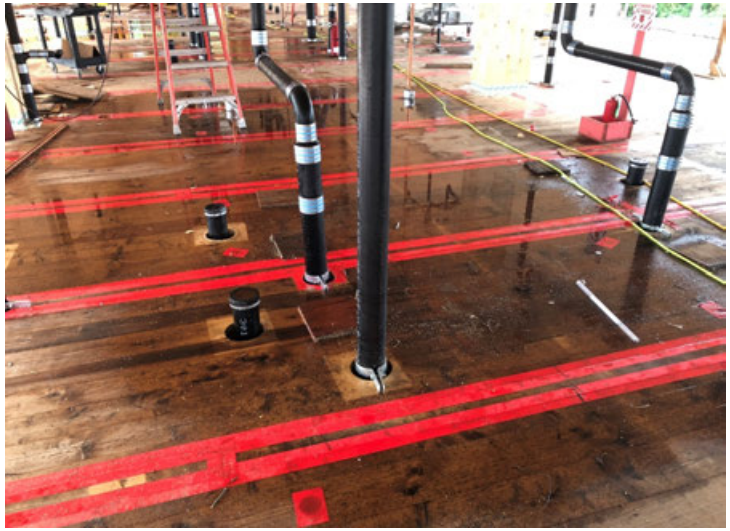
Enroute Exposure



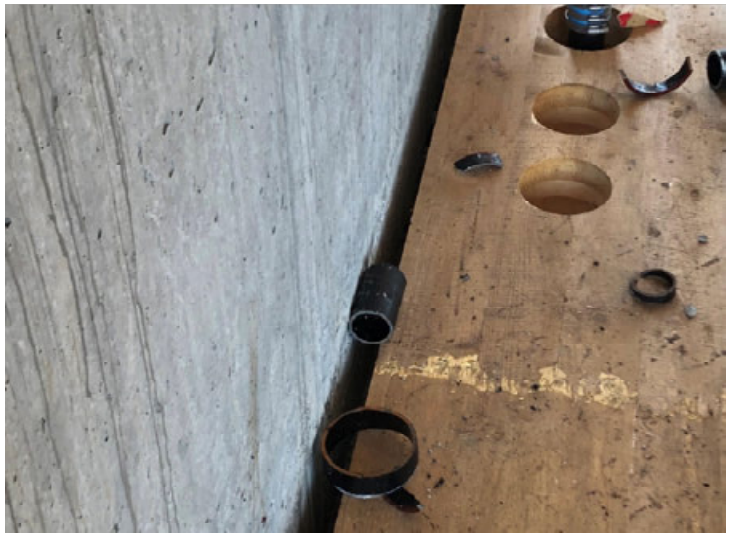
On Site Considerations

On Site Considerations

BBO



Onsite Considerations



Other Materials

BB0

Workforce Development

Training is the key to efficiency
Training takes time and money

Training versus Education

Resources available to all

MT Construction Manual
Installer Curriculum
Other WW Resources
CM Workshops
Previous recorded versions
Learning Management System

Mass Timber Construction Management Program

MASS TIMBER CONSTRUCTION MANUAL

8- & 16-HOUR INSTALLER TRAINING PACKAGE AND TRAINING CENTERS

COMMUNITY COLLEGE AND UNIVERSITY CM PROGRAMS

VIRTUAL AND/OR IN-PERSON WORKSHOPS

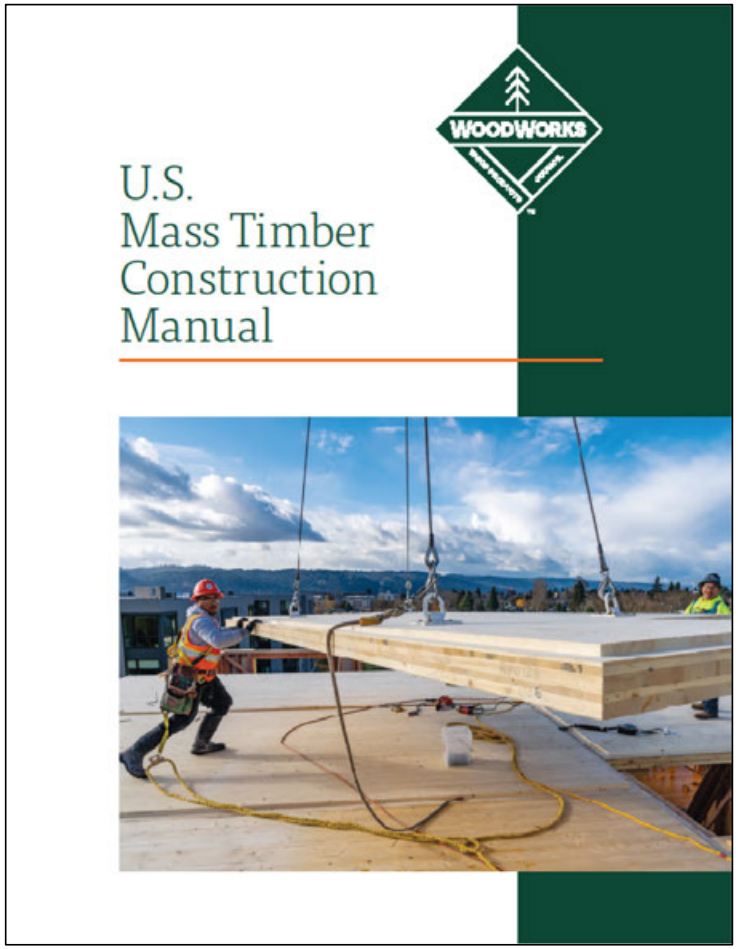
PARTNER WITH CONSTRUCTION ASSOCIATIONS

PROJECT TOURS

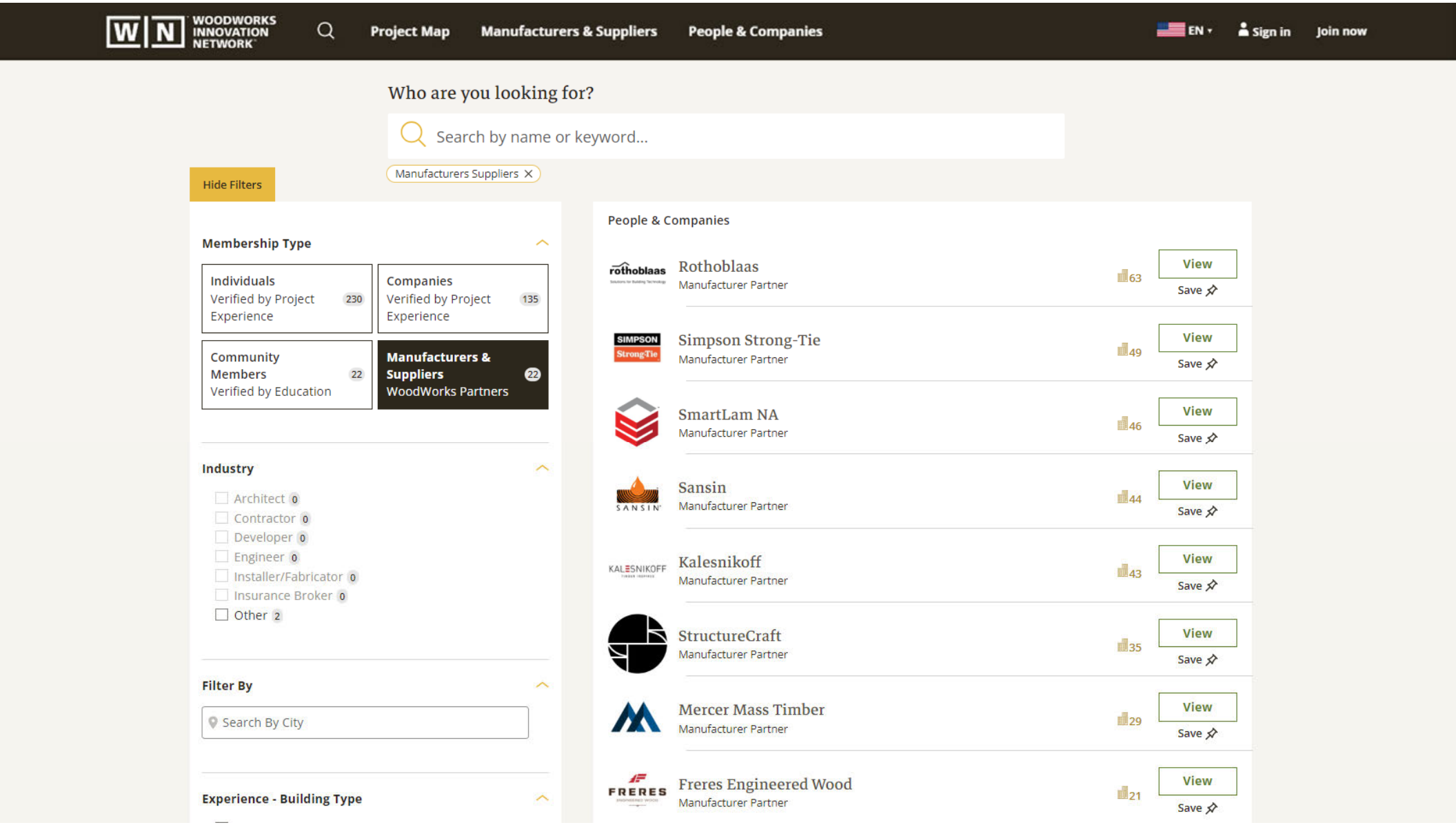
ENGAGE WITH GENERAL CONTRACTORS ACROSS THE US

Released on 20 October 2021

https://www.woodworks.org/mass-timber-construction-management-program/



The Loading Dock, OZ Architecture, KL&A, photo Joe Anastasi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Questions? Ask us anything.

Momo Sun, PE, PEng, LEED Green Associate

Regional Director | NY

(857) 242-8975

momo.sun@woodworks.org

901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn

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