Designing and Engineering Mass Timber Buildings in California

February 16, 2023

Presented by

Chelsea Drenick, SE, WoodWorks
Mike Romanowski, SE, WoodWorks

Apex Plaza / Courtesy William McDonough + Partner

New Code Provisions for Tall Timber Structures in California

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Regional Directors: One-on-One Project Support

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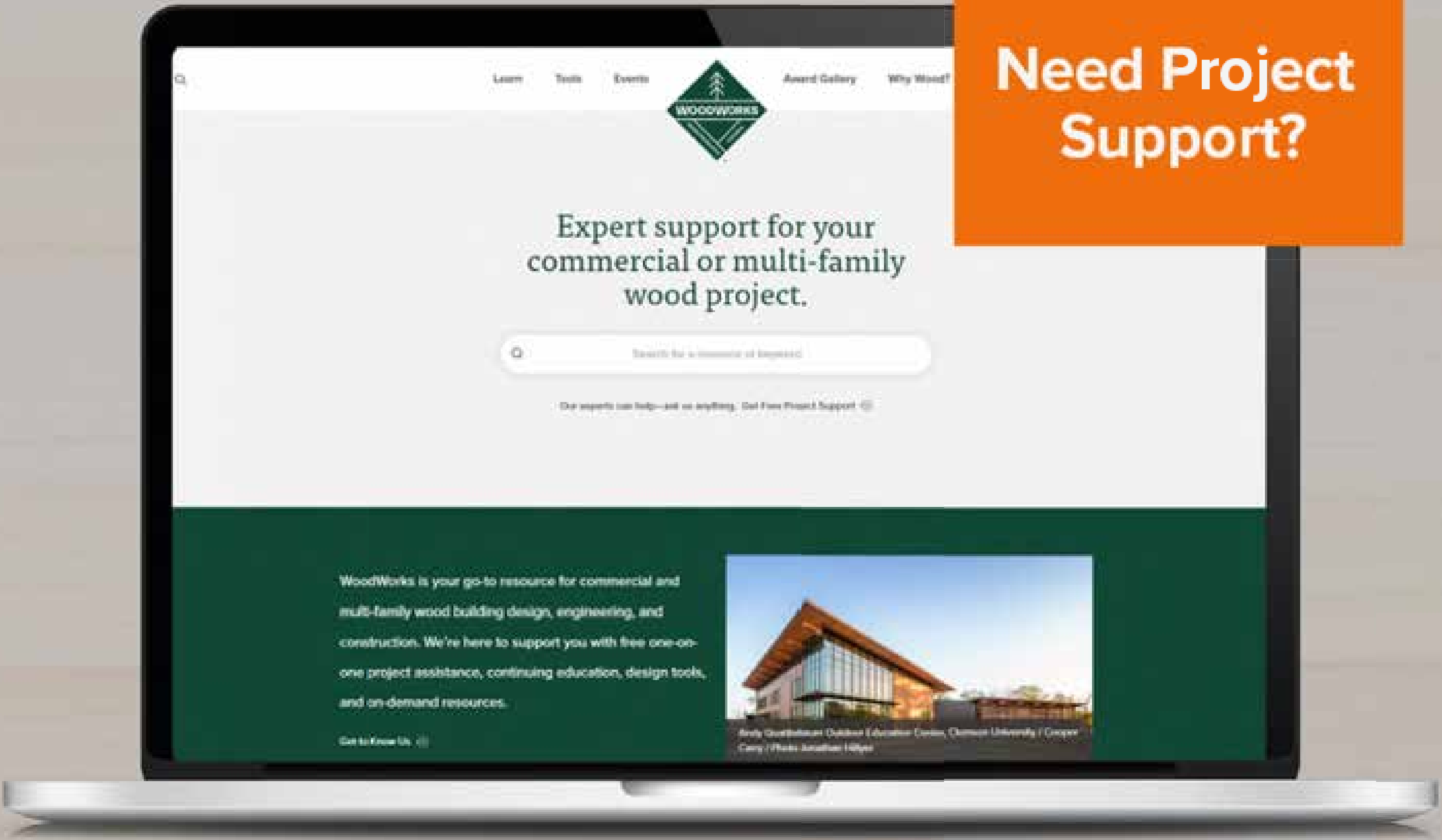

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Building Systems

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

Building Types

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- Education
- Office
- Commercial Low-Rise
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- Civic / Recreational
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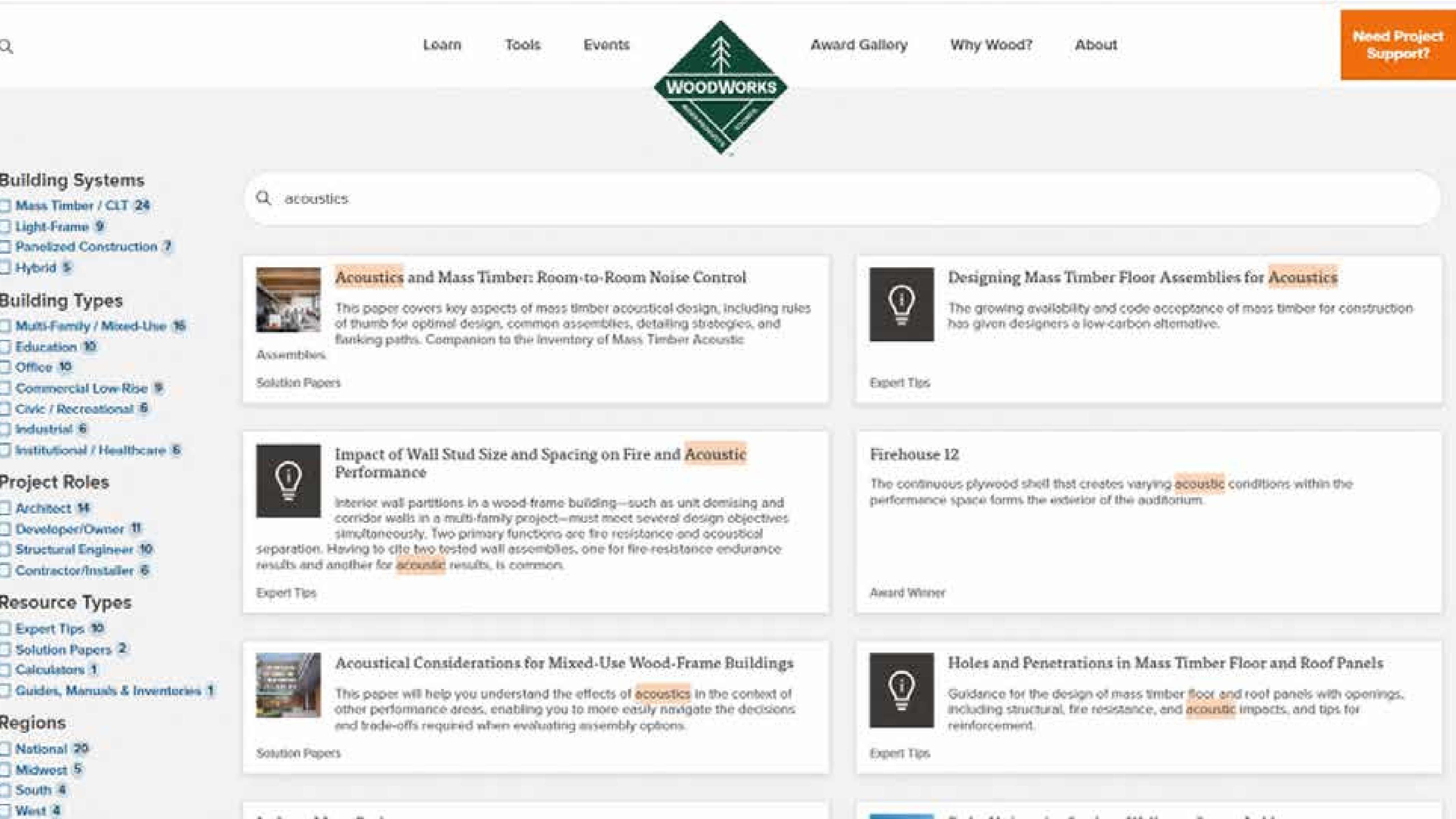


Building Systems

- ☐ Mass Timber / CLT 24
- ☐ Light-Frame 9
- ☐ Panelized Construction 7
- ☐ Hybrid 5

Building Types

- ☐ Multi-Family / Mixed-Use 16
- ☐ Education 10
- ☐ Office 10
- ☐ Commercial Low-Rise 9
- ☐ Civic / Recreational 6
- ☐ Industrial 6
- ☐ Institutional / Healthcare 6

Project Roles

- ☐ Architect 14
- ☐ Developer/Owner 11
- ☐ Structural Engineer 10
- ☐ Contractor/Installer 6

Resource Types

- ☐ Expert Tips 10
- ☐ Solution Papers 2
- ☐ Calculators 1
- ☐ Guides, Manuals & Inventories 1

Regions

- ☐ National 20
- ☐ Midwest 5
- ☐ South 4
- ☐ West 4

acoustics

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

This paper covers key aspects of mass timber acoustical design, including rules of thumb for optimal design, common assemblies, detailing strategies, and flanking paths. Companion to the Inventory of Mass Timber Acoustic Assemblies.

Solution Papers

Designing Mass Timber Floor Assemblies for Acoustics

The growing availability and code acceptance of mass timber for construction has given designers a low-carbon alternative.

Expert Tips

Impact of Wall Stud Size and Spacing on Fire and Acoustic Performance

Interior wall partitions in a wood-frame building—such as unit demising and corridor walls in a multi-family project—must meet several design objectives simultaneously. Two primary functions are fire resistance and acoustical separation. Having to cite two tested wall assemblies, one for fire-resistance endurance results and another for acoustic results, is common.

Expert Tips

Firehouse 12

The continuous plywood shell that creates varying acoustic conditions within the performance space forms the exterior of the auditorium.

Award Winner

Acoustical Considerations for Mixed-Use Wood-Frame Buildings

This paper will help you understand the effects of acoustics in the context of other performance areas, enabling you to more easily navigate the decisions and trade-offs required when evaluating assembly options.

Solution Papers

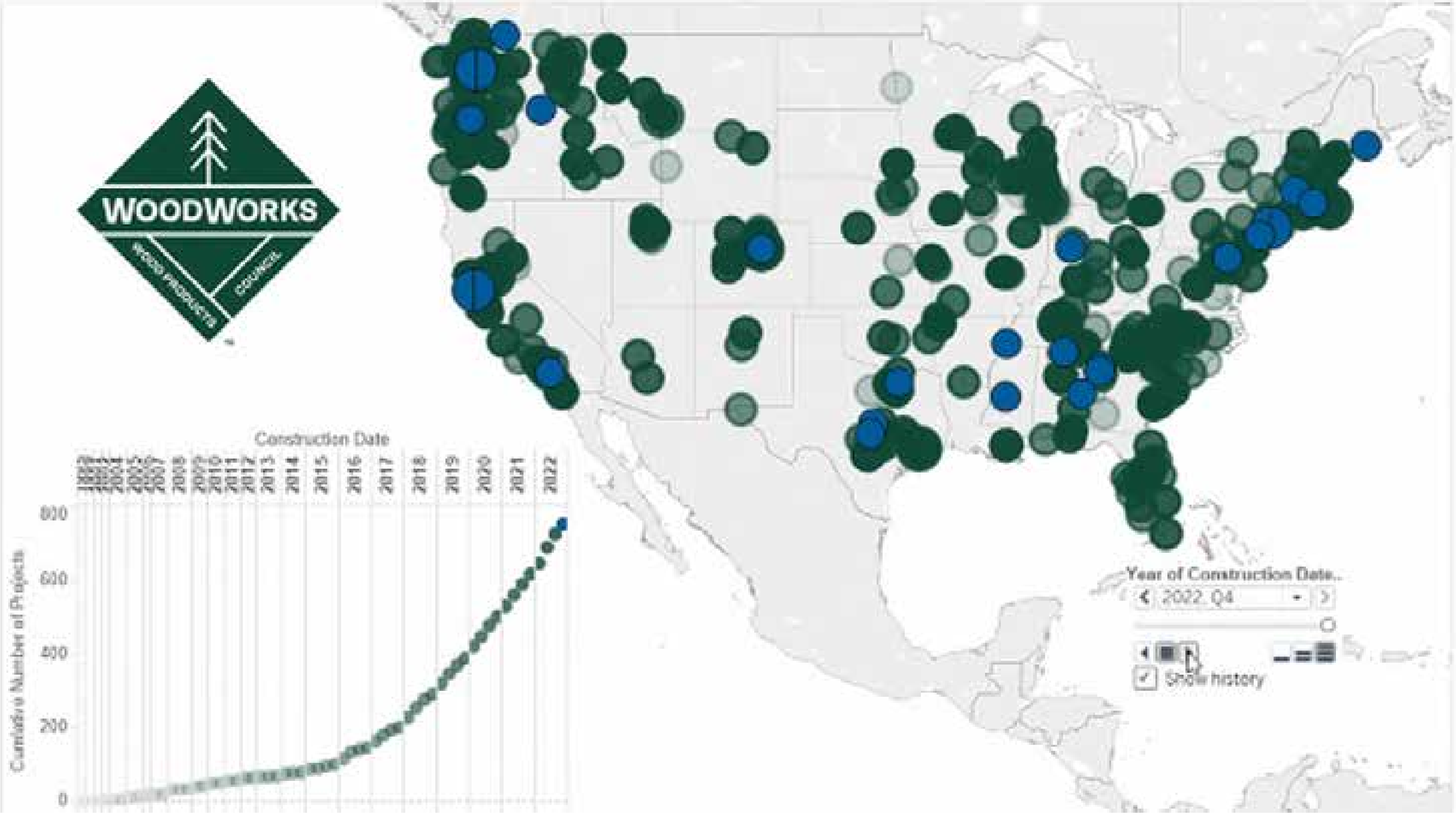
Holes and Penetrations in Mass Timber Floor and Roof Panels

Guidance for the design of mass timber floor and roof panels with openings, including structural, fire resistance, and acoustic impacts, and tips for reinforcement.

Expert Tips

Current State of Mass Timber Projects

As of December 2022, in the US, **1,667** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.

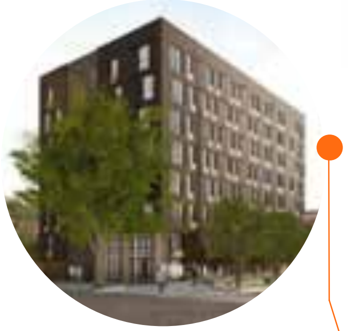


TALL WOOD

○ = 20 in-design tall wood projects

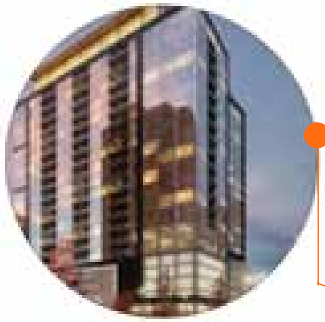
● = tall wood project in construction or completed

INTRO Cleveland
Cleveland, OH
9 stories –
8 mass timber



Heartwood
Seattle, WA
8 stories mass timber

Carbon 12
Portland, OR
8 stories mass timber

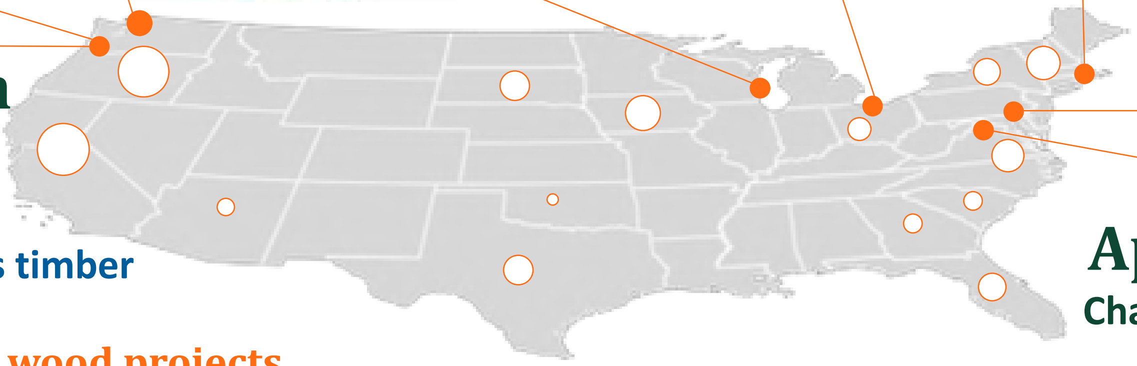


Ascent
Milwaukee, WI
25 stories –
19 mass timber

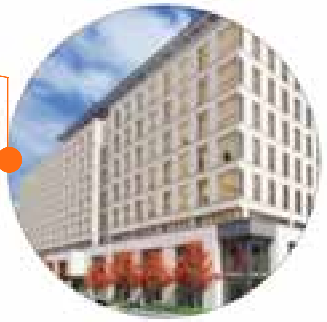
11 E Lenox
Boston, MA
7 stories mass timber

80 M Street
Washington DC
10 stories – 3-story
mass timber
vertical addition

Minnesota Places
Portland, OR
8 stories - 7 mass timber



Apex Plaza
Charlottesville, VA
8 stories –
6 mass timber



WoodWorks is supporting 189 tall wood projects

Minnesota Places, rendering Wright Architecture; Carbon 12, Kaiser+Path, photo Andrew Pogue; Heartwood, rendering Atelier Jones; INTRO Cleveland, Harbor Bay Real Estate Advisors, HPA Architecture; Ascent, Korb + Associates Architects, Thornton Tomasetti; 11 E Lenox, rendering Monte French Design Studio; 80 M Street, Hickok Cole Architects, Columbia Property Trust; Apex Plaza, rendering William McDonough + Partners

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Genentech Child Care Center
Mass Timber

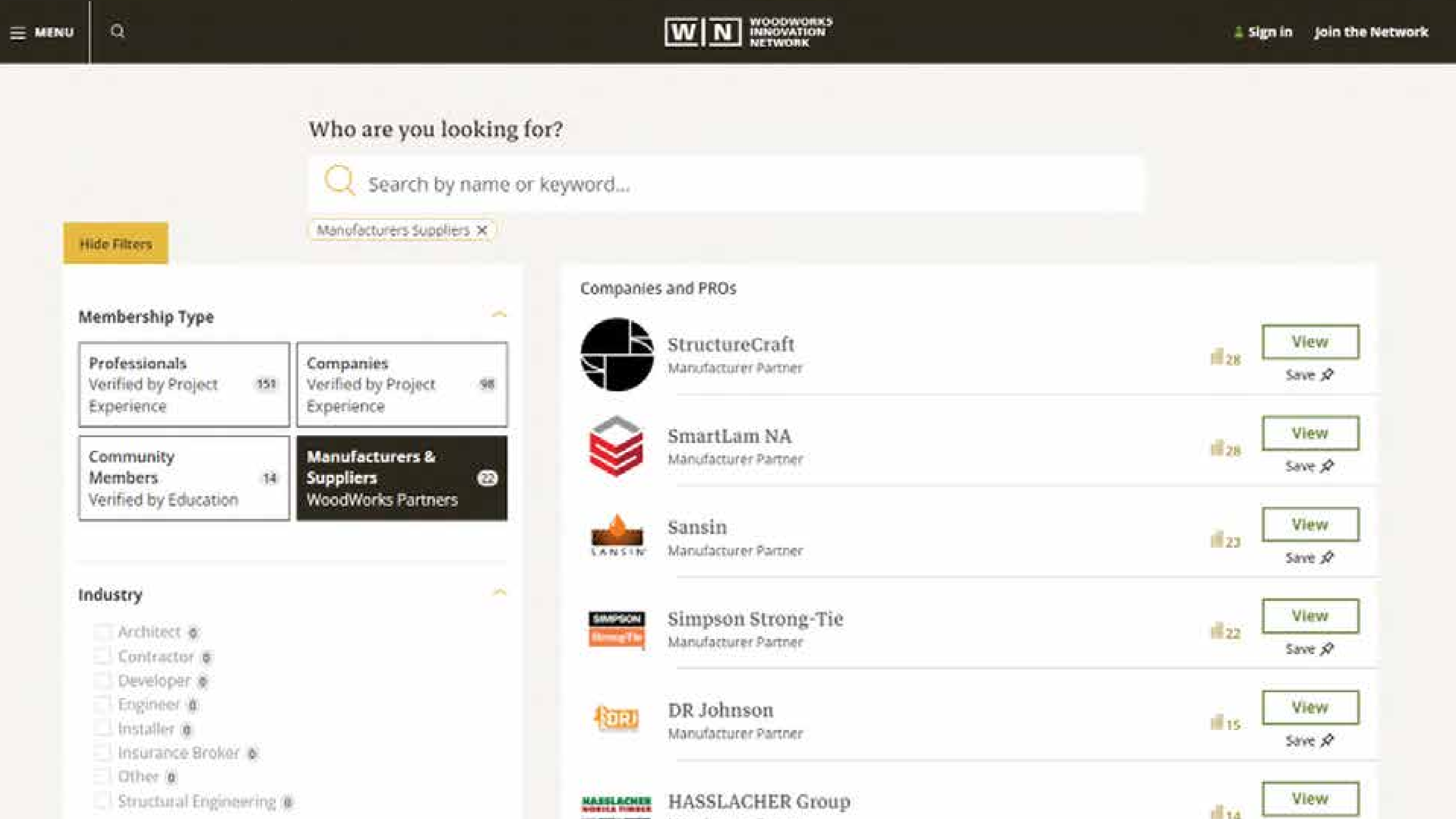
BCIT Tall Timber Student Housing
Mass Timber

Crosswood Apartments
Mass Timber

Wingspan Event and Conference Center
Mass Timber

Kresge College Renewal at UC Santa Cruz
Mass Timber

Knight Campus for Accelerating Scientific Impact at the University of Oregon
Mass Timber



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☐ Developer 0
☐ Engineer 0
☐ Installer 0
☐ Insurance Broker 0
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☐ Structural Engineering 0

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Sansin Manufacturer Partner	23	View	Save
Simpson Strong-Tie Manufacturer Partner	22	View	Save
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HASSLACHER Group	14	View	

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ELEMENT5 MODERN TIMBER BUILDINGS
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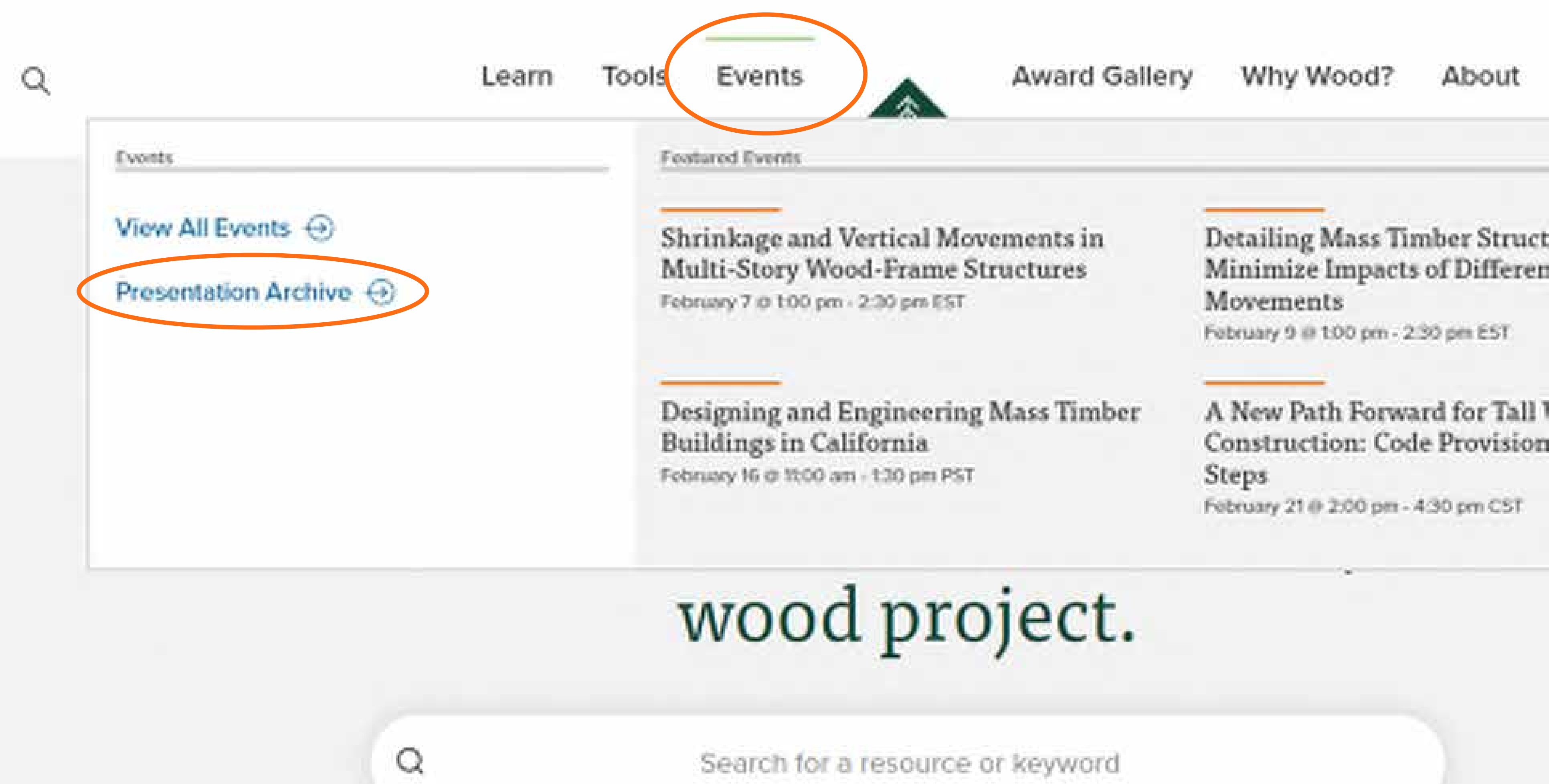
KALESNIKOFF TIMBER INSPIRED
RedBUILT
rothoblaas Solutions for Building Technology
STRUCTURLAM MASS TIMBER CORPORATION

presentation slides in pdf:

woodworks.org/presentation-archive/



Shrinkage and Vertical Movements in Multi-Story Wood-Frame Structures
February 7 @ 1:00 pm - 2:30 pm EST

Detailing Mass Timber Struct
Minimize Impacts of Differen
Movements
February 9 @ 1:00 pm - 2:30 pm EST

Designing and Engineering Mass Timber Buildings in California
February 16 @ 11:00 am - 1:30 pm PST

A New Path Forward for Tall W
Construction: Code Provision
Steps
February 21 @ 2:00 pm - 4:30 pm CST

wood project.

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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

As awareness of mass timber's potential for tall wood structures has grown, there has been a push among U.S. building designers to achieve greater heights with these materials. Initially, tall wood buildings in the U.S. were proposed using international examples as precedent, with a project-specific performance-based design approach used. However, a uniform set of tall wood code provisions has begun going into effect in many States with adoption of the 2021 International Building Code (IBC), which will allow up to 18 stories of mass timber construction. The 2022 California Building Code (CBC) has now also been adopted with a series of tall wood code changes based on the new IBC provisions, but with California-specific modifications. Following a brief discussion of history and motivators, this presentation will introduce the new IBC and CBC tall wood code provisions, as well as the technical research and testing that supported their adoption.

Learning Objectives

1. Review the global history of tall wood construction and highlight the mass timber products used in these structures.
2. Explore the work and conclusions of the ICC Ad Hoc Committee on Tall Wood Buildings in establishing 17 new code provisions for the 2021 IBC.
3. Identify differences between the 2021 IBC and 2022 CBC relative to code allowances for tall timber structures.
4. Discuss differences between the new tall wood mass timber construction types and existing construction types.

The What, Why and How of Tall Mass Timber


Photo: Michael Green Architecture

TALL MASS TIMBER
ASSESSING THE WHAT

Brock Commons, Vancouver, BC | Architect: Acton Ostry| Image Courtesy naturallywood

Photos: Michael Elkan | Naturally Wood | UBC

BROCK COMMONS, BRITISH COLUMBIA

18 STORIES | 174 FT

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

CARBON12, PORTLAND, OR

8 STORIES | 85 FT

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

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

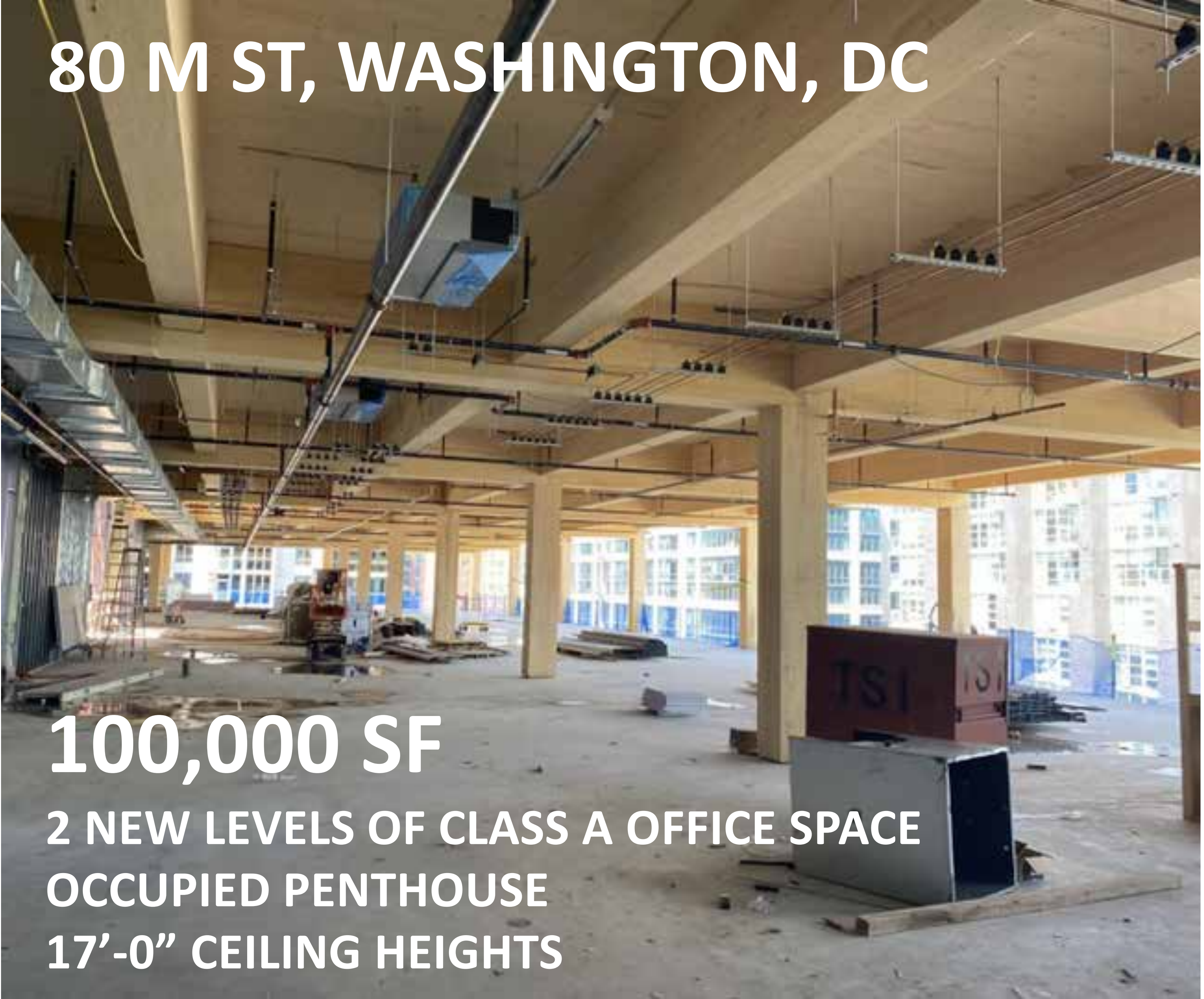
80 M ST, WASHINGTON, DC

3 STORY VERTICAL ADDITION

ON EXISTING 7-STORY CONCRETE BUILDING

Photo: Hickok Cole | 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

APEX PLAZA

CHARLOTTESVILLE, VA

8 STORIES

6 TIMBER OVER 2 PODIUM, 100 FT

187,000 SF

PRIMARILY OFFICE SPACE

Photo: William McDonough + Partners | Architect: William McDonough + Partners

11 E LENOX, BOSTON, MA

7 STORIES

70 FT

Passive House

Multi-Family

Credit: H + O Structural Engineering

Credit: Monte French Design Studio

11 E LENOX, BOSTON, MA

Credit: H + O Structural Engineering

HEARTWOOD, SEATTLE

8 STORIES

Workforce Housing

Photo: Atelier Jones |
Architect: Atelier Jones

Type IV-C **66,000 SF**

MINNESOTA PLACES, PORTLAND

8 STORIES

Affordable Housing

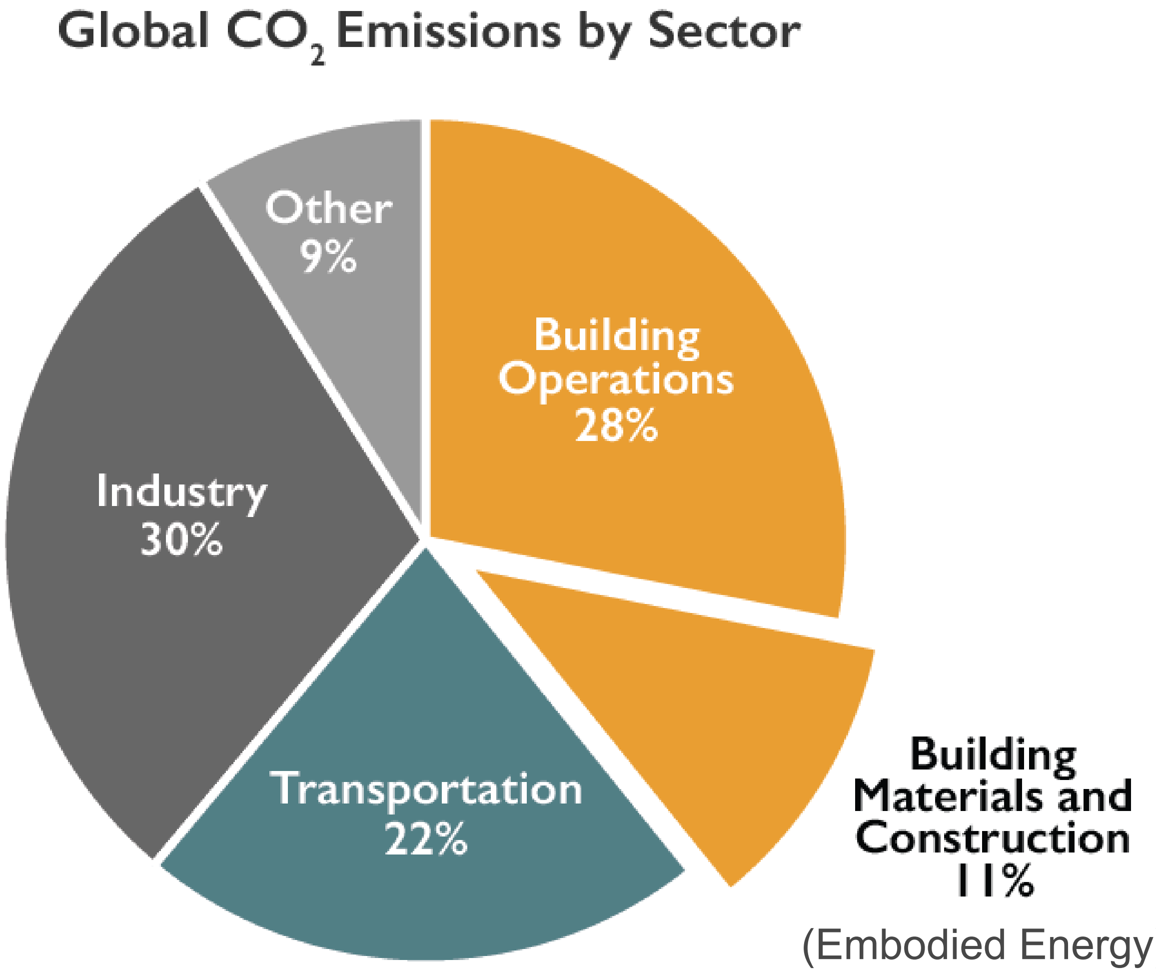
Photo: Wright Architecture|
Architect: Wright Architecture

Type IV-C **72 Units** **7 Stories of Timber over Podium**

TALL MASS TIMBER
UNDERSTANDING THE WHY

Brock Commons, Vancouver, BC | Architect: Acton Ostry | Image Courtesy naturallywood

New Buildings & Greenhouse Gases



Global CO_2 Emissions by Sector

(Embodied Energy)

Source: © 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources:
UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

Buildings generate nearly 40% of annual global greenhouse gas emissions (*building operations* + *embodied energy*)

Embodied Energy (11%): Concrete, iron + steel produce approximately 9% of this (Architecture 2030)

Image: Architecture 2030

Embodied vs. Operational Energy

(High Performing Non-Wood Building)

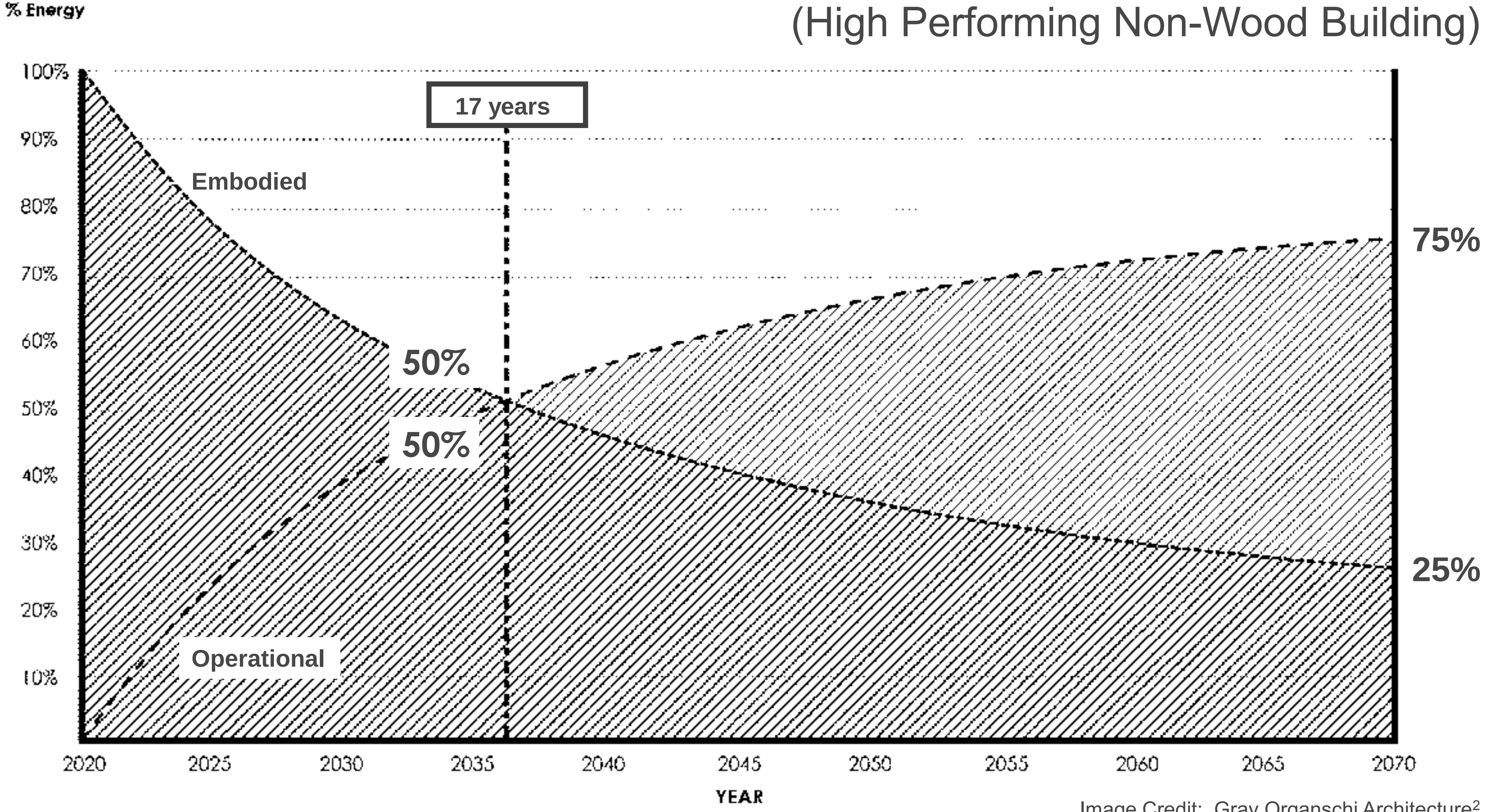


Image Credit: Gray Organschi Architecture[2]

Carbon Storage

Wood ≈ 50% Carbon (dry weight)

Image: Kaiser + Path

Image: Lever Architecture

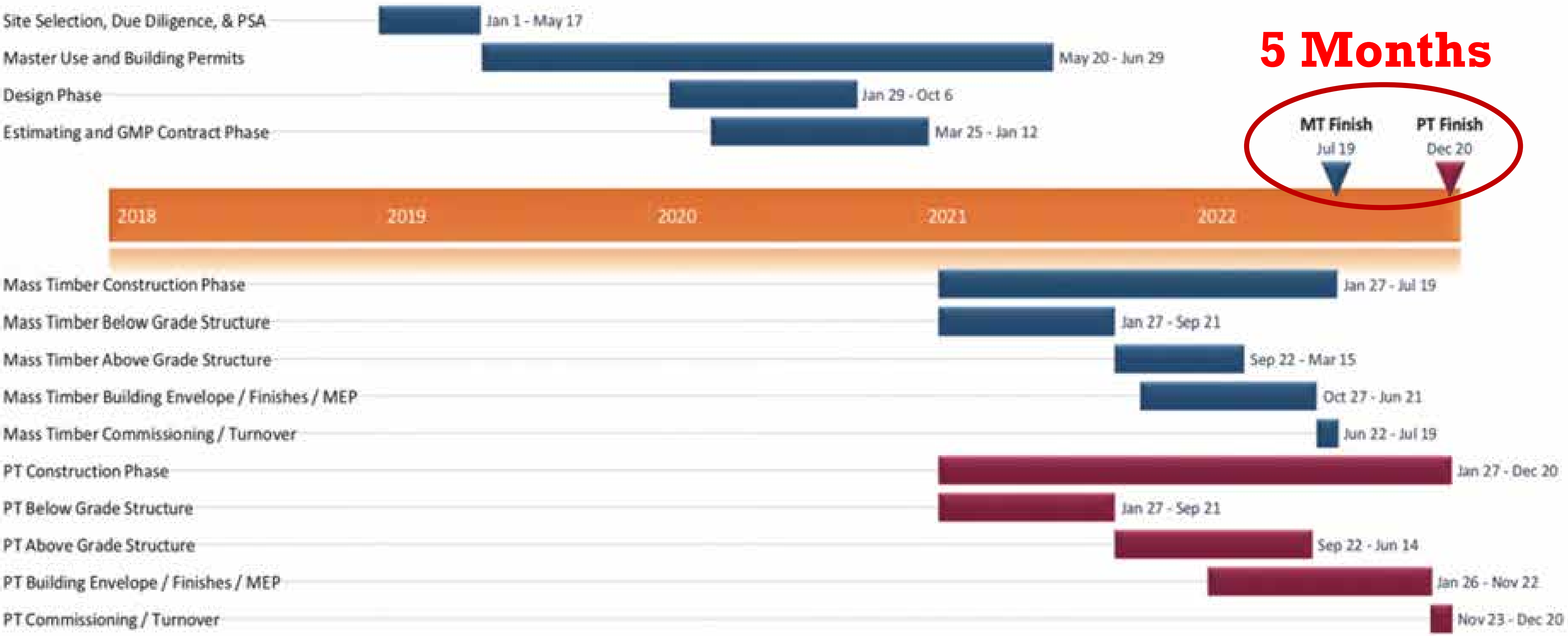
Biophilia - Structural Warmth is a Value-Add

TMBR (unbuilt) Minneapolis, MN | Images: D/O Architects

Construction Impacts: Labor Availability

Photo: Lendlease

Construction Impacts: Schedule

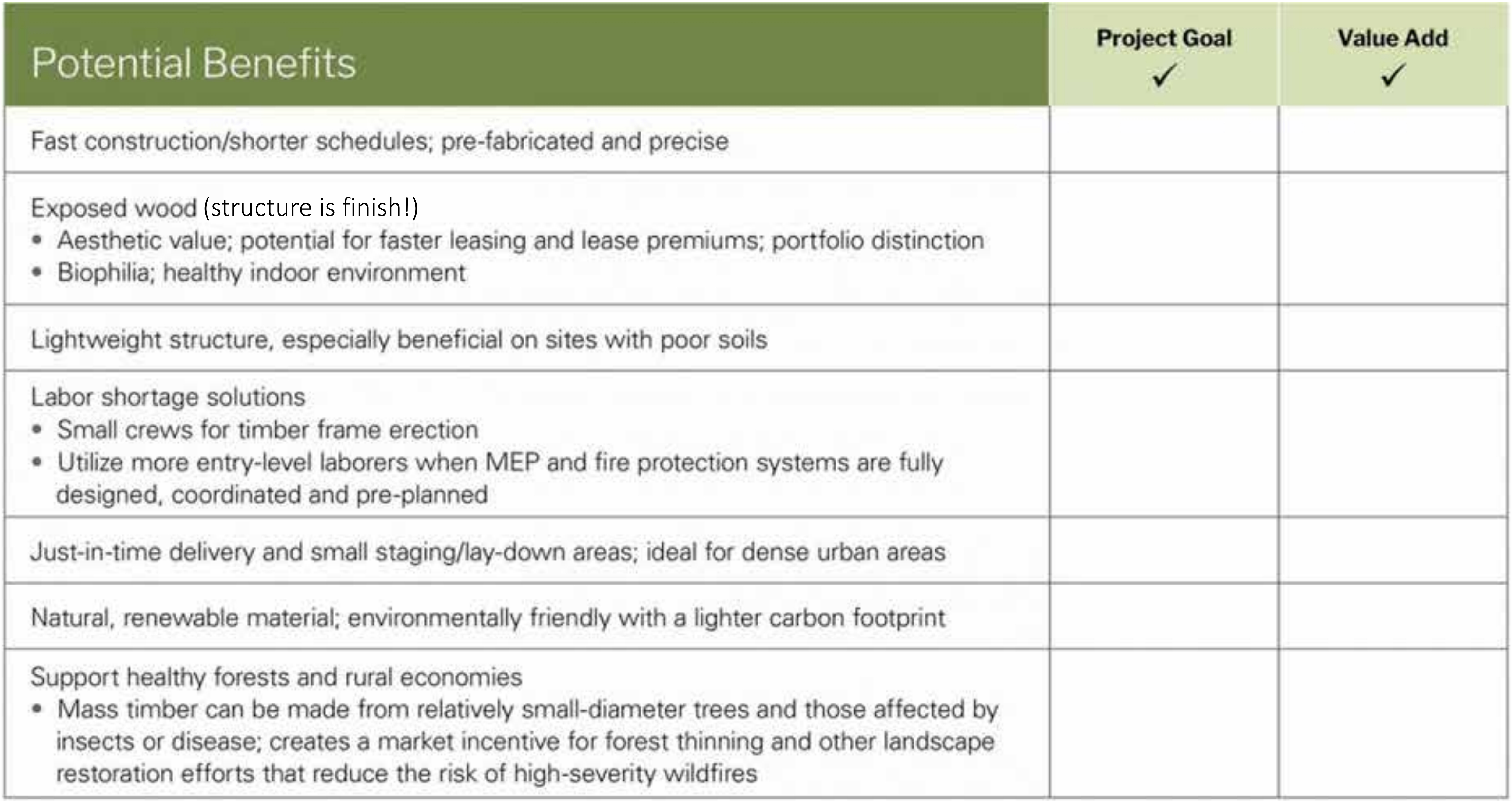


5 Months

Seattle Mass Timber Tower Study, Source: DLR Group | Fast + Epp | Swinerton Builders

Lightweight Structure

75% lighter weight than concrete



Potential Benefits	Project Goal ✓	Value Add ✓
Fast construction/shorter schedules; pre-fabricated and precise		
Exposed wood (structure is finish!) • Aesthetic value; potential for faster leasing and lease premiums; portfolio distinction • Biophilia; healthy indoor environment		
Lightweight structure, especially beneficial on sites with poor soils		
Labor shortage solutions • Small crews for timber frame erection • Utilize more entry-level laborers when MEP and fire protection systems are fully designed, coordinated and pre-planned		
Just-in-time delivery and small staging/lay-down areas; ideal for dense urban areas		
Natural, renewable material; environmentally friendly with a lighter carbon footprint		
Support healthy forests and rural economies • Mass timber can be made from relatively small-diameter trees and those affected by insects or disease; creates a market incentive for forest thinning and other landscape restoration efforts that reduce the risk of high-severity wildfires		

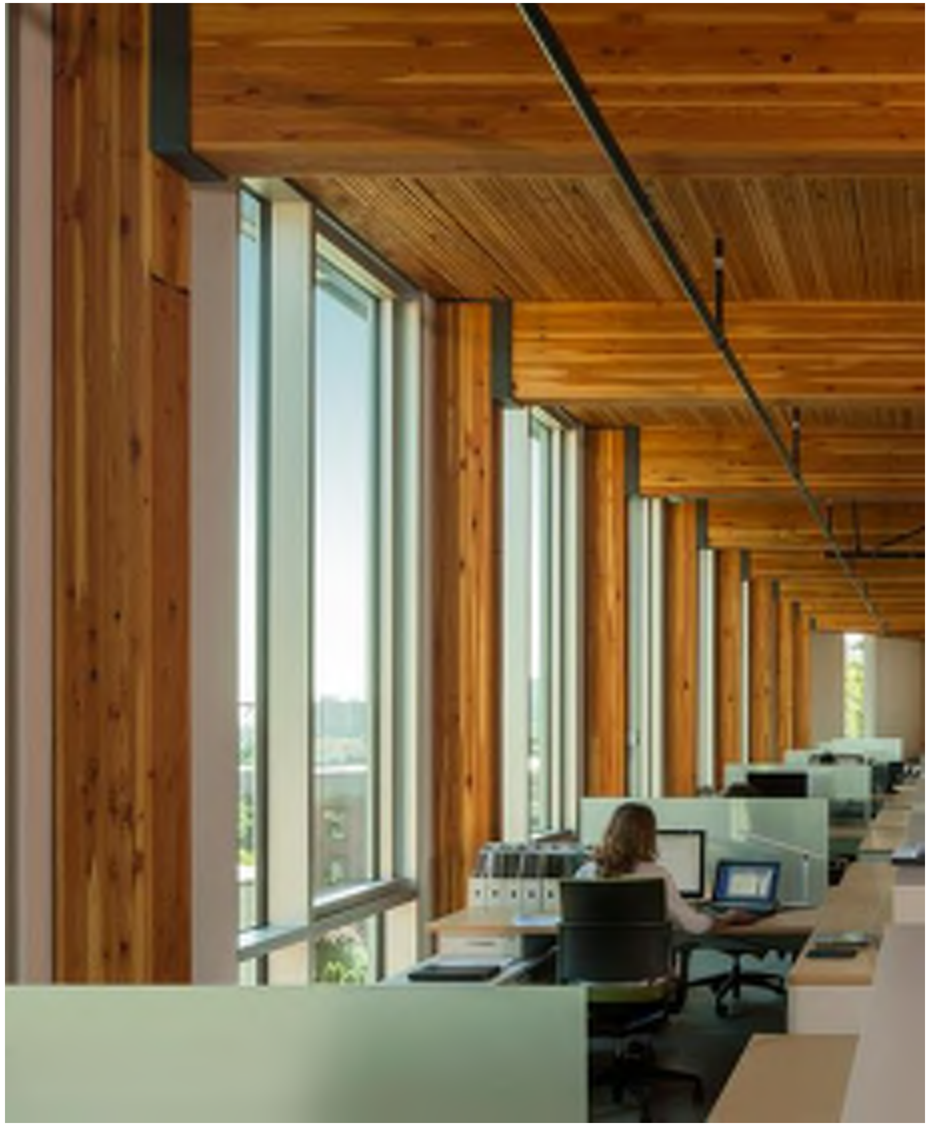
TALL MASS TIMBER
DEMONSTRATING THE HOW

Brock Commons, Vancouver, BC | Architect: Acton Ostry| Image Courtesy naturallywood

OVERVIEW | TERMINOLOGY

Light-Frame Wood
Photo: WoodWorks

Heavy Timber
Photo: Benjamin Benschneider



Mass Timber
Photo: John Stamets

Glue Laminated Timber (Glulam)

Beams & columns

Photo: StructureCraft

Cross-Laminated Timber (CLT)

Solid sawn laminations

Photo: LendLease

Cross-Laminated Timber (CLT)

SCL laminations

Photo: Freres Lumber

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

NEW MASS TIMBER CONNECTIONS INDEX

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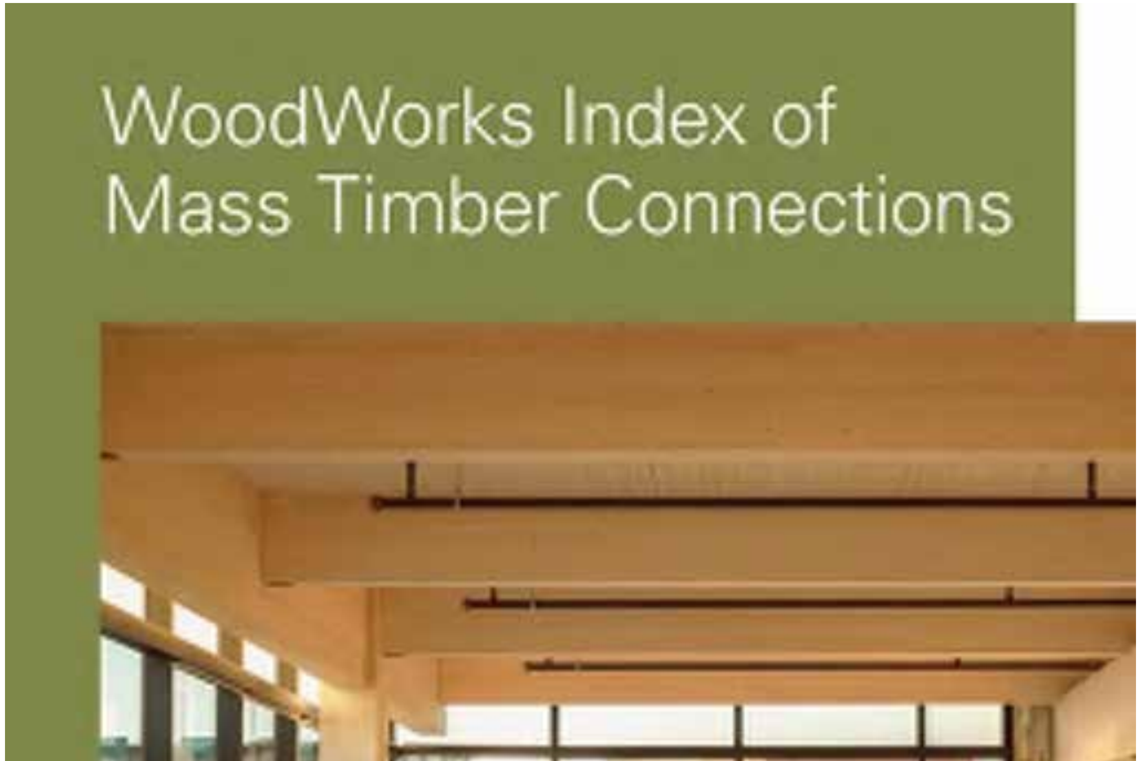
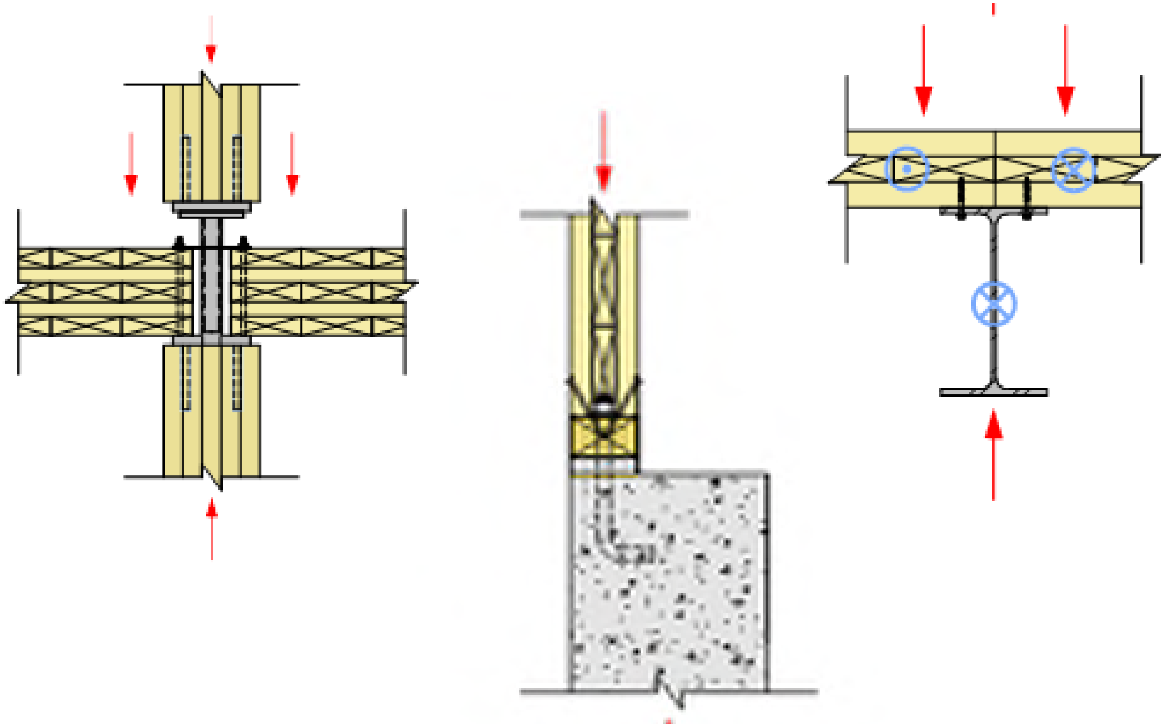
OZ
ARCHITECTURE
URBAN DESIGN
INTERIOR DESIGN

SWINERTON
MASS TIMBER

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



WoodWorks Index of Mass Timber Connections



MASS TIMBER DESIGN

FIRE RESISTANCE

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

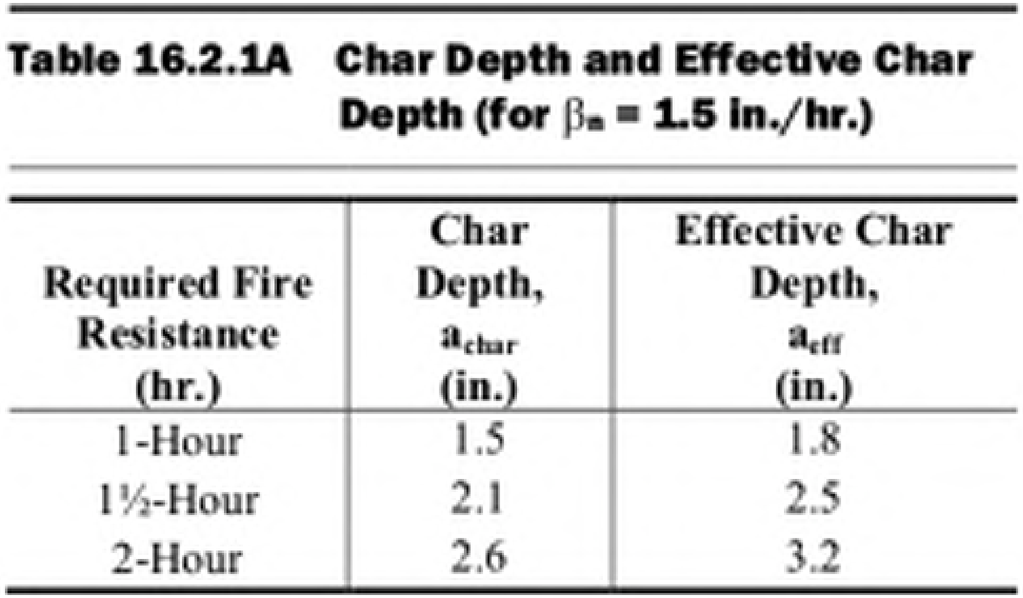
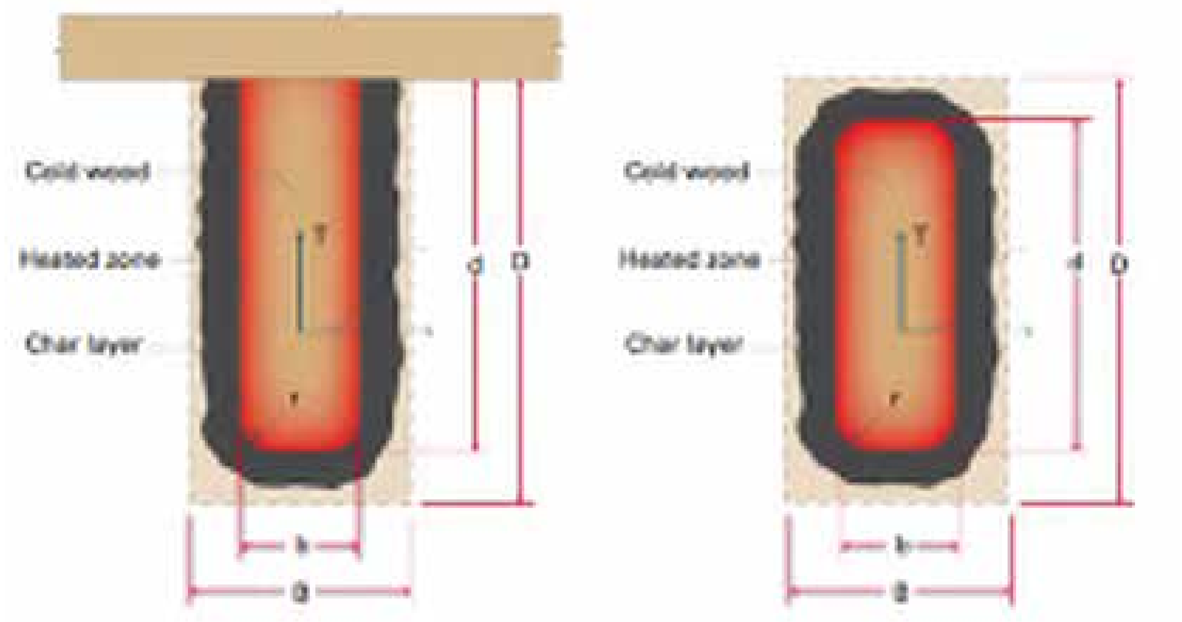


Table 16.2.1A Char Depth and Effective Char Depth (for β_n = 1.5 in./hr.)

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



Credit: David Barber, ARUP

Source: AWC's TR 10

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)**

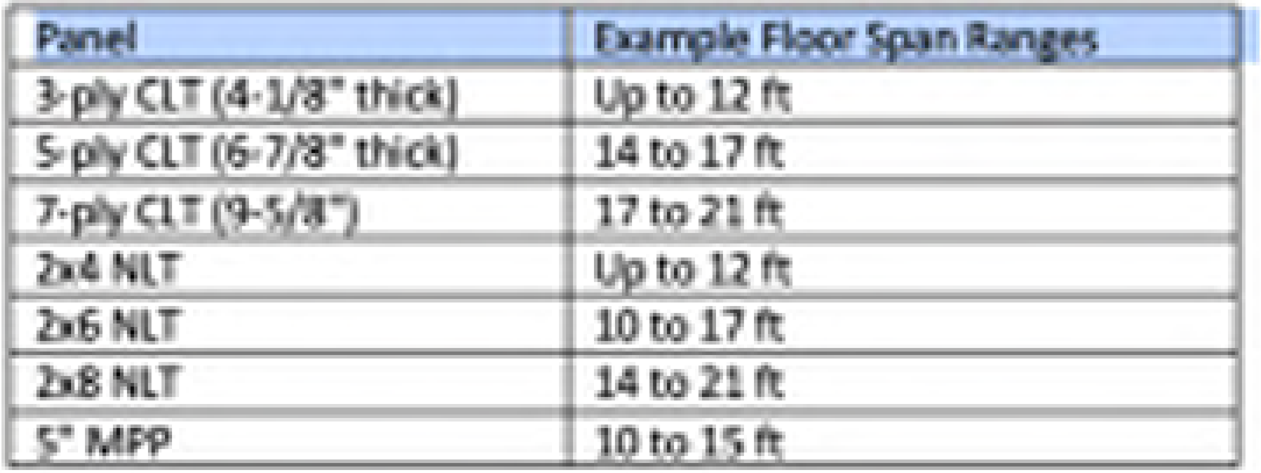
NDS Chapter 16
Fire Design of Wood Members

- 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.

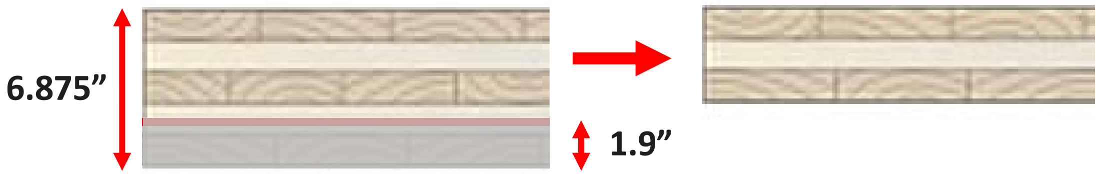
Key Early Design Decisions

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



FRR Design of MT

WoodWorks Inventory of Fire Tested MT Assemblies

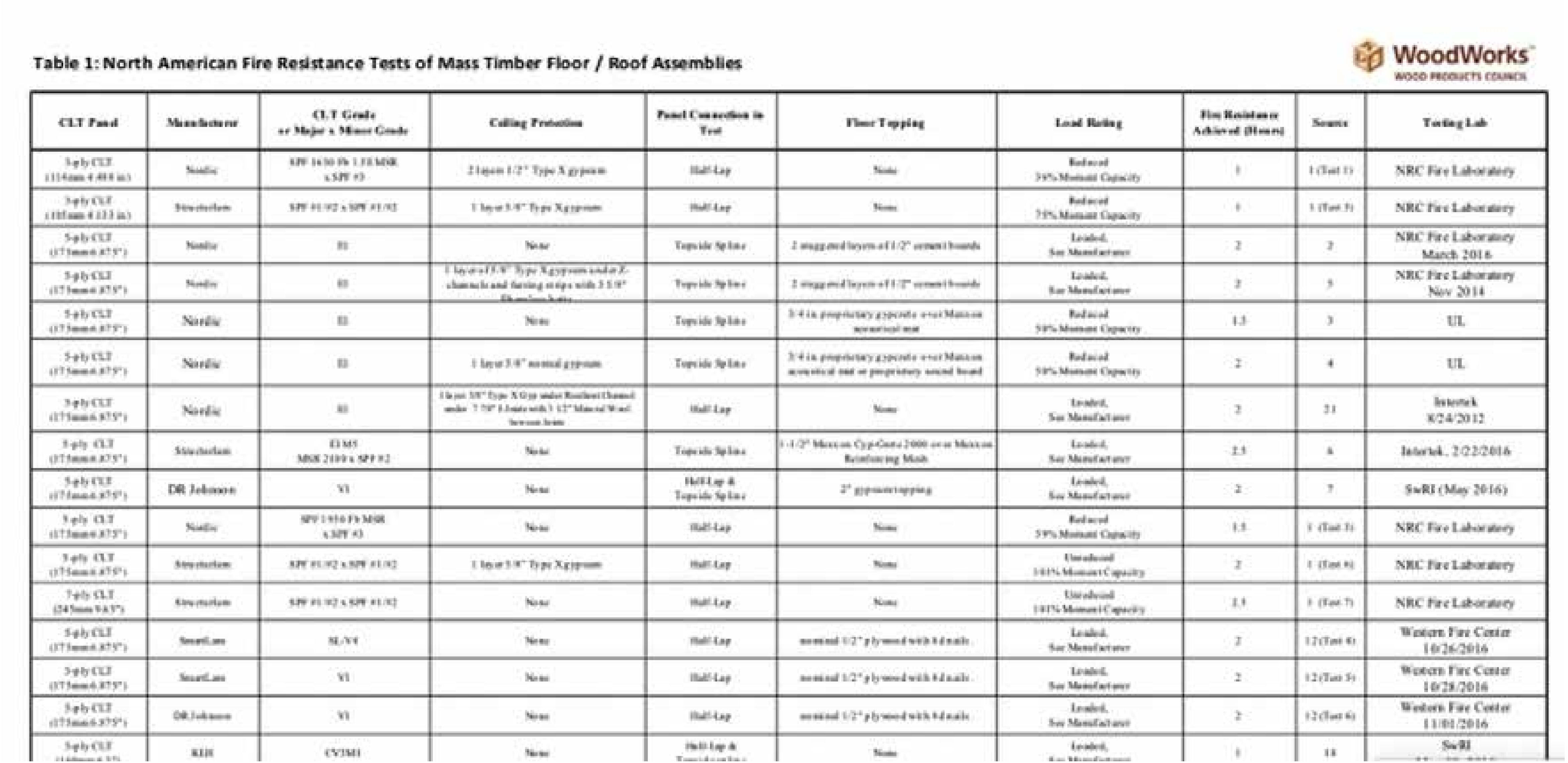


Table 1: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies

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 59% Moment Capacity	1	1 (Test 1)	NRC Fire Laboratory
3-ply CLT (105mm 4.133 in.)	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Reduced 75% Moment Capacity	1	1 (Test 5)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	2	NRC Fire Laboratory March 2016
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer of 5/8" Type X gypsum under Z-channels and furring strips with 3 5/8" fiberglass batts	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	5	NRC Fire Laboratory Nov 2014
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat	Reduced 59% Moment Capacity	1.5	3	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" normal gypsum	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat or proprietary sound board	Reduced 59% Moment Capacity	2	4	UL
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer 5/8" Type X Gyp under Resilient Channel under 7 7/8" I-Joists with 3 1/2" Mineral Wool between Joists	Half-Lap	None	Loaded, See Manufacturer	2	21	Intertek 8/24/2012
5-ply CLT (175mm 6.875")	Structurlam	E1 M5 MSR 2100 x SPF #2	None	Topside Spline	1-1/2" Maxxon Gyp-Crete 2000 over Maxxon Reinforcing Mesh	Loaded, See Manufacturer	2.5	6	Intertek, 2/22/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap & Topside Spline	2" gypcrete 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	KLH	CV3M1	None	Half-Lap & Topside spline	None	Loaded, See Manufacturer	1	14	SwRI

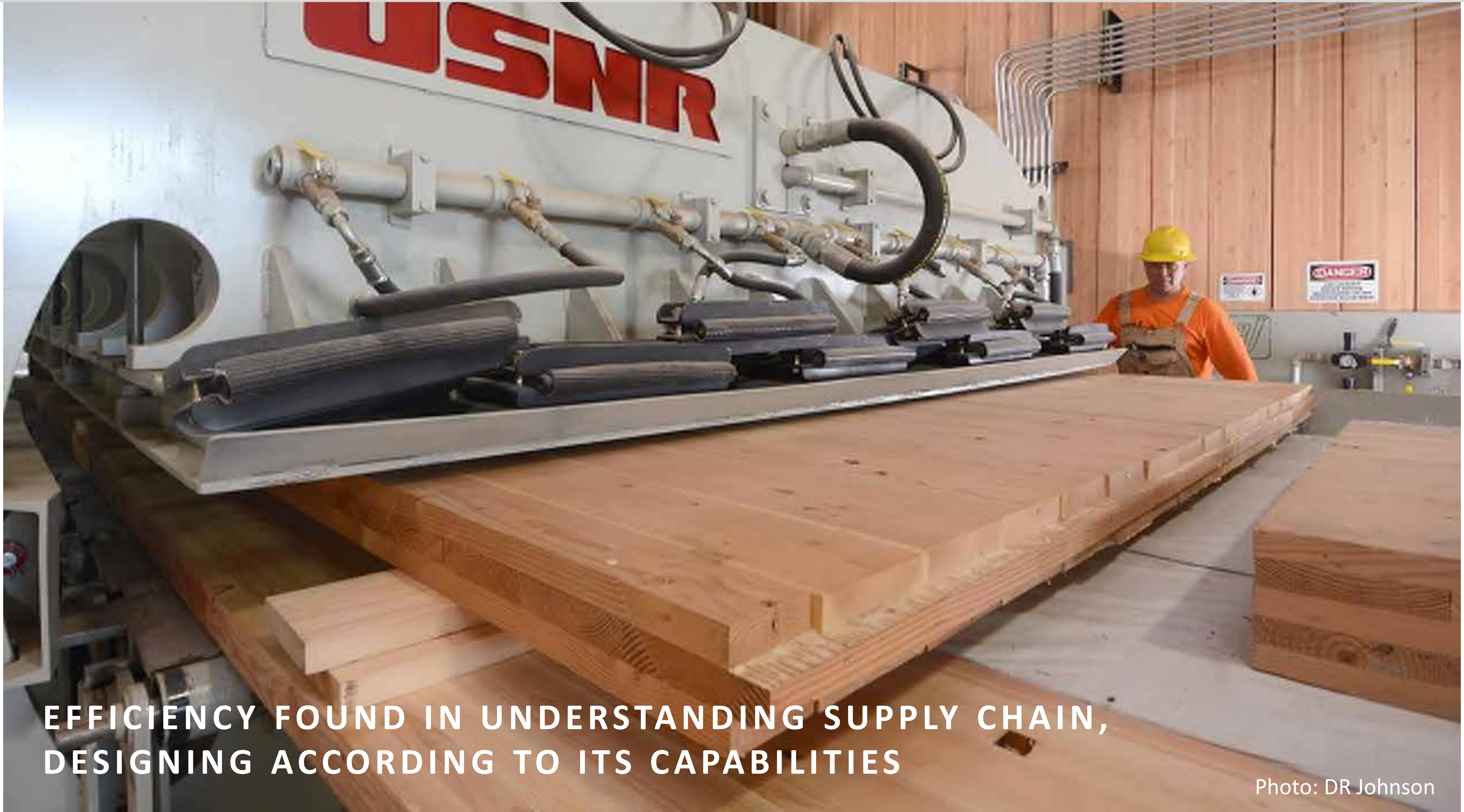
Mass Timber Acoustics

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

Image credit: AcoustiTECH

Know The Supply Chain



EFFICIENCY FOUND IN UNDERSTANDING SUPPLY CHAIN, DESIGNING ACCORDING TO ITS CAPABILITIES

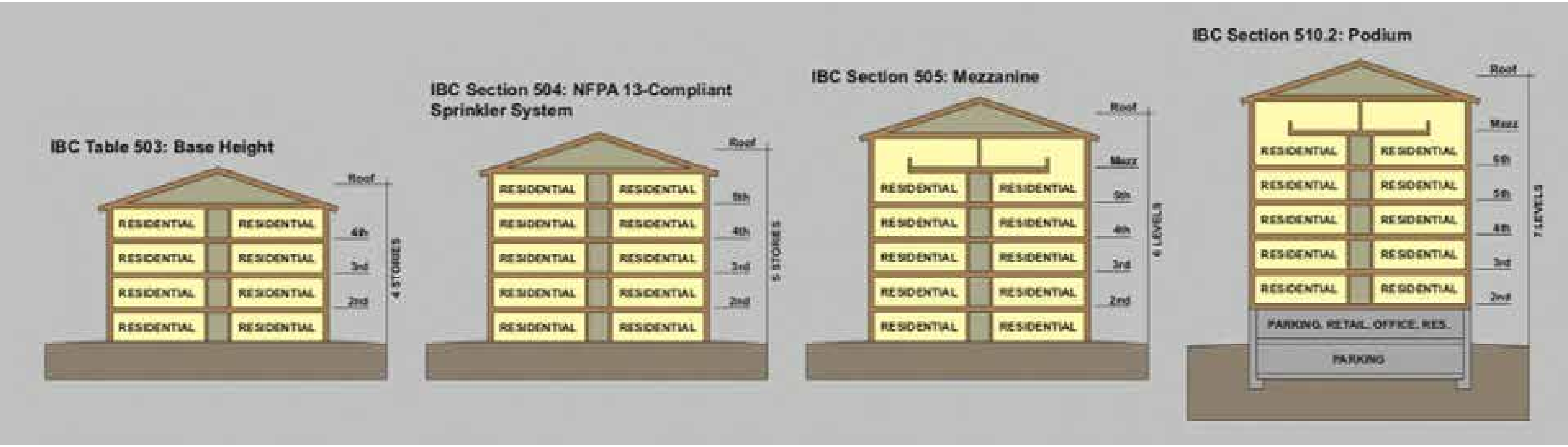
Photo: DR Johnson

TALL WOOD IN THE U.S.

BEFORE 2021 IBC Code Limit for wood - 6 stories (business) 5 stories (residential) and 85 feet

Over 6 Stories:

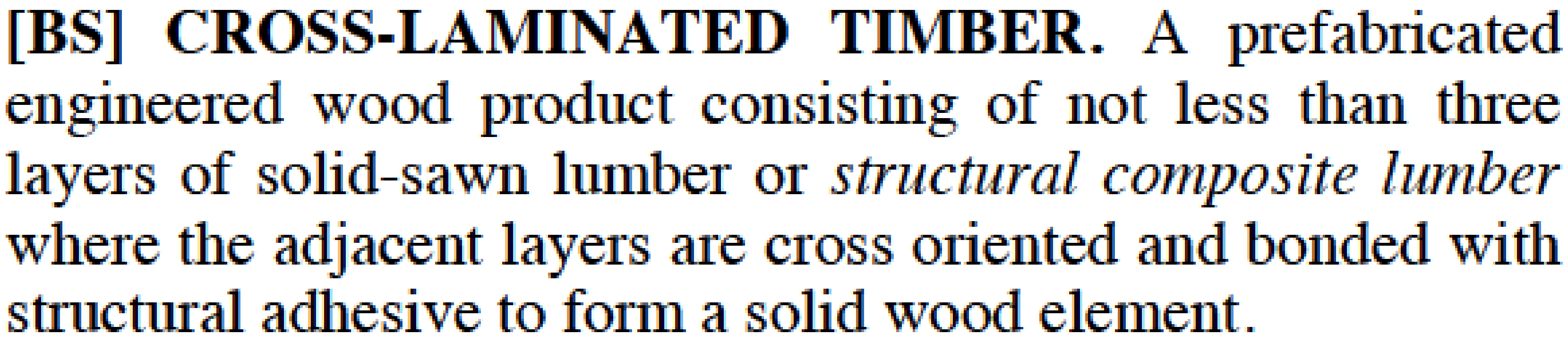
Alternate Means and Methods Request (AMMR) through performance based design



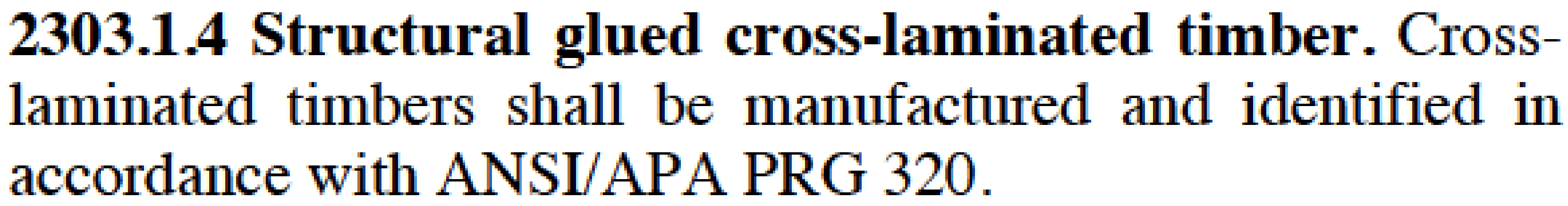
Type V → Type III
Type IV (HT) → + Mezzanines → + Podiums

U.S. TALL WOOD
DEVELOPMENT AND CHANGES

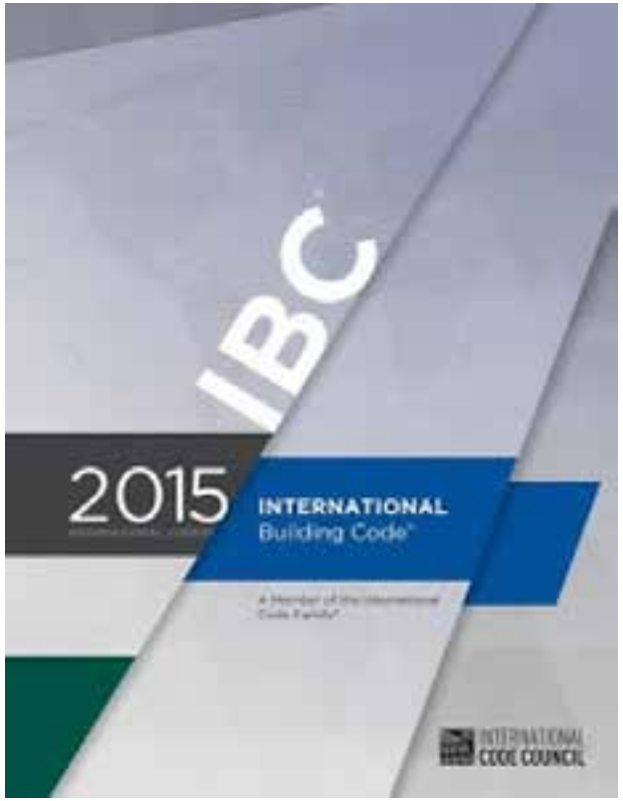
Seen as the catalyst for the mass timber revolution, CLT first recognized in US codes in the 2015 IBC



[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.



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



U.S. TALL WOOD
DEVELOPMENT AND CHANGES

In December 2015, the ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings. Objectives:

1. Explore the building science of tall wood buildings
2. Investigate the feasibility, and
3. Take action on developing code changes for tall wood buildings.

Taller wood buildings create new set of challenges to address:

AHC established 6 performance objectives:

1. No collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered.
2. Highly reliable fire suppression systems to reduce the risk of failure during reasonably expected fire scenarios. The degree of reliability should be proportional to evacuation time (height) and the risk of collapse.

Photo: LEVER Architecture

AHC established 6 performance objectives:

3. No unusually high radiation exposure from the subject building to adjoining properties to present a risk of ignition under reasonably severe fire scenarios.
4. No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.

AHC established 6 performance objectives:

5. No unusual fire department access issues
6. Egress systems designed to protect building occupants during the design escape time, plus a factor of safety.

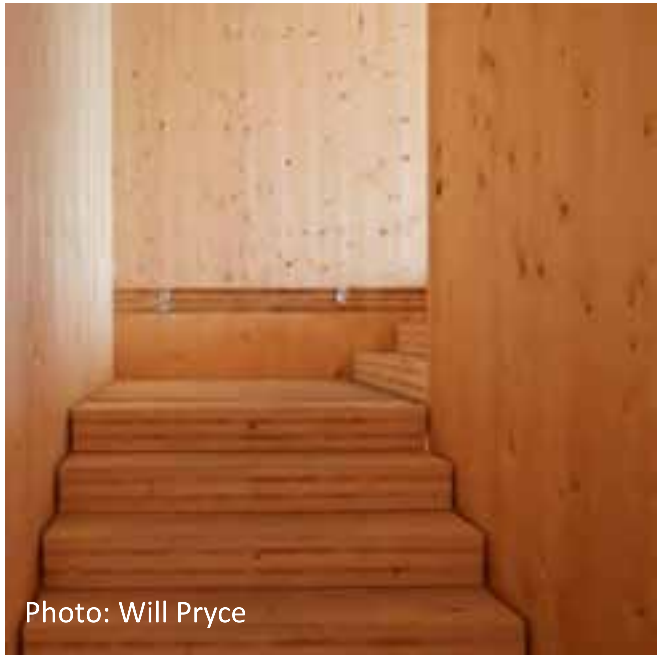


Photo: Will Pryce

U.S. BUILDING CODES

Tall Wood Ad Hoc Committee

Commissioned series of 5 full-scale tests on 2-story mass timber structure at ATF lab in MD, May-June 2017

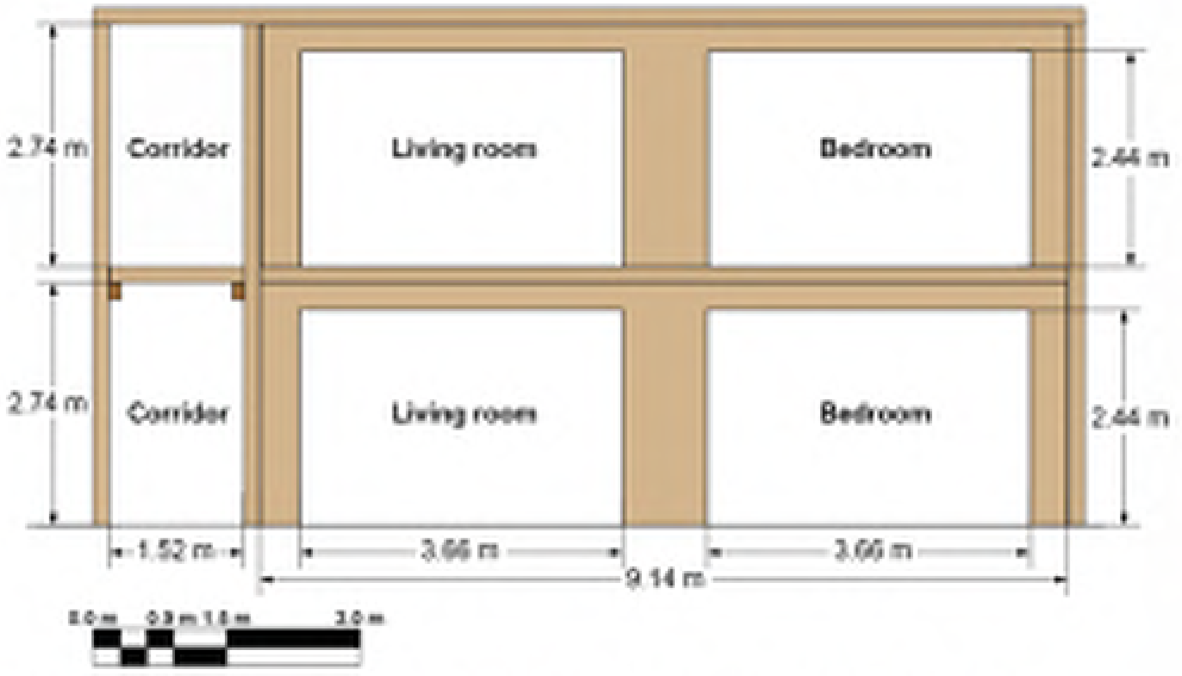


Figure 2. Elevation view of the front of the cross-laminated timber test structure.

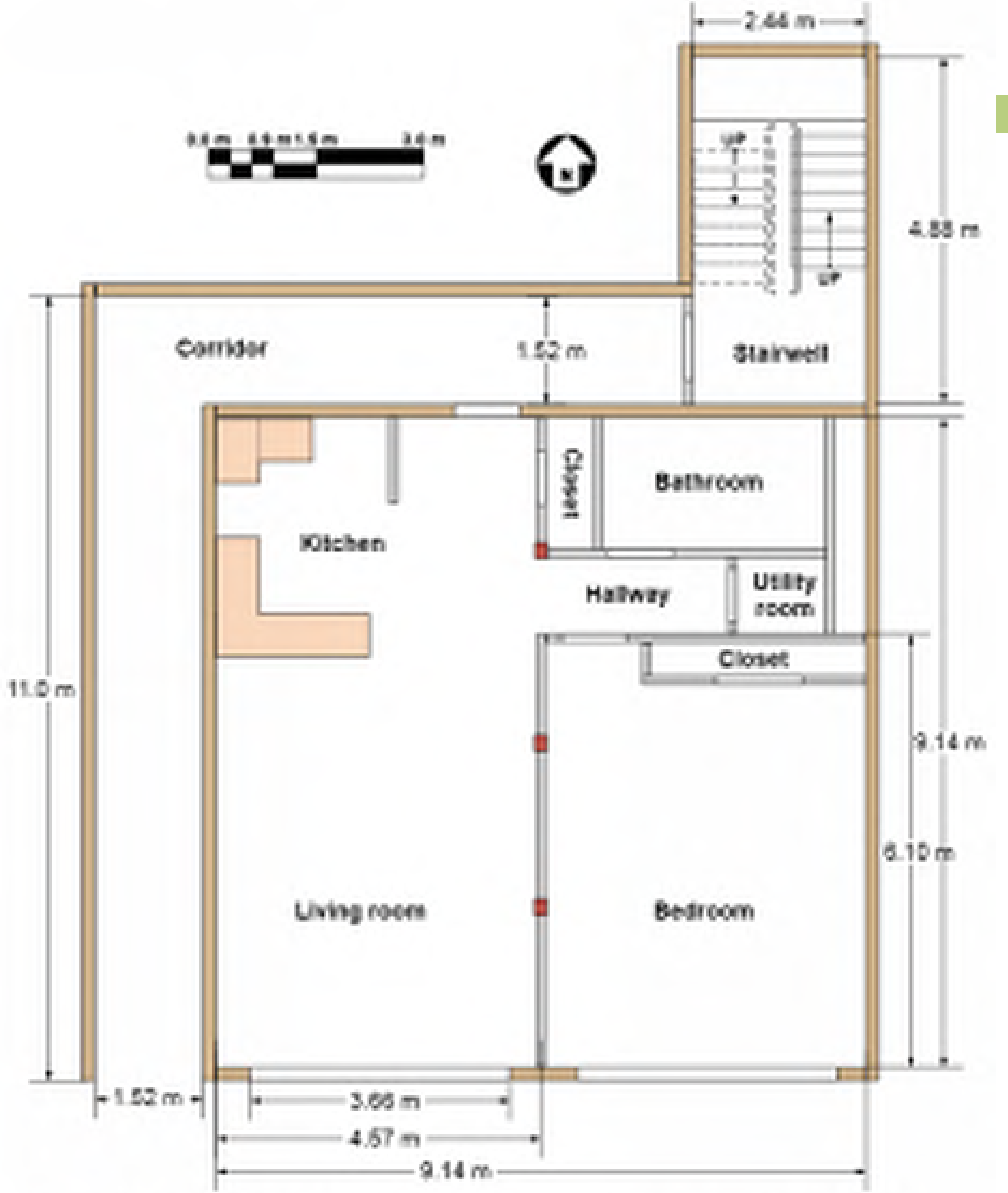


Figure 1. General plan view of cross-laminated timber test structure.

Images: AWC

U.S. BUILDING CODES

Tall Wood Ad Hoc Committee

Tests on exposed mass timber, gypsum-covered mass timber; normal sprinkler protection, delayed sprinkler protection

Majority of flames seen are from contents, not structure

Photo: LendLease

Photo: LendLease

Photo: LendLease

Photo: LendLease

Photo: LendLease

TALL WOOD APPROVED!

Unofficial results posted Dec 19, 2018

Final votes ratified Jan 31, 2019

AWC: Tall Mass Timber code changes get final approval

Dec 19, 2018

LEESBURG, VA – The International Code Council (ICC) has released the unofficial voting results on code change proposals considered in 2018, including passage of the entire package of 14 tall mass timber code change proposals. The proposals create three new types of construction (Types IV-A, IV-B and IV-C), which set fire safety requirements, and allowable heights, areas and number of stories for tall mass timber buildings. Official results are expected to be announced during the first quarter of 2019. The new provisions will be included in the 2021 *International Building Code* (IBC).

"Mass timber has been capturing the imagination of architects and developers, and the ICC result means they can now turn sketches into reality. ICC's rigorous study, testing and voting process now

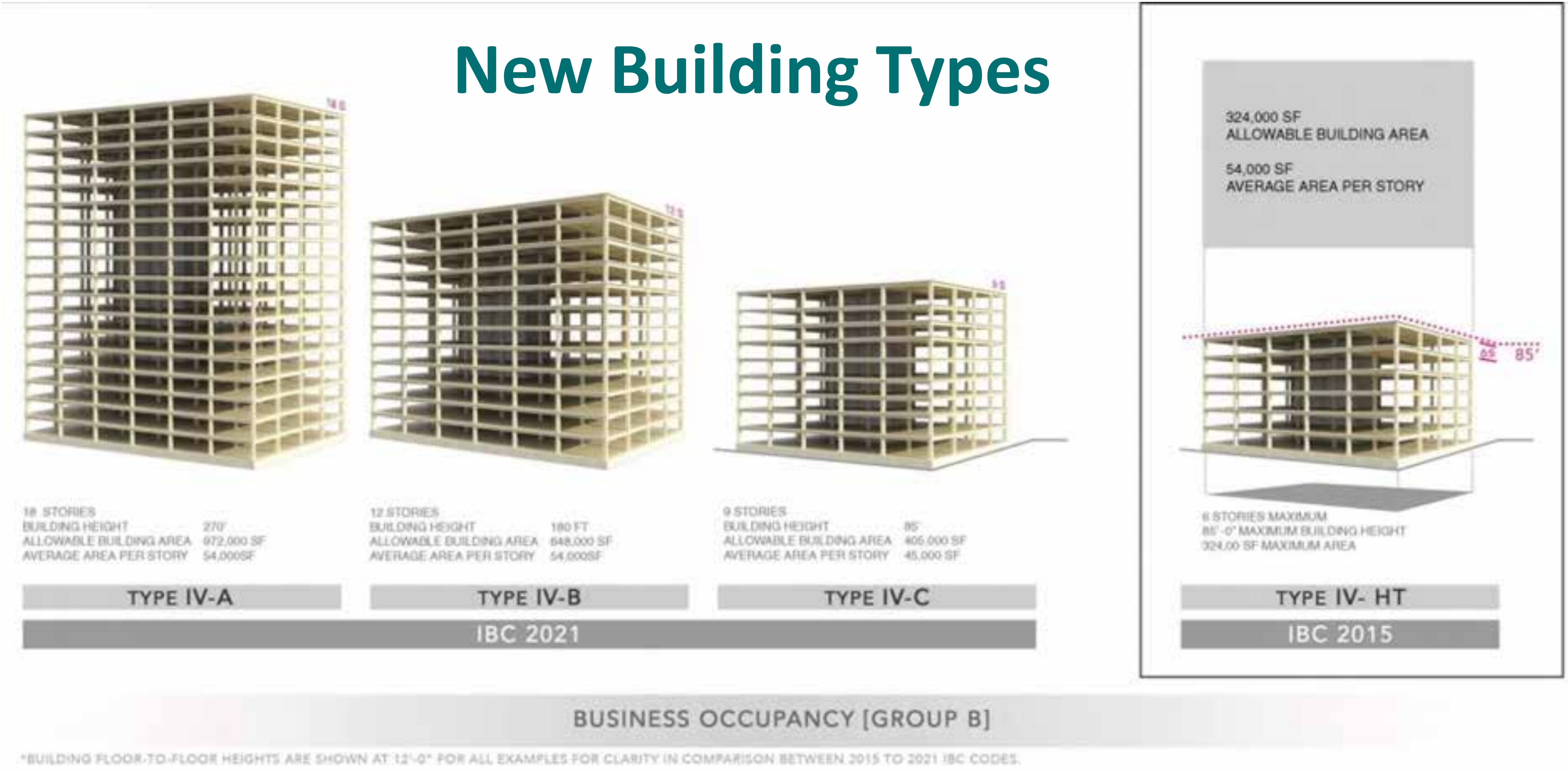
2021 IBC Introduces 3 new tall wood construction types:

IV-A, IV-B, IV-C

Previous type IV renamed type IV-HT

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B

New Building Types



Credit: Susan Jones, atelierjones

Type IV-A

18 STORIES

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

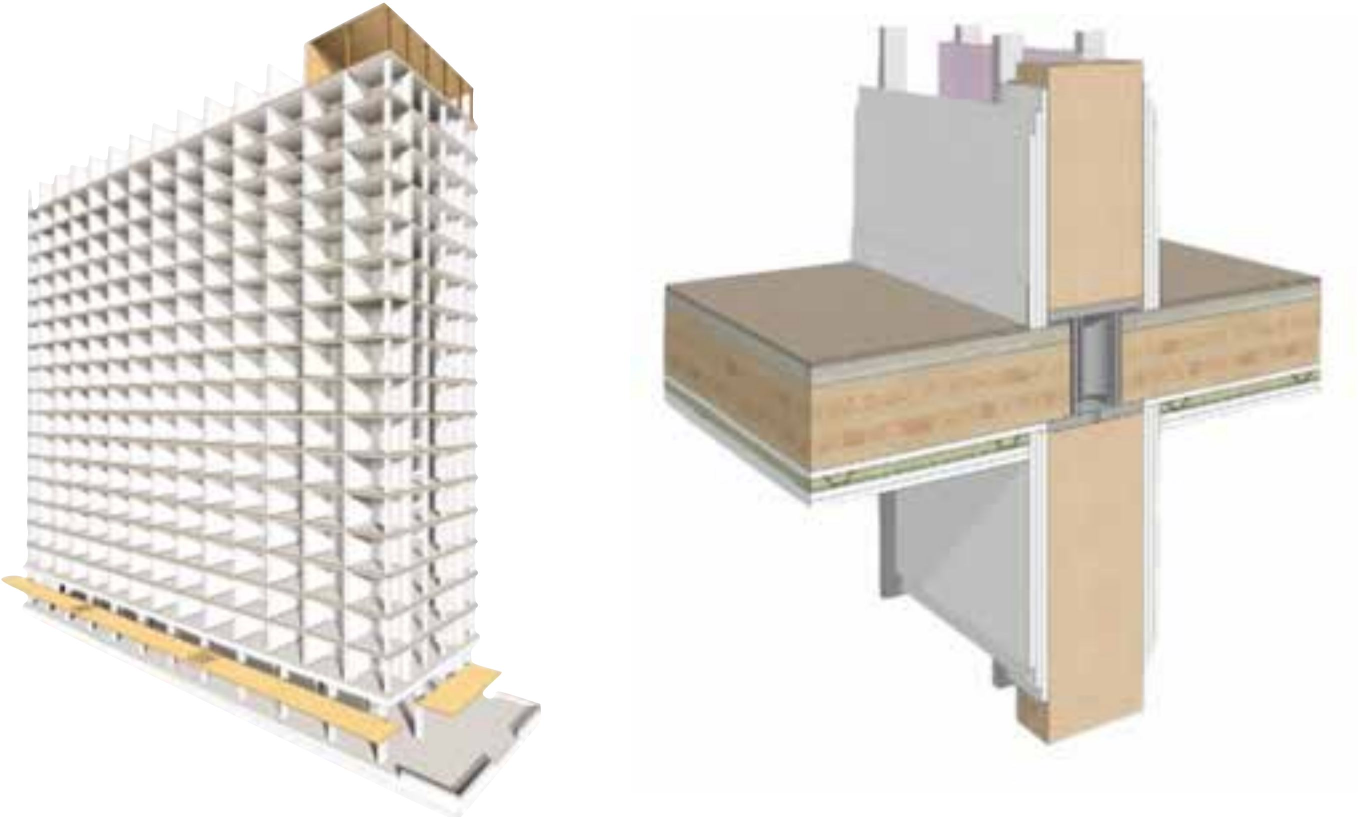
TYPE IV-A

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp, Urban One

Type IV-A Protection vs. Exposed

Credit: Susan Jones, atelierjones



Credit: Acton Ostry Architects, Fast + Epp

100% NC protection on all surfaces of Mass Timber

Type IV-B

12 STORIES

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

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Protection vs. Exposed

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

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, see code for requirements

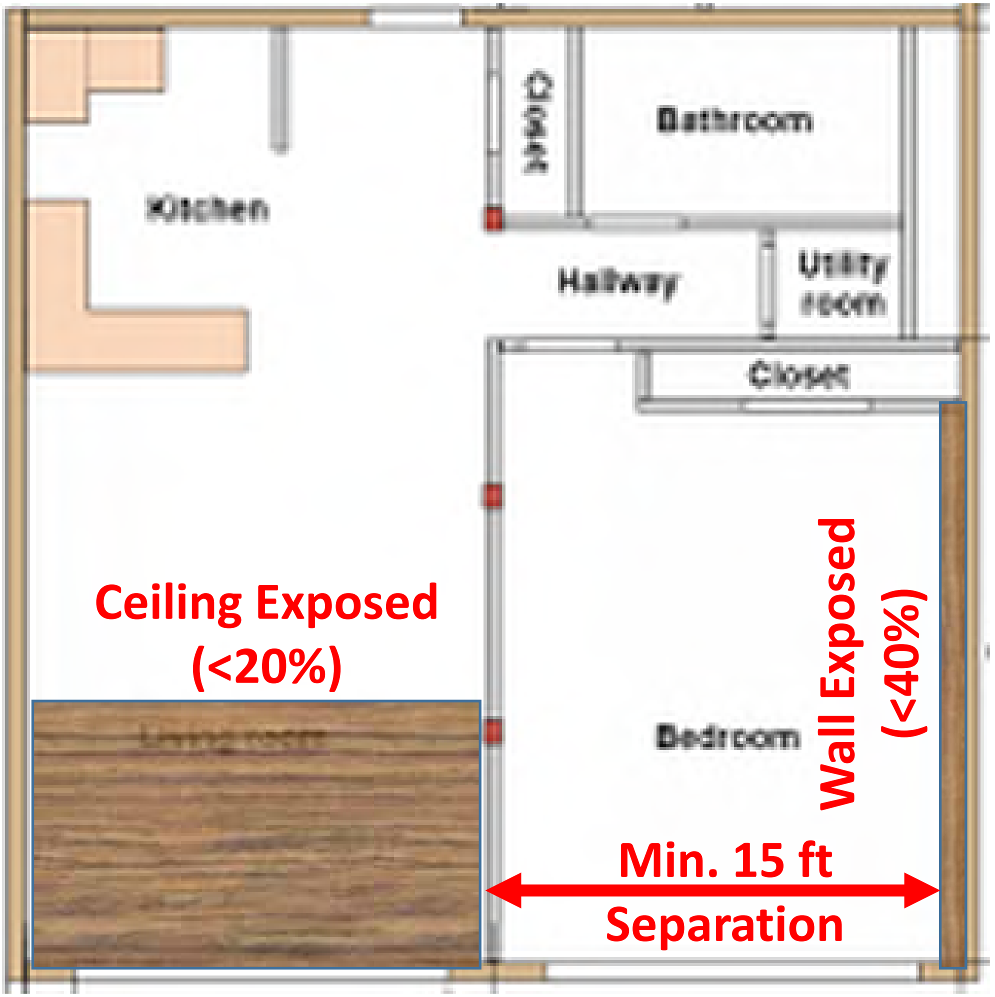
2024 IBC Changes

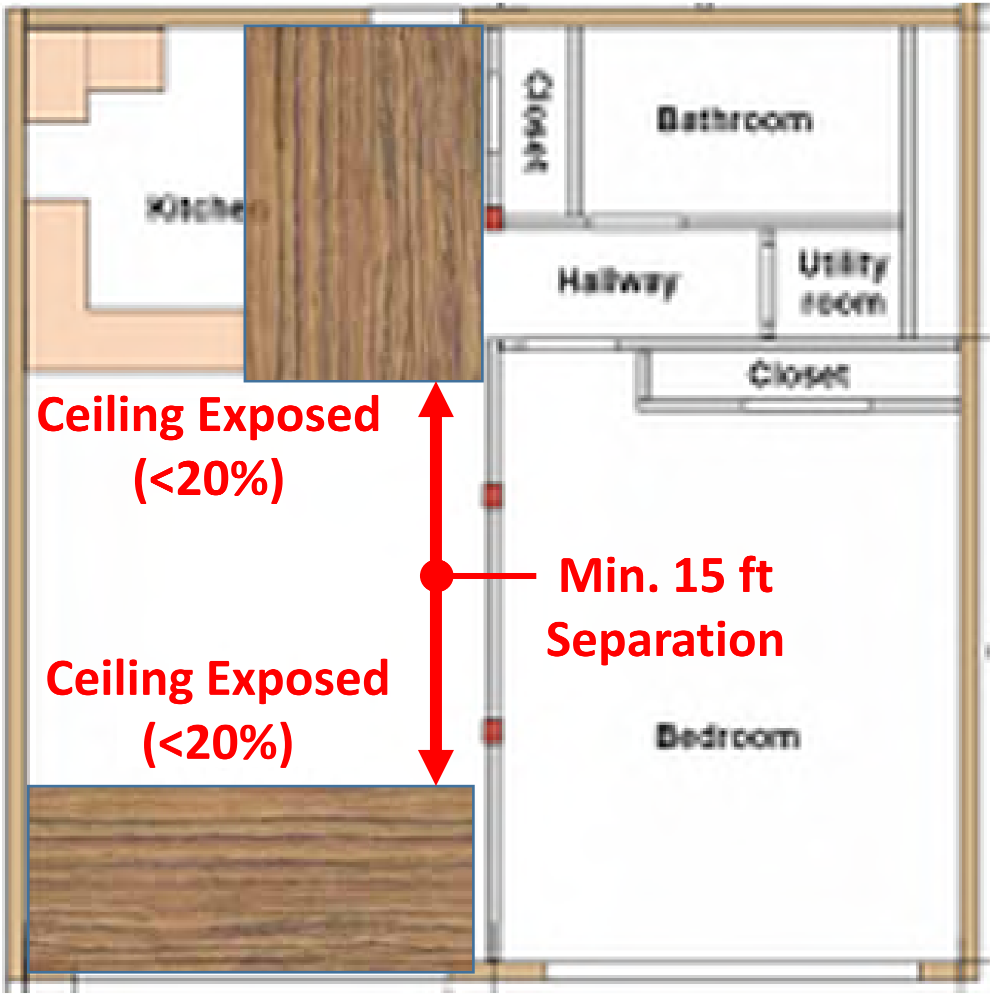
RISE Tests, 2020
Photo: RISE

Type IV-B Protection vs. Exposed

IV-B

2021 IBC Allowances



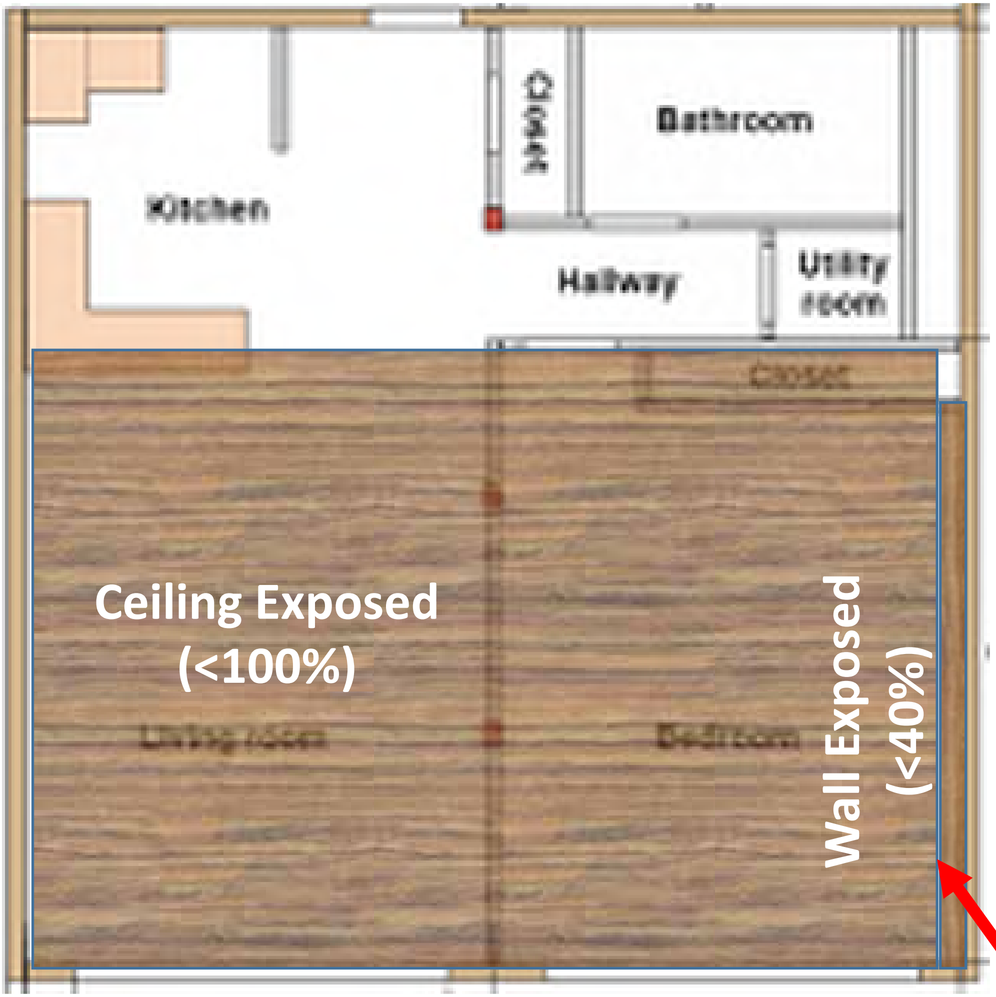


Credit: AWC

Type IV-B Protection vs. Exposed

IV-B

2024 IBC Allowances



No separation req'd between wall & ceiling

Credit: AWC

Type IV-C

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Protection vs. Exposed

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

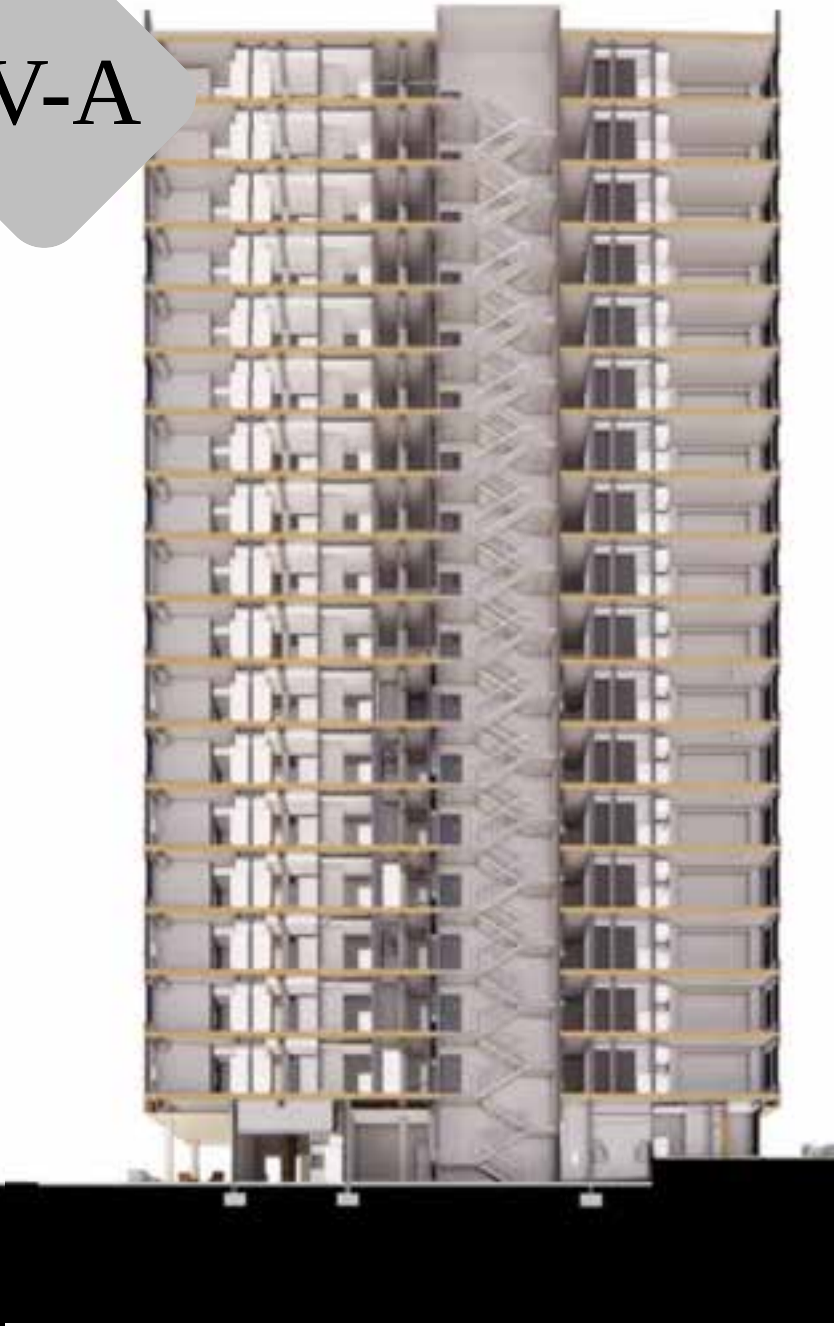
All Mass Timber surfaces may be exposed

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

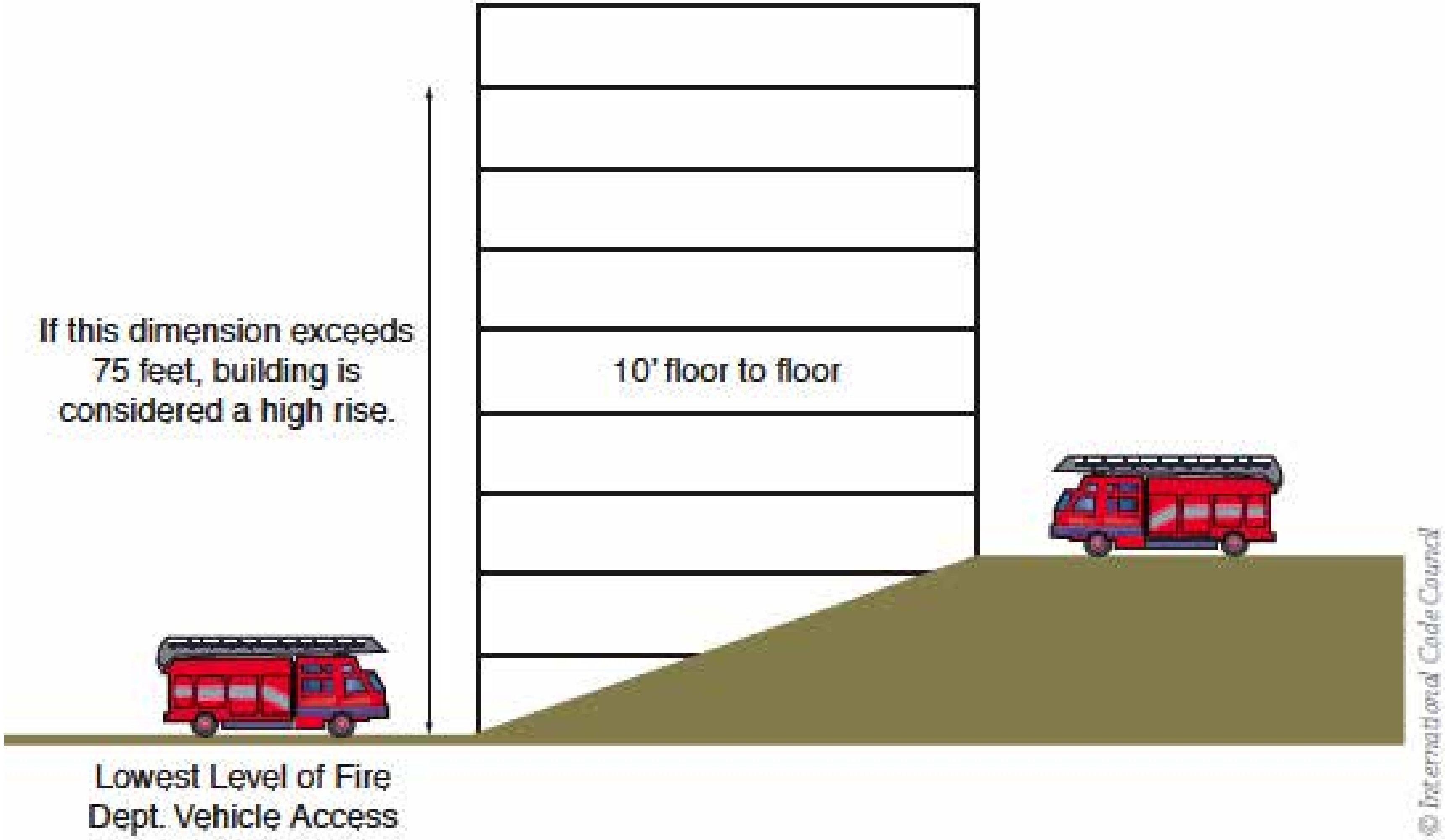
IV-C

IV-B

IV-A



Mid-Rise vs. High-Rise



© International Code Council

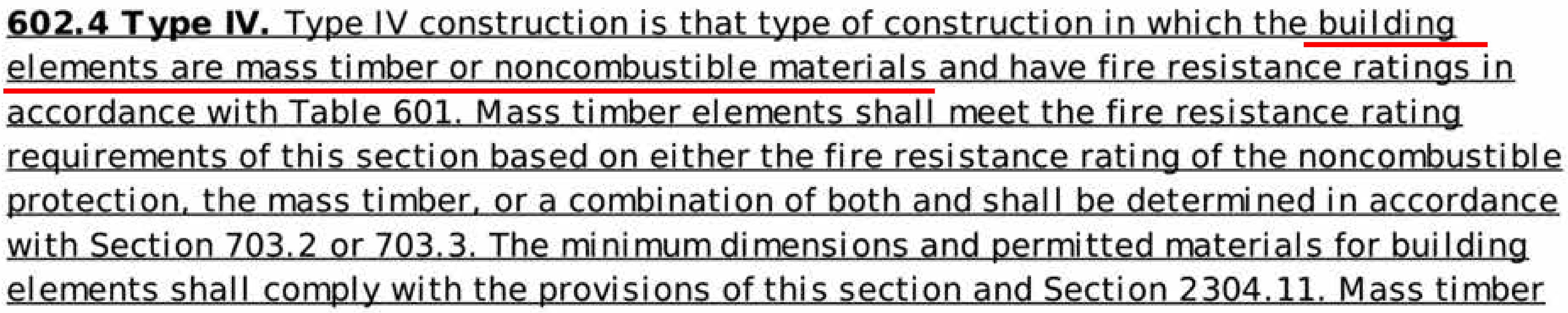
FIGURE 6-6 Determination of high-rise building

Sprinklers in High Rises

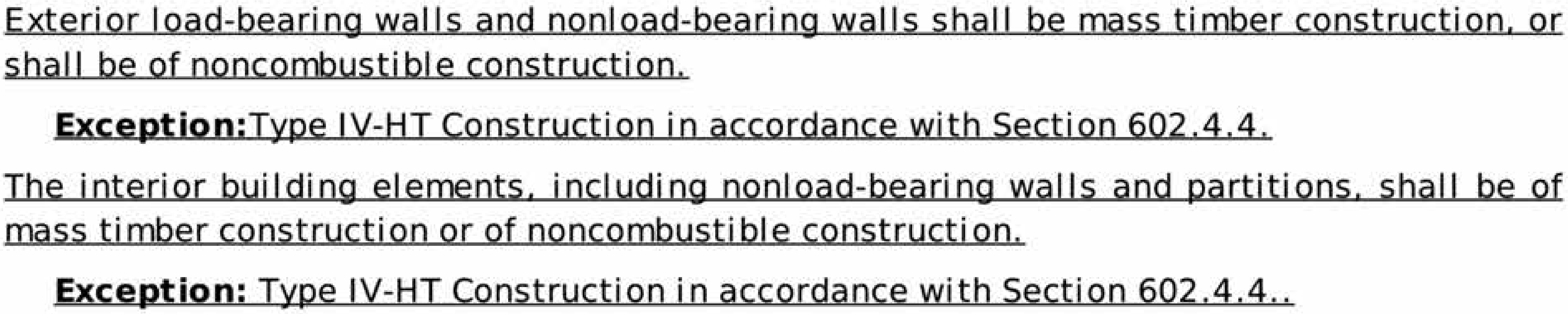
- **Two Water Mains Required if:**
    - Building Height Exceeds 420 ft, or
    - **Type IV-A and IV-B buildings that exceed 120 ft in height**


Photo: Michael Green Architecture

Materials Permitted



602.4 Type IV. Type IV construction is that type of construction in which the building elements are mass timber or noncombustible materials and have fire resistance ratings in accordance with Table 601. Mass timber elements shall meet the fire resistance rating requirements of this section based on either the fire resistance rating of the noncombustible protection, the mass timber, or a combination of both and shall be determined in accordance with Section 703.2 or 703.3. The minimum dimensions and permitted materials for building elements shall comply with the provisions of this section and Section 2304.11. Mass timber



Exterior load-bearing walls and nonload-bearing walls shall be mass timber construction, or shall be of noncombustible construction.

Exception: Type IV-HT Construction in accordance with Section 602.4.4.

The interior building elements, including nonload-bearing walls and partitions, shall be of mass timber construction or of noncombustible construction.

Exception: Type IV-HT Construction in accordance with Section 602.4.4..

MT Type IV Minimum Sizes

In addition to meeting FRR, all MT elements must also meet minimum sizes

These minimum sizes have been in place for old type IV (current type IV-HT) construction and the same minimums sizes also apply to MT used in new types IV-A, IV-B and IV-C

Contained in IBC 2304.11

Photo:: Ema Peter

Noncombustible Protection (NC)

The definition of “Noncombustible Protection (For Mass Timber)” is created to address the passive fire protection of mass timber.

Mass timber is permitted to have its own fire-resistance rating (e.g., Mass Timber only) or have a fire resistance rating based on the fire resistance through a combination of the mass timber fire-resistance plus protection by non-combustible materials as defined in Section 703.5 (e.g., additional materials that delay the combustion of mass timber, such as gypsum board).

Credit: Urban One

Tall Wood Materials & Protection

<table>
<tr><th></th><th>IV-A</th><th>IV-B</th><th>IV-C</th></tr>
<tr><td>Exterior Walls</td><td colspan="3">Mass Timber, exterior surface protected with 1 layer 5/8” type X gyp</td></tr>
<tr><td>Structural Materials</td><td colspan="3">Mass Timber or Non-combustible</td></tr>
<tr><td>Concealed Spaces</td><td colspan="3">Permitted, requires NC protection on MT surfaces</td></tr>
<tr><td>Gypsum Protection</td><td>All MT is protected
3 HR: 3 layers 5/8” type X gyp
2 HR or less: 2 layers 5/8” type X gyp</td><td>Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies</td><td>All MT permitted may be exposed except as noted</td></tr>
</table>

Tall Wood Fire Resistance Ratings (FRR)

	IV-A	IV-B	IV-C
Primary Frame or Brng Wall FRR	3 HR (2 HR at Roof)	2 HR (1 HR at Roof)	2 HR (1 HR at Roof)
Floor Construction FRR	2 HR	2 HR	2 HR
Roof Construction FRR	1.5 HR	1 HR	1 HR
Floor Surface Protection	1 inch of NC protection	1 inch of NC protection	No protection req’d

MT Fire Resistance Ratings (FRR)

IBC 722.7

The fire resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element (MT) added to the protection time of the noncombustible (NC) protection.

Mass Timber

+

Non-Combustible

Credit: Urban One

=

Fire Resistance Rating

Fire Safety During Construction

New code provisions in International Fire Code (IFC) address construction fire safety of tall wood buildings

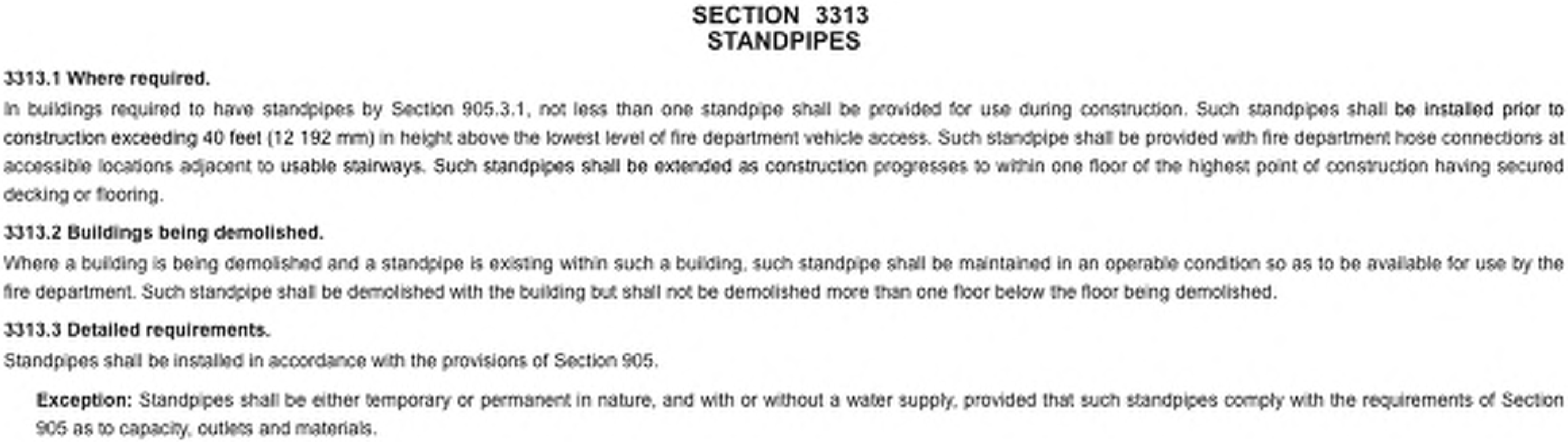
IFC 3308.4 Fire safety requirements for buildings of Types IV-A, IV-B, and IV-C construction. Buildings of Types IV-A, IV-B, and IV-C construction designed to be greater than six stories above grade plane shall meet the following requirements during construction unless otherwise approved by the fire code official.

1. Standpipes shall be provided in accordance with Section 3313.
2. A water supply for fire department operations, as approved by the fire chief.

Photo: Structurlam

Fire Safety During Construction

IFC/CFC 3313 Standpipe Requirements



SECTION 3313
STANDPIPES

3313.1 Where required.

In buildings required to have standpipes by Section 905.3.1, not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairways. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

3313.2 Buildings being demolished.

Where a building is being demolished and a standpipe is existing within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

3313.3 Detailed requirements.

Standpipes shall be installed in accordance with the provisions of Section 905.

> **Exception:** Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes comply with the requirements of Section 905 as to capacity, outlets and materials.

Credit: IFC

Fire Safety During Construction

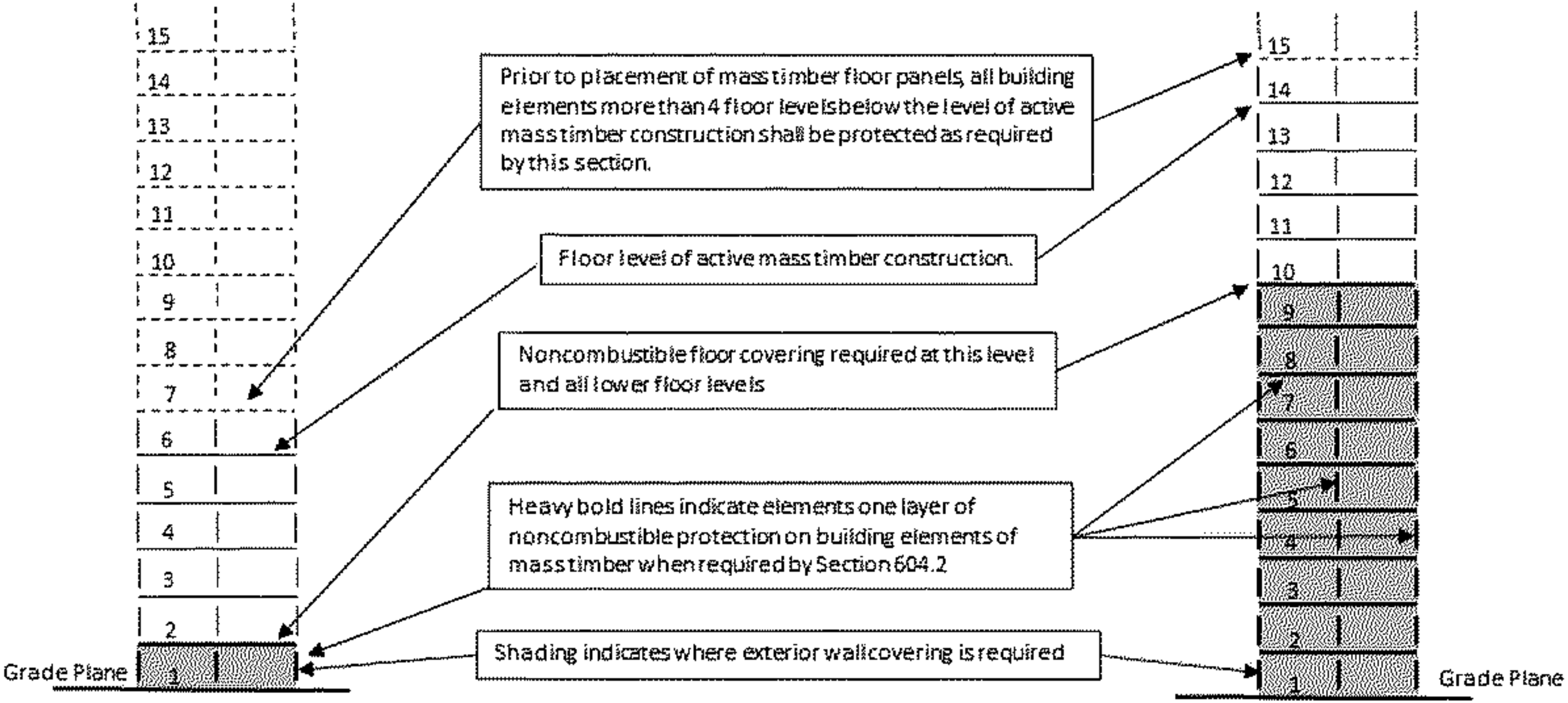
IFC 3308.4 Cont'd

3. Where building construction exceeds six stories above grade plane, at least one layer of noncombustible protection where required by Section 602.4 of the International Building Code shall be installed on all building elements more than 4 floor levels, including mezzanines, below active mass timber construction before erecting additional floor levels.
4. Where building construction exceeds six stories above grade plane required exterior wall coverings shall be installed on all floor levels more than 4 floor levels, including mezzanines, below active mass timber construction before erecting additional floor level.


Photo: Urban One

Exception: Shafts and vertical exit enclosures

Fire Safety During Construction



Prior to placement of mass timber floor panels, all building elements more than 4 floor levels below the level of active mass timber construction shall be protected as required by this section.

Floor level of active mass timber construction.

Noncombustible floor covering required at this level and all lower floor levels

Heavy bold lines indicate elements one layer of noncombustible protection on building elements of mass timber when required by Section 604.2

Shading indicates where exterior wallcovering is required

Figure 1

Figure 2

Examples of Protection During Construction For Mass Timber Buildings Greater Than 6 Stories Above Grade Plane

Credit: ICC

WoodWorks™
WOOD PRODUCTS COUNCIL

Tall Wood Buildings in the 2021 IBC
Up to 18 Stories of Mass Timber

Scott Breneman, PhD, SE, WoodWorks – Wood Products Council • Matt Timmers, SE, John A. Martin & Associates • Dennis Richardson, PE, CBO, CASp, American Wood Council

In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings as part of the 2021 International Building Code (IBC). Based on these proposals, the 2021 IBC will include three new construction types—Type IV-A, IV-B and IV-C—allowing the use of mass timber or noncombustible materials. These new types are based on the previous Heavy Timber construction type (renamed Type IV-HT) but with additional fire-resistance ratings and levels of required noncombustible protection. The code will include provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies.

Based on information first published in the Structural Engineers Association of California (SEAOC) 2019 Conference Proceedings, this paper summarizes the background to these proposals, technical research that supported their adoption, and resulting changes to the IBC and product-specific standards.

Background: ICC Tall Wood Building Ad Hoc Committee

Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Breneman 2013, Timmers 2015). Around the world there

Forté	Melbourne, Australia	8-over-1	2012
Via Cenni	Milan, Italy	9	2013

WoodWorks Tall Wood Design Resource

https://www.woodworks.org/resources/tall-wood-buildings-in-the-2021-ibc-up-to-18-stories-of-mass-timber/

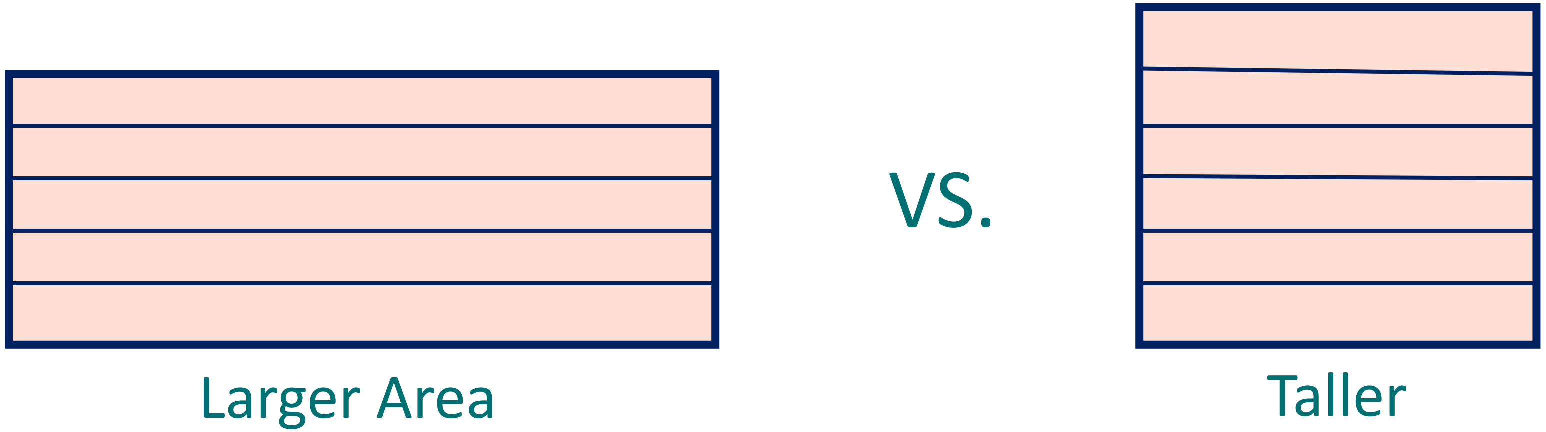
TALL WOOD CODE ADOPTION IN CALIFORNIA

CBC Tall Wood Building Size Limits

The CBC has historically not allowed “double-dipping” for sprinkler increases of building height and area for A, E, H, I, L or R occupancies. The IBC has no such restriction.

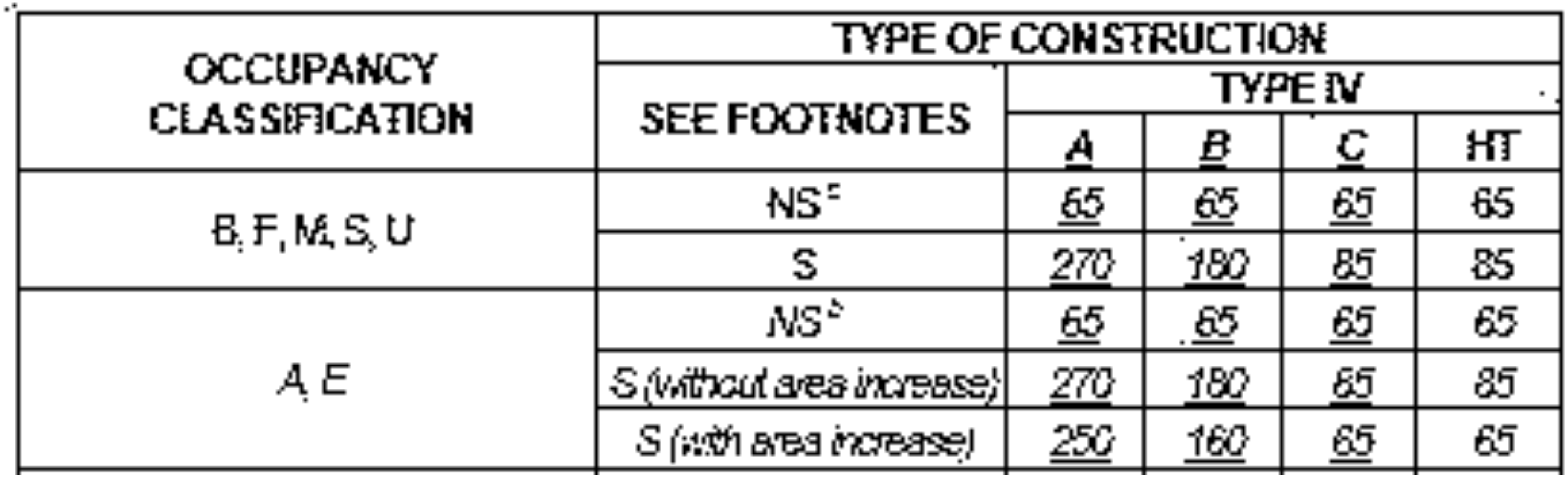
Also specific to the CBC, for multi-story buildings that are A, E, H, I, L or R occupancies, the total allowable building area is equal to the allowable floor area multiplied by the number of stories, not to exceed 2. In the IBC, this value is 3 for all occupancies.

This is also the case for Tall Wood.



CBC Tall Wood Building Size Limits

For example, if using the sprinkler area increases, the allowable height in the CBC is 20 ft and 1 story less than the IBC limits for Type IV-A, IV-B and IV-C construction for A, E, H-4, I-4, R-1 and R-2 occupancies.



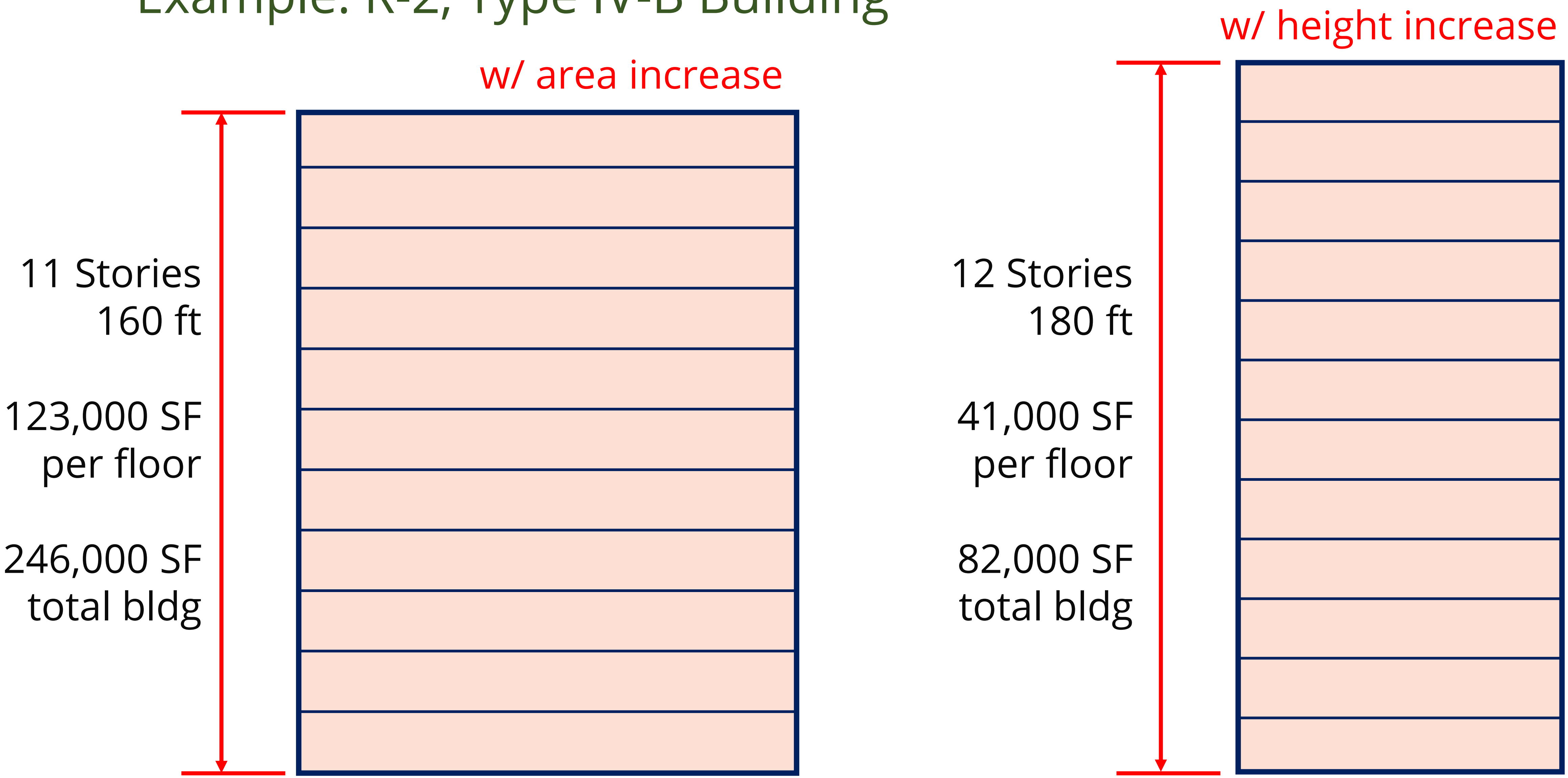
OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION				
	SEE FOOTNOTES	TYPE IV			
		A	B	C	HT
B, F, M, S, U	NS[c]	65	65	65	65
	S	270	180	85	85
A, E	NS[c]	65	65	65	65
	S (without area increase)	270	180	85	85
	S (with area increase)	250	160	65	65

CBC Tall Wood Building Size Limits

	Construction Type (Sprinklered Values)						
	I-A	I-B	**IV-A**	**IV-B**	**IV-C**	IV-HT	III-A
Occupancies	**Allowable Building Height above Grade Plane, Feet (CBC Table 504.3)**						
B, F, M, S, U, R-3, R-4	Unlimited	180*	**270**	**180**	**85**	85	85
A, E, R-1, R-2 (w/ area increase)	Unlimited	180 (160)	**270 (250)**	**180 (160)**	**85 (65)**	85 (65)	85 (65)
	Allowable Number of Stories above Grade Plane (CBC Table 504.4)						
A-2, A-3, A-4 (w/ area increase)	Unlimited	12 (11)	**18 (17)**	**12 (11)**	**6 (5)**	4 (3)	4 (3)
B	Unlimited	12	**18**	**12**	**9**	6	6
R-1, R-2 (w/ area increase)	Unlimited	12 (11)	**18 (17)**	**12 (11)**	**8 (7)**	5 (4)	5 (4)
	Allowable Area Factor (At) for SM, Feet^2 (CBC Table 506.2)						
A-1, A-2, A-3, A-4 (w/ height increase)	Unlimited	Unlimited	**135,000 (45,000)**	**90,000 (30,000)**	**56,250 (18,750)**	45,000 (15,000)	42,000 (14,000)
B	Unlimited	Unlimited	**324,000**	**216,000**	**135,000**	108,000	85,500
R-1, R-2 (w/ height increase)	Unlimited	Unlimited	**184,500 (61,500)**	**123,000 (41,000)**	**76,875 (25,625)**	61,500 (20,500)	72,000 (24,000)

CBC Tall Wood – Sprinkler Increase Options

Example: R-2, Type IV-B Building



w/ area increase

11 Stories
160 ft

123,000 SF
per floor

246,000 SF
total bldg

w/ height increase

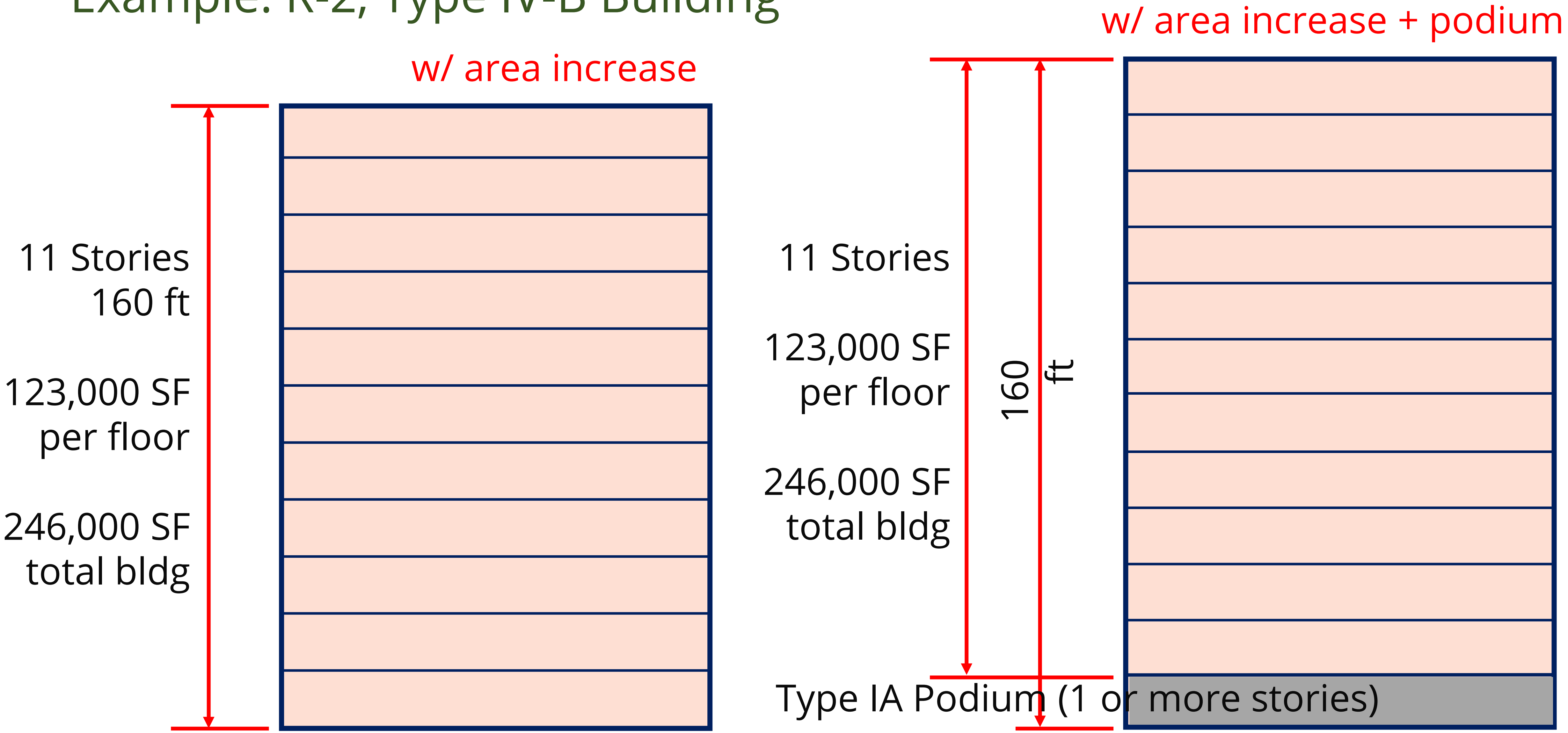
12 Stories
180 ft

41,000 SF
per floor

82,000 SF
total bldg

CBC Tall Wood – Podium Option (w/ Sprinkler Increase)

Example: R-2, Type IV-B Building



w/ area increase

11 Stories
160 ft

123,000 SF
per floor

246,000 SF
total bldg

w/ area increase + podium

11 Stories

123,000 SF
per floor

246,000 SF
total bldg

160 ft

Type IA Podium (1 or more stories)