Mass Timber in Multi-family Construction: Mid-Rise and Beyond

November 13, 2025

Presented by

Michael Muller, SE

WoodWorks

Image: The Canyons, Kaiser+Path, Catena Consulting Engineers, Photo Jeremy Bittermann

Regional Directors: **One-on-One Project Support**

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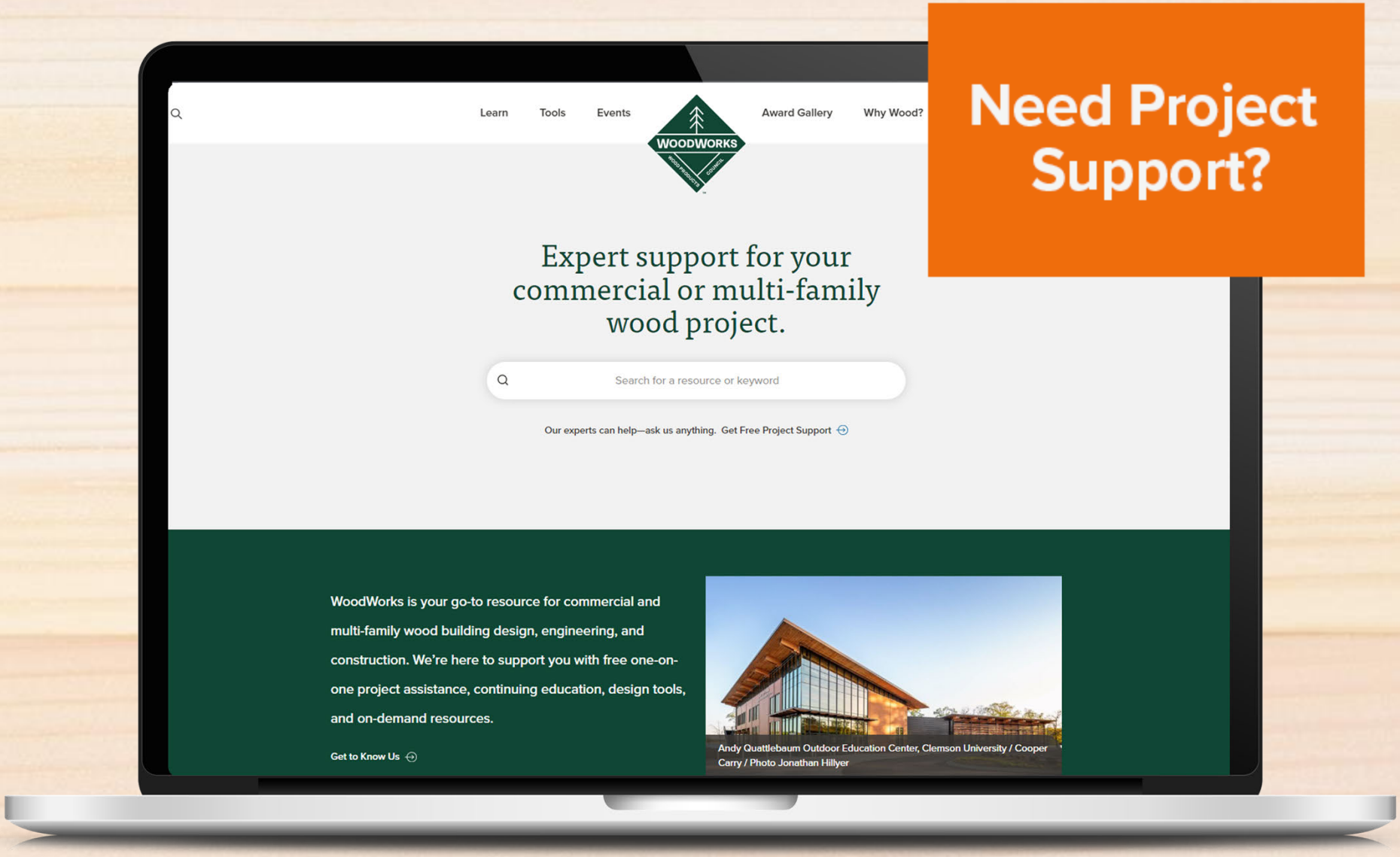

Building Systems

- Light-Frame
- Mass Timber / CLT
- Off-Site / Panelized Construction
- Hybrid

Building Types

- Multi-Family / Mixed Use
- Education
- Office
- Commercial Low-Rise
- Industrial
- Civic / Recreational
- Institutional / Healthcare

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WoodWorks Innovation Network

Discover mass timber projects across the US and connect with their teams.

Our experts can help—ask us anything. Get Free Project Support

WoodWorks is your go-to resource for commercial and multi-family wood building design, engineering, and construction. We're here to support you with free one-on-

Building Systems

- Light-Frame 26
- Mass Timber / CLT 20
- Hybrid 10
- Panelized Construction 6

Building Types

- Multi-Family / Mixed-Use 35
- Office 15
- Education 8
- Institutional / Healthcare 8
- Commercial Low-Rise 7
- Civic / Recreational 5
- Industrial 5

Project Roles

- Architect 26
- Structural Engineer 23

podium

Using Podiums in Tall Wood Buildings

Common in light-frame wood construction, podiums are a viable, code-compliant option for tall mass timber buildings under the 2021 IBC.

Expert Tips

5-over-2 Podium Design: Part 1 – Path to Code Acceptance

First published in Structure, Part 1 of this two-part article covers design considerations and traditional approaches to 5-over-2 projects.

Solution Papers

5-over-2 Podium Design: Part 2 – Diaphragm and Shear Wall Flexibility

First published in Structure, Part 2 of this article covers flexibility issues associated with 5-over-2 structures and how they can affect the design process.

Solution Papers

Thomas Logan – Wood-Frame Podium Project Creates Affordable Housing

Developed to help fill a critical need for affordable housing in Boise's downtown core, Thomas Logan is a brick-clad building that fits perfectly within the urban neighborhood.

Case Studies

Who are you looking for?

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WFP
WFP Engineered Products

PLITEQ

QB QUALITY BUILDINGS

SEAGATE MASS TIMBER INC.
QUALITY + INTEGRITY

Attendee Notes

1. Lunch and networking will follow the presentation!

2. The PDF of today's presentation can be found on WoodWorks.org under the *Events* tab—then *Presentation Archives*.

3. Certificates will be sent via email, within a week.

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

AIA Approved Continuing Education

Course Description

Can mass timber make financial sense for mid-rise multi-family construction? What new opportunities does the 2021 International Building Code create for mass timber housing in the 6 to 18-story range? While mass timber is often associated with one-off projects that celebrate innovation over repeatability, options for multi-family buildings that provide a strong return on investment have never been greater—if a designer understands how to leverage the benefits of these materials in the context of the new mass timber construction types. This presentation will review decisions that are key to the viability of mass timber multi-family projects, including construction type selection, grid layout, approach to achieving fire-resistance ratings, lateral system selection, and acoustics.

Learning Objectives

1. Review mass timber and traditional light-frame wood systems and explore multi-family applications suited to each.
2. Compare the mass timber construction types introduced in the 2021 International Building Code (IBC) using criteria such as allowable heights and areas.
3. Explore how mass timber can be successfully utilized in both mid-rise and high-rise multi-family projects, including the tall wood provisions in the IBC and allowances for exposed wood.
4. Highlight key considerations during the design of multi-family mass timber buildings, including grid layout, fire-resistance ratings, lateral system design, and acoustics, and evaluate the impact of these decisions on providing cost-effective, code-compliant buildings.

Agenda

Utilizing Mass Timber in Multifamily Construction: Mid-Rise and Beyond		
	10:00 – 10:10 am	Welcome and Intro
	10:10 – 11:10 am	***Part 1: Mass Timber in Multi-family: Evolution & Revolution***
	11:10 – 11:25 pm	Break
	11:25 – 12:25 pm	***Part 2: Mass Timber in Multi-family: Tall Wood, Key Design Decisions***
	12:25 – 1:00 pm	Lunch and Q&A

Is Mass Timber a Good Fit for Your Multi-Family Project?

Ascent, Milwaukee, WI
Source: Korb & Associates Architects

Global Population Boom

Global Population

7.9 billion in 2022

9.7 billion by 2050

23% increase

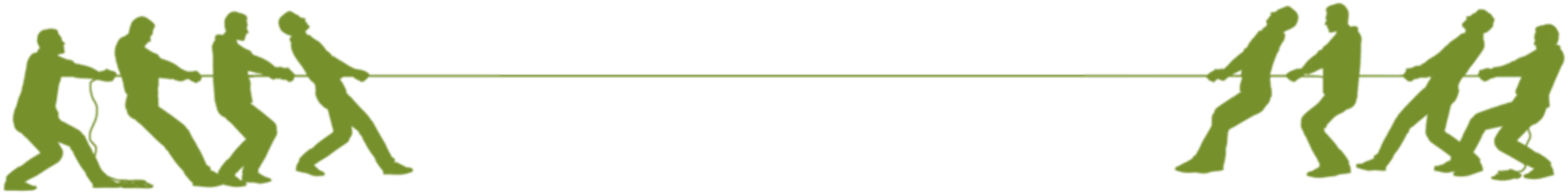
Urban Population

6.4 billion by 2050

62% increase

Source: United Nations Department of Economic and Social Affairs

Sustainable Multi-Family & Mixed-Use Structures



Economically Meet
Urban Housing Needs

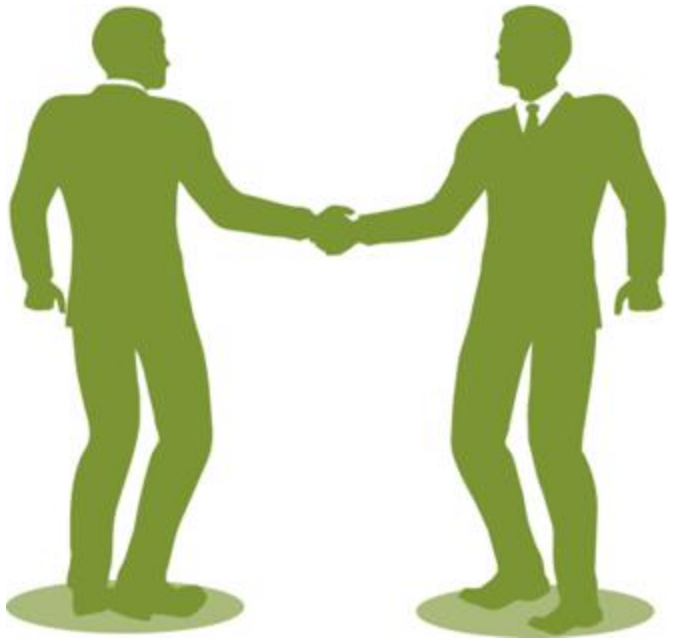
Increase Environmental
Responsibility

These 2 items don't need to be in opposition—
Wood-framing helps them work together!

Sustainable Multi-Family & Mixed-Use Structures

Mid-rise wood-frame construction provides a common ground for both

How?



Why Wood?

Using wood helps reduce environmental impact
Wood products play significant role in modern economy

- Wood Costs Less
- Wood is Versatile
- Wood Meets Code
- Wood is Durable
- Wood is Renewable

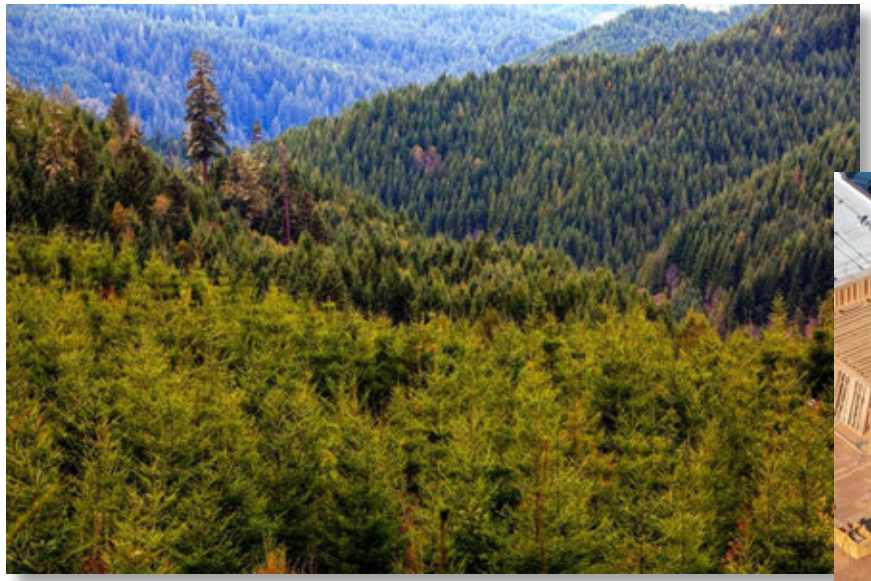


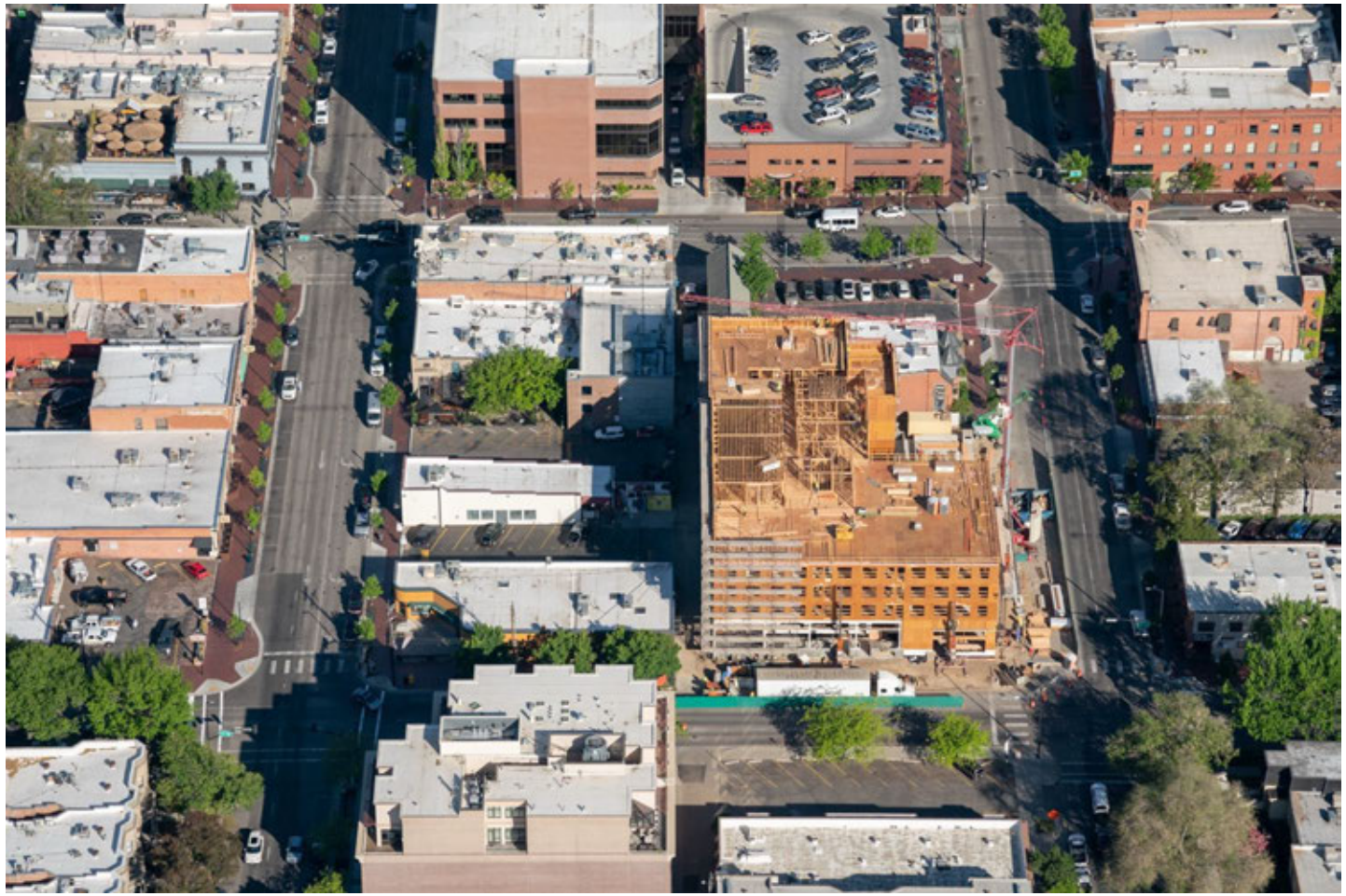
Photo courtesy OFRI

The Gibson, Hummel Architects, KPFF Consulting Engineers, photo Leo A. Geis

Mid-Rise Construction

Where **wood** is a viable option,
it's likely the most appropriate choice.

- Senior Living
- Apartments/Condos
- Mixed Use
- Student Housing
- Affordable Housing
- Hotels



The Gibson, Hummel Architects, KPFF Consulting Engineers, photo Leo A. Geis

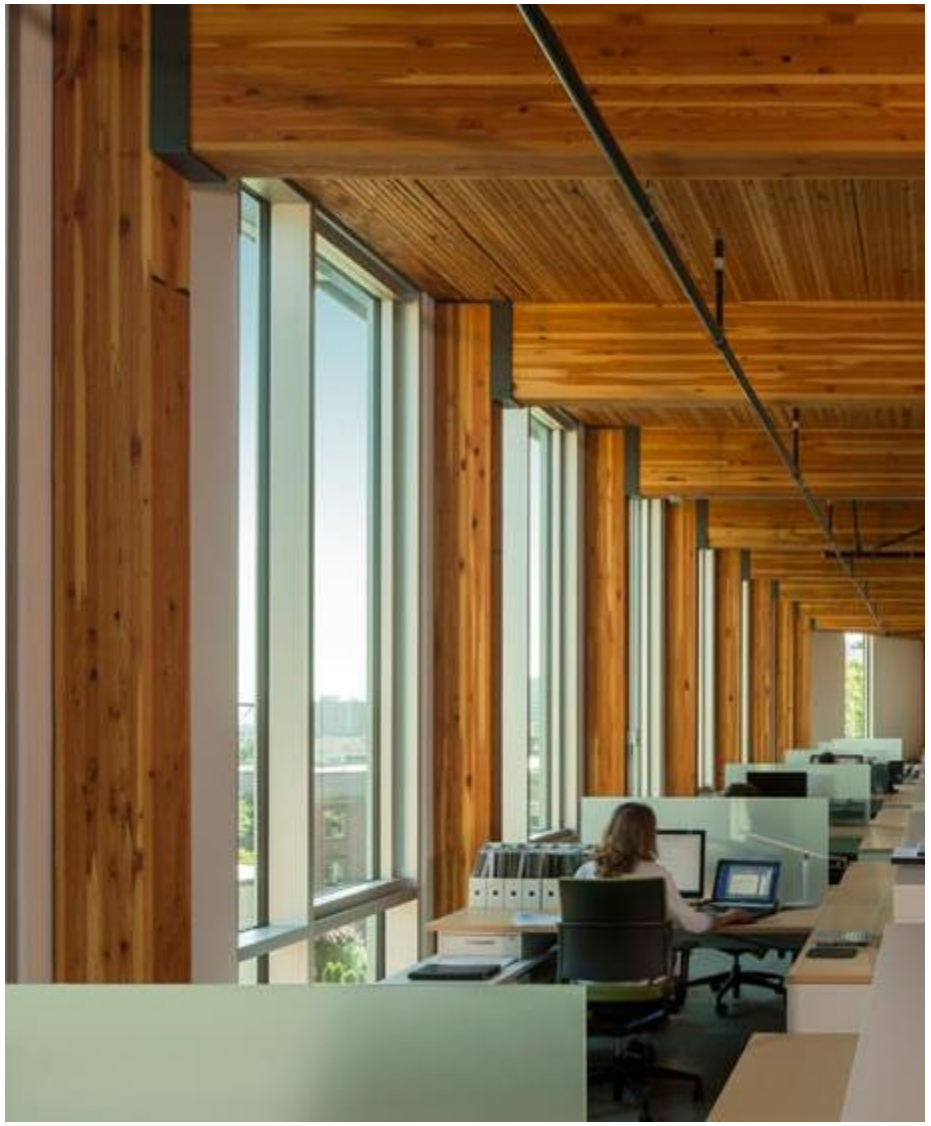
MASS TIMBER OVERVIEW

Ascent / New Land Enterprises / Korb + Associates Architects / Thorton Tomasetti / photo New Land Enterprises

Wood Construction Terminology

Light-Frame Wood
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

Wood Construction Terminology

Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo:
Freres Lumber

Wood Construction Terminology

Dowel-Laminated Timber (DLT)

Photo: StructureCraft

Nail-Laminated Timber (NLT)

Photo: Think Wood

Glue-Laminated Timber (GLT)

Plank orientation

Photo: StructureCraft

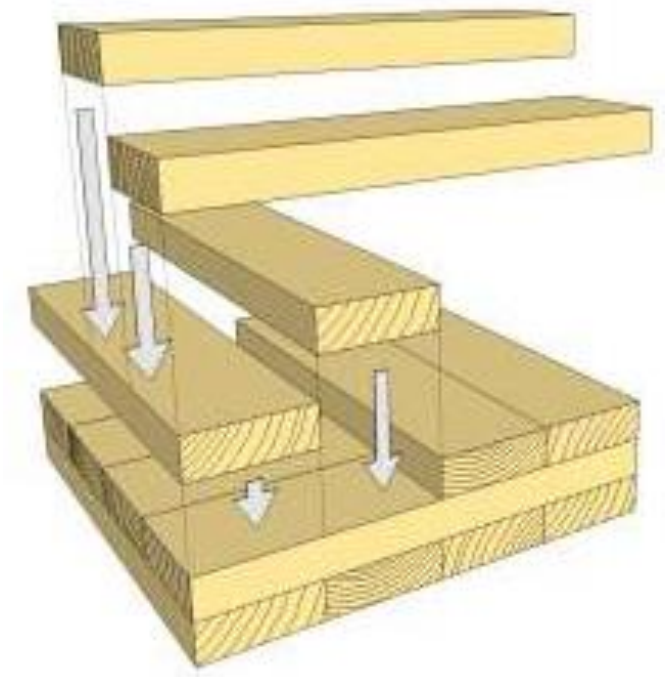
Photo: StructureCraft

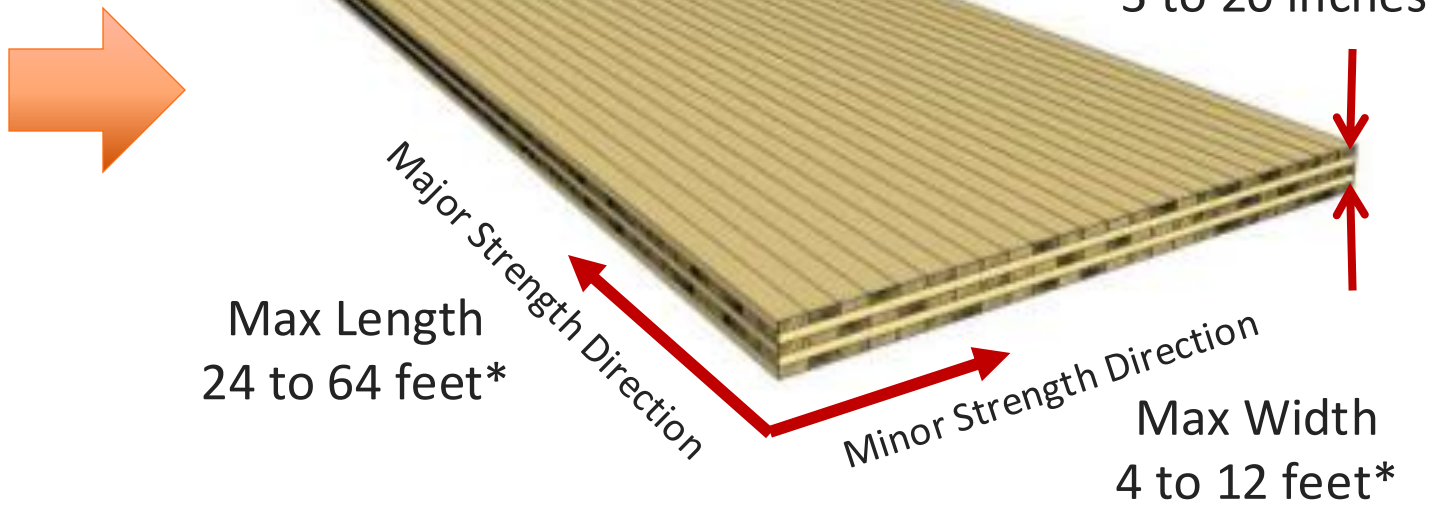
Photo: Ema Peter

Photo: Manasc Isaac Architects/Fast + Epp

What is CLT?

- 3+ layers of laminations
- Solid Sawn or Structural Composite Lumber Laminations
- Cross-Laminated Layup
- Glued with Structural Adhesives





*All dimensions are approximate.
Consult with manufacturers.

Mass Timber Building Options


Photo: Blaine Brownell

Post and Beam


Photo: acton ostry architects

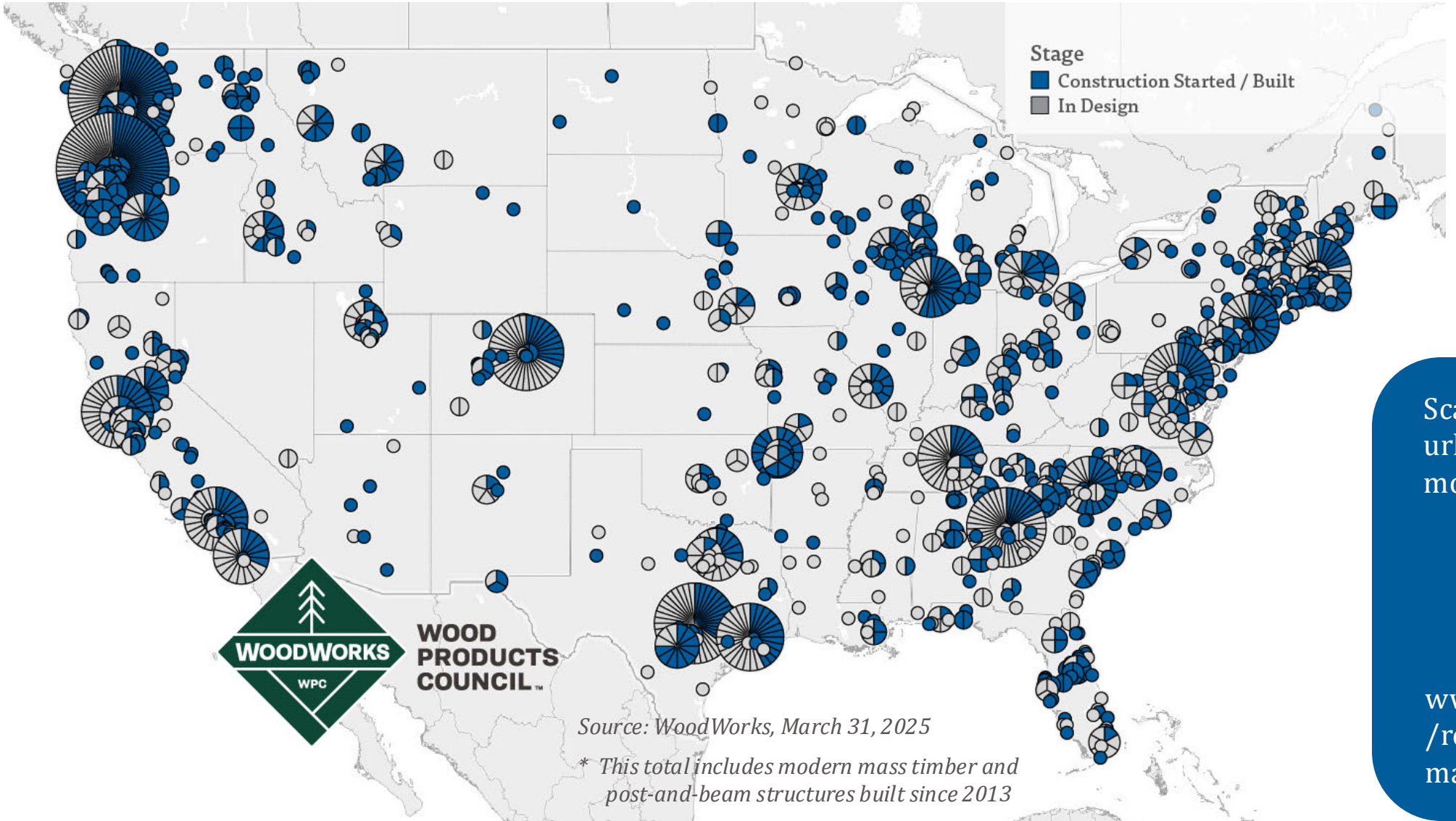
Flat Plate


Photo: : LendLease

Honeycomb

Current State of Mass Timber Projects

As of Q1 2025, in the US, **2,427** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



1,244 Built

1,183 In Design

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WOOD PRODUCTS COUNCIL

Source: WoodWorks, March 31, 2025

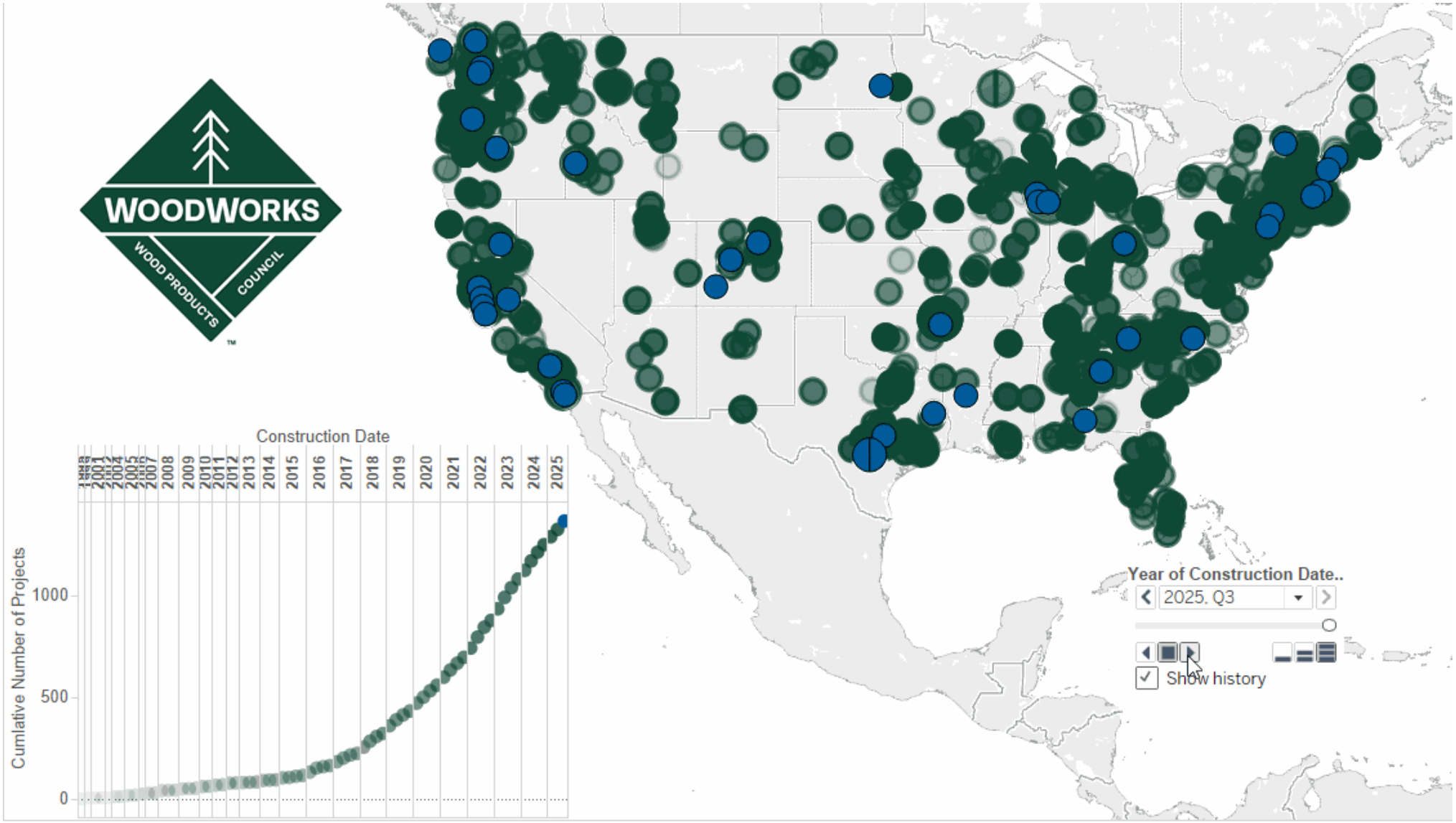
** This total includes modern mass timber and post-and-beam structures built since 2013*

Scan this code or use the url to find the map and more details online.

www.woodworks.org/resources/mapping-mass-timber/

Current State of Mass Timber Projects Over Time

US Market Q3 2025



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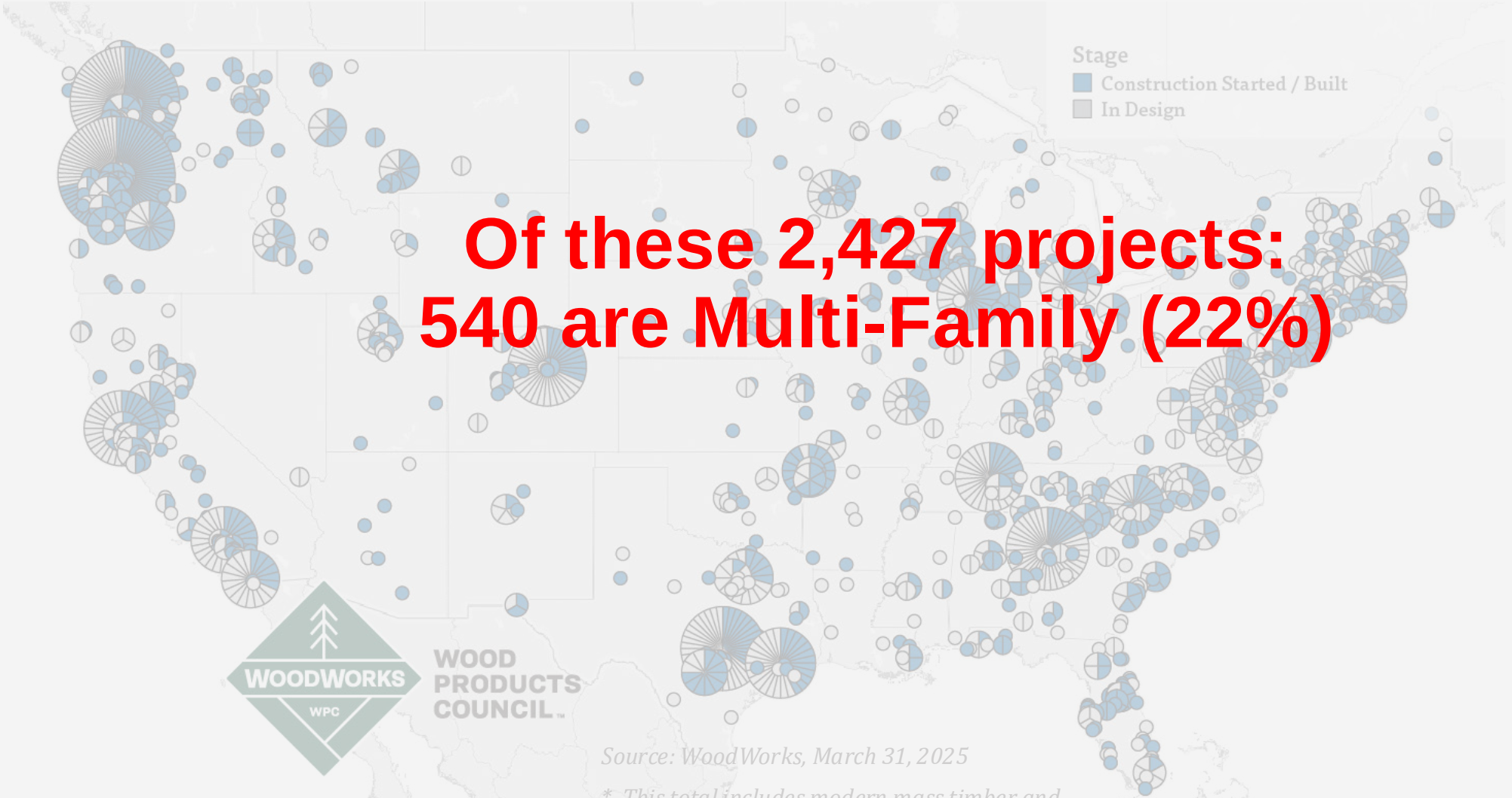

Of these 2,427 projects:
540 are Multi-Family (22%)

WOODWORKS
WPC
WOOD PRODUCTS COUNCIL

Source: WoodWorks, March 31, 2025

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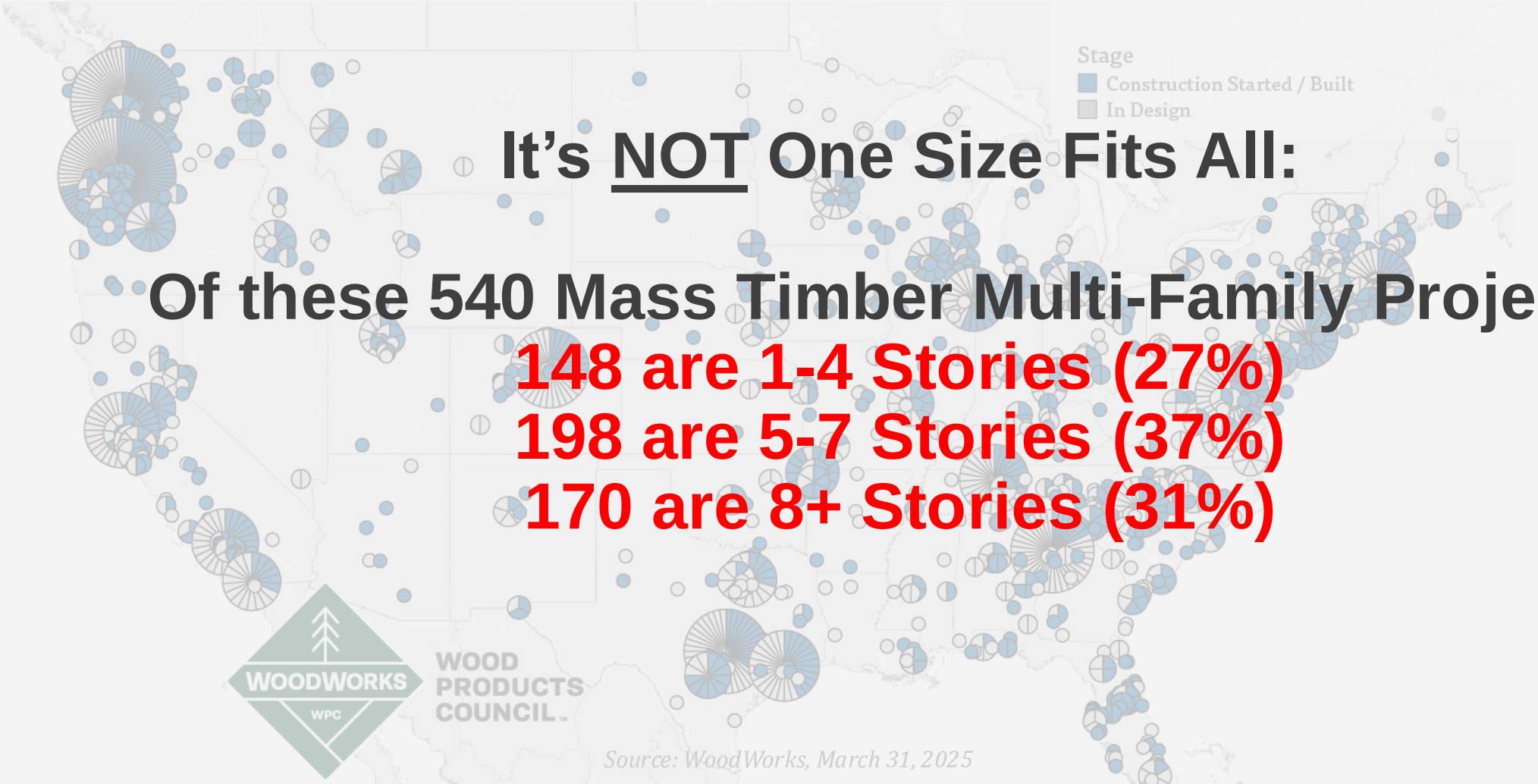

It's NOT One Size Fits All:

Of these 540 Mass Timber Multi-Family Projects:

148 are 1-4 Stories (27%)
198 are 5-7 Stories (37%)
170 are 8+ Stories (31%)

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Source: WoodWorks, March 31, 2025

** This total includes modern mass timber and post-and-beam structures built since 2013*

* For 4% of the projects, the building height is unknown/too early in design

MASS TIMBER IN MULTI-FAMILY

EVOLUTION OR REVOLUTION?

MASS TIMBER IN THE CODE

Central Lofts / Jones Architecture / Froelich Engineers / Photo Jones Architecture

Mass Timber in the IBC: Cross-Laminated Timber (CLT)

- CLT was first recognized in the 2015 IBC
- CLT in the 2021 IBC:
  - 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.

  - Chapter 23: Wood

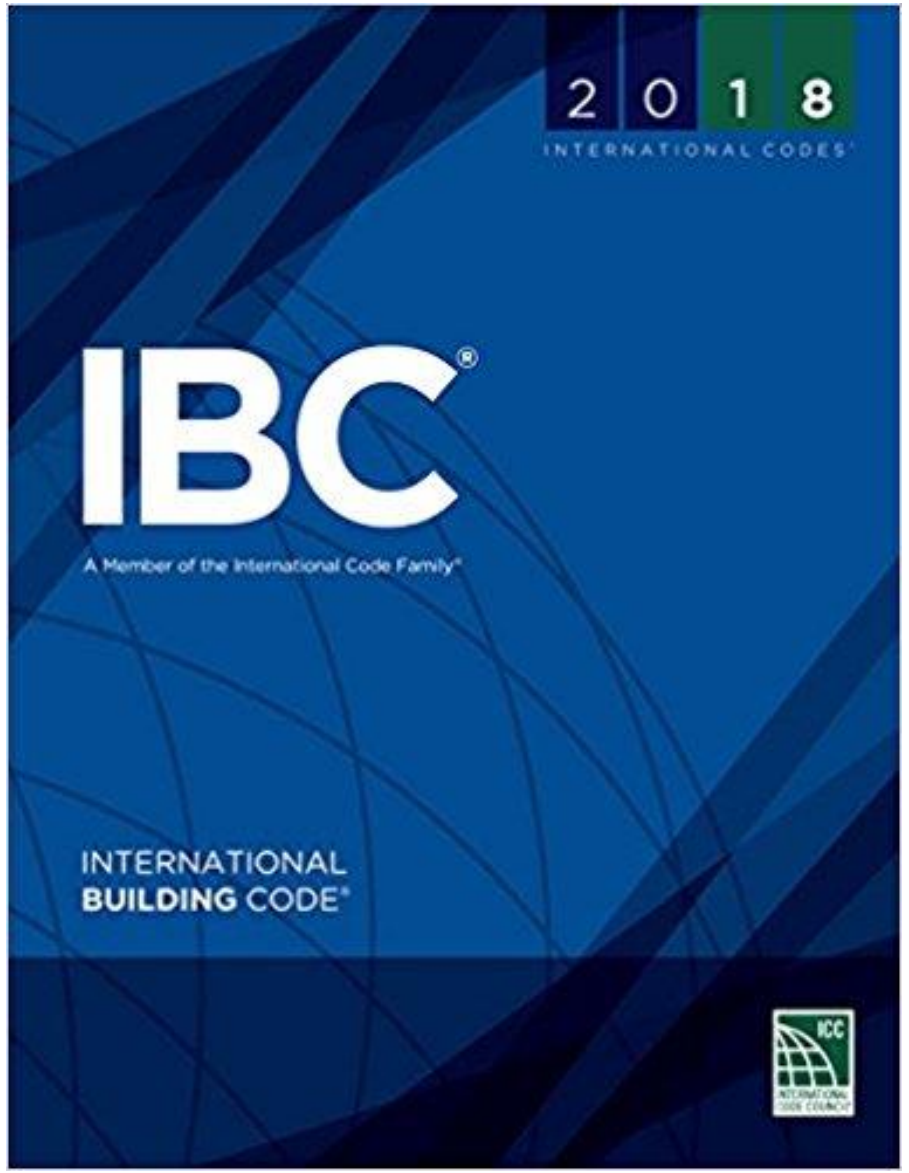
    2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

Construction Types

When does the code allow mass timber to be used in low- and mid-rise multi-family projects?

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

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)

Photo Credit: Hacker Architects, Jeremy Bittermann

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)

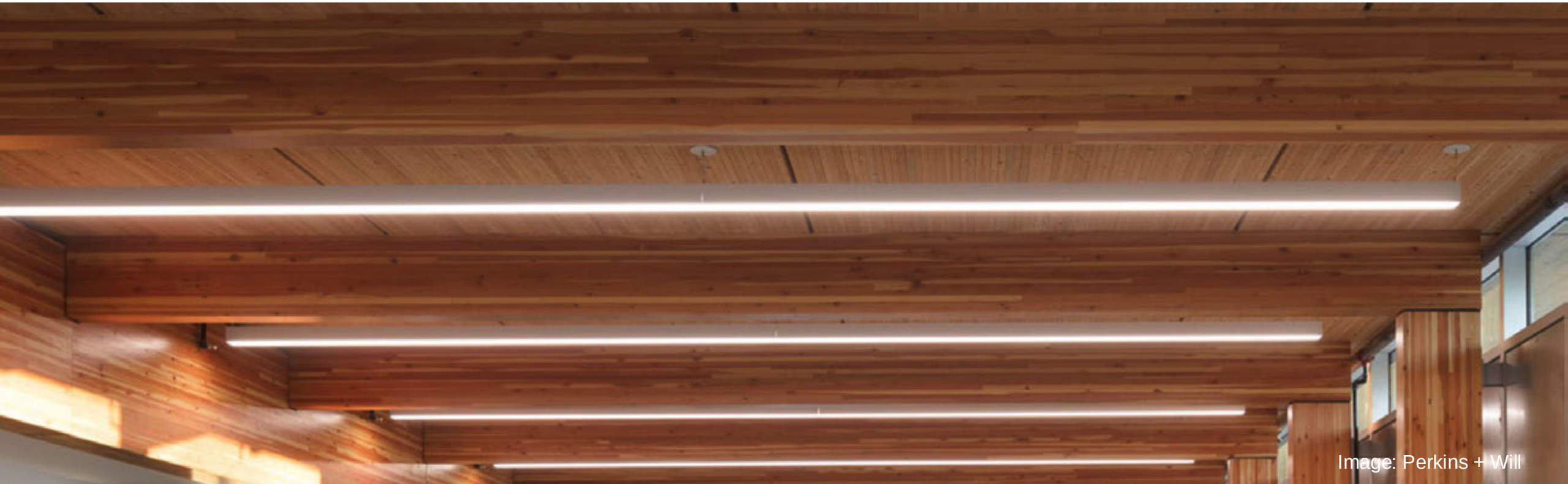


Image: Perkins + Will

Construction Types

Where does the code allow MT to be used?

- Type V: All interior elements, roofs & exterior walls

EVOLUTION

INCREMENTAL CHANGE

REVOLUTION

TRANSFORMATIONAL CHANGE

Low- and Mid-Rise Multi-Family

Credit: ABX Creative and Engberg Anderson

Multi-Housing Typologies

Credit: WGI

Multi-Housing Typologies

MT Floors & Roofs on LWF Bearing Walls

Credit: KL&A Engineers & Builders

MT Floors & Roofs on Post & Beam Framing

Credit: ADX Creative and Engberg Anderson

MT Floors & Roofs on MT Bearing Walls

Credit: Grey Organschi Architecture and Spiritos Properties

Photo: John Klein

HYBRID LIGHT-FRAME + MASS TIMBER

THE POSTMARK APARTMENTS, SHORELINE, WA

Credit: Katerra, Hans-Erik Blomgren

CANYONS, PORTLAND, OR

Credit: Jeremy Bittermann & Kaiser + Path

THE KIND PROJECT, SACRAMENTO, CA

Credit: Kalesnikoff Mass Timber

CONDOS AT LOST RABBIT, MS

Lost Rabbit, MS
Credit: Everett Consulting Group

CIRRUS, DENVER, CO

Credit: KL&A Engineers & Builders

THE DUKE, AUSTIN, TX

Credit: WGI

PROJECT ONE, OAKLAND, CA

Credit: Gurnet Point

Photo: Ema Peter

POST, BEAM + PLATE

360 WYTHE AVENUE, BROOKLYN, NY

Credit: Flank

BARRACUDA CONDOS, MADISON, WI

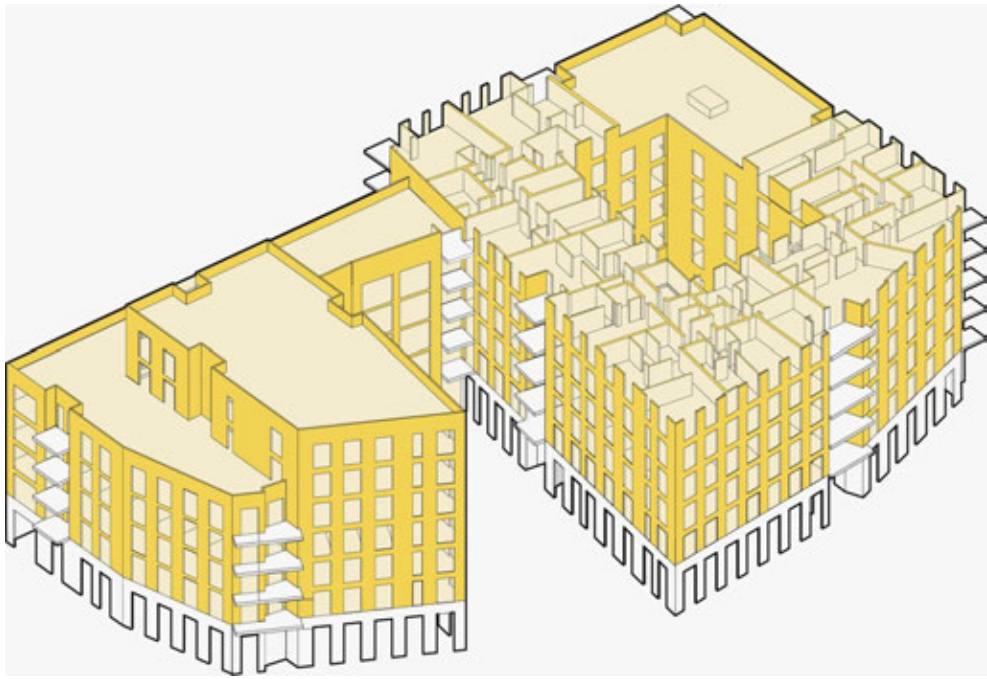
Credit: Populance Architecture and Development

Photo: Lendlease

MASS TIMBER BEARING WALLS

DALSTON WORKS, LONDON

Photos: Daniel Shearin | Waugh Thistleton Architects



Left: 69 A Street, Boston, MA Credit: Greg Folkins
Above: Timber Lofts, Milwaukee, WI
Credit: ADX Creative and Engberg Anderson Architects

VERTICAL ADDITIONS AND ADAPTIVE REUSE

BREWERY LOFTS, TACOMA, WA

Brewery Lofts, Flynn Architecture, Eclipse Engineering, photos: Brewery Blocks Tacoma, SmartLam

TIMBER LOFTS
MILWAUKEE, WI

ANN PIEPER EISENBROWN
OWNER/PRESIDENT | PIPER PROPERTIES
TIMBER LOFTS

"Mass timber shaved 20% off our construction schedule. It's a renewable resource and also creates that warm look."

Source: Think Wood

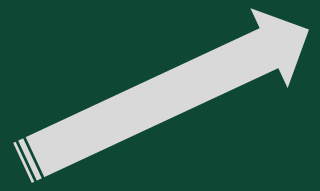
Source: ADX Creative and Engberg Anderson Architects

EVOLUTION

INCREMENTAL CHANGE

REVOLUTION

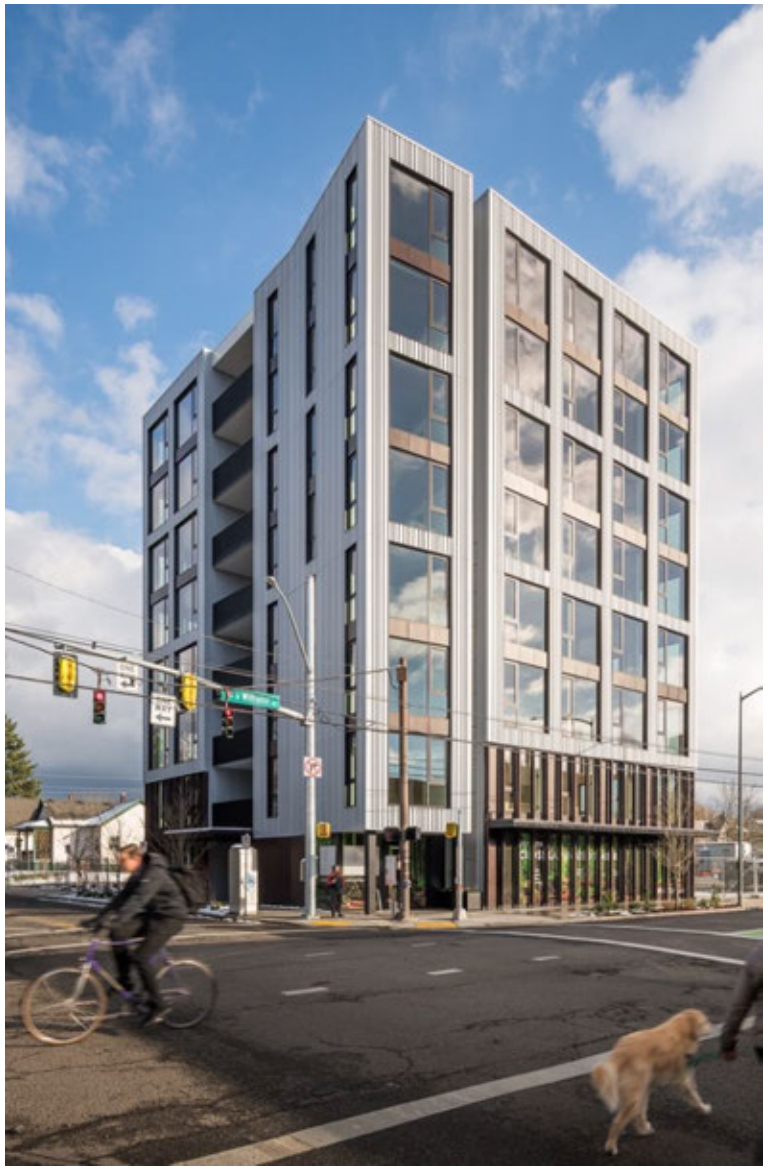
TRANSFORMATIONAL CHANGE



Tall Mass Timber Multi-Family

Credit: Harbor Bay Real Estate Advisors, Purple Film, INTRO, Cleveland, OH

CARBON 12, PORTLAND, OR



Credit: Baumberger Studio/PATH Architecture

INTRO

CLEVELAND, OH

Hartshorne Plunkard Architecture
Forefront Structural Engineers
Fast + Epp
Photo Nick Johnson, Tour D Space

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

9 Stories | 115 ft

8 Timber Over 1 Podium

Type IV-B

Variance to expose ~50% ceilings

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

Ascent

Milwaukee, WI

Korb + Associates Architects
Thronton Tomasetti
Photo: C.D. Smith Construction

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

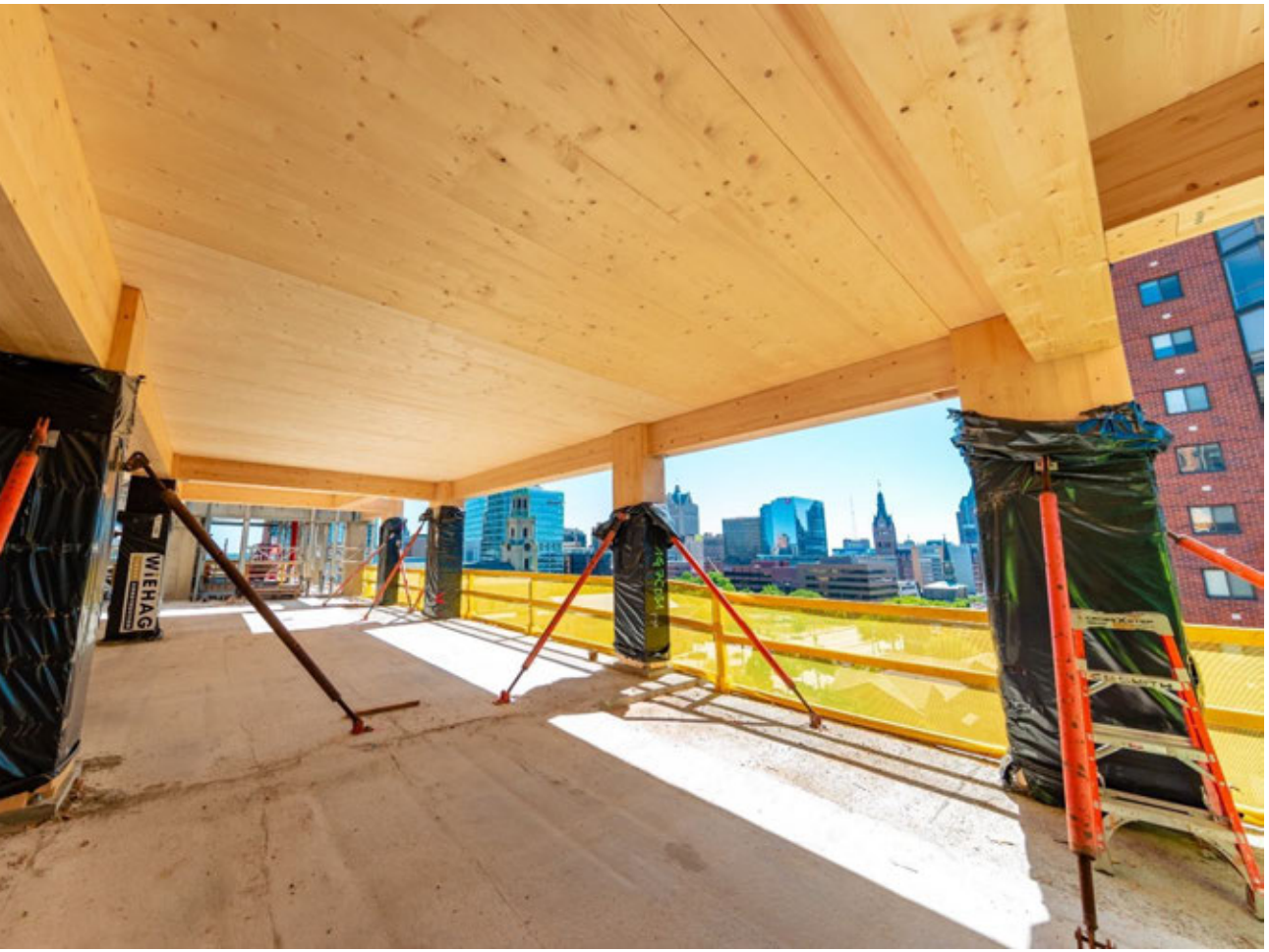


Photo: CD Smith Construction |
Architect: Korb & Associates Architects

ASCENT, MILWAUKEE

25 STORIES

19 TIMBER OVER 6 PODIUM, 284 FT

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

11 E LENOX, BOSTON, MA

7 STORIES

70 FT

Passive House

Multi-Family

Credit: H + O Structural Engineering

Credit: Monte Frahan Design Studio

11 E LENOX, BOSTON, MA

Credit: H + O Structural Engineering

Heartwood

Seattle, WA

atelierjones LLC
DCI Engineers
Image: atelierjones LLC

Heartwood

Seattle, WA

atelierjones LLC
DCI Engineers
Image: atelierjones LLC

66,000 sf, 8 stories

Type IV-C

Workforce Housing

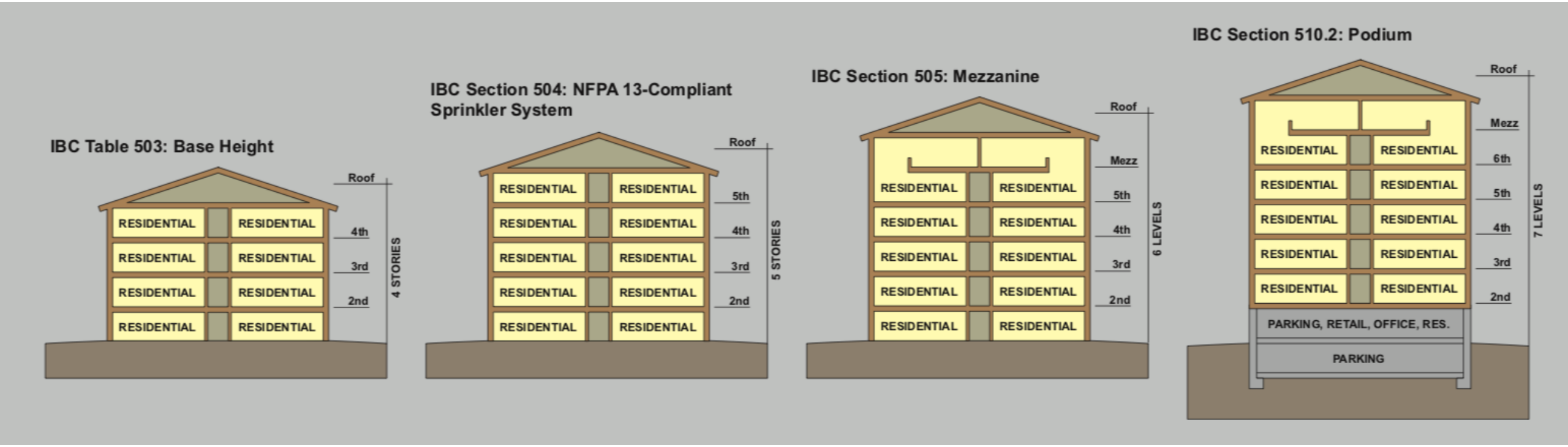
MT / CLT

Wood construction: 1 day per floor

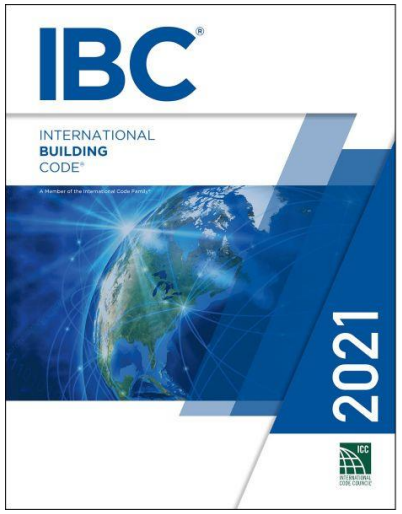
Completed 2023

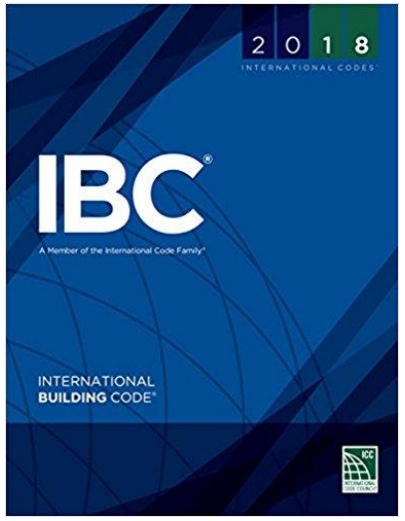
WN PROFILE

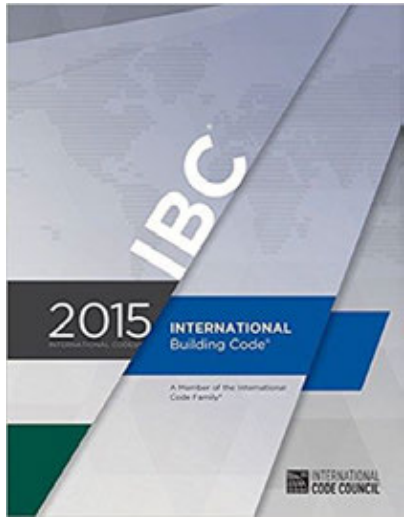
PRESCRIPTIVE BUILDING CODES

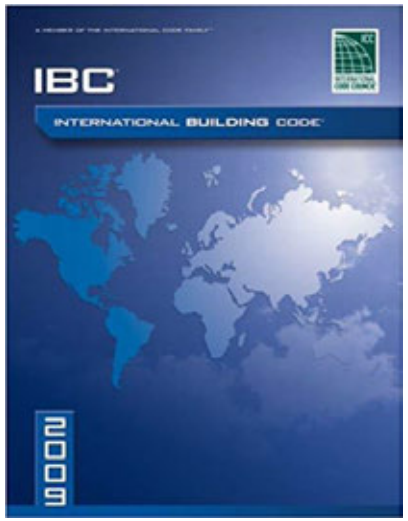


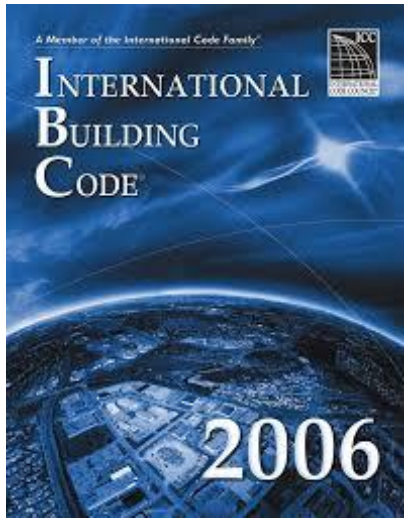
3 YEAR CODE CYCLE

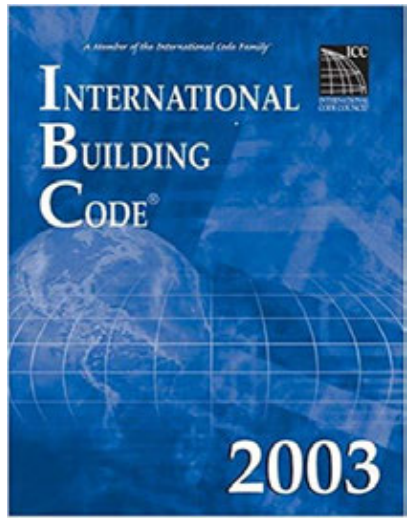


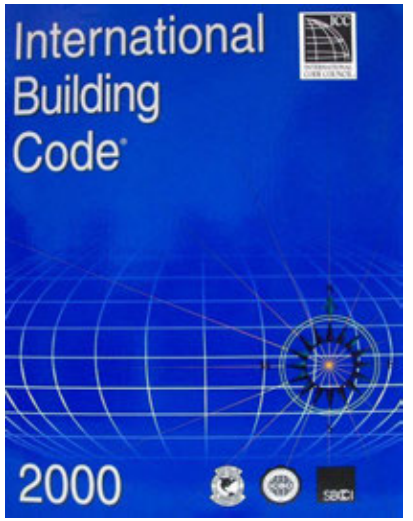












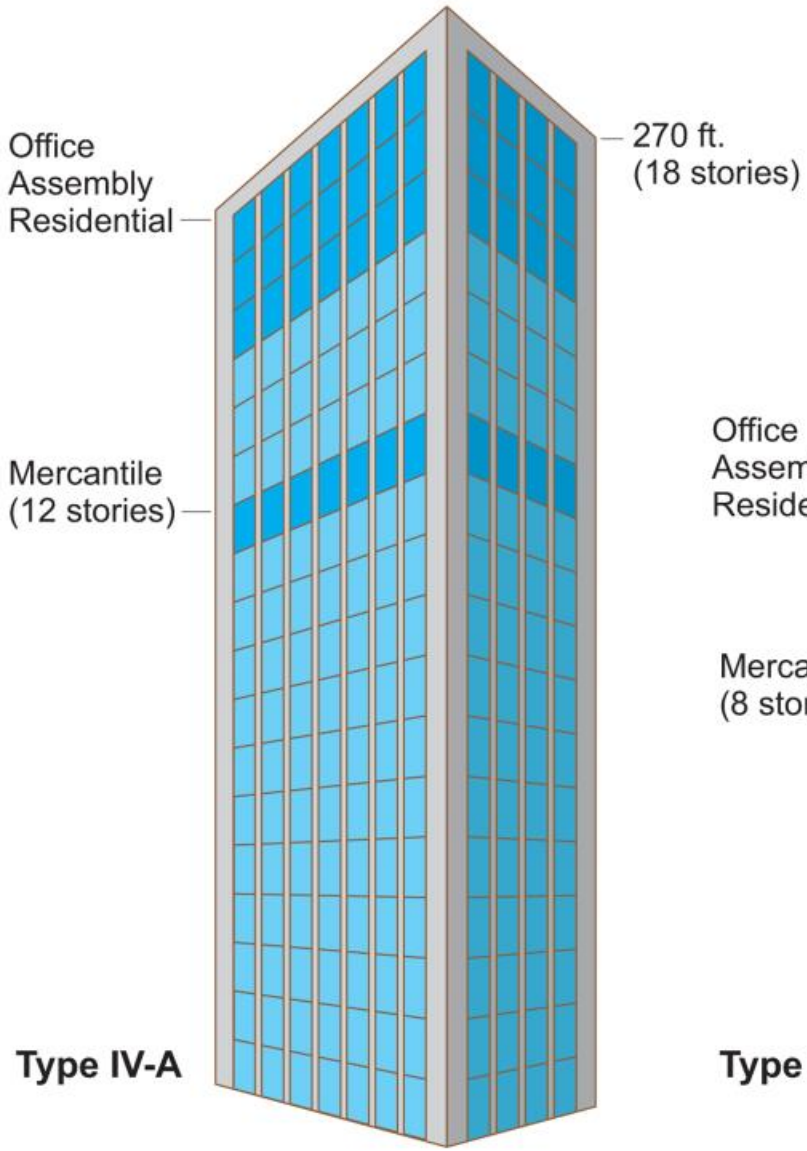
Source: ICC

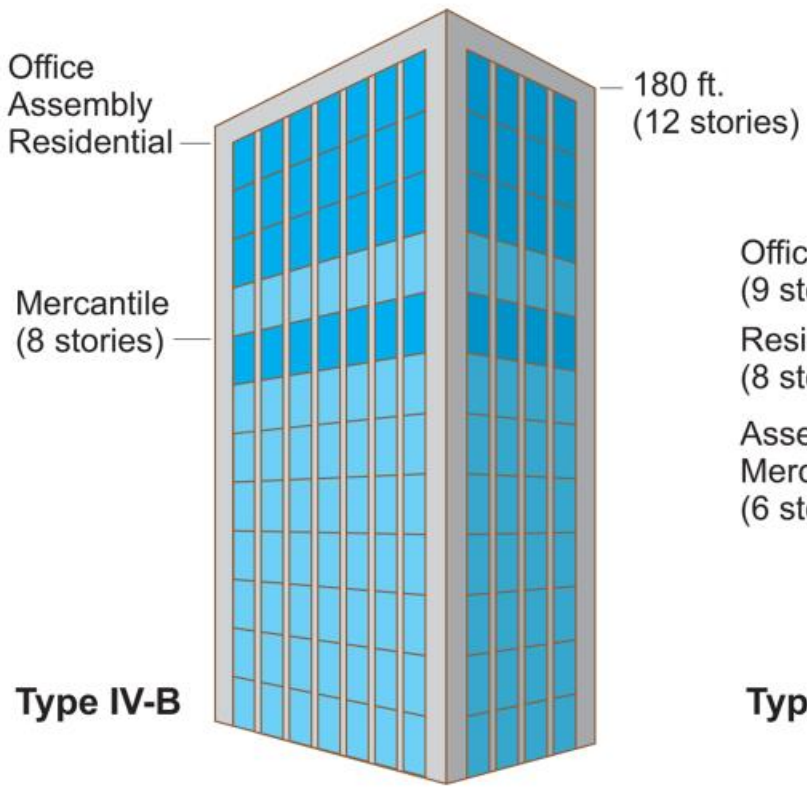
ATF Lab Tests, 2017
Photo: LendLease

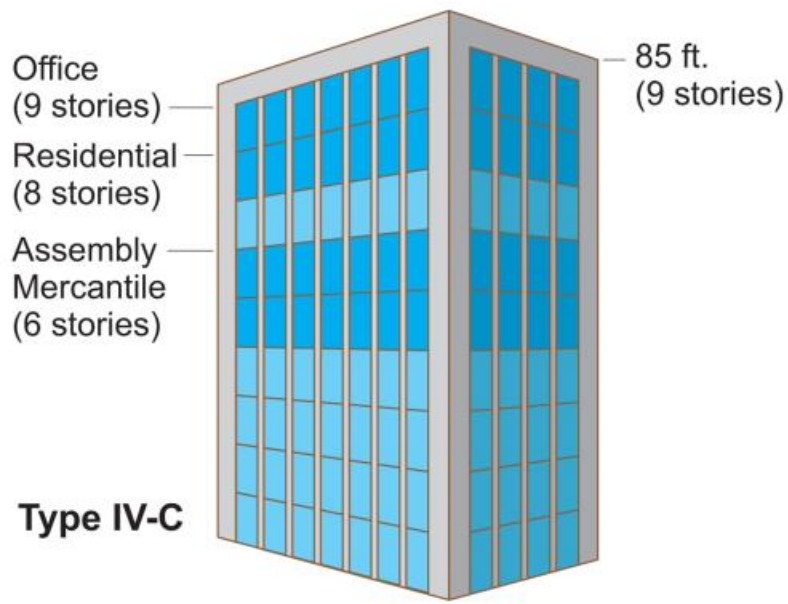
ATF Lab Tests, 2017
Photo: LendLease

Tall Mass Timber

2021 IBC: 3 New Tall Mass Timber Construction Types



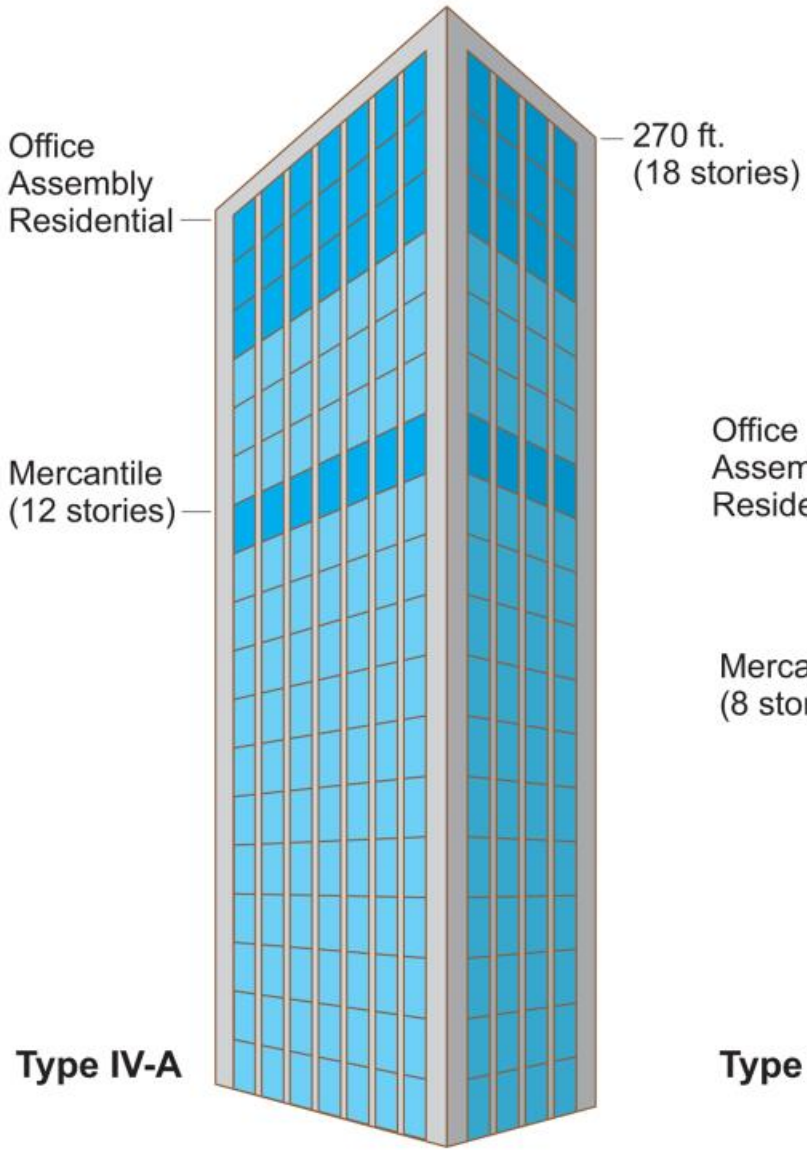


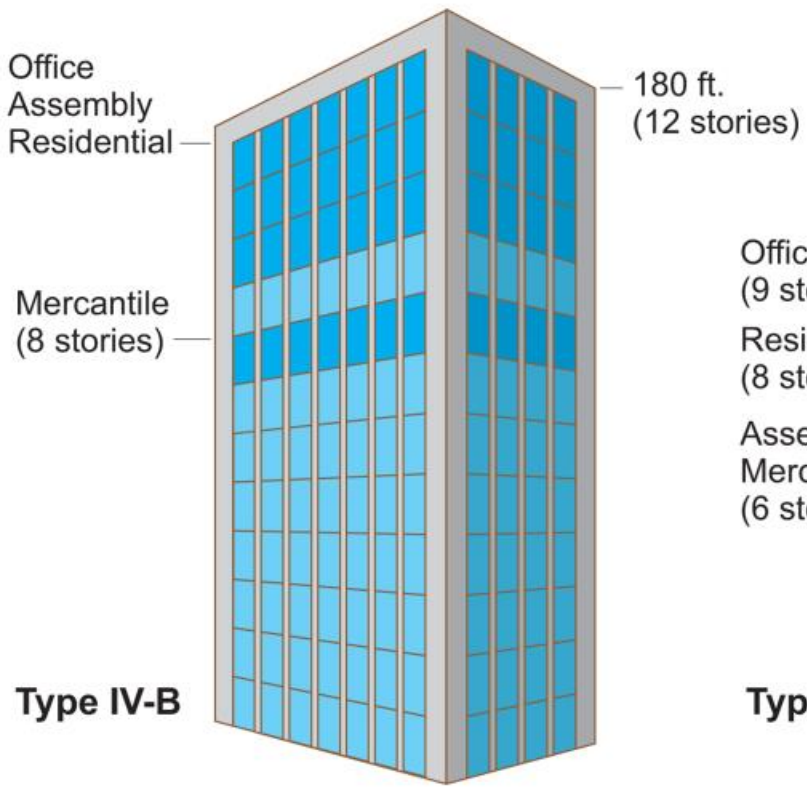


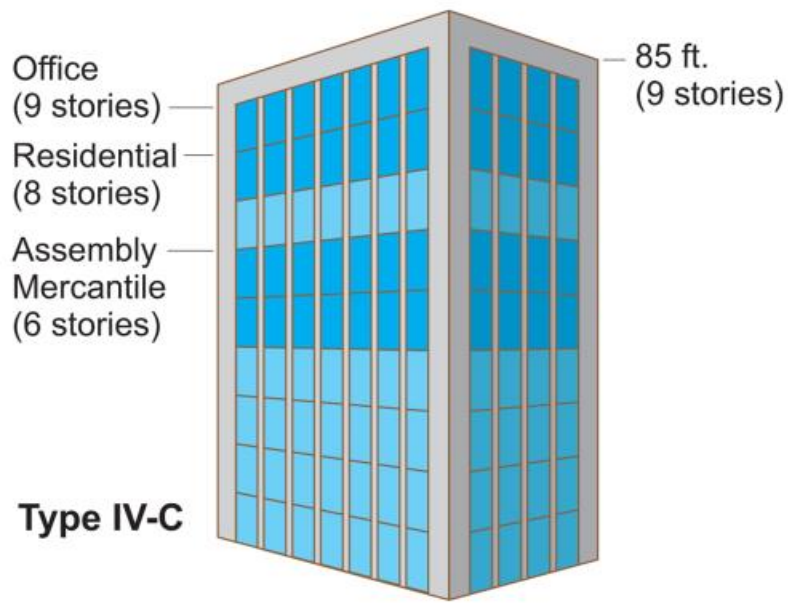
Back in 15!

Tall Mass Timber

2021 IBC: 3 New Tall Mass Timber Construction Types





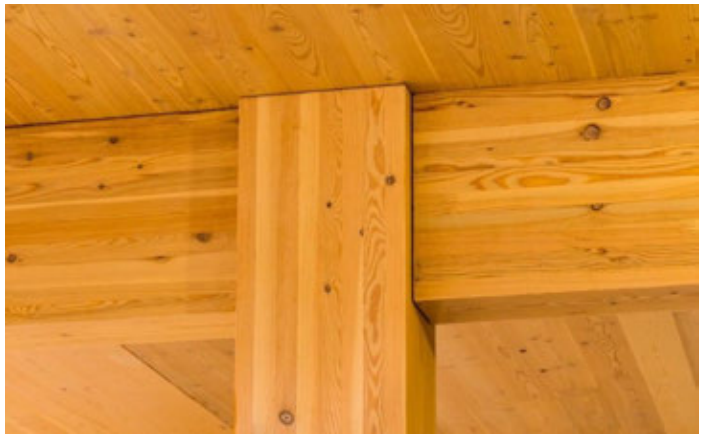


Type IV-C

9 STORIES	
BUILDING HEIGHT	85’
ALLOWABLE BUILDING AREA	405,000 SF
AVERAGE AREA PER STORY	45,000 SF

TYPE IV-C

Credit: Susan Jones, atelierjones



Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Height and Area Limits

IV-C

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
B	9	85 ft	135,000 SF	405,000 SF
M	6	85 ft	76,875 SF	230,625 SF
R-2	8	85 ft	76,875 SF	230,625 SF

Areas exclude potential frontage increase

In most cases, Type IV-C height allowances = Type IV-HT height allowances, but add'l stories permitted due to enhanced FRR

Type IV-C area = 1.25 * Type IV-HT area

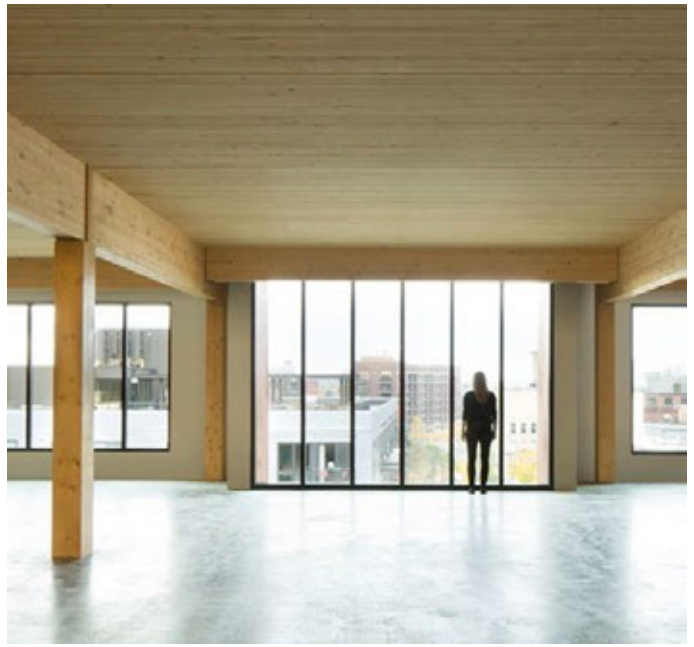
Type IV-C Protection vs. Exposed

IV-C

9 STORIES	
BUILDING HEIGHT	85’
ALLOWABLE BUILDING AREA	405,000 SF
AVERAGE AREA PER STORY	45,000 SF

TYPE IV-C

Credit: Susan Jones, atelierjones



Credit: Kaiser+Path, Ema Peter

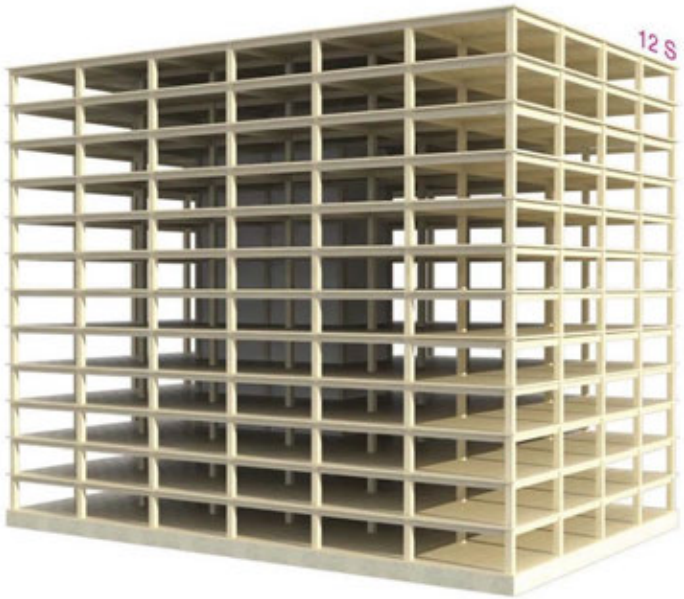
All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls

IV-C

IV-C

Type IV-B



12 STORIES

BUILDING HEIGHT	180 FT
ALLOWABLE BUILDING AREA	648,000 SF
AVERAGE AREA PER STORY	54,000SF

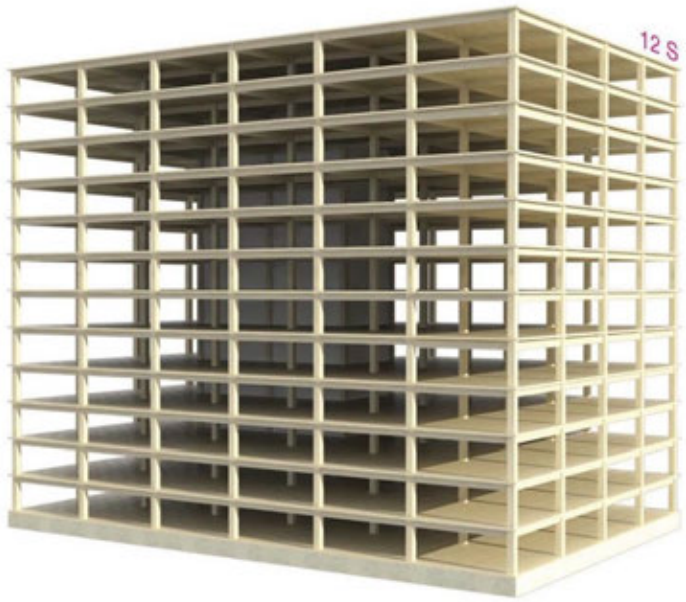
TYPE IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Height and Area Limits

IV-B



12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-B

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
B	12	180 ft	216,000 SF	648,000 SF
M	8	180 ft	123,000 SF	369,000 SF
R-2	12	180 ft	123,000 SF	369,000 SF

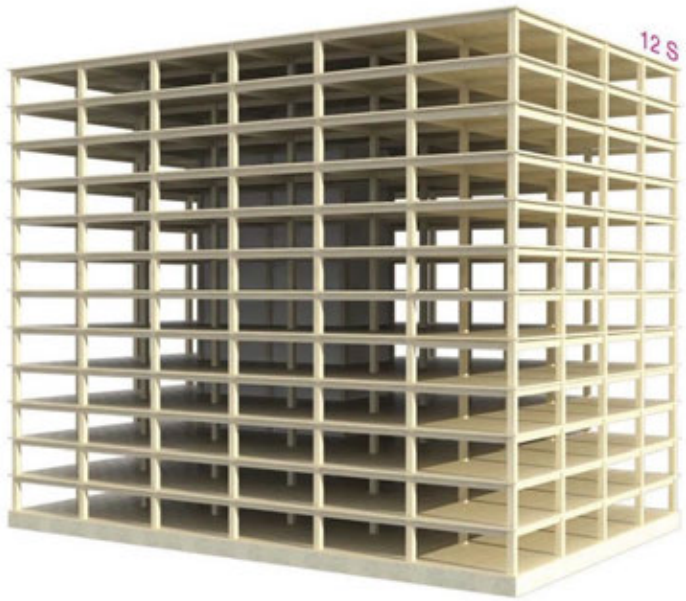
Areas exclude potential frontage increase

In most cases, Type IV-B height & story allowances = Type I-B height & story allowances

Type IV-B area = 2 * Type IV-HT area

Type IV-B Protection vs. Exposed

IV-B



12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-B

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed

Type IV-B Protection vs. Exposed

IV-B

Limited Exposed MT allowed in Type IV-B for:

- **MT beams and columns which are not integral part of walls or ceilings, no area limitation applies**
- **MT ceilings and beams up to 20% of floor area in dwelling unit or fire area, or**
- **MT walls and columns up to 40% of floor area in dwelling unit or fire area, or**
- **Combination of ceilings/beams and walls/columns, calculated as follows:**

Credit: Kaiser+Path

Type IV-B Protection vs. Exposed

IV-B

Mixed unprotected areas, exposing both ceilings and walls:

- **In each dwelling unit or fire area, max. unprotected area =**

$$(U_{tc}/U_{ac}) + (U_{tw}/U_{aw}) \leq 1.0$$

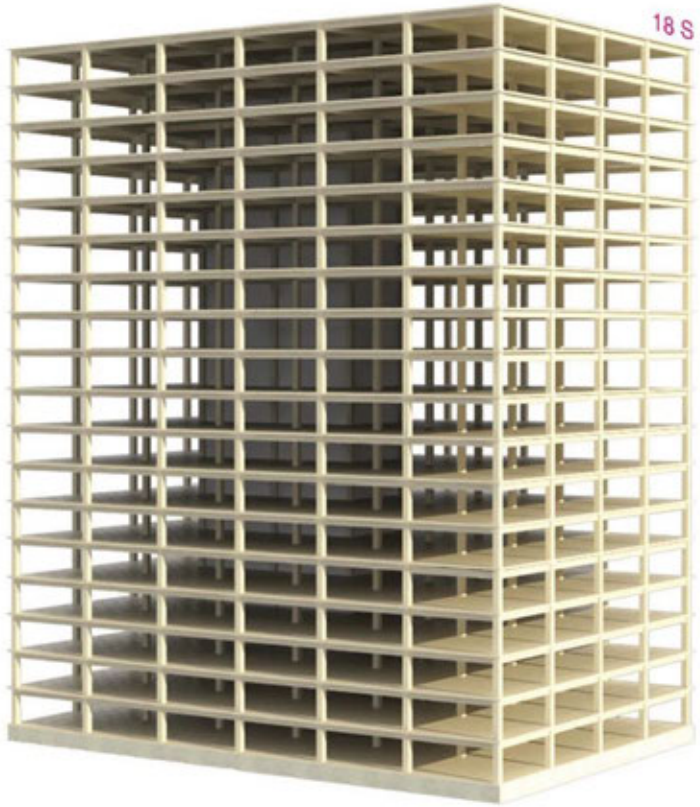
- **U_{tc} = Total unprotected MT ceiling areas**
- **U_{ac} = Allowable unprotected MT ceiling areas**
- **U_{tw} = Total unprotected MT wall areas**
- **U_{aw} = Allowable unprotected MT wall areas**

Credit: Kaiser+Path

IV-B

IV-B

Type IV-A



18 STORIES	
BUILDING HEIGHT	270'
ALLOWABLE BUILDING AREA	972,000 SF
AVERAGE AREA PER STORY	54,000SF

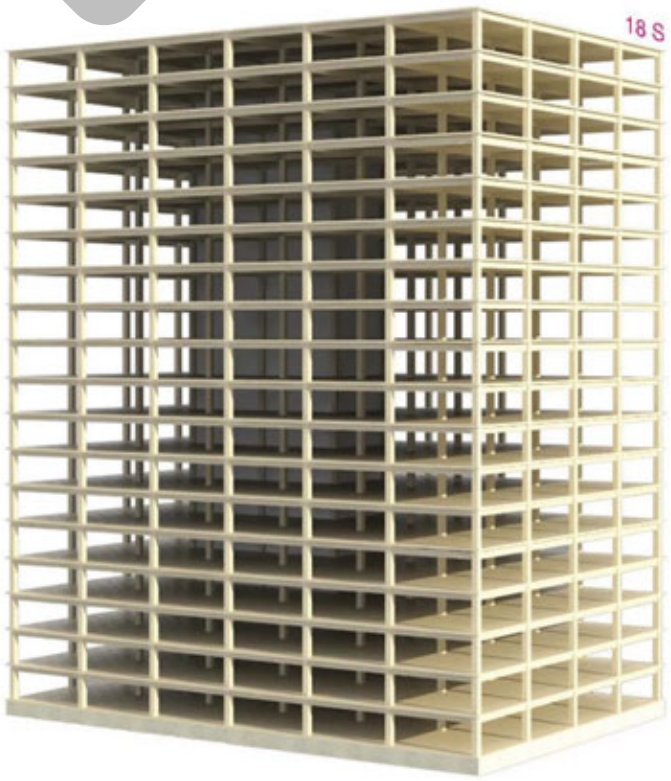
TYPE IV-A

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp

IV-A

Type IV-A Height and Area Limits



18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-A

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
B	18	270 ft	324,000 SF	972,000 SF
M	12	270 ft	184,500 SF	553,500 SF
R-2	18	270 ft	184,500 SF	553,500 SF

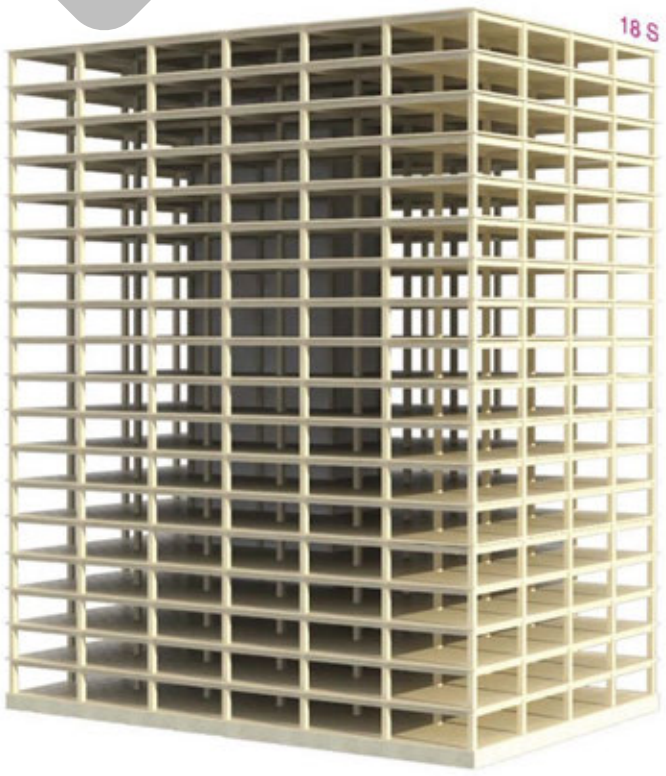
Areas exclude potential frontage increase

In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height & story allowances

Type IV-A area = 3 * Type IV-HT area

IV-A

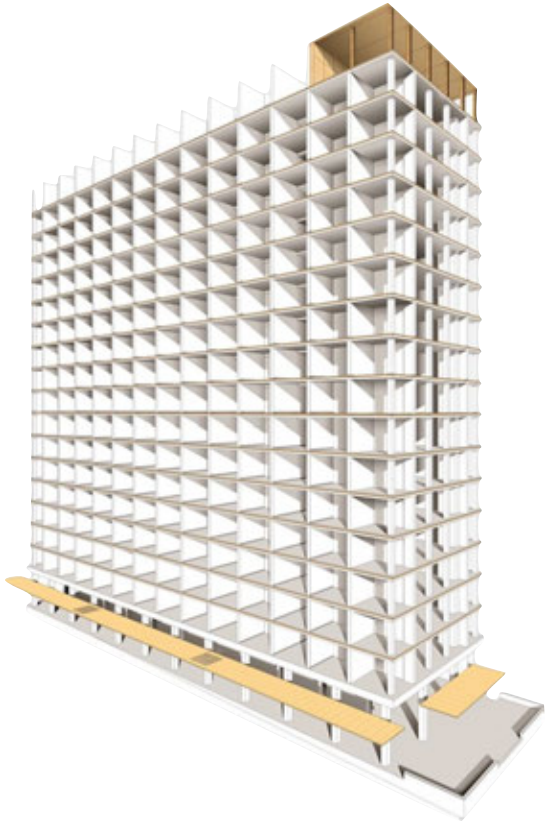
Type IV-A Protection vs. Exposed

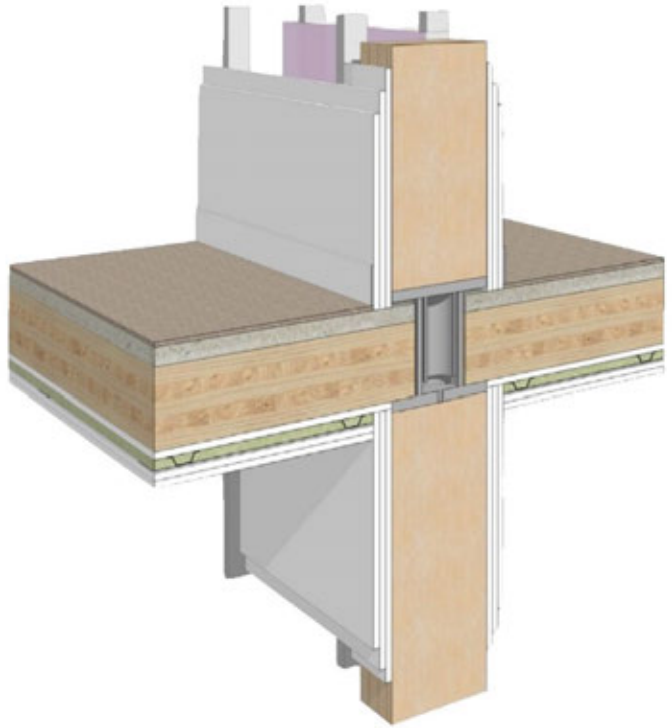


18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

TYPE IV-A

Credit: Susan Jones, atelierjones





100% NC protection on all surfaces of Mass Timber

Credit: Acton Ostry Architects, Fast + Epp

IV-A

2024 IBC Changes

RISE Tests, 2020
Photo: RISE

2019-2022: REFINING THE CODE ROADMAP

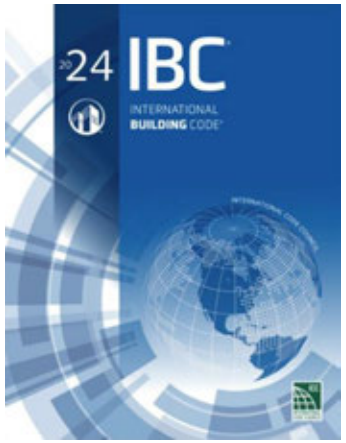
PRG 320 is manufacturing & performance standard for CLT

2019 edition (referenced in 2021 IBC) added new elevated temperature adhesive performance requirements validated by full-scale and medium-scale qualification testing to ensure CLT does not exhibit fire re-growth

ANNEX B. PRACTICE FOR EVALUATING ELEVATED TEMPERATURE PERFORMANCE OF ADHESIVES USED IN CROSS-LAMINATED TIMBER (MANDATORY)

2019-2022: REFINING THE CODE ROADMAP

Change to 2024 IBC: IV-B Ceiling Exposure



602.4.2.2.2 Protected area.

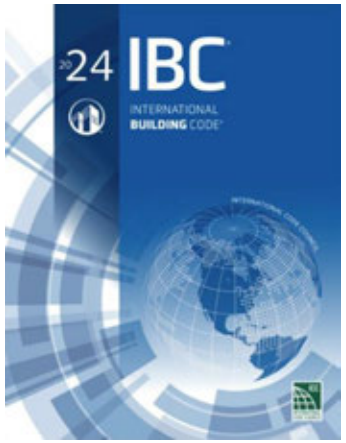
Interior faces of *mass timber* elements, including the inside face of exterior *mass timber walls* and *mass timber roofs*, shall be protected in accordance with Section 602.4.2.2.1.

Exceptions: Unprotected portions of *mass timber* ceilings and walls complying with Section 602.4.2.2.4 and the following:

1. Unprotected portions of *mass timber* ceilings and walls complying with one of the following:
   1.1. Unprotected portions of *mass timber* ceilings, including attached beams, limited to an area less than or equal to 100 percent of the floor area in any *dwelling unit* within a *story* or fire area within a *story*.
   1.2. Unprotected portions of *mass timber* walls, including attached columns, limited to an area less than or equal to 40 percent of the floor area in any *dwelling unit* within a *story* or fire area within a *story*.
   1.3. Unprotected portions of both walls and ceilings of *mass timber*, including attached columns and beams, in any *dwelling unit* or fire area and in compliance with Section 602.4.2.2.3.
2. *Mass timber* columns and beams that are not an integral portion of walls or ceilings, respectively, without restriction of either aggregate area or separation from one another.

2019-2022: REFINING THE CODE ROADMAP

Change to 2024 IBC: IV-B Exposure Separation



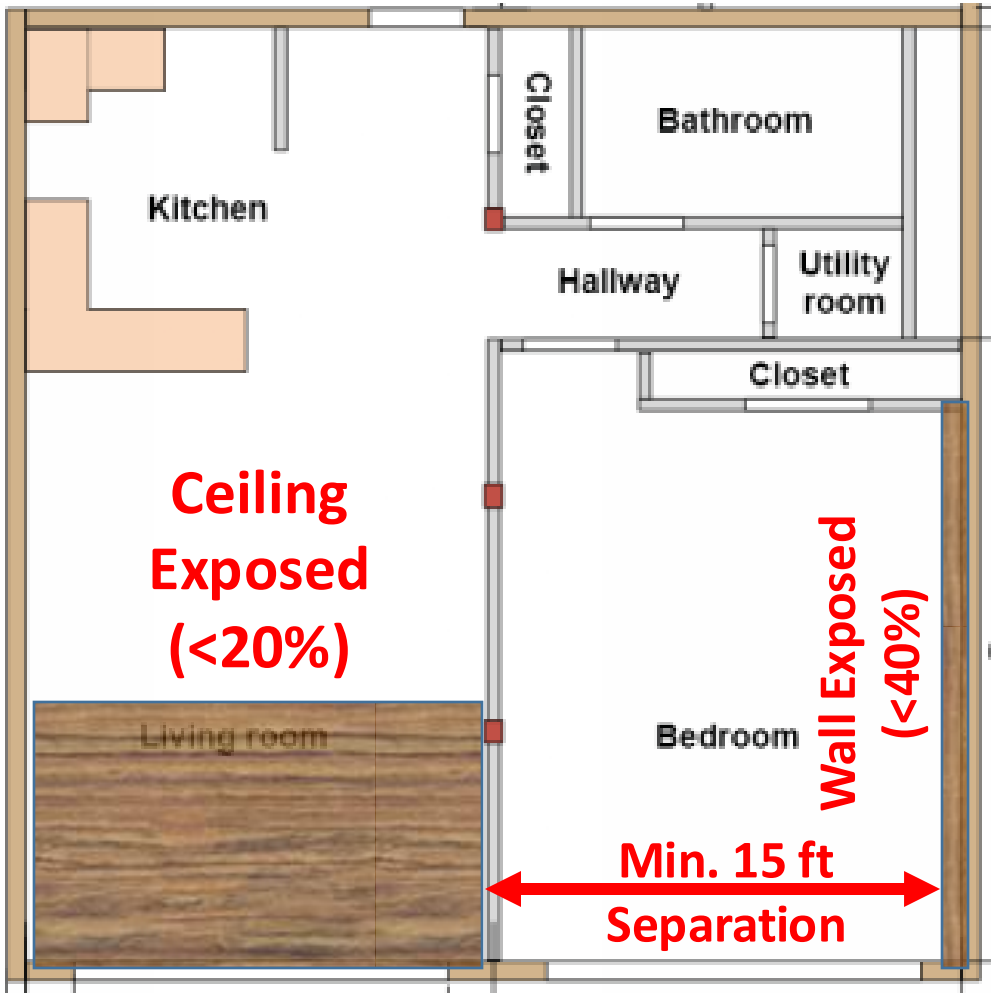
602.4.2.2.4 Separation distance between unprotected *mass timber* elements.

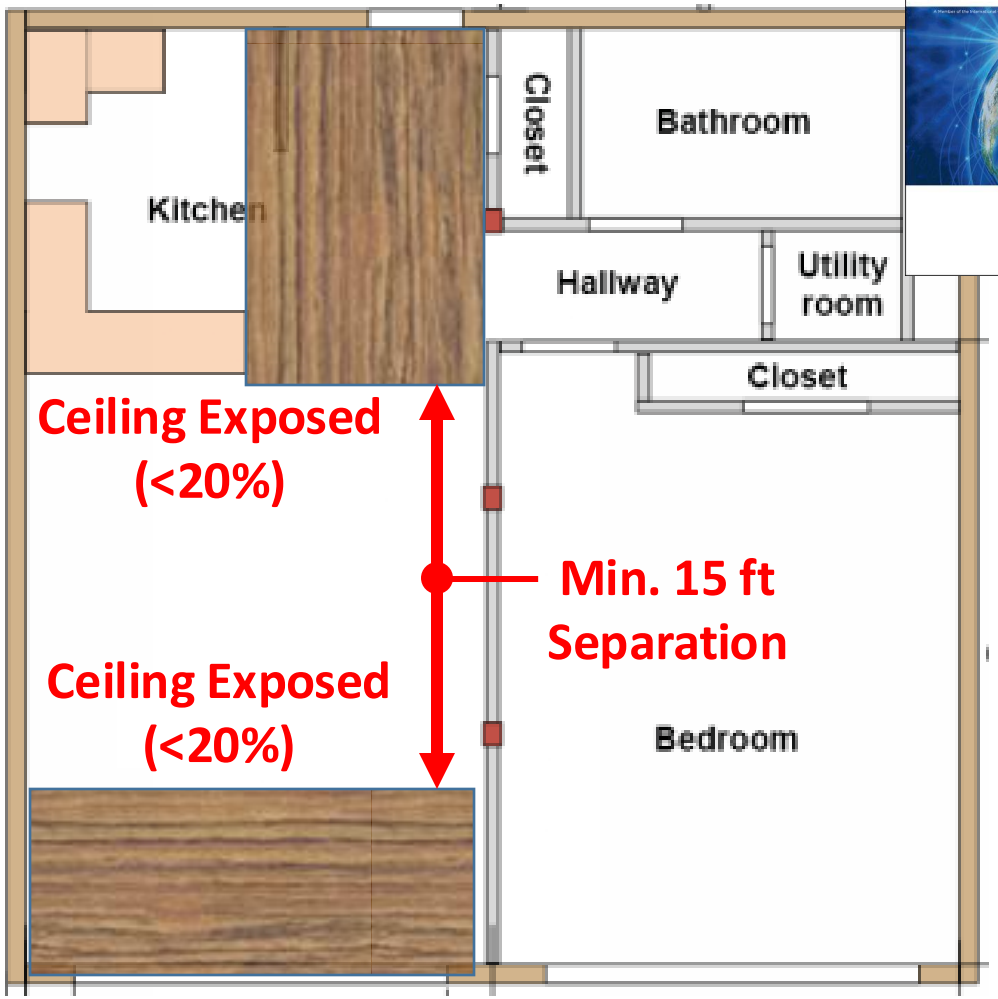
In each *dwelling unit* or *fire area*, unprotected portions of *mass timber* walls shall be not less than 15 feet (4572 mm) from unprotected portions of other walls measured horizontally along the floor.

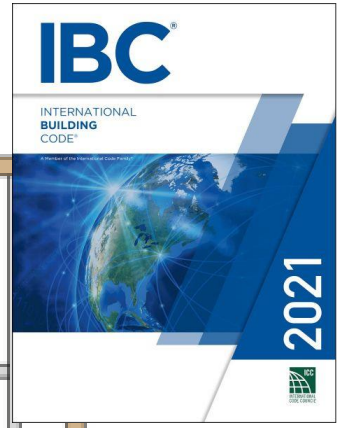
2024 IBC eliminates need for 15 ft separation between exposed walls and ceilings, and between portions of exposed ceilings

2019-2022: REFINING THE CODE ROADMAP

2021 IBC Allowances



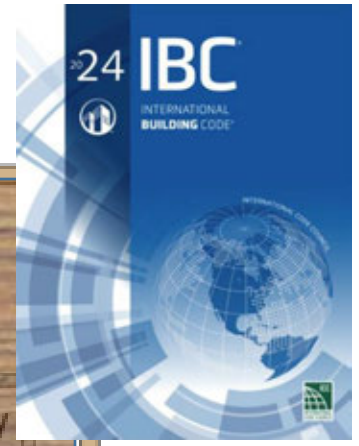


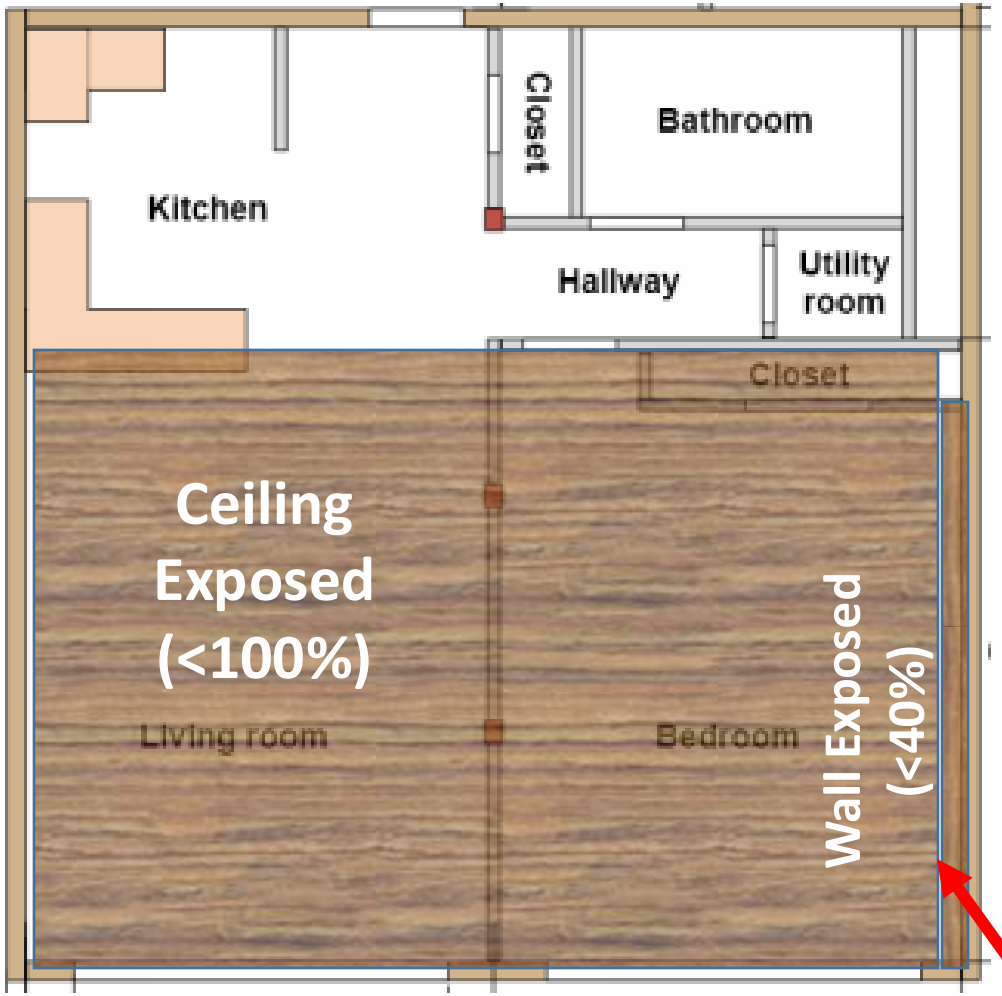


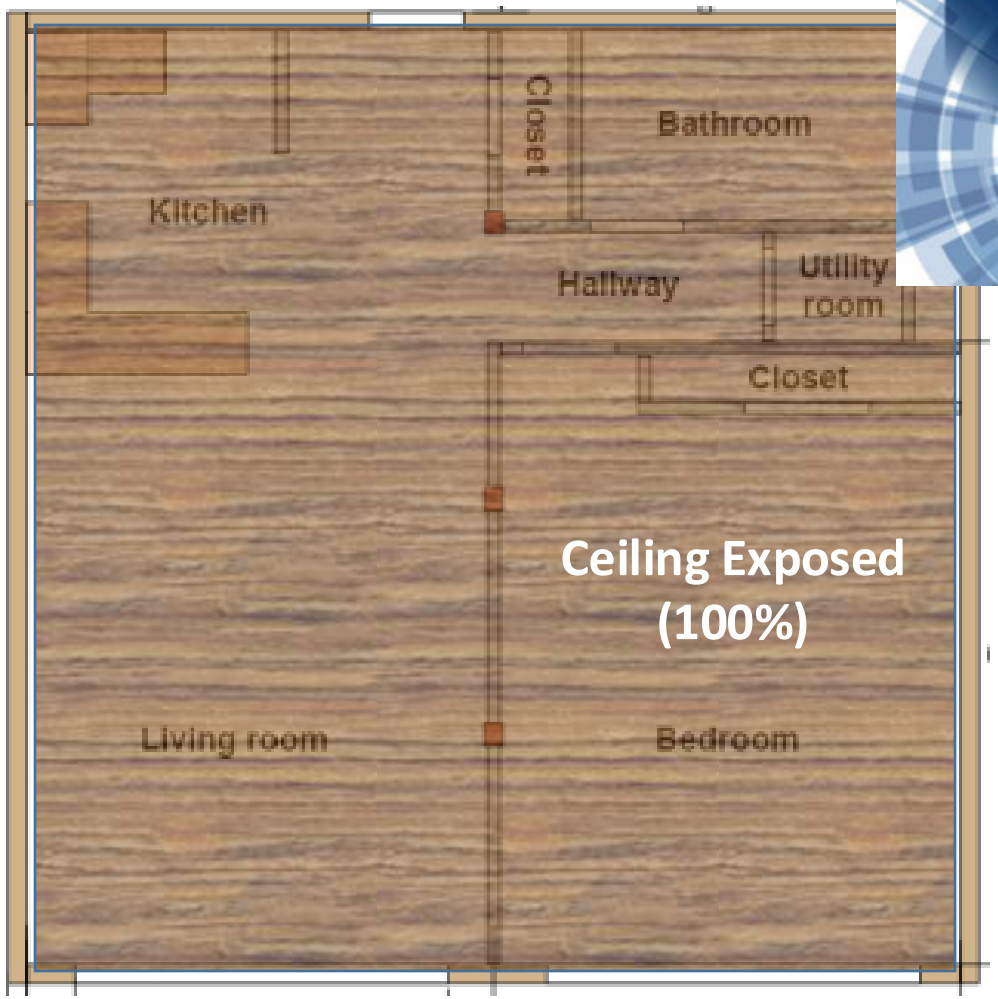
Credit: AWC

2019-2022: REFINING THE CODE ROADMAP

2024 IBC Allowances







Credit: AWC

No separation req'd between wall & ceiling

Modular Construction

Volumetric Units:

- Bathroom Pods
- Multi-family units
- Classrooms
- Offices

Image: Lendlease

Modular Construction

Multi-Family Units:

- Hotel Rooms
- Apartments
- Condos
- Workforce Housing
- Student Housing

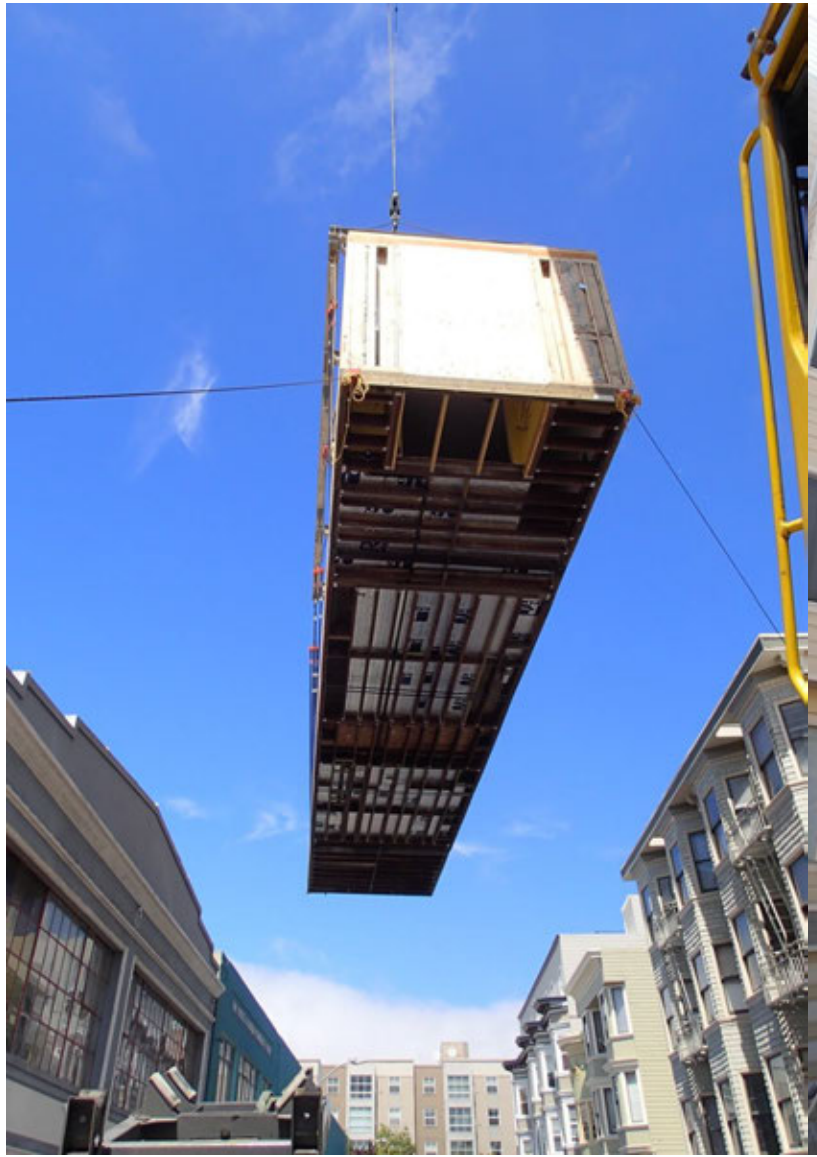


Image: Zeta Design+Build

Modular Construction

Can include finishes and furnishings.

Image: Guerdon Modular

Off-Site Construction Advantages

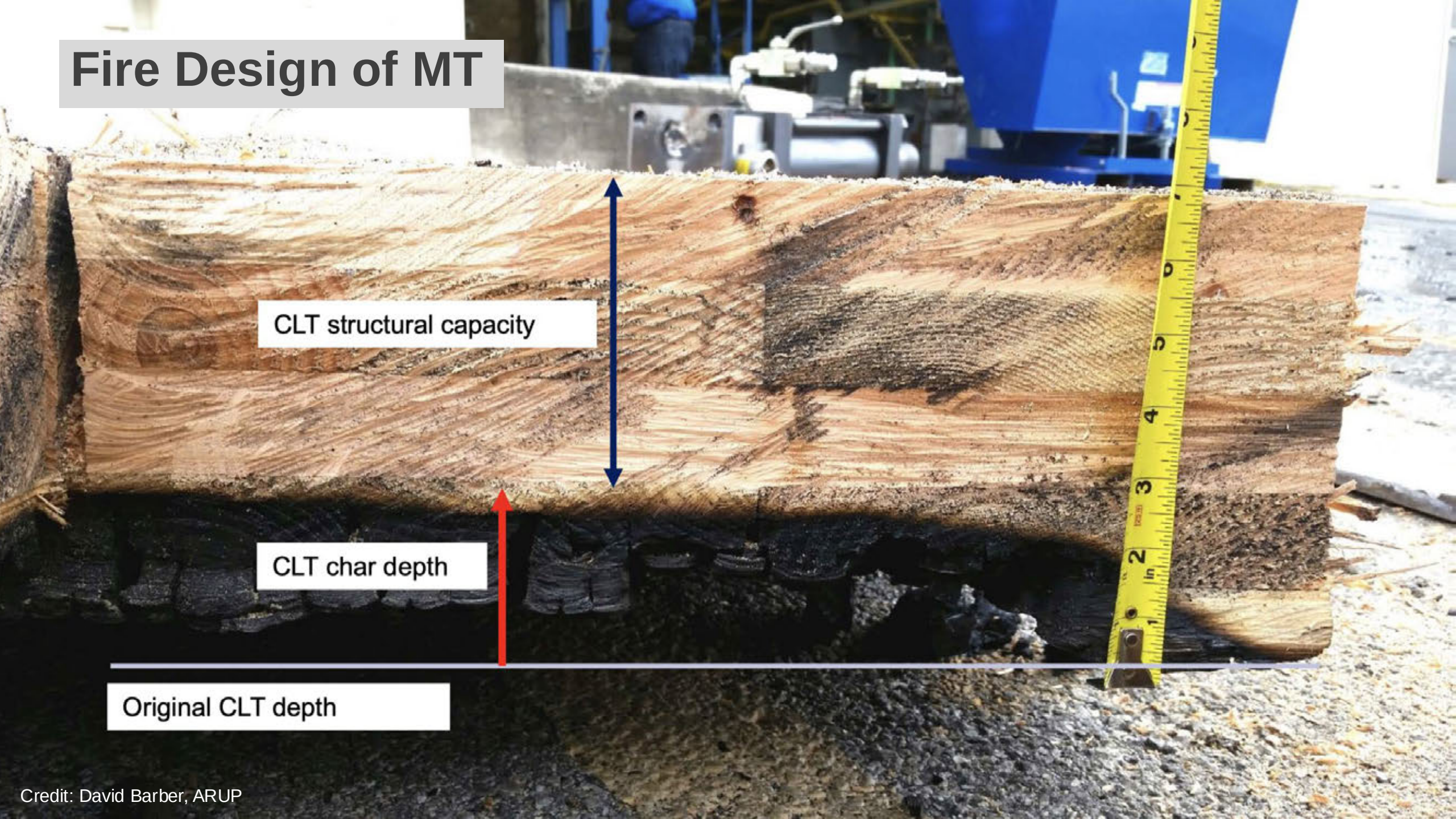
Builds on Wood's Material Cost Savings to:

- Reduce Risk
- Shorten Schedule
- Lower Costs
- Reduce Waste

KEY DESIGN CONSIDERATIONS

INTRO, Cleveland, OH. Credit: Harbor Bay Real Estate Advisors

Fire Design of MT



Credit: David Barber, ARUP

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

Key Early Design Decisions

Construction type influences FRR

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


Fire Testing Laboratory

TEST REPORT

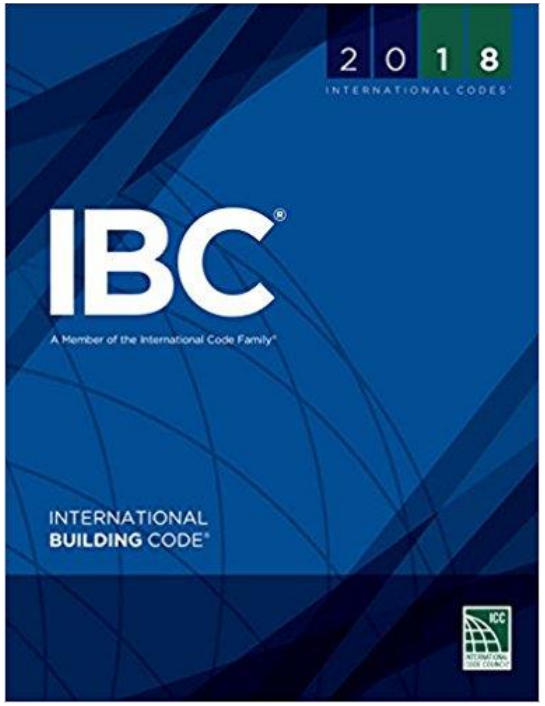
for

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

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

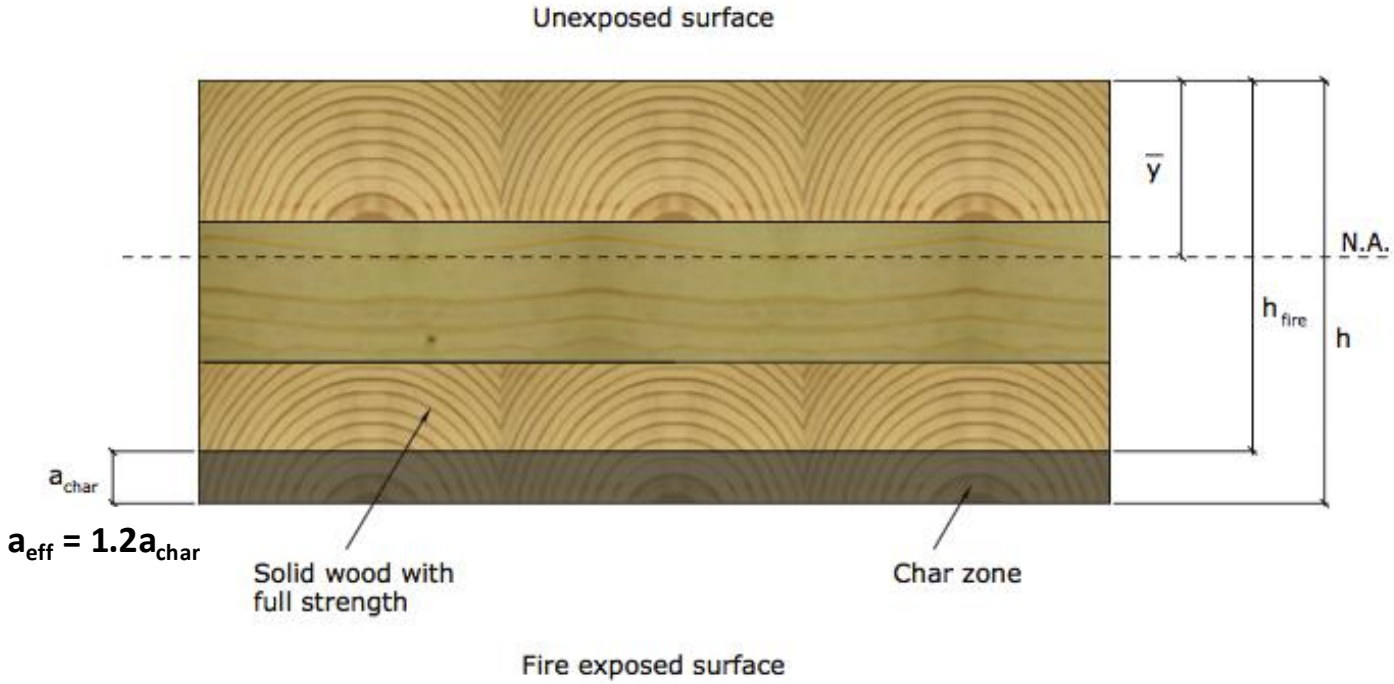


Key Early Design Decisions

Which Method of Demonstrating FRR of MT is Being Used?

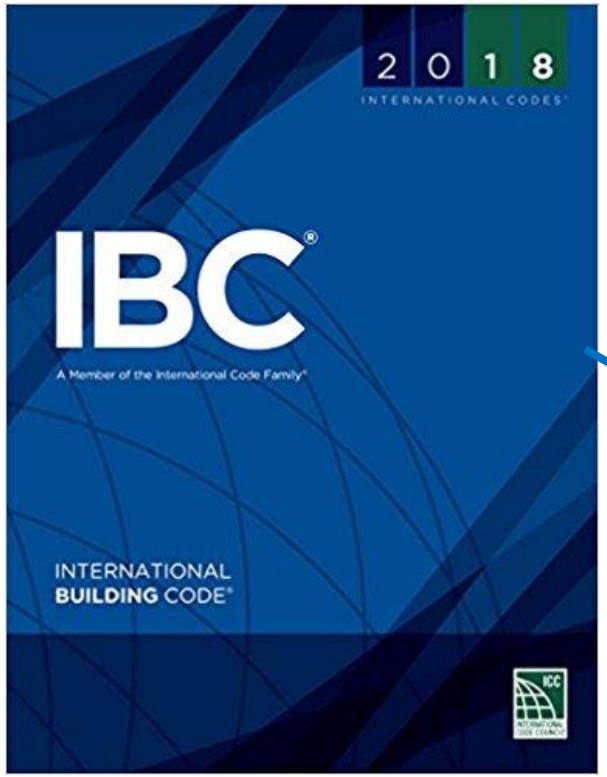
1. Calculations in Accordance with IBC 722 → NDS Chapter 16
2. Tests in Accordance with ASTM E119

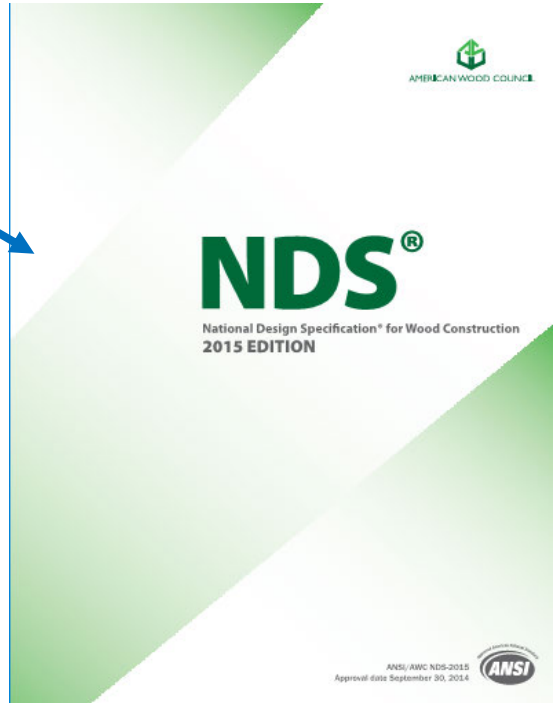

Credit: Urban One



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

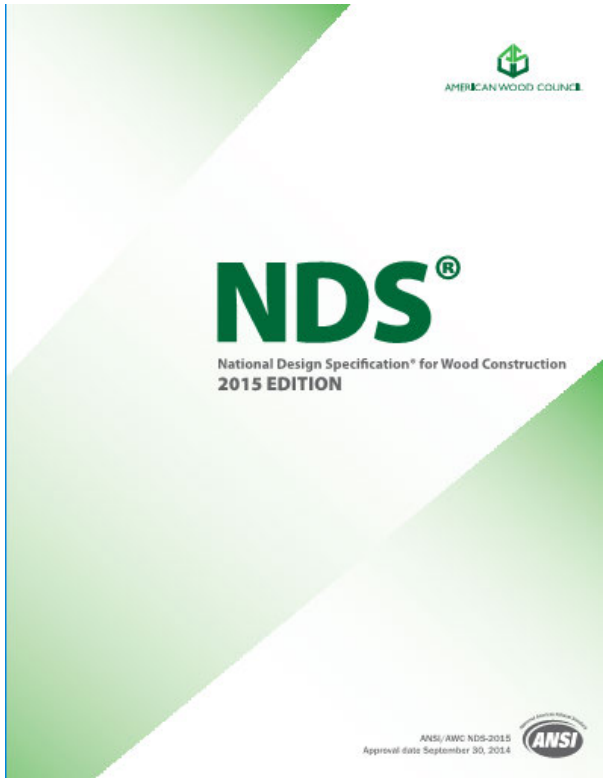
IBC 722
Calculated Fire Resistance

"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

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

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

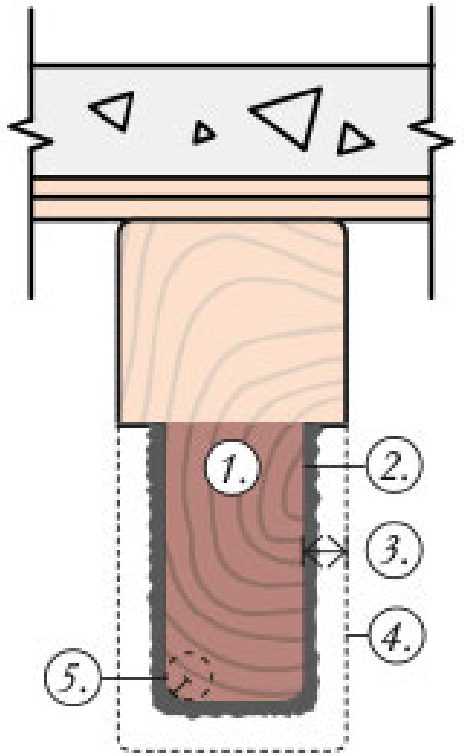
Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

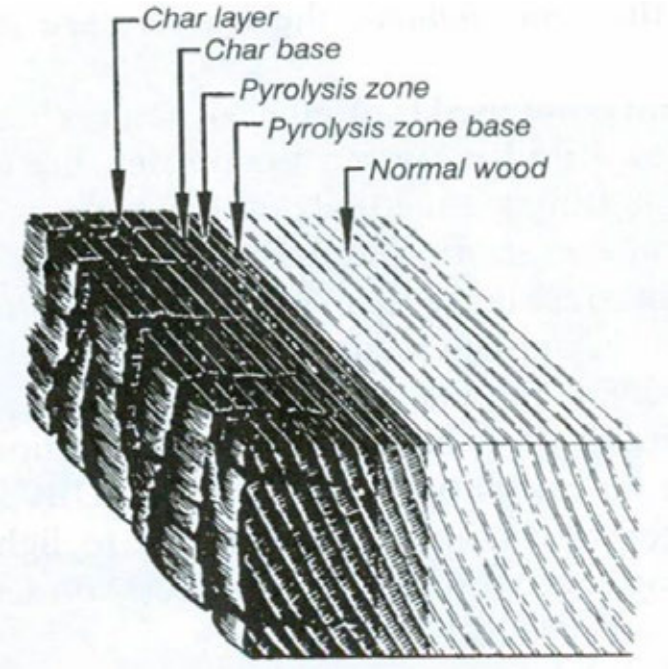
Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

FRR Design of MT

Two structural capacity checks performed:

1. On entire cross section neglecting fire effects
2. On post-fire remaining section, with stress increases





Credit: Forest Products Laboratory

$$a_{char} = \beta_t t^{0.813}$$ Solid Sawn, Glulam, SCL

$$a_{char} = n_{lam} h_{lam} + \beta_t \left(t - \left(n_{lam} t_{gj}\right)\right)^{0.813}$$ CLT

$$a_{eff} = 1.2 a_{char}$$ Effective Char Depth

Key Early Design Decisions

Fire-Resistance Ratings (FRR)

- **Thinner panels (i.e. 3-ply) generally difficult to achieve a 1+ hour FRR**
- **5-ply CLT / 2x6 NLT & DLT panels can usually achieve a 1- or 2-hour FRR**
- **Construction Type | FRR | Member Size | Grid (or re-arrange that process but follow how one impacts the others)**

Panel	Example Floor Span Ranges
3-ply CLT (4-1/8" thick)	Up to 12 ft
5-ply CLT (6-7/8" thick)	14 to 17 ft
7-ply CLT (9-5/8")	17 to 21 ft
2x4 NLT	Up to 12 ft
2x6 NLT	10 to 17 ft
2x8 NLT	14 to 21 ft
5" MPP	10 to 15 ft


Credit: David Barber, ARUP

FRR Design of MT

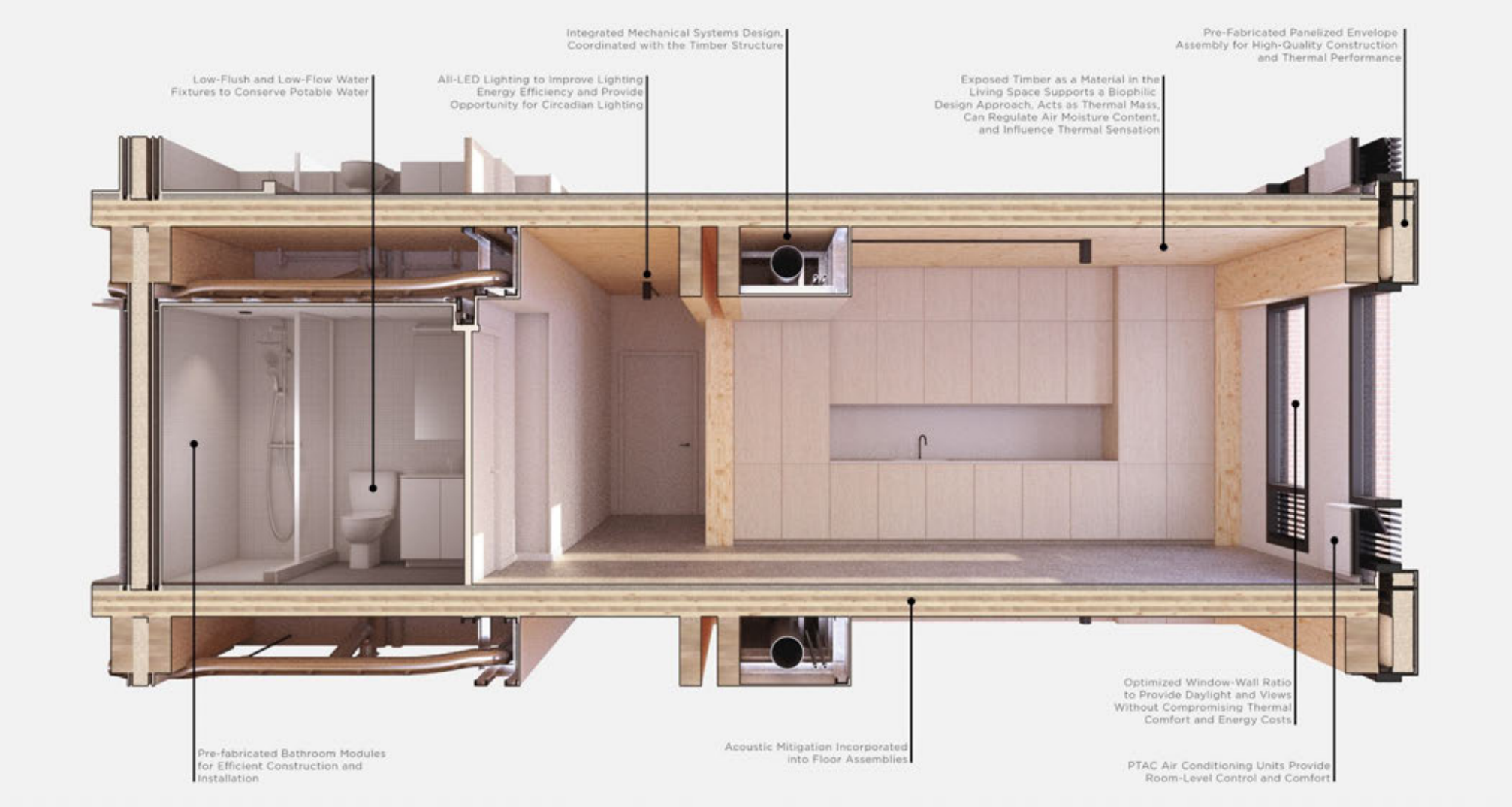
WoodWorks Inventory of Fire Tested MT Assemblies

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 1.5E MSR 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	EI	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	EI	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	EI	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	EI	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	EI	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	EI M5 MSR 2100 x SPF #2	None	Topside Spline	1-1/2" Maxxon Cyp-Grete 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

MEP SYSTEMS, ROUTING, INTEGRATION



INTEGRATED SYSTEMS

The Tallhouse building system prioritizes the integration of design, engineering, and construction. This results in a high performance building finely tuned to meet energy, comfort, acoustic, and design criteria that has been vetted by constructability experts to ensure fast, efficient production.

Utilizing Pre-Fabricated Facade Panels and Bathroom Modules that are manufactured off-site in factories allows for reducing construction time on-site, higher quality control practices, and safer labor conditions for construction workers. Efficient routing of duct-work conserves material, and associated embodied carbon, allowing more exposed timber all while providing the air quality needed for healthy living. Water conserving fixtures reduce potable water use as a precious resource, while maintaining reliable performance.

Credit: John Klein, Generate Architecture

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

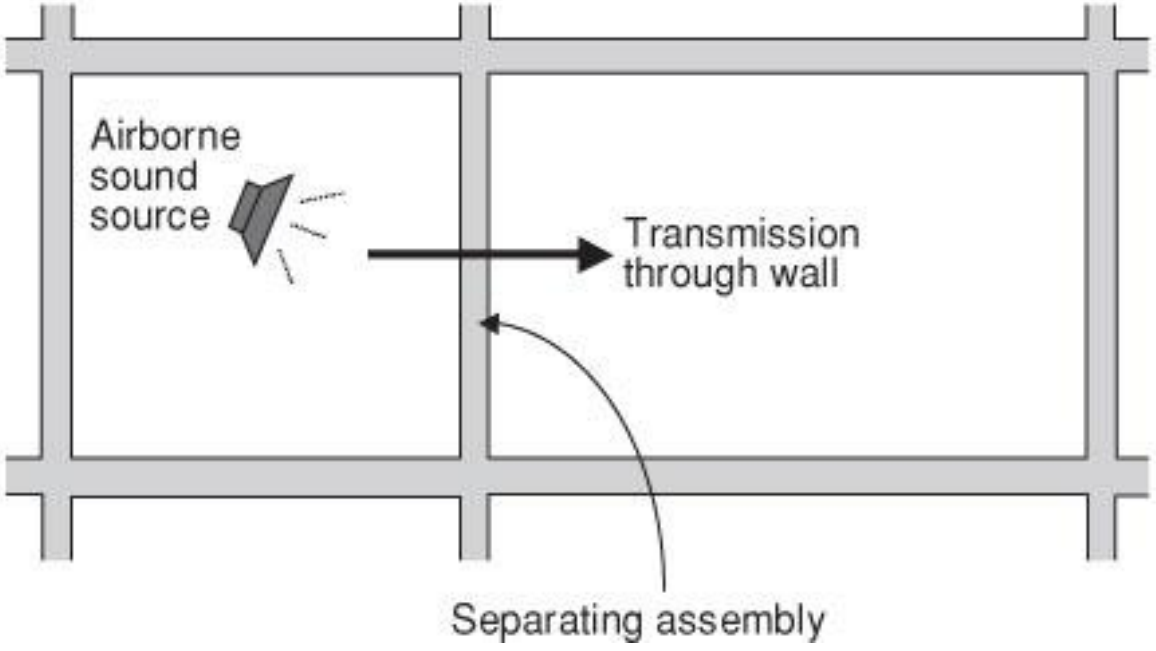
Acoustics & Sound Control

Acoustics & Sound Control

Air-Borne Sound:

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

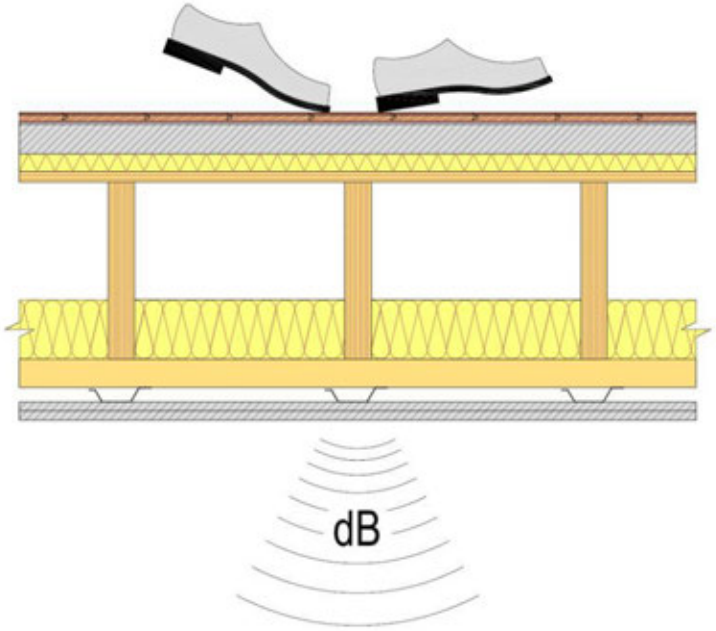


Acoustics & Sound Control

<u>Structure-borne sound:</u>

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:

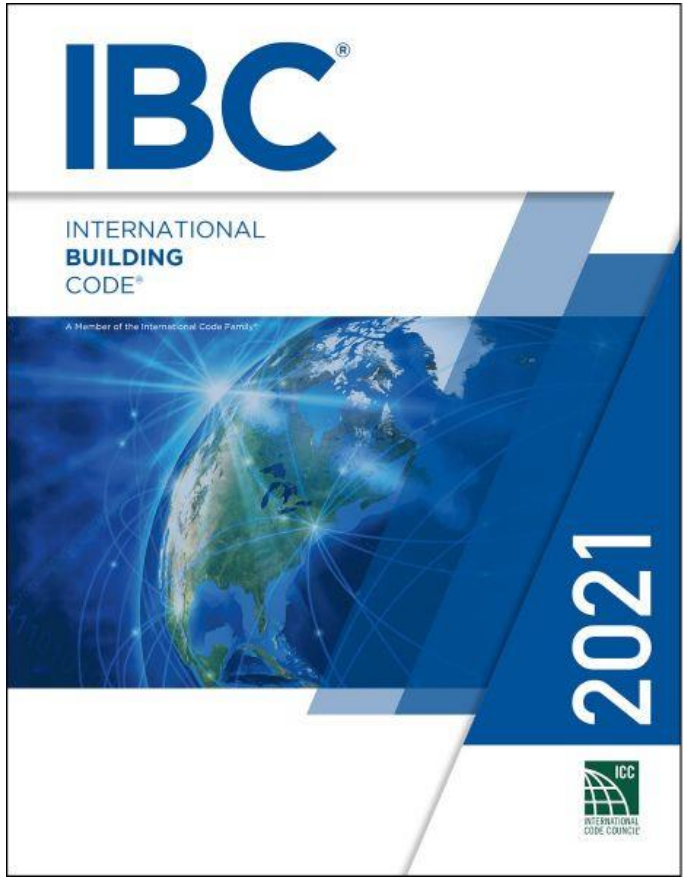
For unit to unit or unit to public or service areas:

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

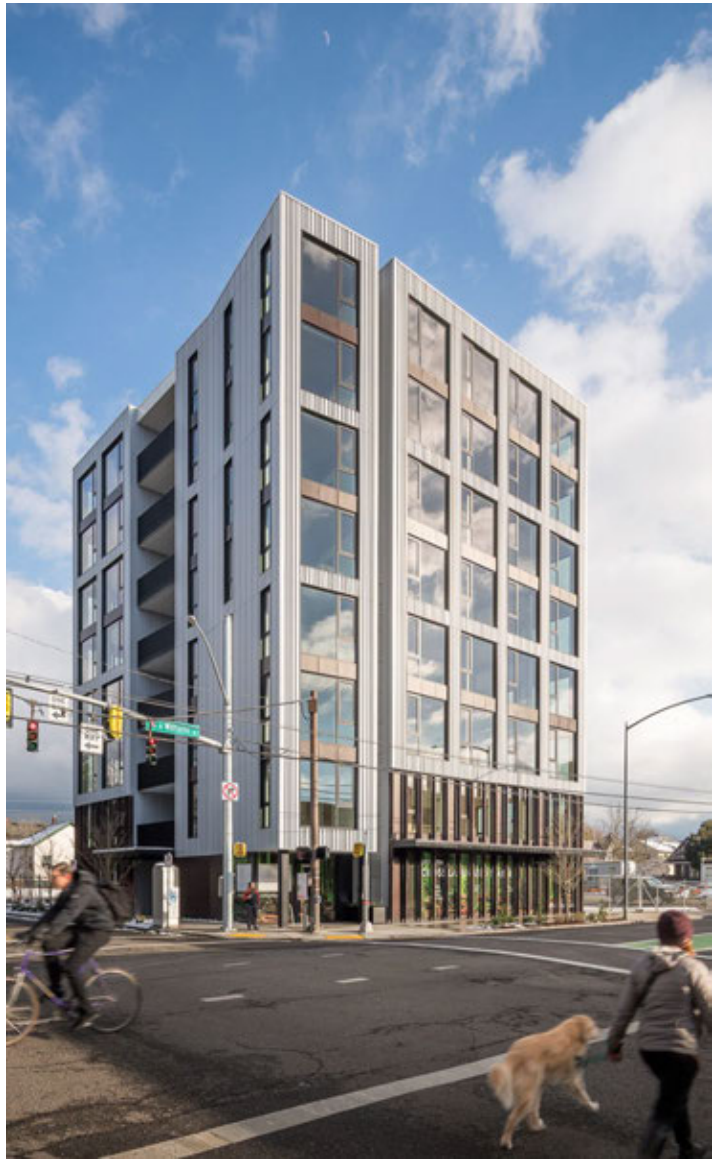


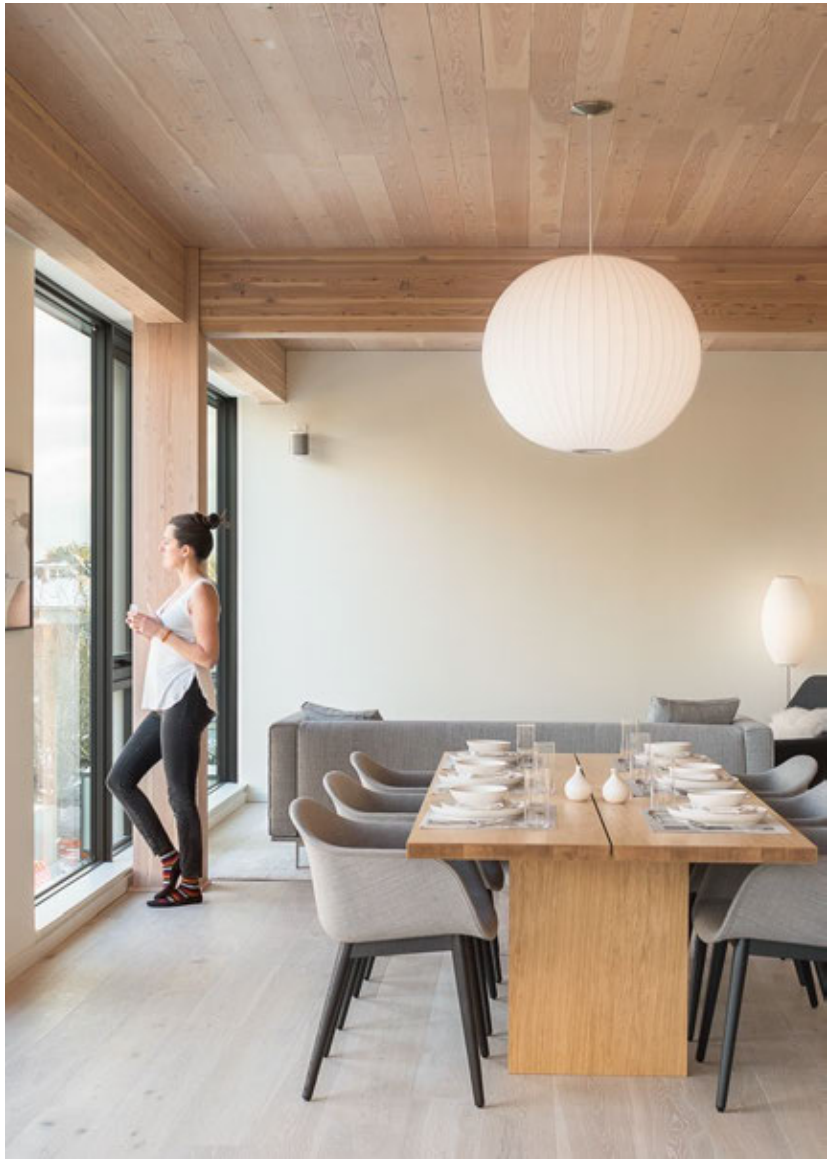
Acoustics & Sound Control

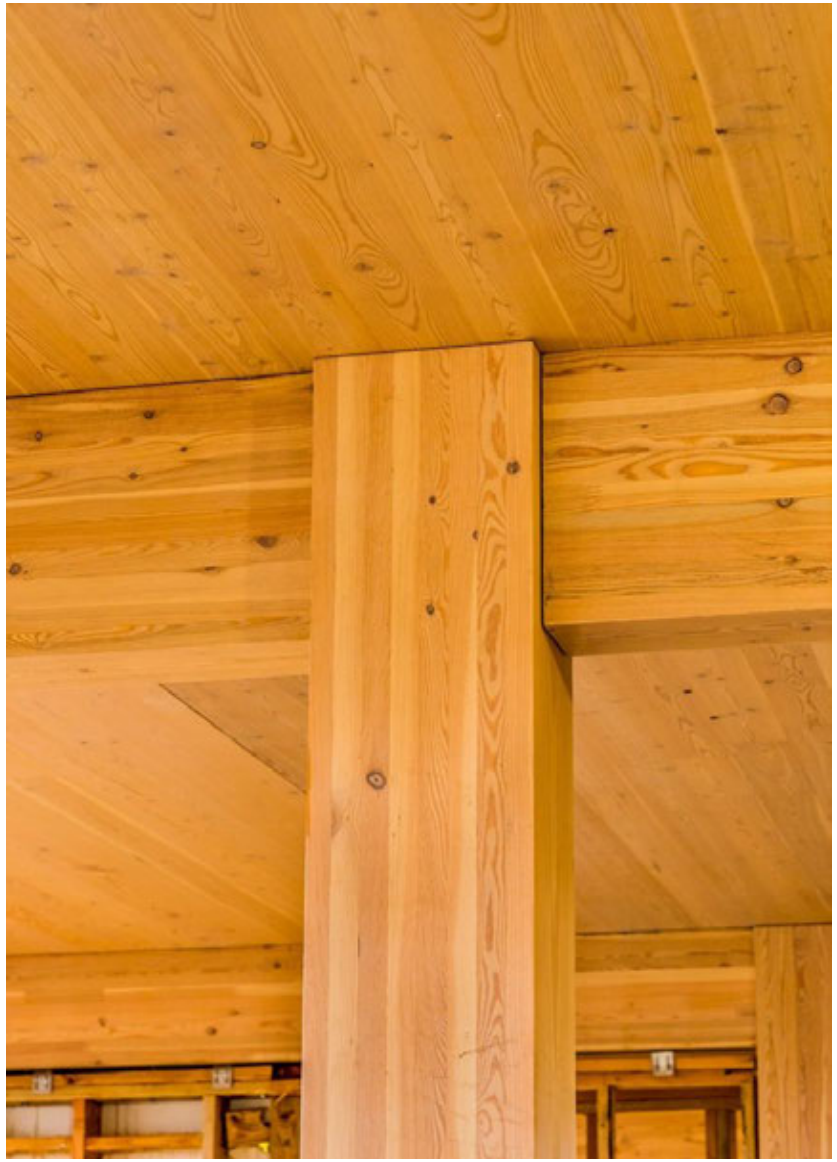
STC	What can be heard
25	Normal speech can be understood quite easily and distinctly through wall
30	Loud speech can be understood fairly well, normal speech heard but not understood
35	Loud speech audible but not intelligible
40	Onset of "privacy"
42	Loud speech audible as a murmur
45	Loud speech not audible; 90% of statistical population not annoyed
50	Very loud sounds such as musical instruments or a stereo can be faintly heard; 99% of population not annoyed.
60+	Superior soundproofing; most sounds inaudible

Acoustics & Sound Control

MT: Structure Often is Finish







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

Acoustics & Sound Control

TABLE 1:

Examples of Acoustically-Tested Mass Timber Panels

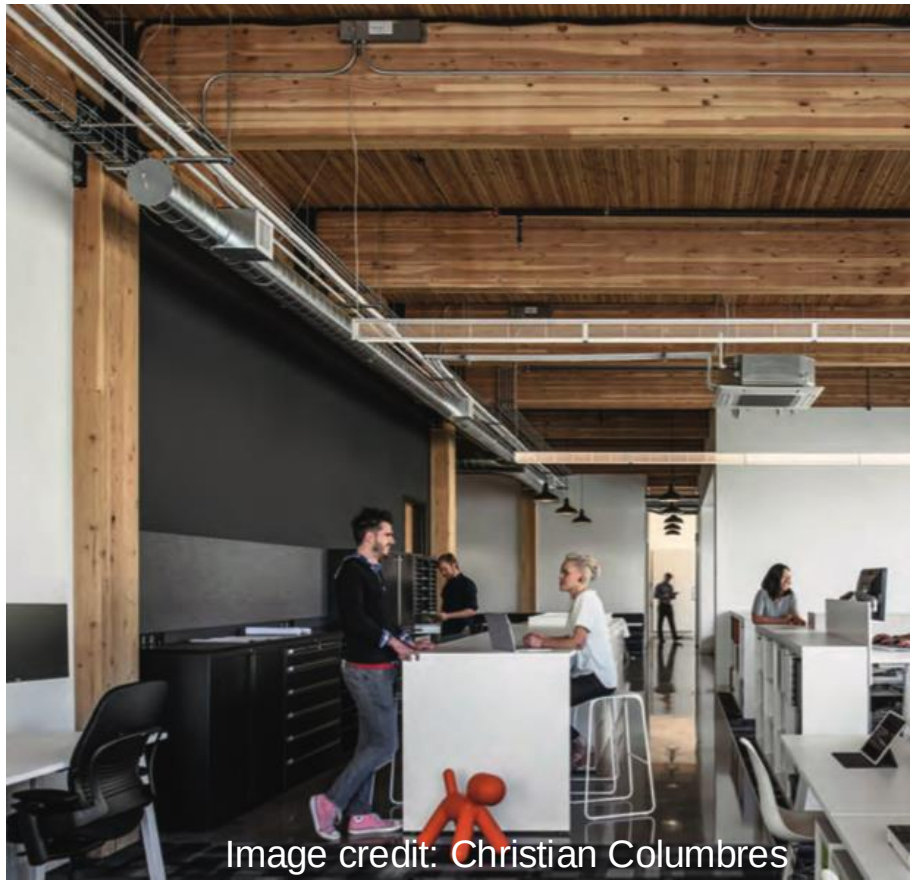
Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall[4]	3.07"	33	N/A
5-ply CLT wall[4]	6.875"	38	N/A
5-ply CLT floor[5]	5.1875"	39	22
5-ply CLT floor[4]	6.875"	41	25
7-ply CLT floor[4]	9.65"	44	30
2x4 NLT wall[6]	3-1/2" bare NLT 4-1/4" with 3/4" plywood	24 bare NLT 29 with 3/4" plywood	N/A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

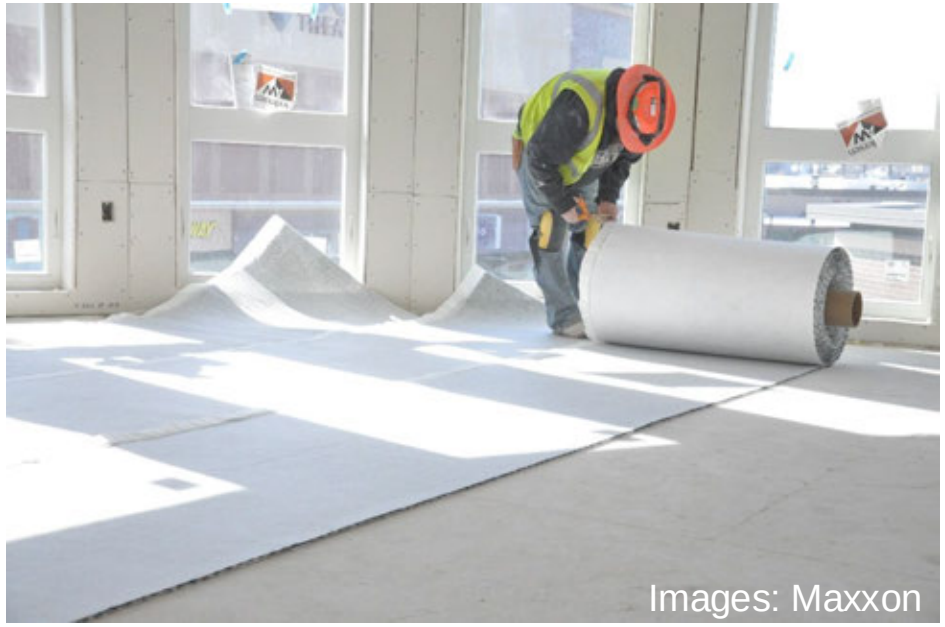
Acoustics & Sound Control

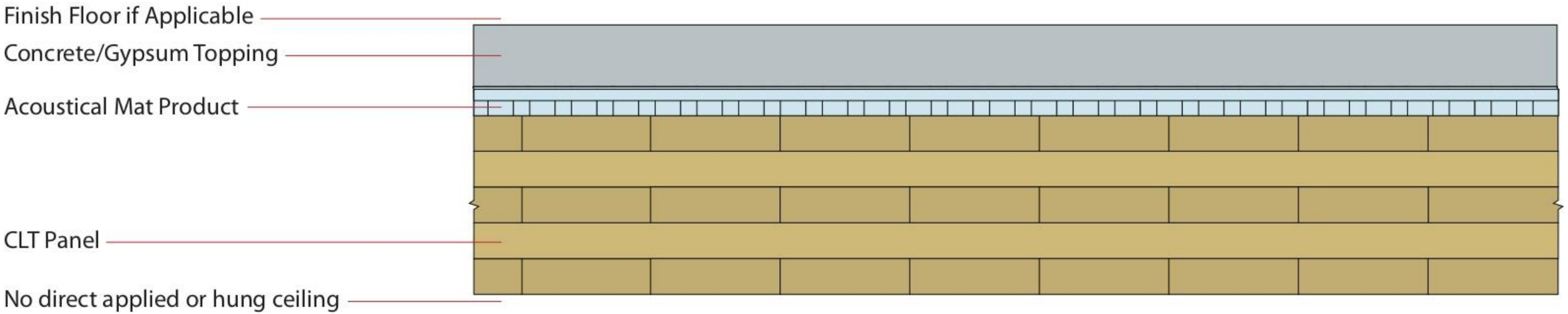
Regardless of the structural materials used in a wall or floor ceiling assembly, there are 3 effective methods of improving acoustical performance:

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



Acoustics & Sound Control





Acoustics & Sound Control

Mass timber has relatively low “mass”
Recall the three ways to increase acoustical performance:

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

Acoustics & Sound Control

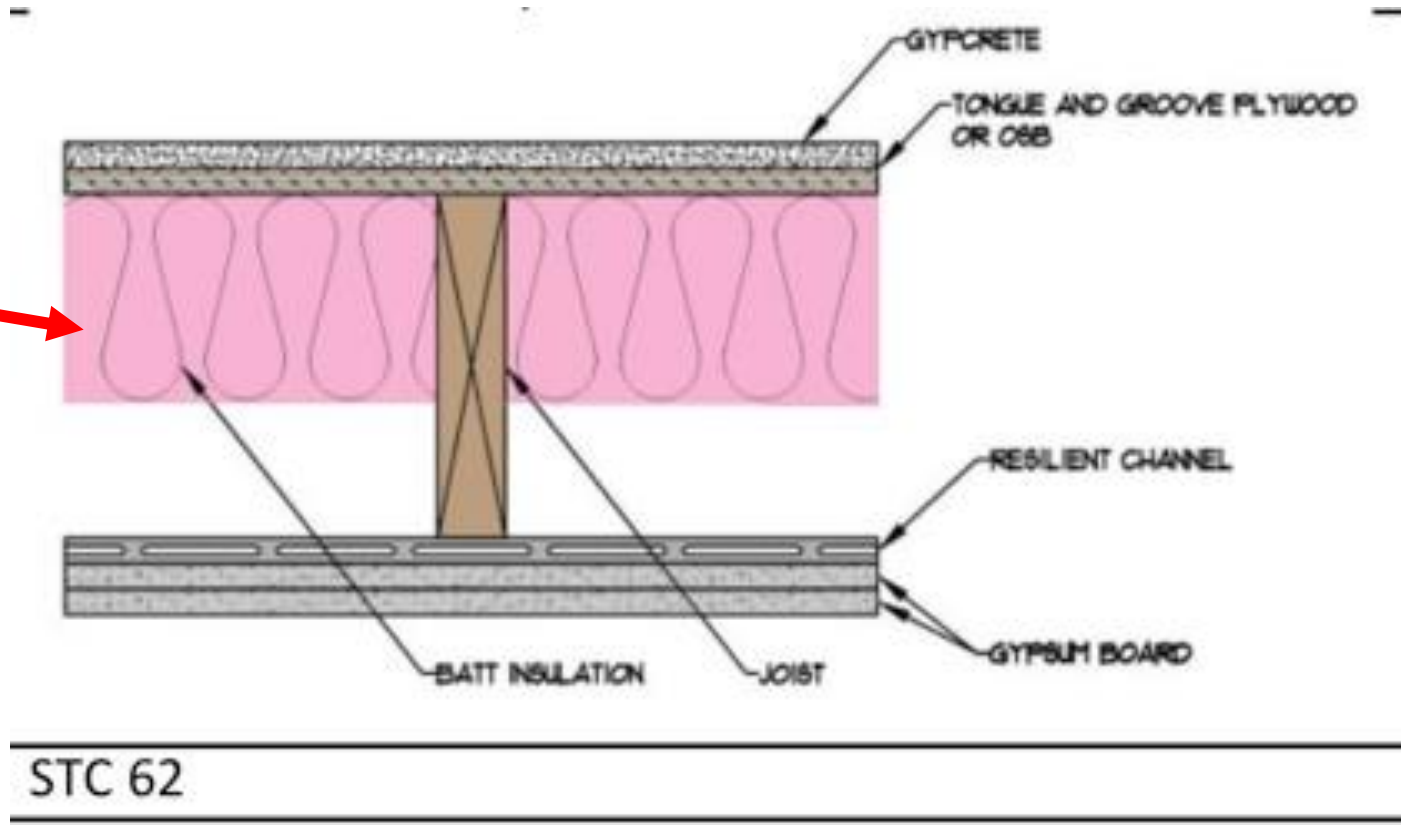
<u>Concrete Slab:</u>
6” Thick
80 PSF
STC 53

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

Acoustics & Sound Control

What does this look like in typical wood-frame construction:

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

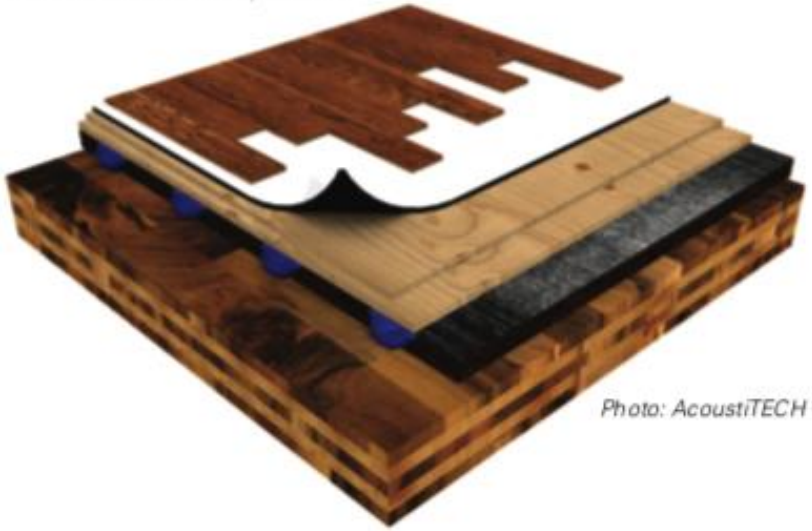


Photo: AcoustiTECH [10]

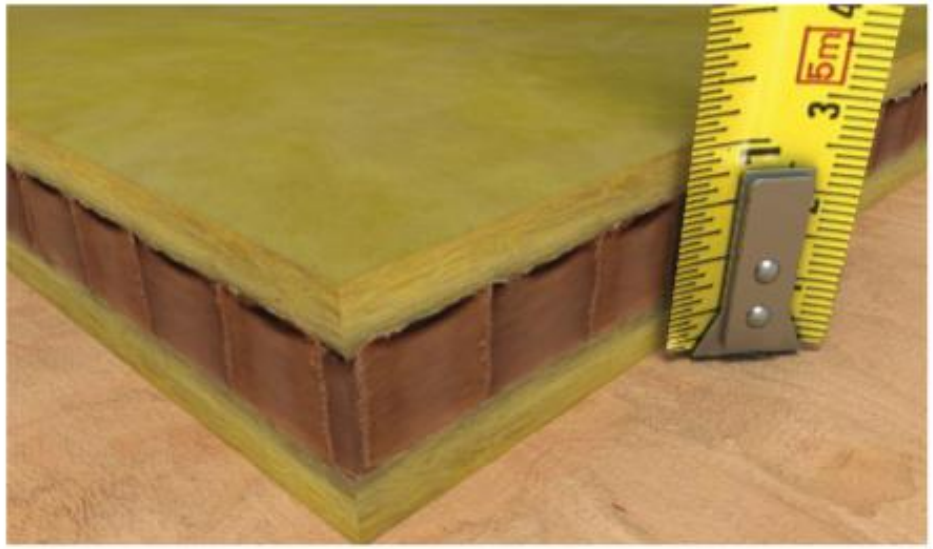


Photo: Kinetics Noise Control, Inc.,[11]

Photo: Maxxon Corporation

Photo: Pliteq Inc.,[12]

Acoustics & Sound Control

Common mass timber floor assembly:

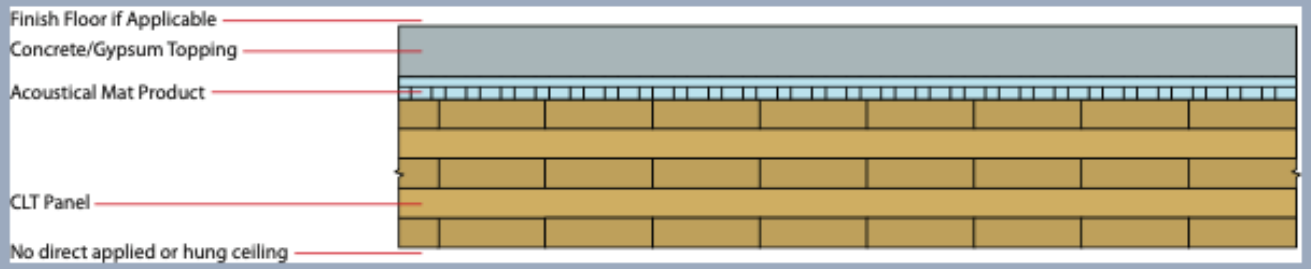
- Finish floor (if applicable)
- Underlayment (if finish floor)
- 1.5” to 4” thick concrete/gypcrete topping
- Acoustical mat
- WSP (if applicable)
- Mass timber floor panels

Credit: AcoustiTECH

Acoustics & Sound Control

Inventory of Tested Assemblies

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



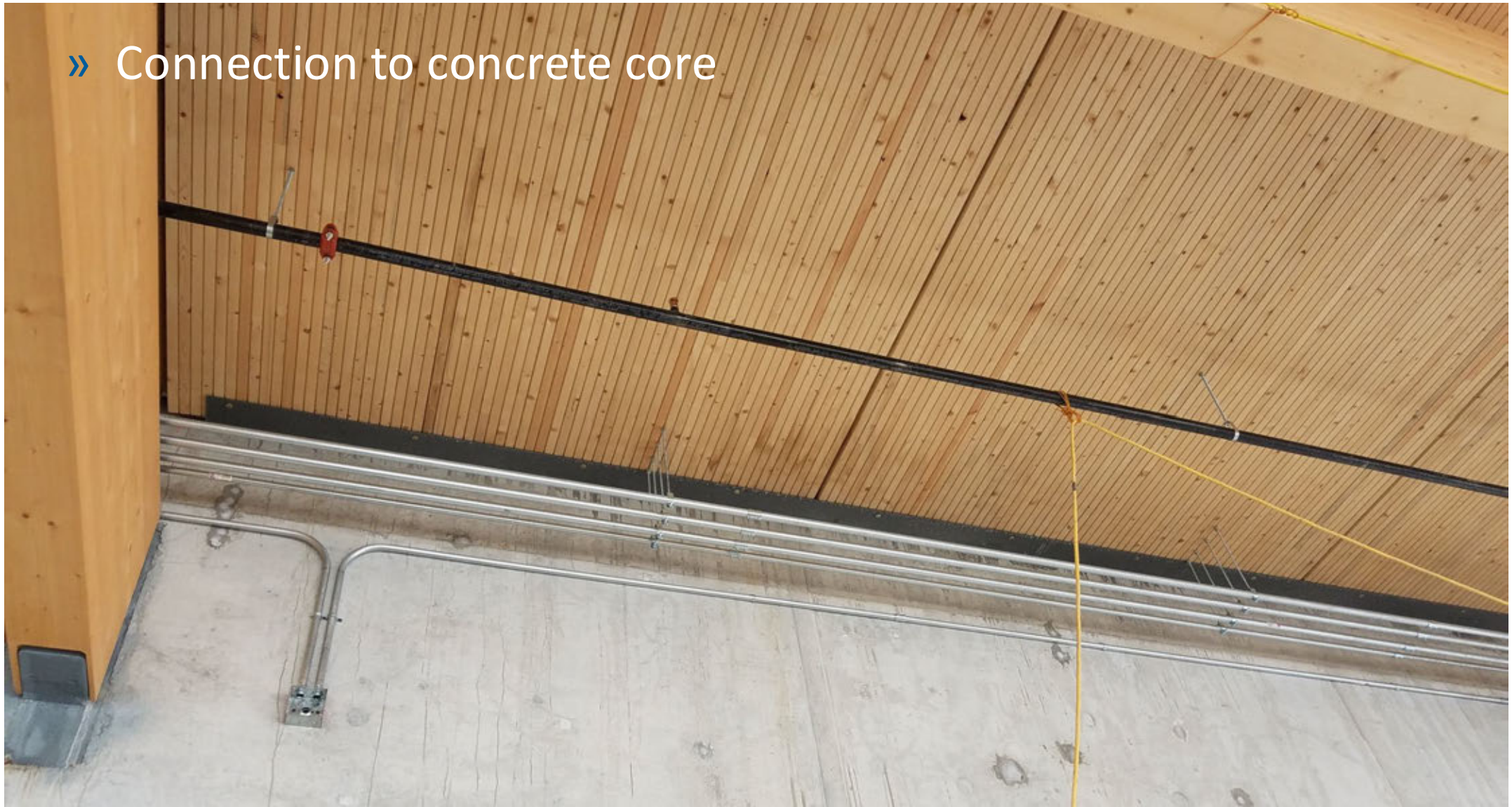
CLT Panel	Concrete/Gypsum Topping	Acoustical Mat Product Between CLT and Topping	Finish Floor	STC[1]	IIC[1]	Source
CLT 5-ply (6.875")	1-1/2" Gyp-Crete®	Maxxon Acousti-Mat® 3/4	None	47[2] ASTC	47[2] AIIC	1
			LVT	-	49[2] AIIC	
			Carpet + Pad	-	75[2] AIIC	
			LVT on Acousti-Top®	-	52[2] AIIC	
			Eng Wood 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

LATERAL DESIGN OPTIONS

Mass Timber Lateral Systems

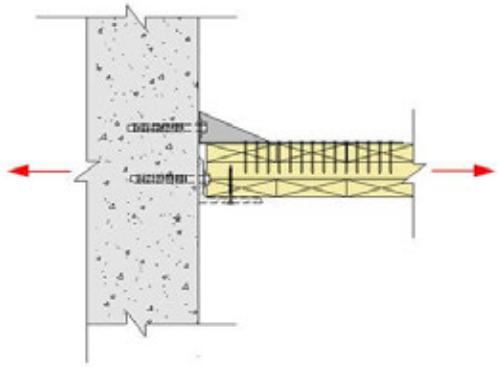
Mass Timber Lateral Systems

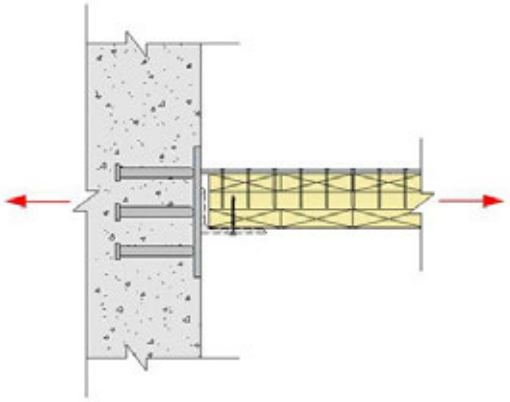
- Connection to concrete core

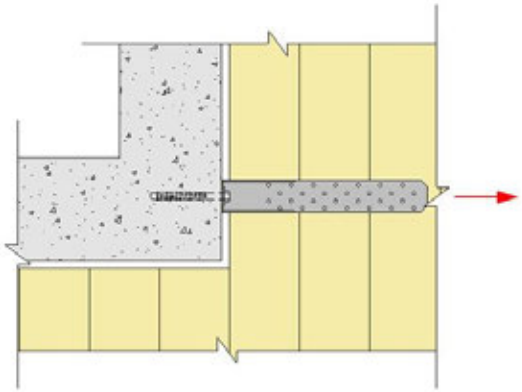


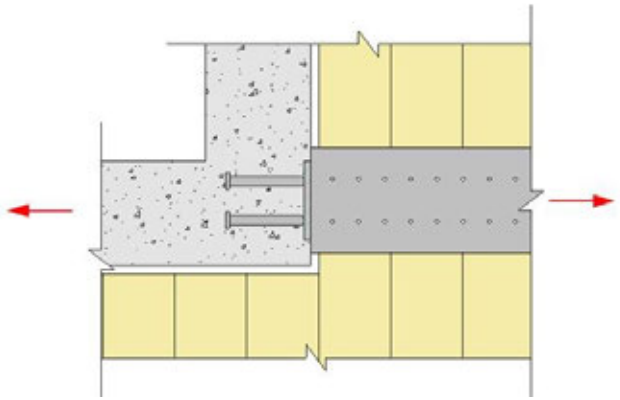
Mass Timber Lateral Systems

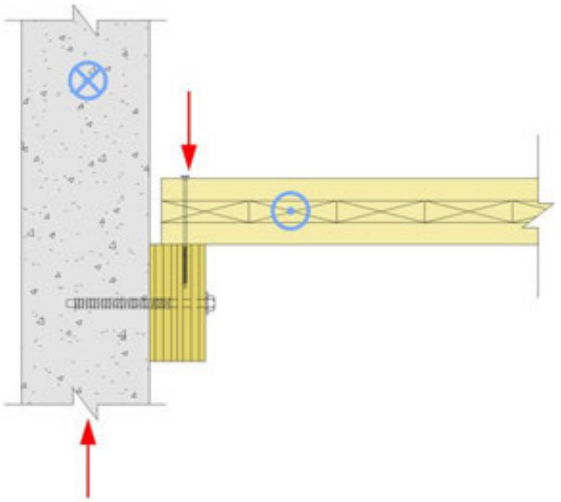
- Connections to concrete core
  - Tolerances & adjustability
  - Drag / collector forces











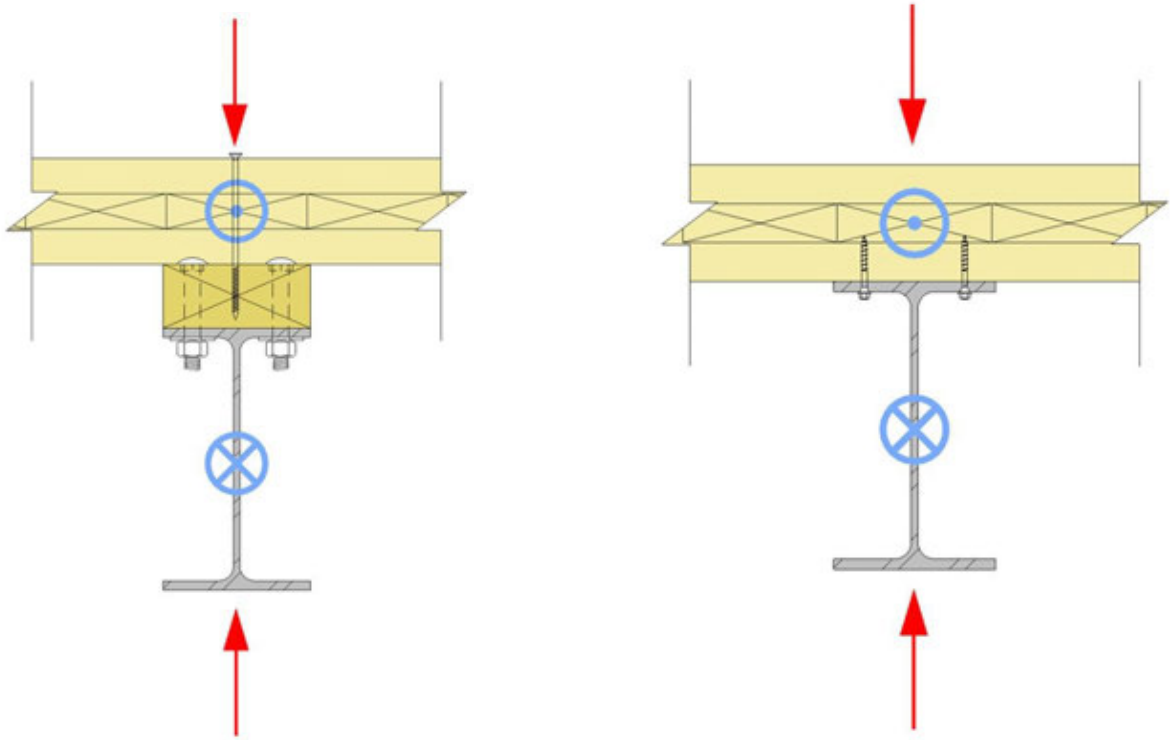
Mass Timber Lateral Systems

- Steel Braced Frame

Photos: Marcus Kauffmann, ODF

Mass Timber Lateral Systems

- Connections to steel frame
  - Tolerances & adjustability
  - Consider temperature fluctuations
  - East of installation



Photos: Marcus Kauffmann, ODF

Mass Timber Lateral Systems

- Light Frame Wood Shear Walls

Credit: KL&A Engineers & Builders

Mass Timber Lateral Systems

- Light frame wood Shear Walls:
  - Code compliance
  - Standard of construction practice well know
  - Limited to 65’ shear wall height, 85’ overall building height (Type III-A)


Credit: Jeremy Bittermann & Kaiser + Path

Mass Timber Lateral Systems

- Mass Timber Shear Walls

Photo: Alex Schreyer

Mass Timber Lateral Systems

- Mass Timber Rocking Shear Walls

Photo: WoodWorks

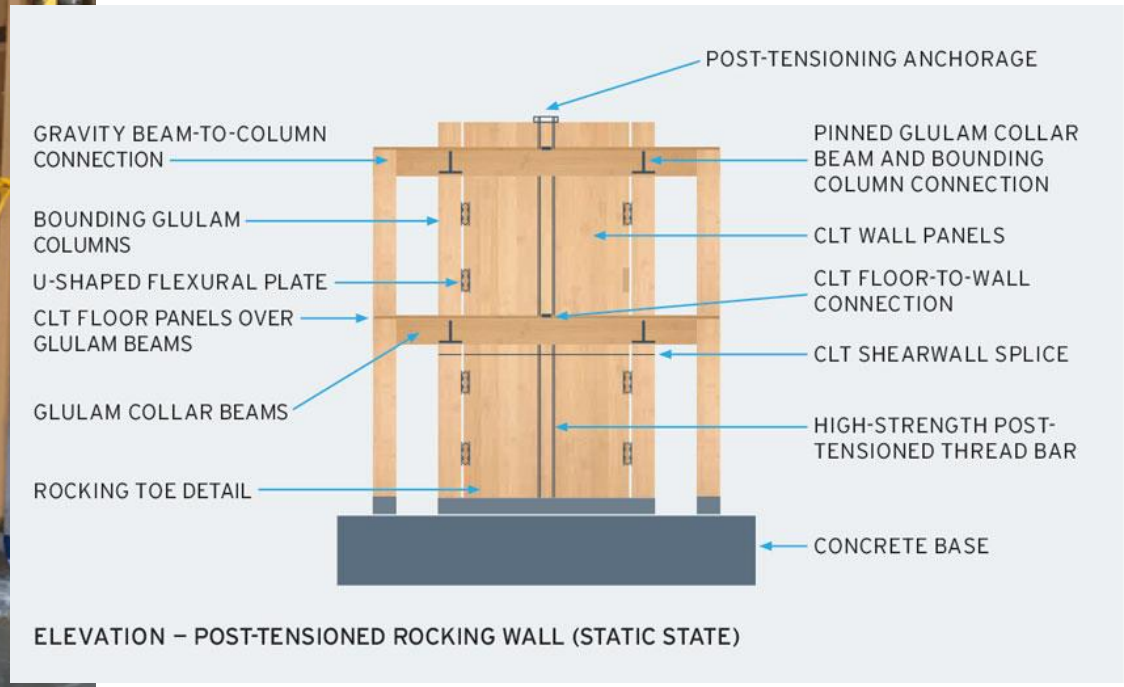


Image: KPFF

Mass Timber Lateral Systems

Speed of Construction

Market Distinction

KNOW YOUR WHY

Sustainability

Lightweight

Leasing Velocity

Cost

Urban Density

Holistic Costing

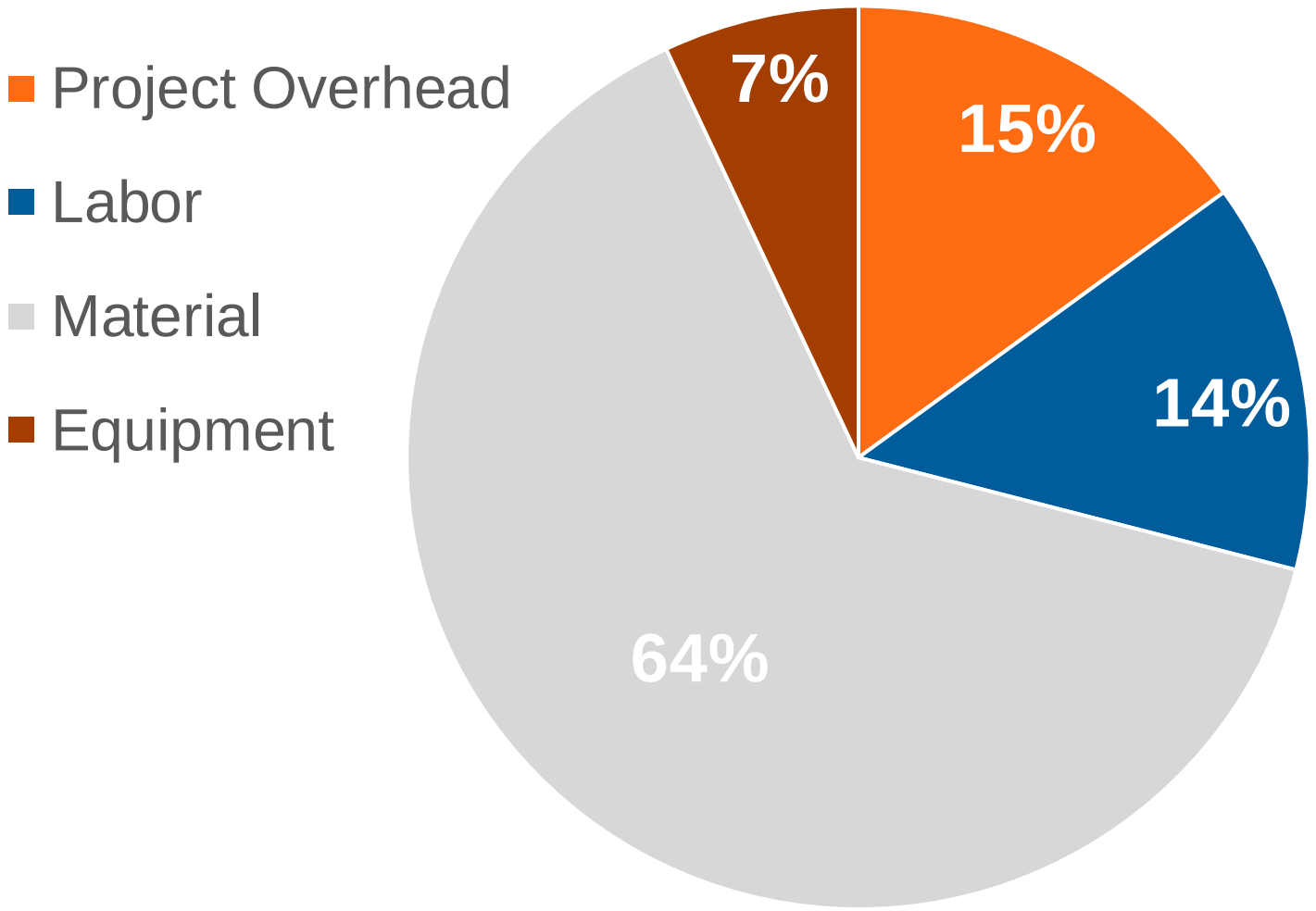
$/SF

$/SF

Image: GBD Architects

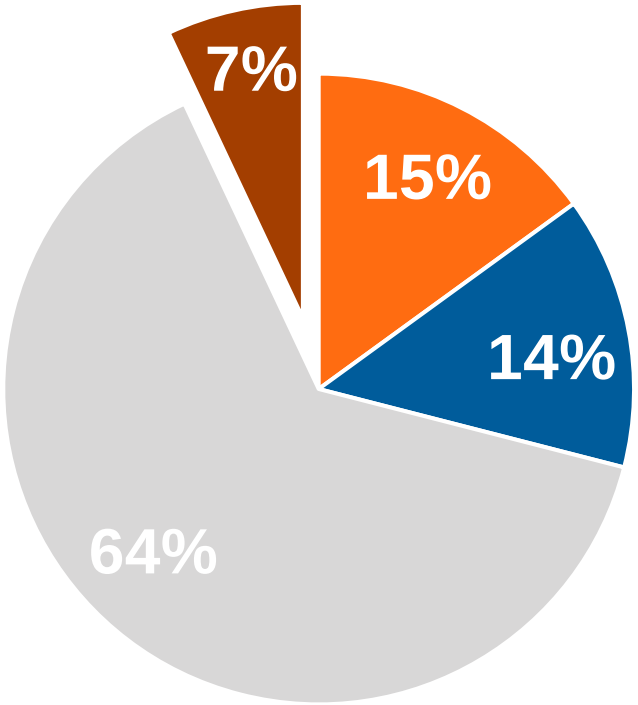
Source: Generate Architecture + Technologies

Anatomy of a Turnkey Mass Timber Package



Source: Swinerton

Equipment (Direct Cost)



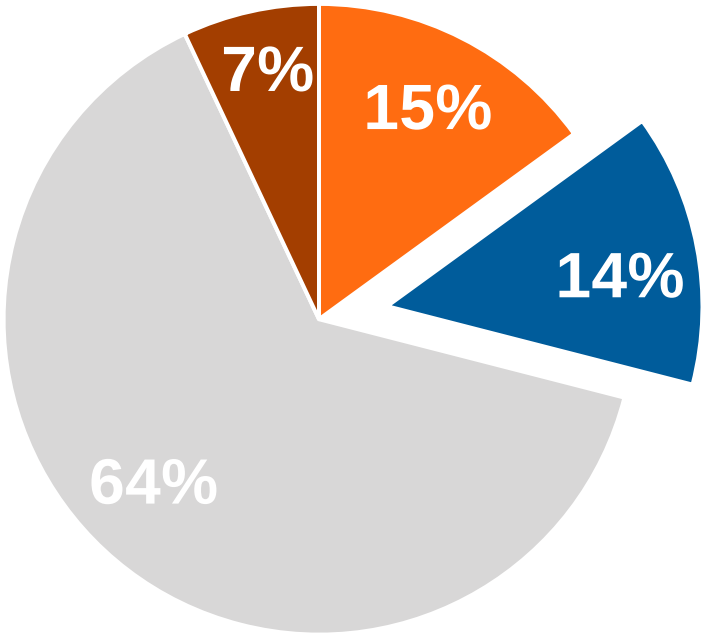
Turnkey Mass Timber Package

Photo: Swinerton

Photo: Alex Schreyer

Source: Swinerton

Labor (Direct Cost)

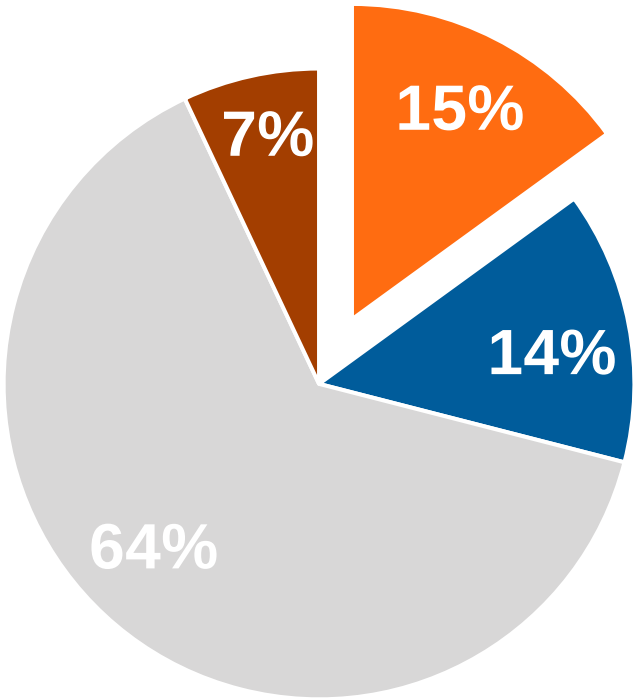


Turnkey Mass Timber Package

Photo: Swinerton

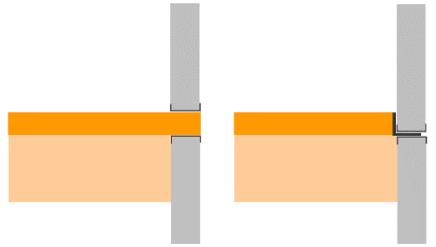
Source: Swinerton

Project Overhead



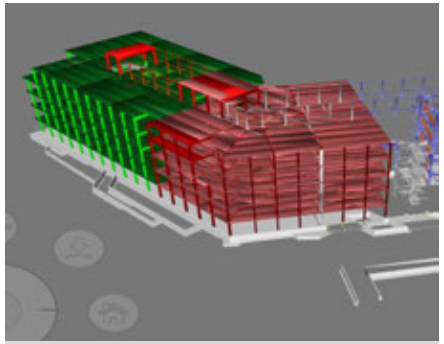
Turnkey Mass Timber Package

Cost Analysis

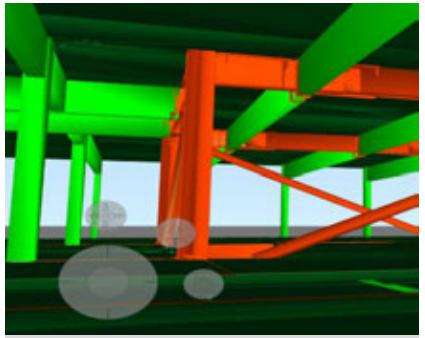


Design Refinement

System Integration



VD&C



Detail Optimization

Logistics Planning

Photos: Swinerton

Source: Swinerton

Total Project Cost Analysis

CONSIDERATIONS:

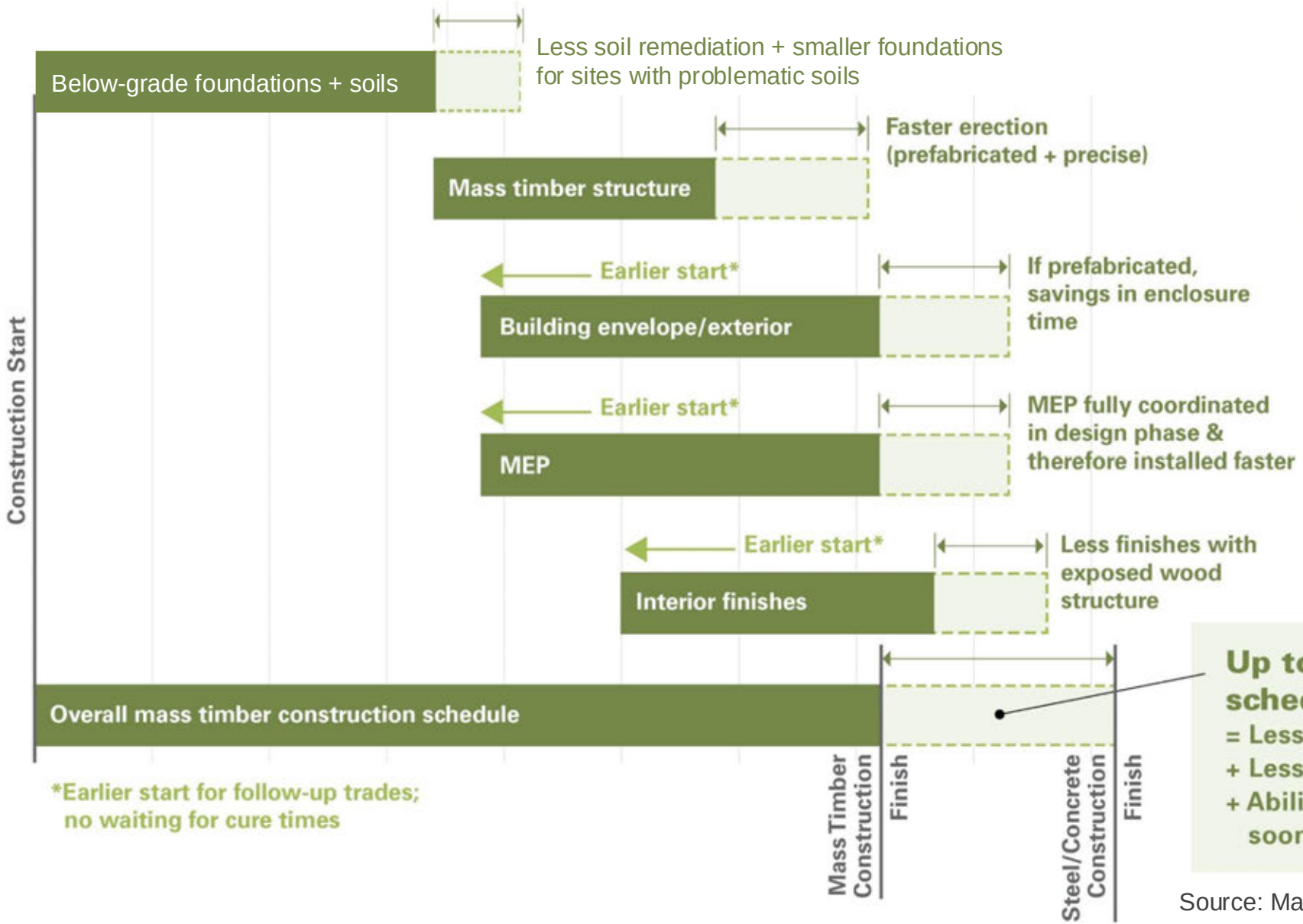
- Ceiling Treatment
- Floor Topping
- HVAC System & Route
- Foundation Size
- Material Savings
- Perimeter glazing
- Value of Time
- Completion Bonds/Insurance

Credit: Hacker Architects

Embrace the Prefab Advantage

Photo: Swinerton

Compressing the Typical Schedule



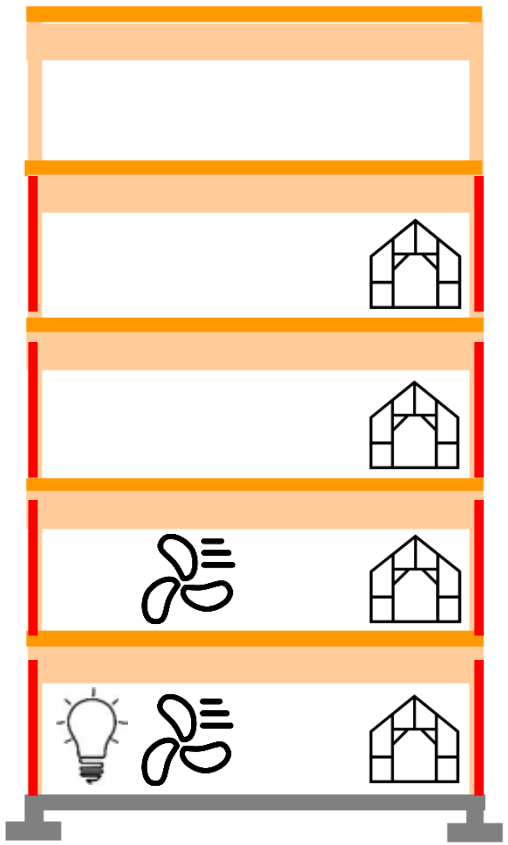
Look for these potential $$ schedule savings with mass timber in comparison to steel and concrete.

Up to 25% schedule savings
= Less carrying costs
+ Less GC overhead
+ Ability to lease/occupy sooner

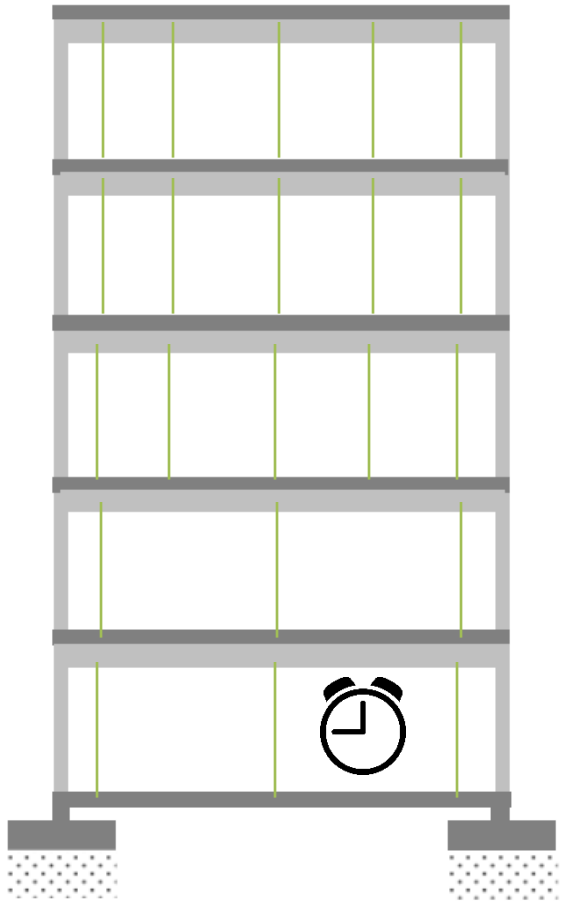
Source: Mass Timber Cost & Design Optimization, WoodWorks[2]

Schedule Savings for Rough-In Trades

Fast Construction



NO curing
(mass timber)



Curing & maze of shores (concrete)

Photo: WoodWorks

Seattle Mass Timber Tower: Detailed Cost Comparison

Fast Construction

- Textbook example done by industry experts
- Mass timber vs. PT conc
- Detailed cost, material takeoff & schedule comparisons

“The initial advantage of Mass Timber office projects in Seattle will come through the

leasing velocity

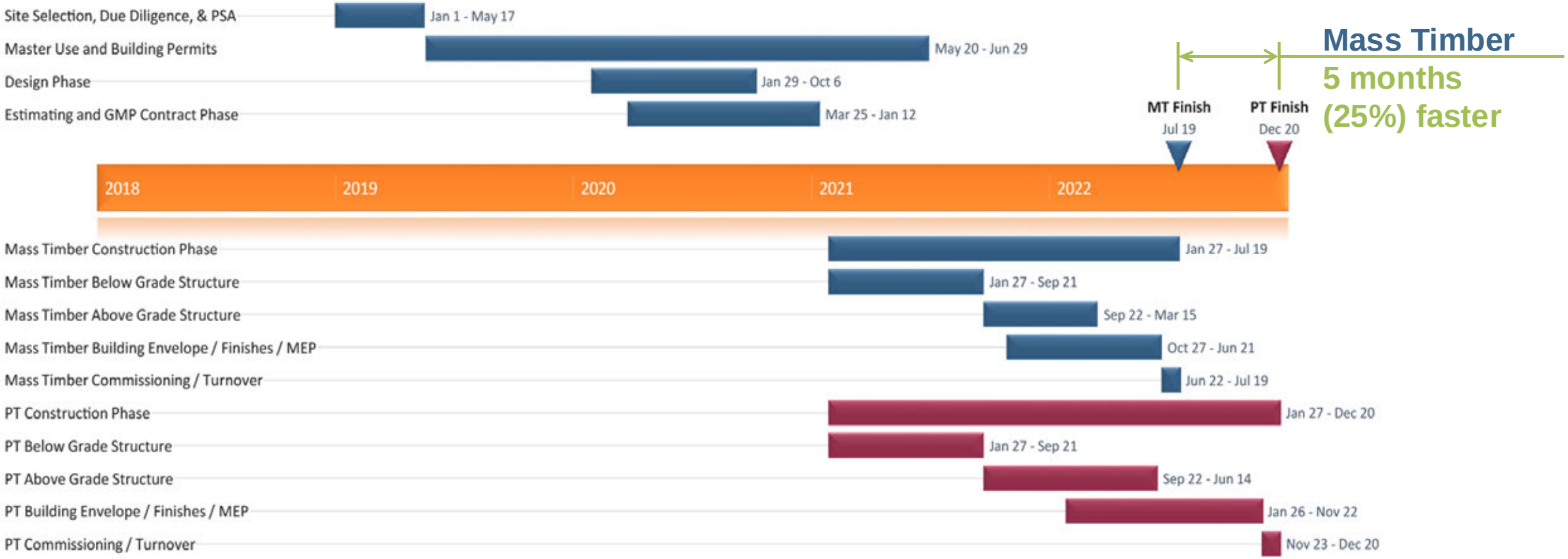
that developers will experience.”

- Connor Mclain, Colliers

Seattle Mass Timber Tower

Fast Construction

Construction Schedule:

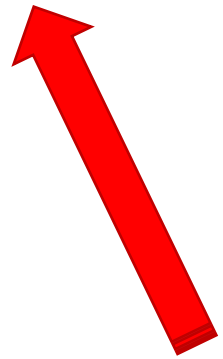


Source: Tall With Timber
A Seattle Mass Timber Tower Case Study by DLR Group[1]

Seattle Mass Timber Tower

Faster Construction + Higher Material Costs = Cost Competitive

System	Mass Timber Design	PT Concrete Design	Mass Timber Savings
Direct Cost of Work	$86,997,136	$85,105,091	2.2%
Project Overhead	$ 9,393,750	$11,768,750	-20.2%
Add-Ons	$ 8,387,345	$ 8,429,368	-0.5%
Total	**$104,778,231**	**$105,303,209**	**-0.5%**



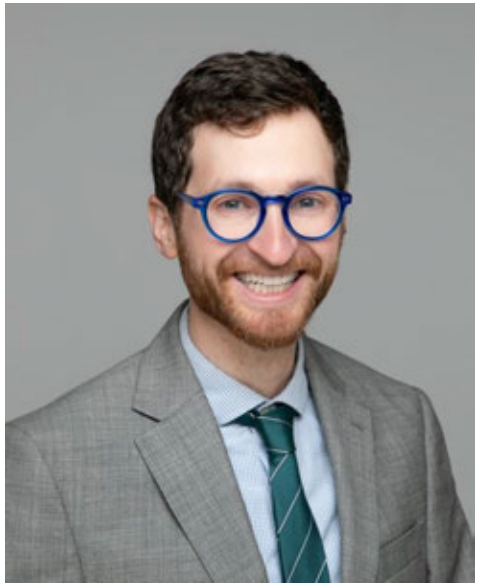
Source: DLR Group | Fast + Epp | Swinerton Builders

Mass Timber in Multi-Family Housing: Is it a Good Fit for Your Project?

There's a good chance it is…Let's talk about it!

Credit: D/O Architects

Questions? Ask us anything.



Please take our survey!

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