



# A New Path Forward for Tall Wood Construction: Code Provisions and Design Steps

Seattle Wood Design Symposium

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Credit: PATH Architecture

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



# Course Description

We are at an exciting confluence in timber construction. The need for sustainable, urban construction has never been higher. Concurrently, mass timber products such as cross-laminated timber have opened the door to many new opportunities for construction, one of which is tall wood. In January 2019, the International Code Council (ICC) approved a set of proposals to allow tall wood buildings of up to 18 stories as part of the 2021 International Building Code (IBC). This presentation will introduce the new tall wood code provisions in depth. Starting with a review of the technical research and testing that supported their adoption, it will then take a detailed look at the new code provisions and methods of addressing the new requirements. Topics will include fire-resistance ratings and allowances for exposed timber, penetrations, sprinklers, connections, exterior walls and much more. Designers can expect to take away the knowledge they need to start exploring tall wood designs on their projects.

# 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 14 new code provisions for the 2021 IBC that address tall wood construction.
3. Discuss code-compliant options for exposing mass timber, where up to 2-hour fire-resistance ratings are required, and demonstrate design methodologies for achieving these ratings.
4. Review code requirements unique to tall wood buildings, focusing on items such as sprinklers, shaft construction and concealed spaces.

# New Building Types – IV-A, IV-B, and IV-C



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

TYPE IV-A



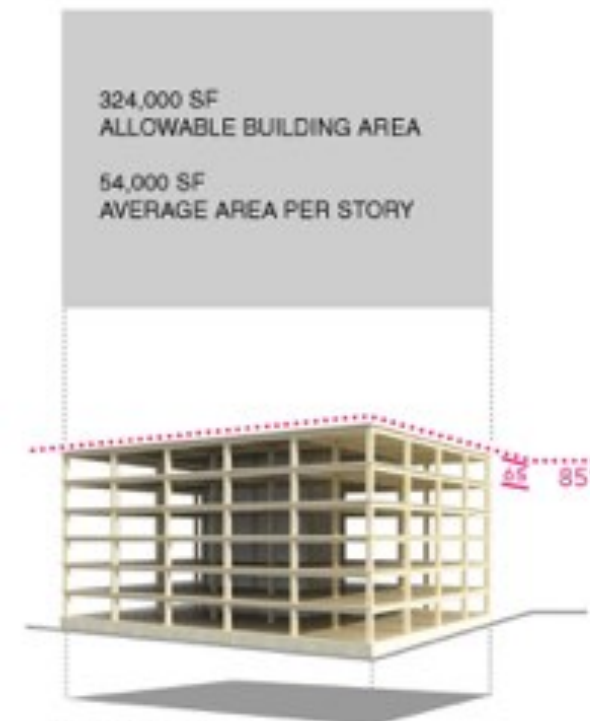
12 STORIES  
BUILDING HEIGHT 180 FT  
ALLOWABLE BUILDING AREA 648,000 SF  
AVERAGE AREA PER STORY 54,000SF

TYPE IV-B



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

TYPE IV-C



6 STORIES MAXIMUM  
85'-0" MAXIMUM BUILDING HEIGHT  
324,00 SF MAXIMUM AREA

TYPE IV- HT

IBC 2015

IBC 2021

## BUSINESS OCCUPANCY [GROUP B]

\*BUILDING FLOOR-TO-FLOOR HEIGHTS ARE SHOWN AT 12'-0" FOR ALL EXAMPLES FOR CLARITY IN COMPARISON BETWEEN 2015 TO 2021 IBC CODES.



# Building Elements in Type IV Construction



Photo:: Ema Peter

Minimum sizes for existing  
Type IV (now IV-HT)  
apply to the new  
Type IV-A, IV-B and IV-C

See  
IBC 2018 2304.11  
IBC 2015 602.4

## Type IV Minimum Timber Sizes - Framing

Framing		Solid Sawn (nominal)	Glulam (actual)	SCL (actual)
Floor	Columns	8 x 8	$6\frac{3}{4} \times 8\frac{1}{4}$	$7 \times 7\frac{1}{2}$
	Beams	6 x 10	$5 \times 10\frac{1}{2}$	$5\frac{1}{4} \times 9\frac{1}{2}$
Roof	Columns	6 x 8	$5 \times 8\frac{1}{4}$	$5\frac{1}{4} \times 7\frac{1}{2}$
	Beams*	4 x 6	$3 \times 6\frac{7}{8}$	$3\frac{1}{2} \times 5\frac{1}{2}$

Minimum Width by Depth in Inches  
See IBC 2018 2304.11 or IBC 2015 602.4 for Details

\*3" nominal width allowed where sprinklered



Photo: WoodWorks



# Type IV Minimum Timber Sizes – Floor/Roof Decks

## Floor Panels/Decking:

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

## Roof Panels/Decking:

- 3" thick CLT (nominal thickness)
- 3" NLT/DLT/GLT (nominal thickness)
- 2" decking (nominal thickness)
- 1-1/8" WSP





# Tall Wood Fire Resistance Ratings (FRR)



Roof Construction

Primary Frame @ Roof

Floor Construction

Primary Frame

Exterior Bearing Walls

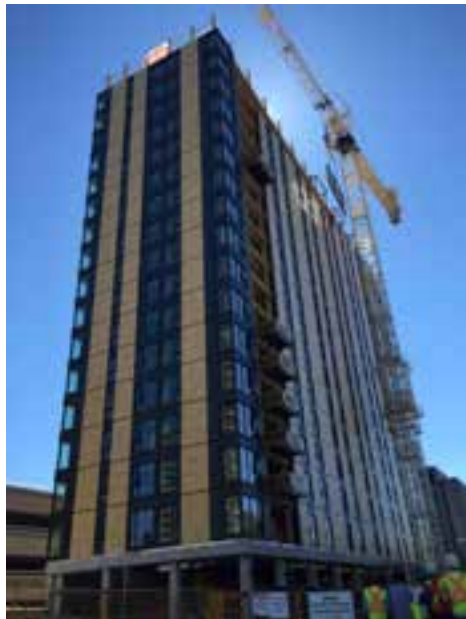
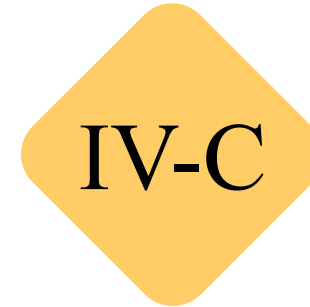
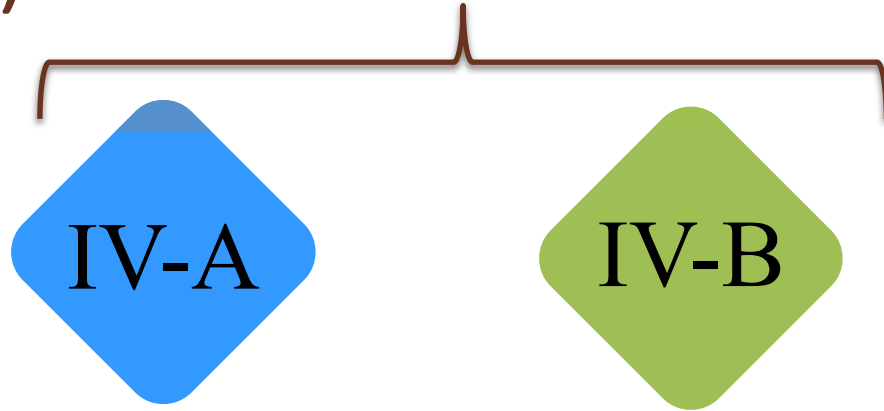
Interior Bearing Walls

<b>1.5</b>	<b>1</b>	<b>1</b>	<b>HT</b>
<b>2</b>	<b>1</b>	<b>1</b>	<b>HT</b>
<b>2</b>	<b>2</b>	<b>2</b>	<b>HT</b>
<b>3</b>	<b>2</b>	<b>2</b>	<b>HT</b>
<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>
<b>3</b>	<b>2</b>	<b>2</b>	<b>1 or HT</b>

Required Fire Resistance Rating in Hours (per Table 601 only)

# Noncombustible Protection

(NC) Noncombustible Protection Required



Credit: LEVER Architecture



Credit: PATH Architecture



Photo: Blaine Brownell

# Noncombustible Protection (NC)



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

**NONCOMBUSTIBLE PROTECTION (FOR MASS TIMBER)**  
Noncombustible material, in accordance with Section 703.5, designed to increase the fire-resistance rating and delay the combustion of mass timber.





# Noncombustible Protection (NC)

**TABLE 722.7.1(b)**  
**PROTECTION PROVIDED BY NONCOMBUSTIBLE COVERING MATERIAL**

<u>Noncombustible Protection</u>	<u>Protection Contribution (minutes)</u>
<u>1/2 inch Type X Gypsum Board</u>	<u>25</u>
<u>5/8 inch Type X Gypsum Board</u>	<u>40</u>

Other Noncombustible materials can qualify by comparative testing per new IBC 703.8

Protection from NC = Tested FRR with NC – Tested FRR without NC

# Noncombustible Protection (NC)

**TABLE 722.7.1(a)**

**PROTECTION REQUIRED FROM NONCOMBUSTIBLE COVERING MATERIAL**

<u>Required Fire Resistance Rating of Building Element per Tables 601 and 602 (hours)</u>	<u>Minimum Protection Required from Noncombustible Protection (minutes)</u>	
<u>1</u>	<u>40</u>	<b>1 layer 5/8 Type X</b>
<u>2</u>	<u>80</u>	<b>2 layers 5/8 Type X</b>
<u>3 or more</u>	<u>120</u>	<b>3 layers 5/8 Type X</b>

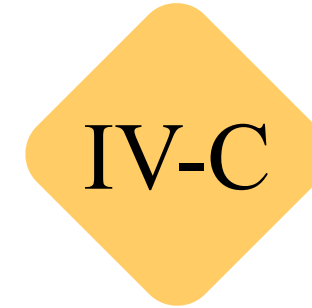
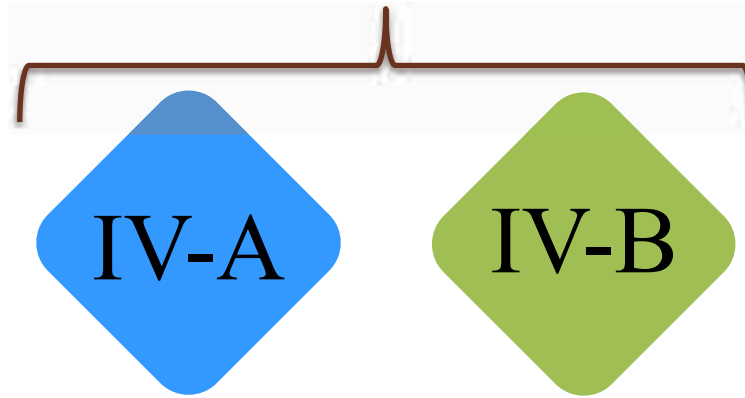


# Noncombustible Protection

(NC)



Noncombustible Protection Required



Roof below Mass Timber

Primary Frame @ Roof

Primary Frame

Below Mass Timber Floor

Above Mass Timber Floor

60 min	40 min*	Not Req.	Not Req.
80 min	40 min*	Not Req.	Not Req.
120 min	80 min*	Not Req.	Not Req.
80 min	80 min*	Not Req.	Not Req.
1" Min NC Material	1" Min NC Material	Not Req.	Not Req.

Requirements Per new 602.4. \* Some MT permitted to be exposed.



# 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.



+



= FRR

# IV-C

## Type IV-C Height and Area Limits



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

TYPE IV-C

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 additional stories permitted due to enhanced FRR**

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

# IV-C

## 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-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

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

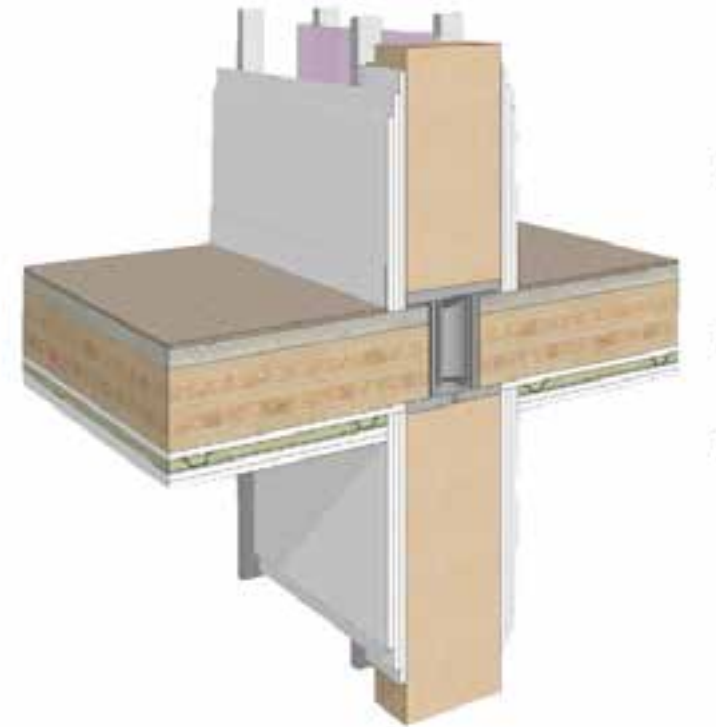
## Type IV-A Protected vs. Exposed



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-B

## Type IV-B Height and Area Limits



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

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**



# IV-B

## Type IV-B Protected vs. Exposed



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**

## IV-B

# Type IV-B Protected vs. Exposed

### 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



Credit: Kaiser+Path

## IV-B

# Type IV-B Protected vs. Exposed

### Horizontal separation of unprotected areas:

- Unprotected portions of mass timber walls and ceilings shall be not less than 15 feet from unprotected portions of other walls and ceilings, measured horizontally along the ceiling and from other unprotected portions of walls measured horizontally along the floor.



Credit: Kaiser+Path

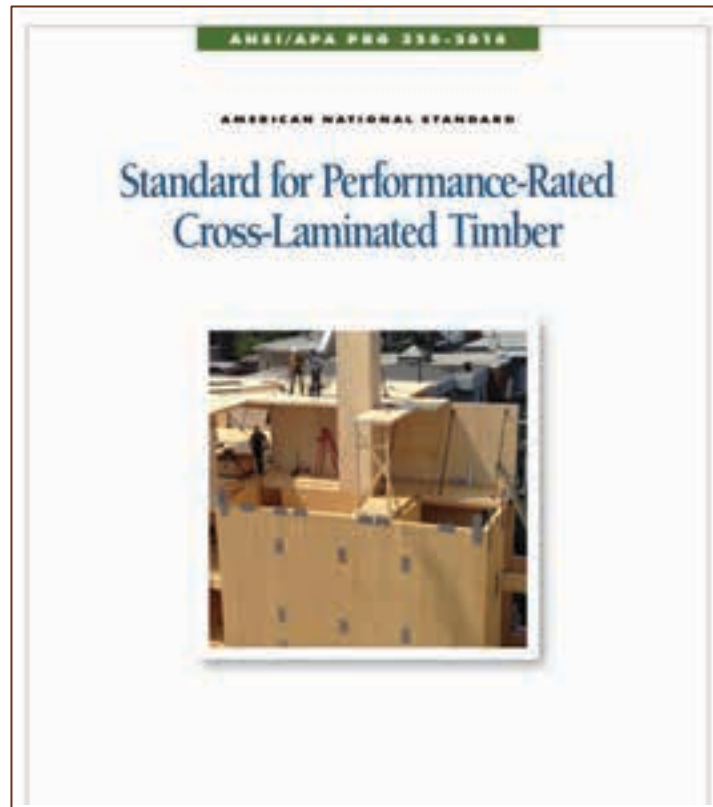
# Advanced CLT Fire Performance

## 2021 IBC Section 602.4 added:

Cross-laminated timber shall be labeled as conforming to PRG 320 - 18 as referenced in Section 2303.1.4.



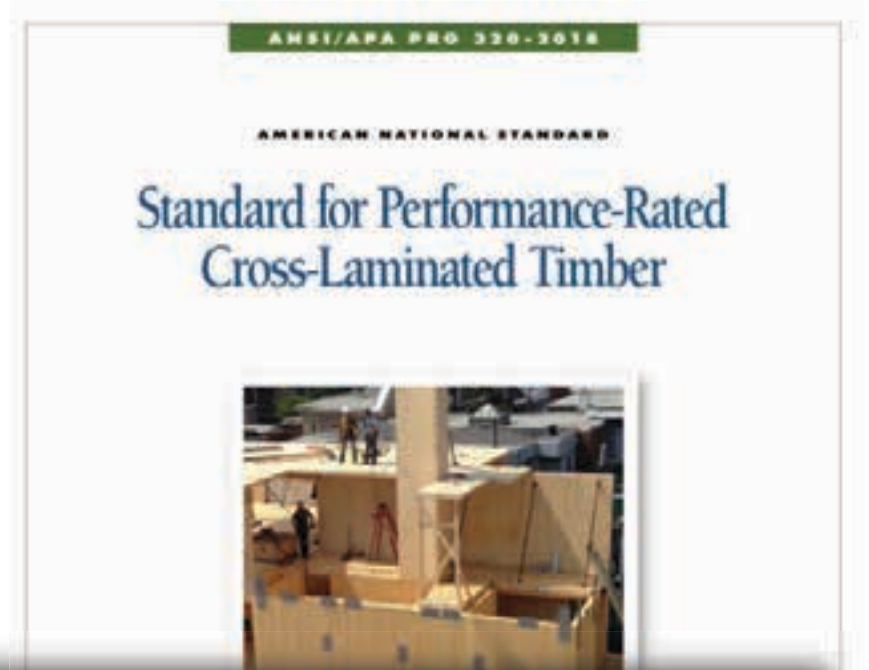
Photo: ARUP





# Advanced CLT Fire Performance

PRG 320 is manufacturing & performance standard for CLT. 2018 edition (referenced in 2021 IBC) added new elevated temp adhesive performance requirements



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

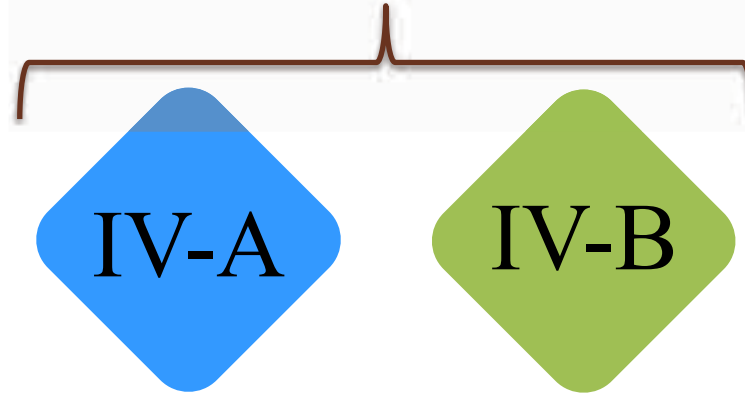
*Note 7. The intent of the elevated temperature performance evaluation is to identify and exclude use of adhesives that permit CLT char layer fall-off resulting in fire regrowth during the cooling phase of a fully developed fire.*

# Noncombustible Protection

(NC)



Noncombustible Protection Required



IV-A

IV-B

IV-C

IV-HT

Roof below Mass Timber

Primary Frame @ Roof

Primary Frame

Below Mass Timber Floor

Above Mass Timber Floor

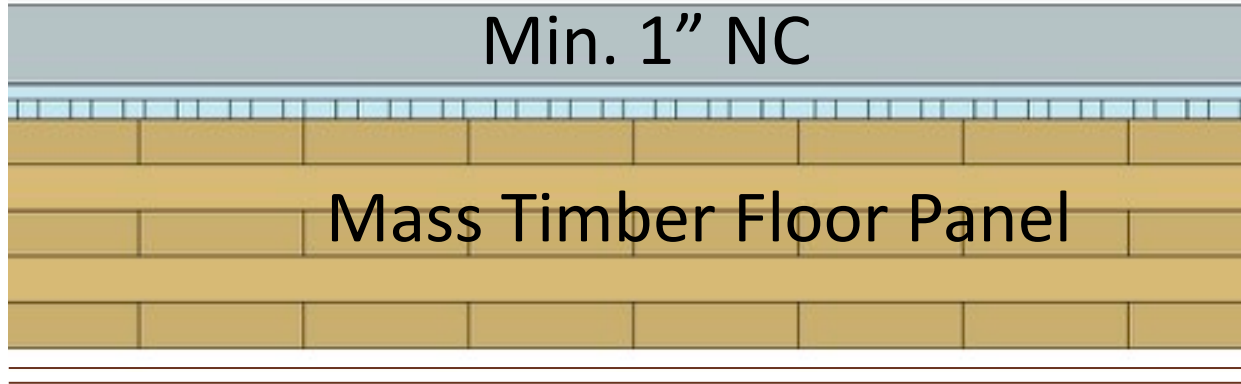
60 min	40 min*	Not Req.	Not Req.
80 min	40 min*	Not Req.	Not Req.
120 min	80 min*	Not Req.	Not Req.
80 min	80 min*	Not Req.	Not Req.
1" Min NC Material	1" Min NC Material	Not Req.	Not Req.

Requirements Per new 602.4. \* Some MT permitted to be exposed.

IV-A

IV-B

## Type IV-A and IV-B NC Protection over MT Floor



In Type IV-A and IV-B, the floor assembly shall contain a noncombustible material not less than one inch in thickness above the mass timber.

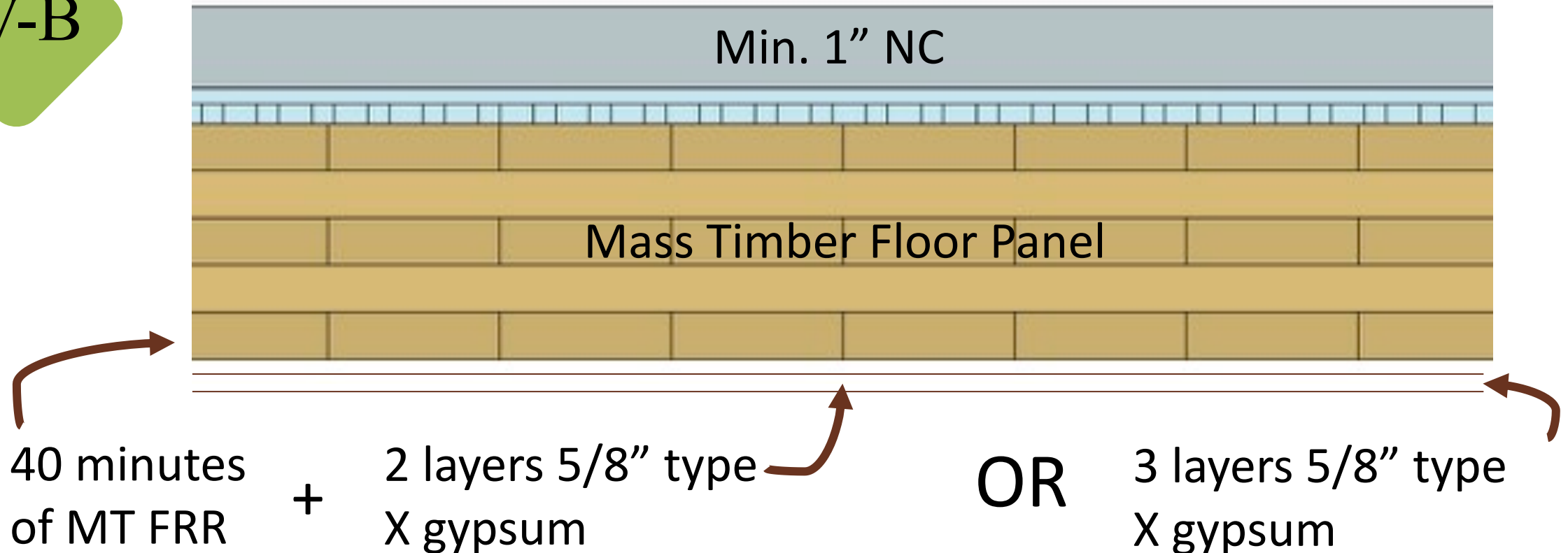


IV-A

IV-B

## Type IV-A and IV-B Example Floor

### 2 Hour Floor with Required NC Protection





# Exterior Wall



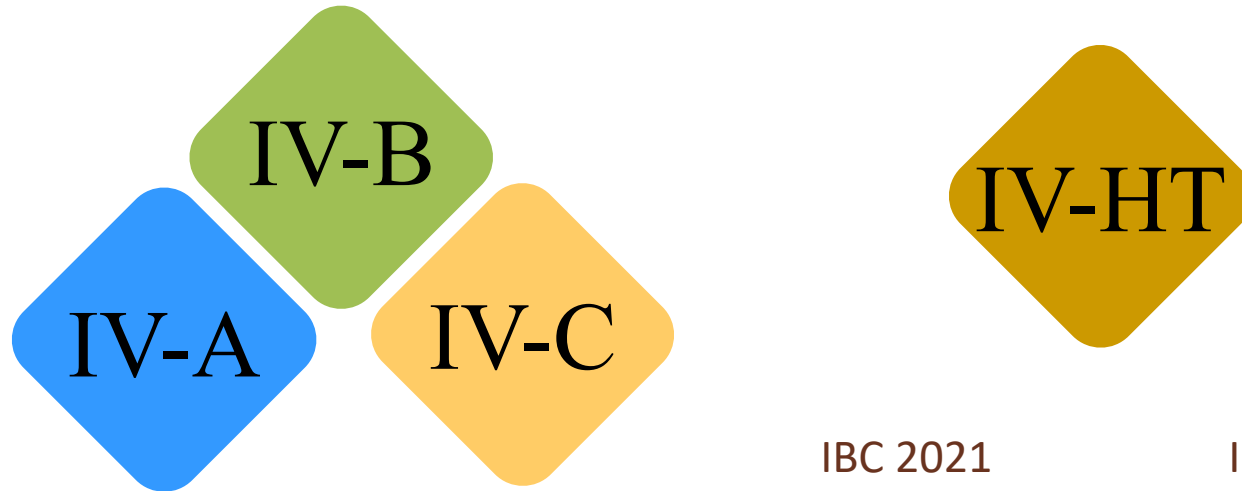
Fire Rating (bearing wall)

Mass Timber

Exterior NC Protection

Interior NC Protection

Light Frame FRTW



IBC 2021

IBC 2018

3 Hr	2 Hr	2 Hr	2 Hr	2Hr
Mass Timber/CLT			4" min thick <u>CLT</u> *	6" <u>Wall</u> *
40 Min NC & No Exterior Combustible Coverings			FRT Sheathing, Gyp or other NC	
Per Interior Requirements			Not Required	
No			Yes*	6" Wall*

\*Changes in IBC 2015, 2018, and 2021 editions

# Interior Wall Construction



- Fire Rating (bearing wall)
- Construction – MT
- NC Protection
- Noncombustible non-bearing wall
- Wood Stud Wall

3 Hr	2 Hr	2 Hr	1 Hr or HT*
Laminated construction 4" thick (CLT, NLT, etc) Solid wood construction min. 2 layers of 1" matched boards			
Per Interior Requirements			No
0 Hr			1 Hr
No			1 Hr

\*IBC 2021 requires at least 1 Hr FRR for HT walls supporting 2 levels

# Tall Wood Exit and Hoistway Shaft Enclosures

IV-A

IV-B

IV-C

IV-HT

Fire Resistance

Mass Timber Option

2 Hr	2 Hr	2 Hr	1 or 2 Hr FRR per IBC 713.4
80 Min NC Protection, inside & outside	80 Min NC Protection, inside & outside	40 Min NC Protection, inside & outside	No NC Protection



# Tall Wood Exit and Hoistway Shaft Enclosures

IV-A

IV-B

IV-C

IV-HT

>12 Stories or  
> 180 ft

Fire Resistance

Mass Timber Option

2 Hr	2 Hr	2 Hr	2 Hr	1 or 2 Hr FRR per IBC 713.4
Not Allowed Noncombustible only	80 Min NC Protection, inside & outside	80 Min NC Protection, inside & outside	40 Min NC Protection, inside & outside	No NC Protection



Credit: Alex Schreyer





What is one code requirement of Type IV today  
that project teams really do not like?

## Restrictions on Concealed Spaces



Photo: Ema Peter Photography

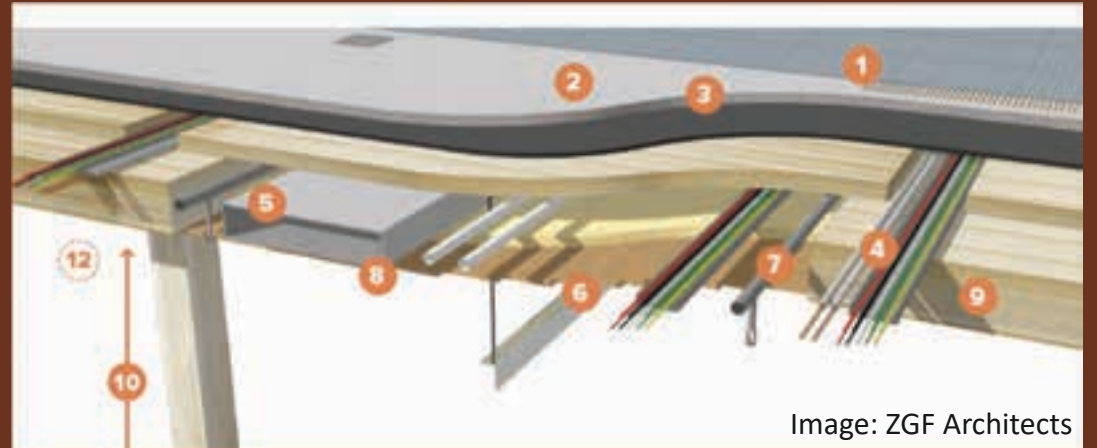


Image: ZGF Architects

# Concealed Spaces in Type IV-A, IV-B

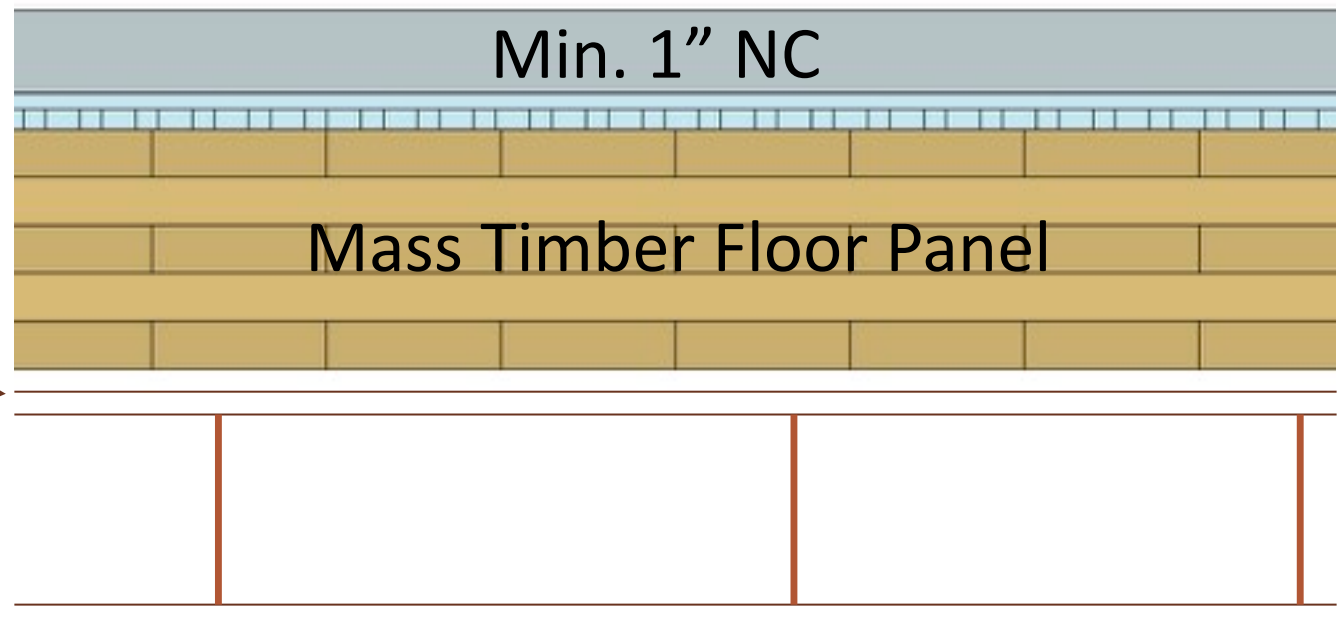


\*Applicable to most locations. Limited exposed MT permitted in IV-B

2 layers 5/8" type X gypsum\*

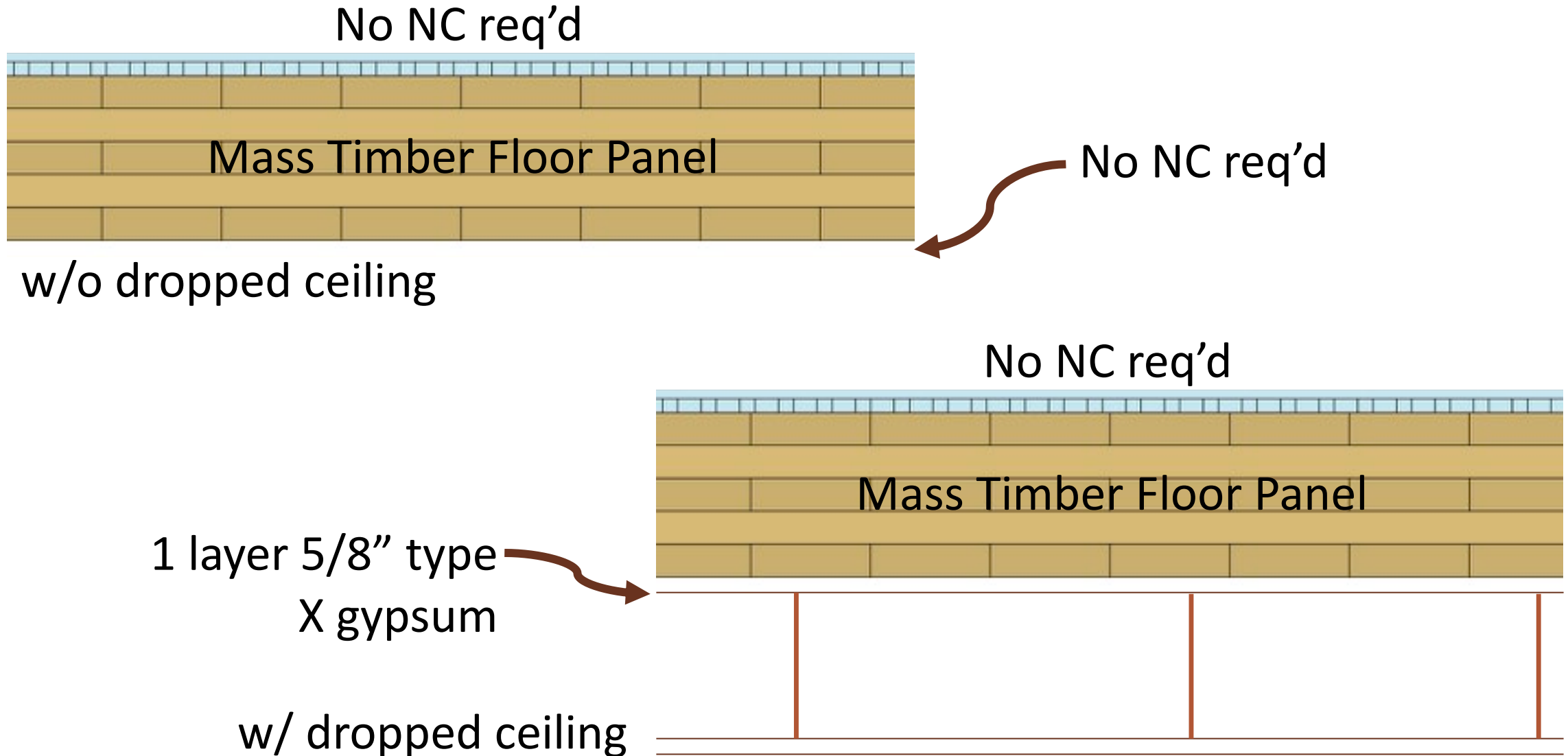
w/o dropped ceiling

2 layers 5/8" type X gypsum

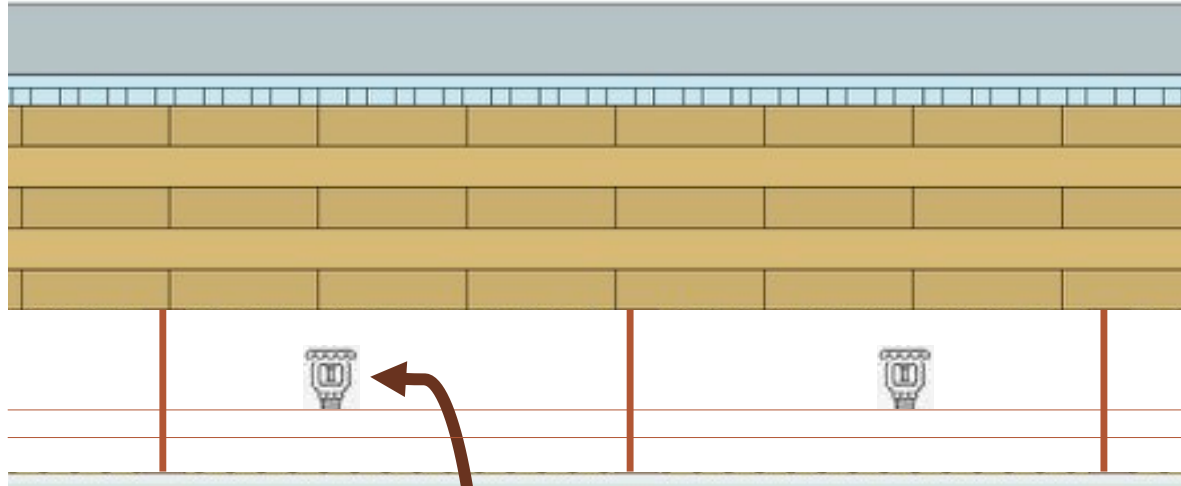


w/ dropped ceiling

# Concealed Spaces in Type IV-C

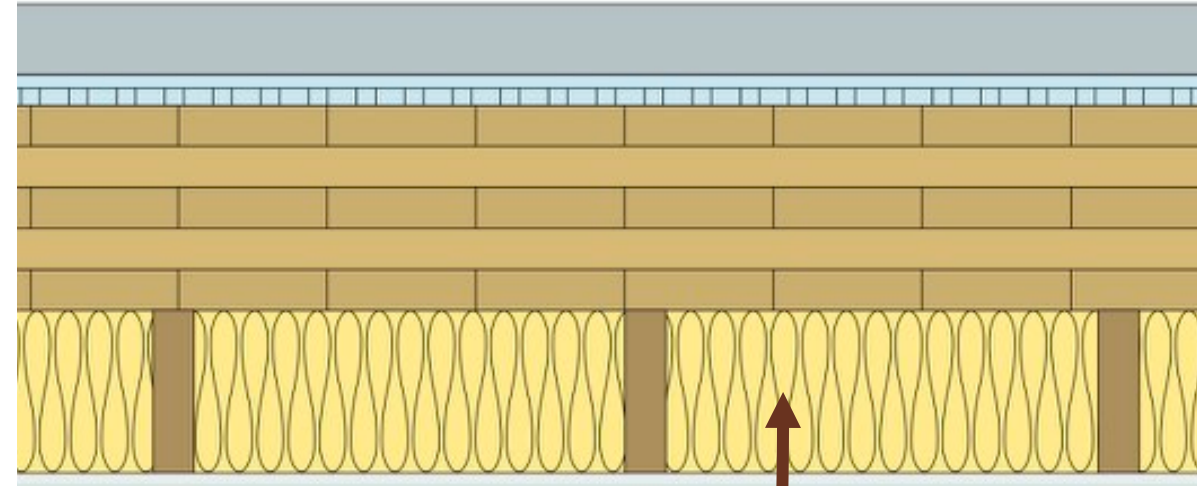


# Concealed Spaces in Type IV-HT



## Option 1

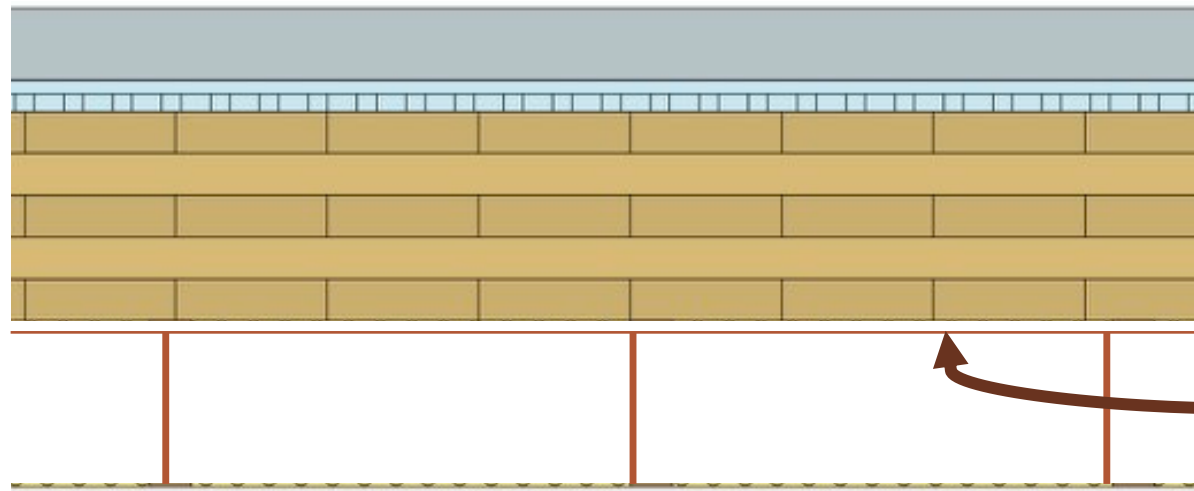
Sprinklers in  
concealed spaces



## Option 2

Noncombustible  
insulation

## Option 3

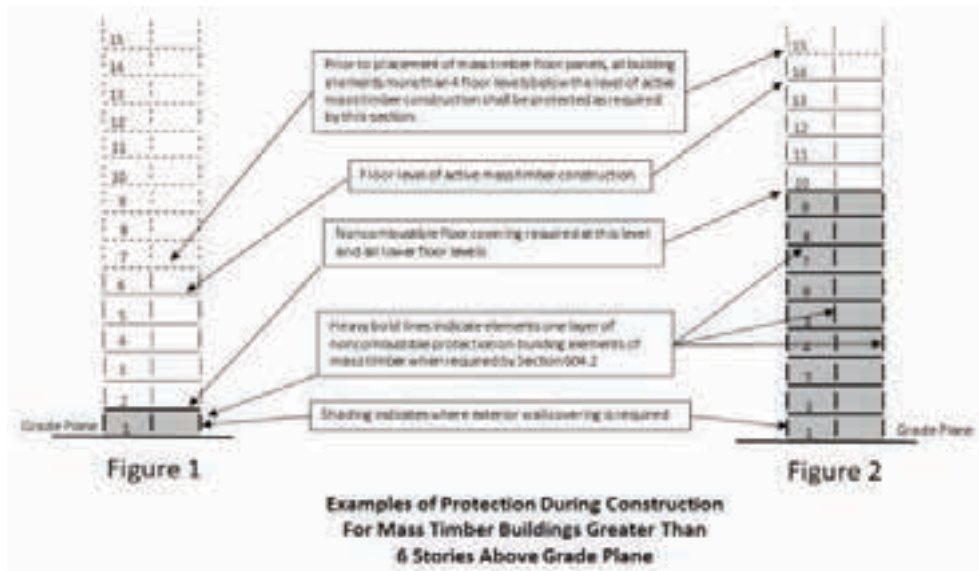


5/8" Type X gypsum  
on all MT surfaces



# Many More Items not Covered

- Sealants at panel edges
- Fire safety during construction
- NC protection at occupancy separations
- Reliability of water supply for sprinklers



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

By: Benjamin, PhD, PE, WoodWorks • Wood Products Council • Matt Timmers, SE, John A. Martin & Associates  
• Dennis Richardson, PE, CBO, CMAA, 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) 2018 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.

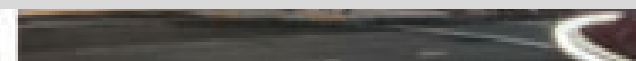
### Background: ICC Tall Wood Building Ad Hoc Committee

Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber materials (Beneman 2013, Timmers 2016). Around the world there



# WoodWorks Tall Wood Design Resource

[http://www.woodworks.org/wp-content/uploads/wood\\_solution\\_paper-TALL-WOOD.pdf](http://www.woodworks.org/wp-content/uploads/wood_solution_paper-TALL-WOOD.pdf)



# QUESTIONS?



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This concludes The American Institute of  
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