
Photo: Structurlam

Session 2: Code Compliance

Mark Bartlett
Bruce Lindsey
Chelsea Drenick

Session 2: Code Compliance

Topics

1. Construction Type & Building Size
2. Fire Resistance Ratings
3. Tall Wood

Construction Types

Primarily based on building size & occupancy

	Construction Type (All Sprinklered Values)							
	IV-A	IV-B	IV-C	IV-HT	III-A	III-B	V-A	V-B
Occupancies	Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)							
A, B, R	270	180	85	85	85	85	70	60
	Allowable Number of Stories above Grade Plane (IBC Table 505.4)							
A-2, A-3, A-4	18	12	6	4	4	3	3	2
B	18	12	9	6	6	4	4	3
R-2	18	12	8	5	5	5	4	3
	Allowable Area Factor (At) for SM, Feet^2 (IBC Table 506.2)							
A-2, A-3, A-4	135,000	90,000	56,250	45,000	42,000	28,500	34,500	18,000
B	324,000	216,000	135,000	108,000	85,500	57,000	54,000	27,000
R-2	184,500	123,000	76,875	61,500	72,000	48,000	36,000	21,000

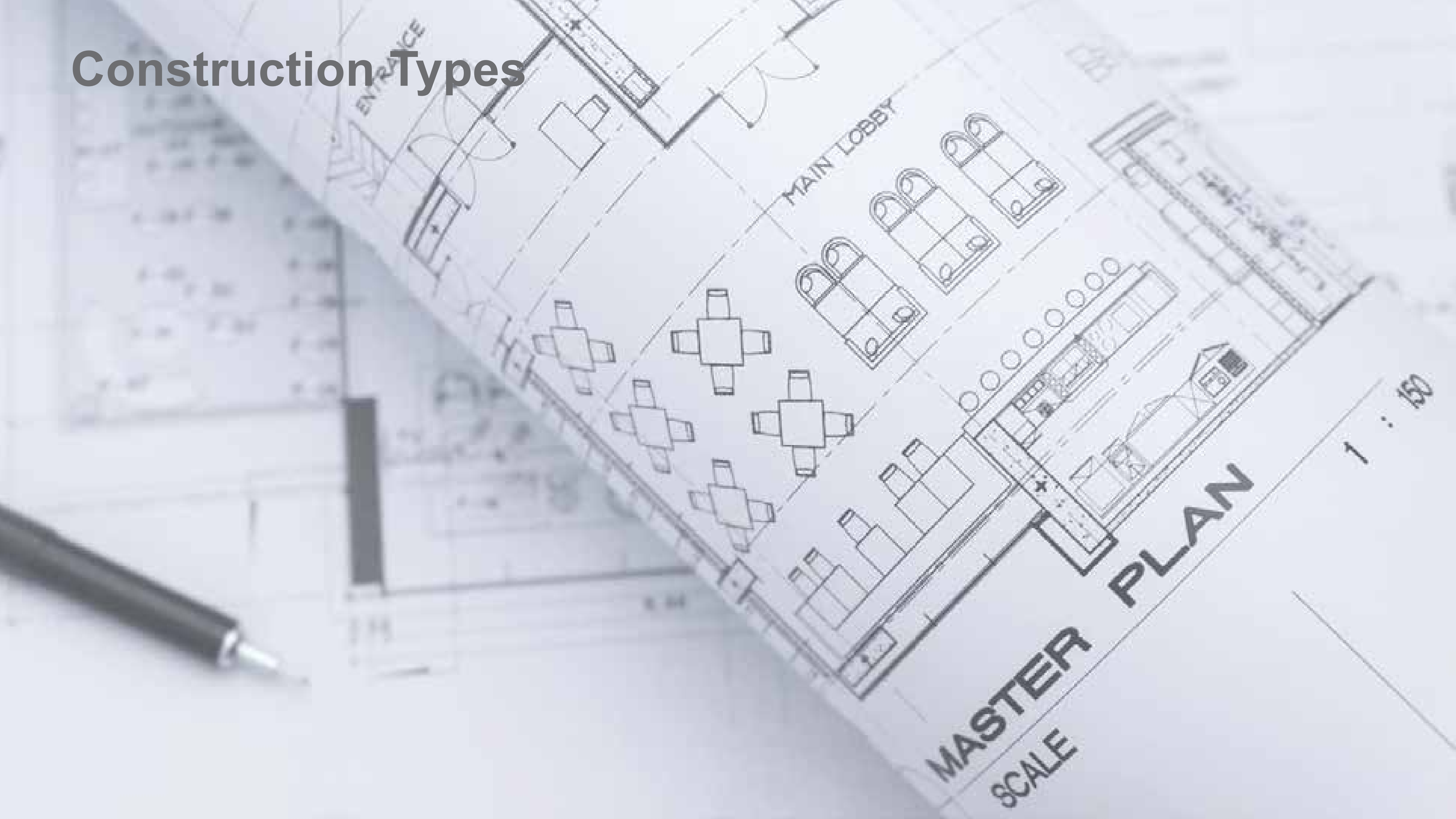
Construction Types

Primarily based on building size & occupancy

	Construction Type (All Sprinklered Values)							
	IV-A	IV-B	IV-C	IV-HT	III-A	III-B	V-A	V-B
Occupancies	Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)							
A, B, R	270	180	85	85	85	85	70	60
	[illegible]							
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B	18	12	9	[illegible]	6	[illegible]	4	3
R-2	18	12	8	5	5	5	4	3
	Allowable Area Factor (At) for SM, Feet^2 (IBC Table 506.2)							
A-2, A-3, A-4	135,000	90,000	56,250	45,000	42,000	28,500	34,500	18,000
B	324,000	216,000	135,000	108,000	85,500	57,000	54,000	27,000
R-2	184,500	123,000	76,875	61,500	72,000	48,000	36,000	21,000

For low- to mid-rise mass timber buildings, there may be multiple options for construction type. There are pros and cons of each, don't assume that one type is always best.

Construction Types

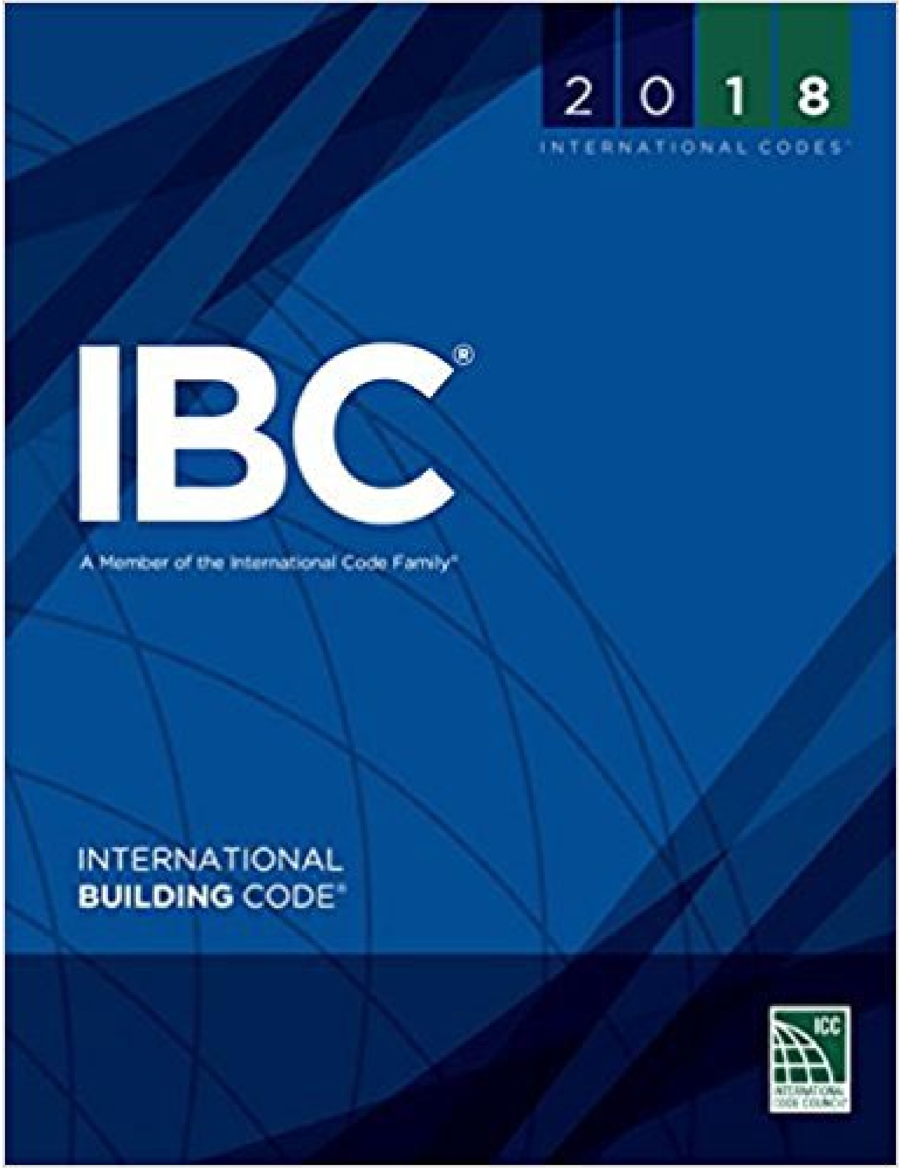


Construction Types

When does the code allow mass timber to be used?

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

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



Construction Types

IBC defines 5 construction types:

- A building must be classified as one of these: I, II, III, IV, V

Further broken down into subcategories

- I-A & I-B
- II-A & II-B
- III-A & III-B

Similar Heights and Areas

- IV-A, IV-B, IV-C, & IV-HT (IBC 2021); IV (IBC 2018 and older)
- V-A & V-B

Nearly Identical

Construction Types I & II:
All elements required to be non-combustible materials

However, there are exceptions including several for mass timber

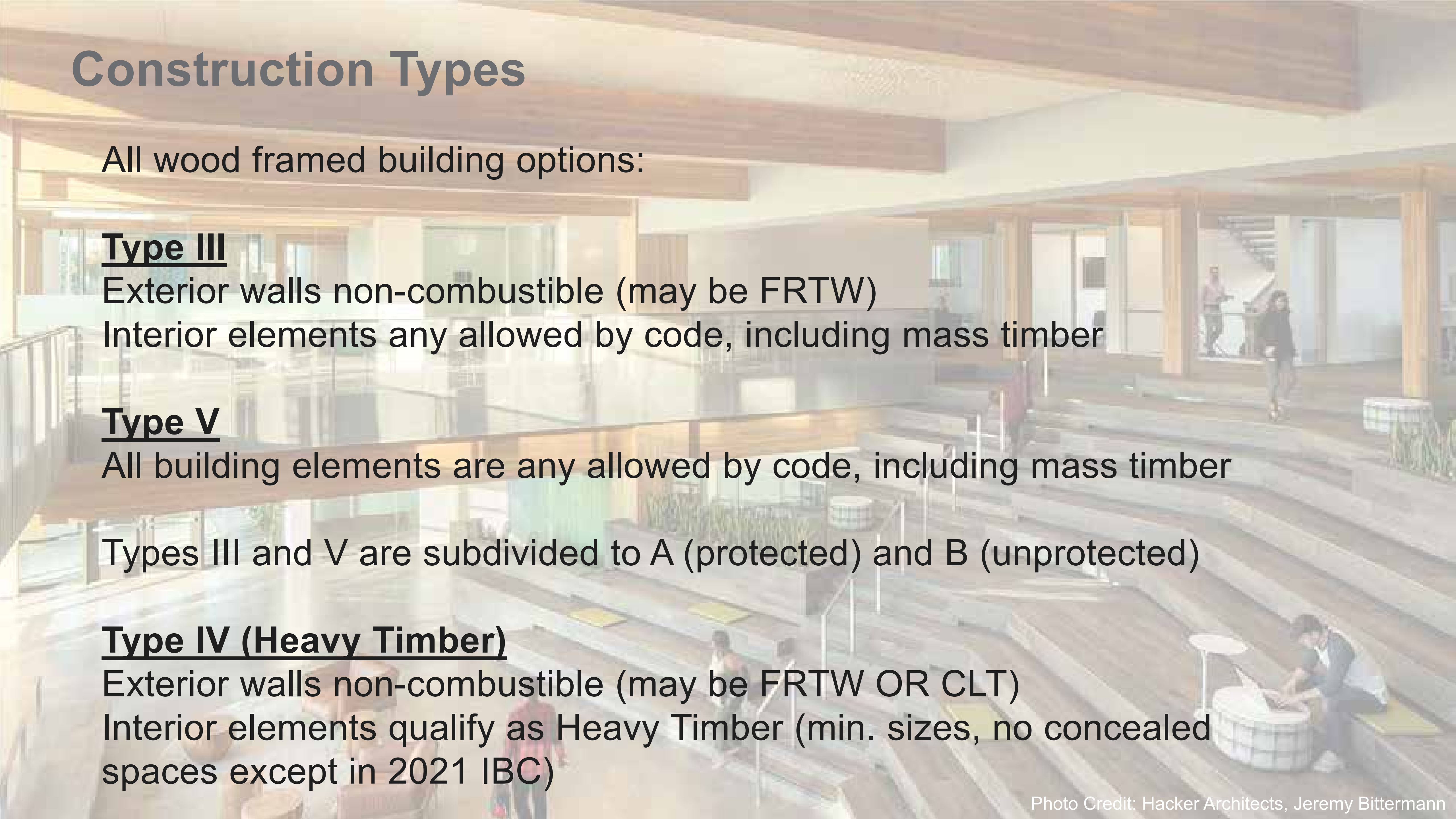
Construction Types

Where does the code allow MT to be used?

- <u>Type I-B & II-A/II-B</u>: Roof Decking

Photo Credit: DeStafano & Chamberlain, Inc, Robert Benson Photography

Image: StructureCraft Builders



Construction Types

All wood framed building options:

Type III
Exterior walls non-combustible (may be FRTW)
Interior elements any allowed by code, including mass timber

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

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

Type IV (Heavy Timber)
Exterior walls non-combustible (may be FRTW OR CLT)
Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces except in 2021 IBC)

Photo Credit: Hacker Architects, Jeremy Bittermann

Type III-A Height and Area Limits

III-A

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	42,000 SF	126,000 SF
B	6	85 ft	85,500 SF	256,500 SF
M	5	85 ft	55,500 SF	166,500 SF
R-2	5	85 ft	72,000 SF	216,000 SF

Credit: Christian Columbres

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

5-story residential / 6-story office

2-hour rating for exterior bearing walls

1-hour rating for other building elements

Type III-B Height and Area Limits

Credit: Lever Architecture

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	75 ft	28,500 SF	85,500 SF
B	4	75 ft	57,000 SF	171,000 SF
M	3	75 ft	37,500 SF	112,500 SF
R-2	5	75 ft	48,000 SF	144,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

4-story office / 5-story residential

2-hour fire resistance rating required for exterior bearing walls only (non combustible or FRT construction)

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

Type IV-HT Height and Area Limits

IV-HT

Credit: John Staments

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	45,000 SF	135,000 SF
B	6	85 ft	108,000 SF	324,000 SF
M	5	85 ft	61,500 SF	184,500 SF
R-2	5	85 ft	61,500 SF	184,500 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

5-story residential / 6-story office

2-hour rating for exterior bearing walls

Interior elements must qualify as Heavy Timber

Construction Types

Where does the code allow MT to be used?

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

Construction Types

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

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

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

*3” nominal width allowed where sprinklered

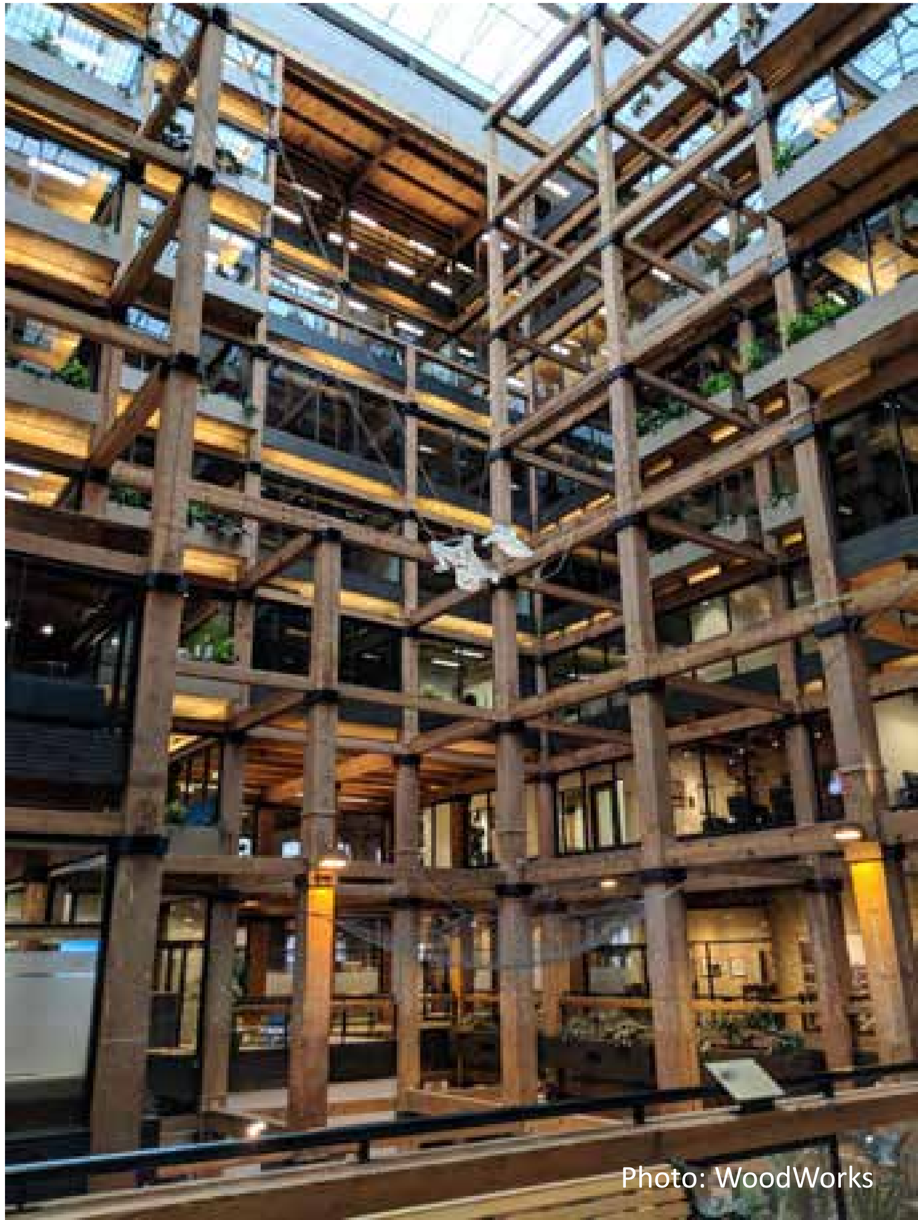


Photo: WoodWorks

Construction Types

Type IV min. sizes:

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

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


Photo: StructureCraft


Photo: Aitor Sanchez/ Ewing Cole


Photo: WoodWorks

Construction Types

Type IV min. sizes:

<u>Interior Walls:</u>

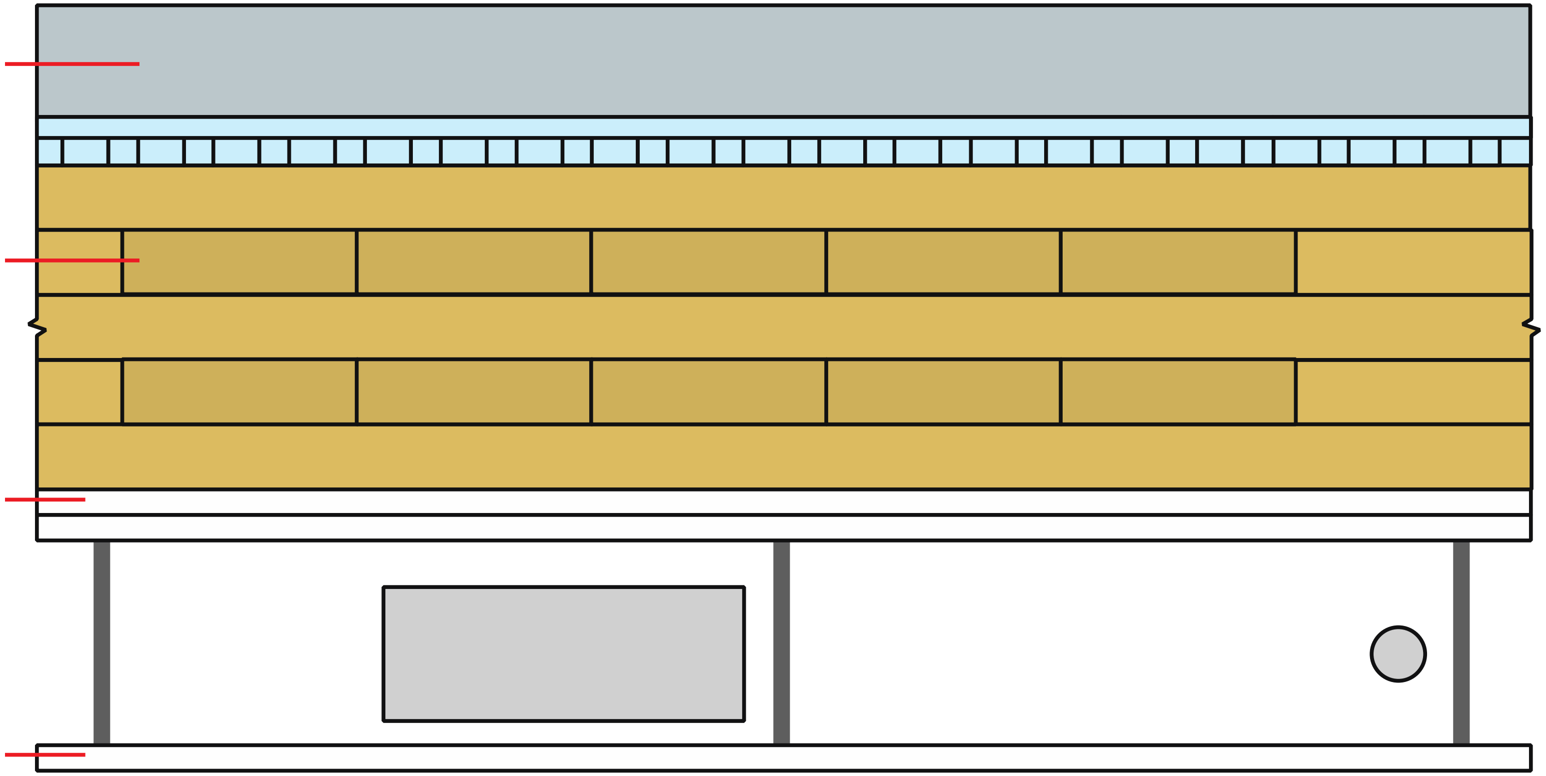
- Laminated construction 4” thick
- Solid wood construction min. 2 layers of 1” matched boards
- Wood stud wall (1 hr min)
- Non-combustible (1 hr min)

Verify other code requirements for FRR (eg. interior bearing wall; occupancy separation)

Construction Types

Type IV concealed spaces

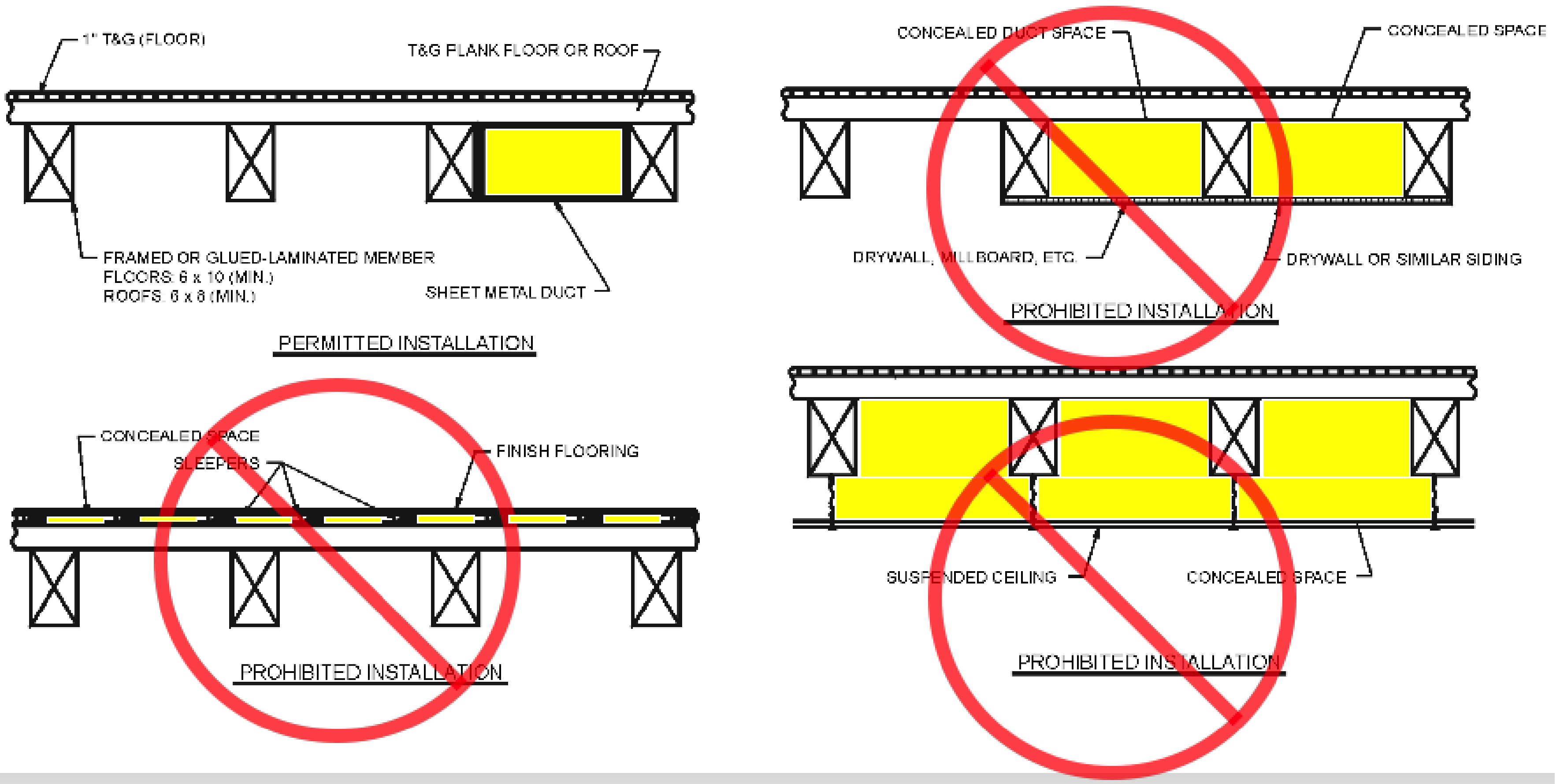
Can I have a dropped ceiling? Raised access floor?



Construction Types

Type IV concealed spaces

Until 2021 IBC, Type IV-HT provisions prohibited concealed spaces



Credit: IBC

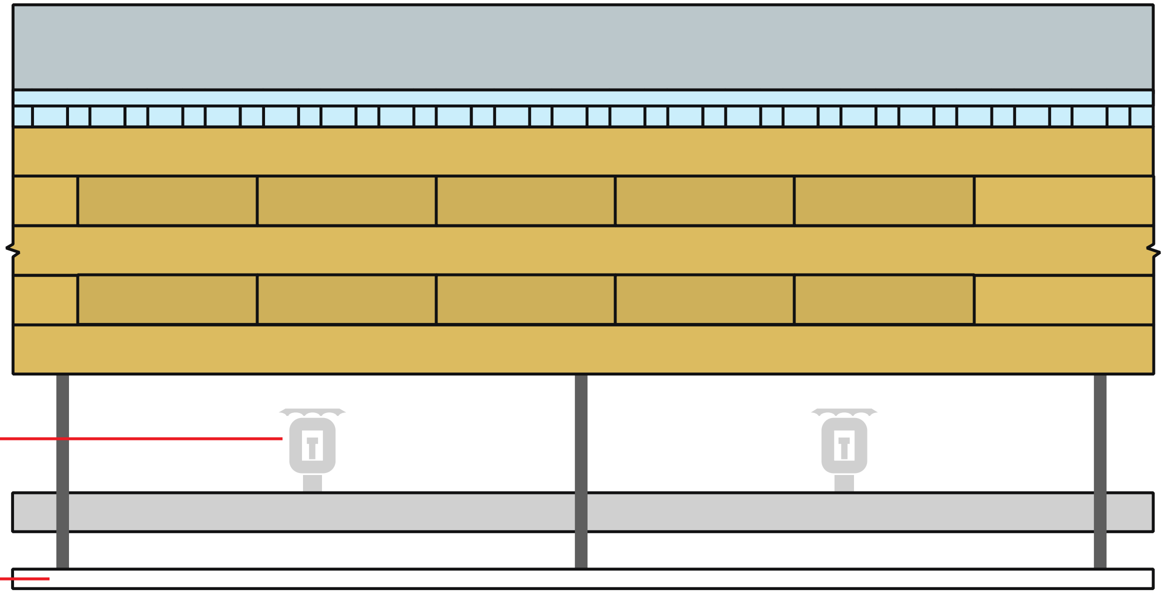
Construction Types

Type IV concealed space options within 2021 IBC

Option 1:

Sprinklers in concealed spaces

Dropped ceiling



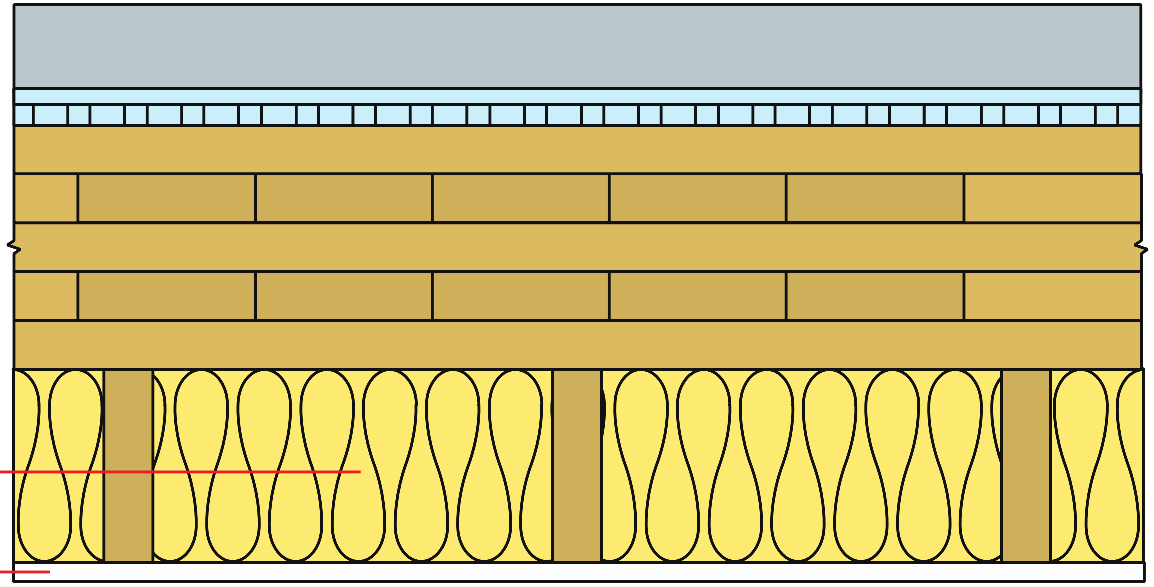
Construction Types

Type IV concealed space options within 2021 IBC

Option 2:

Noncombustible insulation

Dropped ceiling



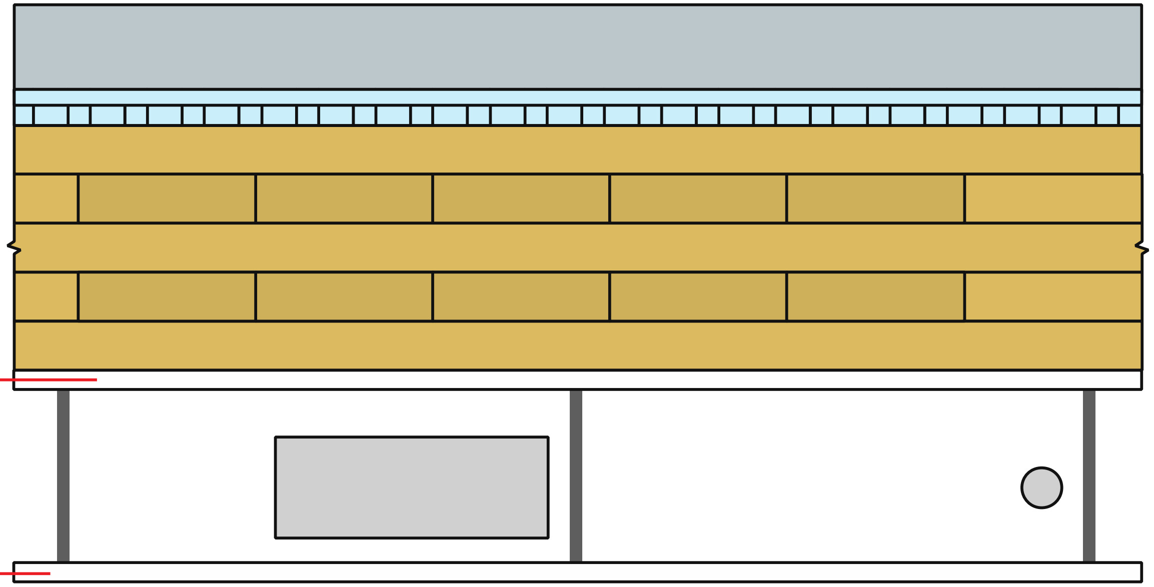
Construction Types

Type IV concealed space options within 2021 IBC

Option 3:

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

Dropped ceiling



Construction Types

Concealed spaces solutions paper

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

WOODWORKS

Concealed Spaces in Mass Timber and Heavy Timber Structures

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

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

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

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

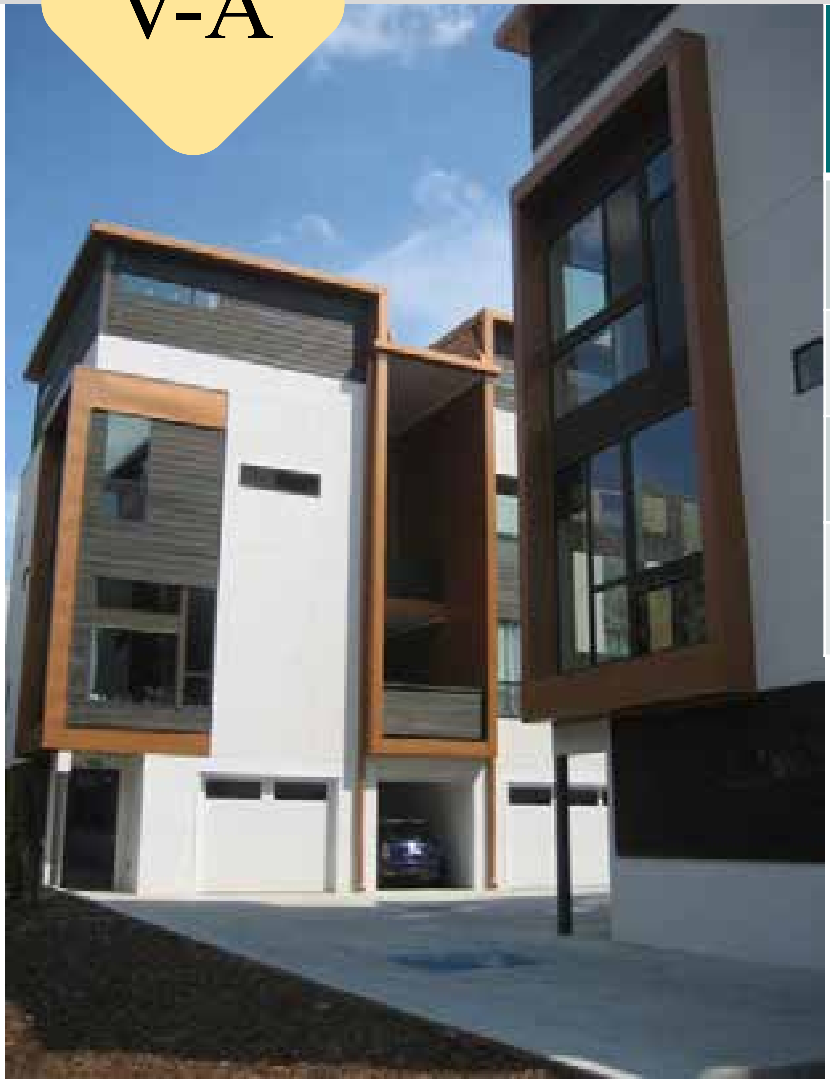
INTRO, Cleveland, | Cleveland, Ohio
Harbor Bay Real Estate Advisors
HPA Architecture

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

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

Type V-A Height and Area Limits

V-A



Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	70 ft	34,500 SF	103,500 SF
B	4	70 ft	54,000 SF	162,000 SF
M	4	70 ft	42,000 SF	126,000 SF
R-2	4	70 ft	36,000 SF	108,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

3 to 4-story residential/office

1-hour fire resistance rating required for most building elements

Type V-B Height and Area Limits

V-B

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	2	60 ft	18,000 SF	36,000 SF
B	3	60 ft	27,000 SF	81,000 SF
M	2	60 ft	27,000 SF	54,000 SF
R-2	3	60 ft	21,000 SF	63,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

1-story retail and restaurants

2 to 3-story residential/office

No fire resistance ratings required

Construction Types

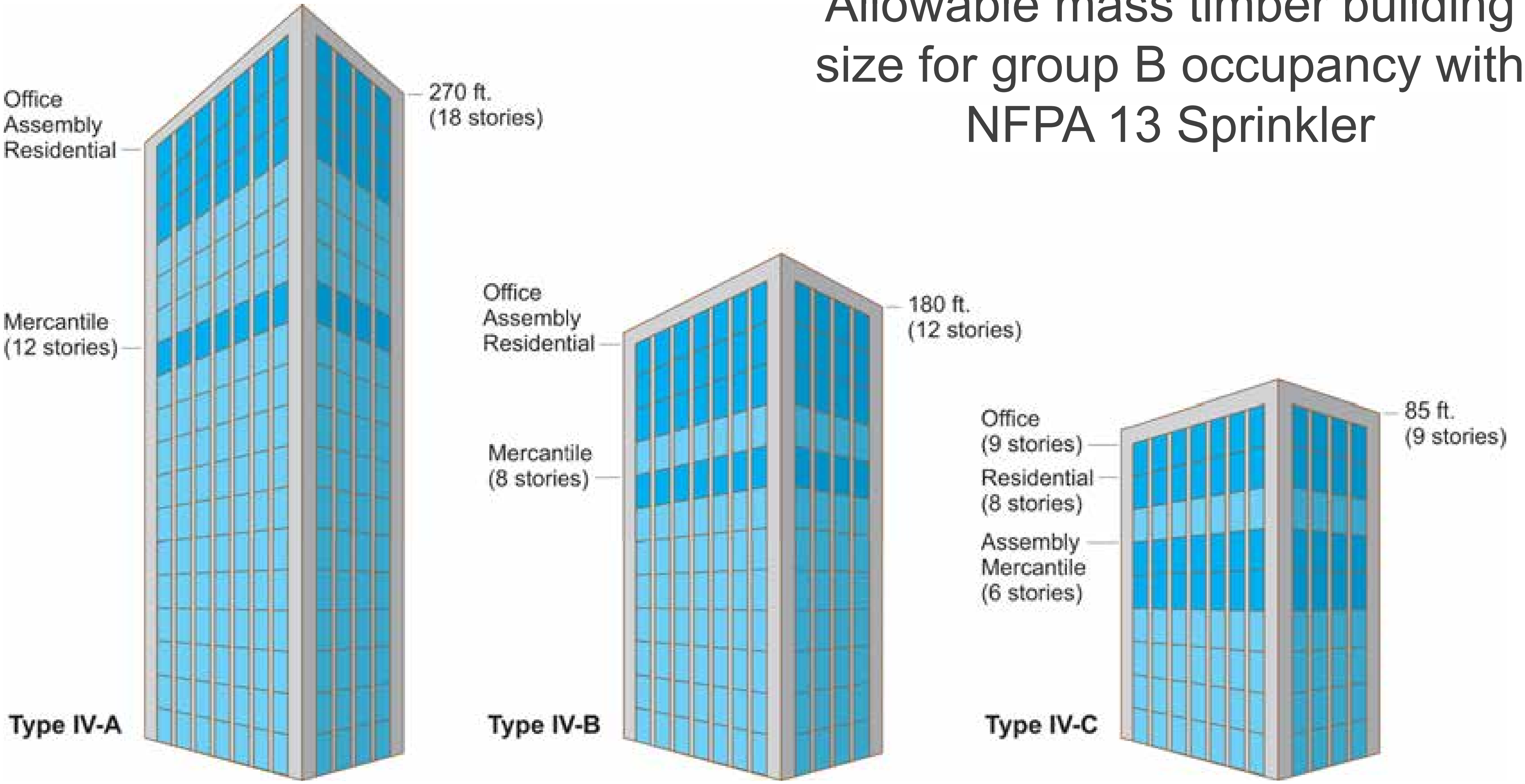
Where does the code allow MT to be used?

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

Image: Christian Columbres Photography

Construction Types

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



Type IV-A Height and Area Limits

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

Type IV-B Height and Area Limits

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-C

Type IV-C Height and Area Limits

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

Credit: Susan Jones, atelierjones

Key Early Design Decisions

Construction Type Early Decision Example

7-story building on health campus
- Group B occupancy, NFPA 13 sprinklers throughout
- Floor plate = 22,300 SF
- Total Building Area = 156,100 SF

MT Construction Type Options:
- **If Building is < 85 ft**
  - **7 stories of IV-C**
  - **6 stories of IIIA or IV-HT over 1 story IA podium**
- **If Building is > 85 ft**
  - **7 stories of IV-B**

Key Early Design Decisions

Construction Type Early Decision Example

MT Construction Type Options:

- If Building is < 85 ft
  - 7 stories of IV-C
  - 6 stories of IIIA or IV-HT over 1 story IA
- If Building is > 85 ft
  - 7 stories of IV-B

Implications of construction type choice in this example:

- FRR (2 hr vs 1 hr vs min sizes)
- Efficient spans & grid
- Exposed timber limitations
- Concealed spaces
- Cost
- And more…

Key Early Design Decisions

Construction Type Early Decision Example

MT Construction Type Options:

- If Building is < 85 ft
    - **7 stories of IV-C**
    - 6 stories of IIIA or IV-HT over 1 story IA
- If Building is > 85 ft
    - 7 stories of IV-B

Implications of Type IV-C:

- 2 hr FRR, all exposed floor panels, beams, columns
- Likely will need at least 5-ply CLT / 2x6 NLT/DLT
- Efficient spans in the 14-17 ft range
- Efficient grids of that or multiples of that (i.e. 30x25, etc)
- No podium required

Key Early Design Decisions

Construction Type Early Decision Example

MT Construction Type Options:

- If Building is < 85 ft
  - 7 stories of IV-C
  - **6 stories of IIIA or IV-HT over 1 story IA**
- If Building is > 85 ft
  - 7 stories of IV-B

Implications of Type IIIA or IV-HT:

- 1 hr FRR or min. sizes
- Potential to use 3-ply or thin 5-ply CLT
- Efficient spans in the 10-12 ft range
- Efficient grids of that or multiples of that (i.e. 20x25, etc)
- 1 story Type IA podium required

Key Early Design Decisions

Construction Type Early Decision Example

MT Construction Type Options:

- If Building is < 85 ft
  - 7 stories of IV-C
  - 6 stories of IIIA or IV-HT over 1 story IA
- If Building is > 85 ft
  - **7 stories of IV-B**

Implications of Type IV-B:

- 2 hr FRR, mostly protected floor panels, beams, columns
- Exposed areas: likely 5-ply / 2x6 NLT/DLT
- Protected areas: potential for thinner panels
- Choose 1 system throughout or multiple systems?
- Does grid vary or consistent throughout?
- No podium required

Questions?

Mark Bartlett, PE

Regional Director

214-679-1874

mark.bartlett@woodworks.org

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

Session II – Code Compliance
Part II - Fire Resistance Ratings

Bruce Lindsey

Senior Technical Director

bruce@woodworks.org

(704) 877-6255

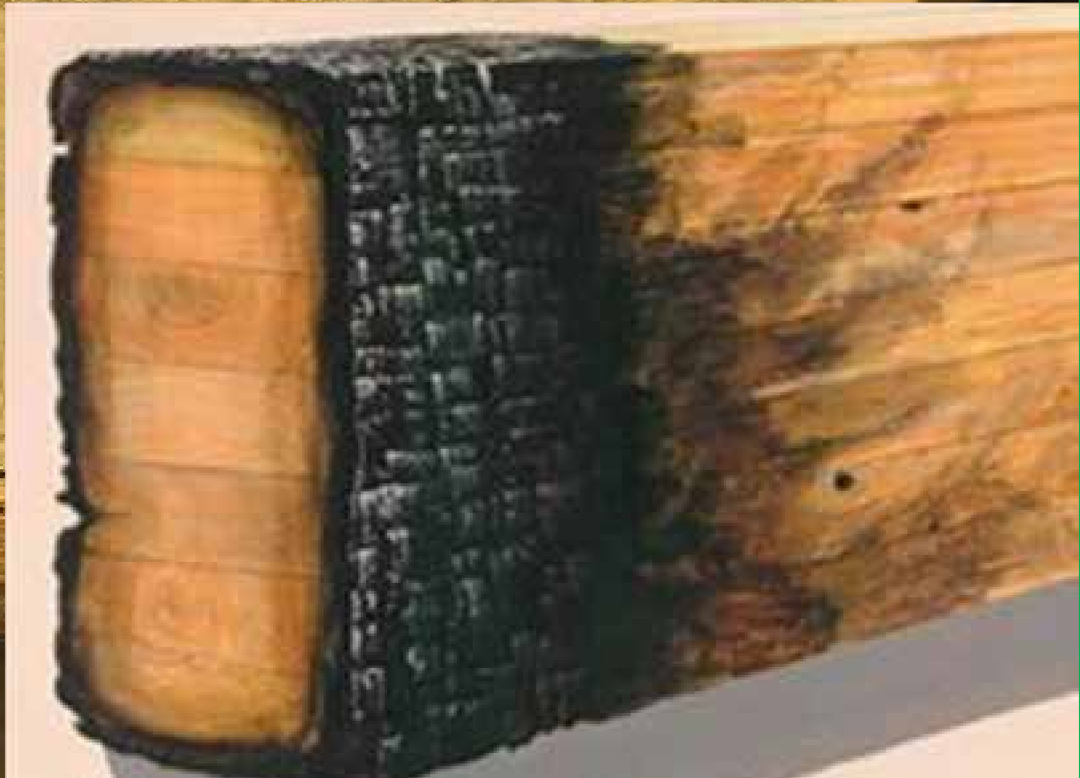


PHOTO CREDIT: FPINNOVATIONS

WOODWORKS

WPC

Key Early Design Decisions

Construction type influences FRR

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

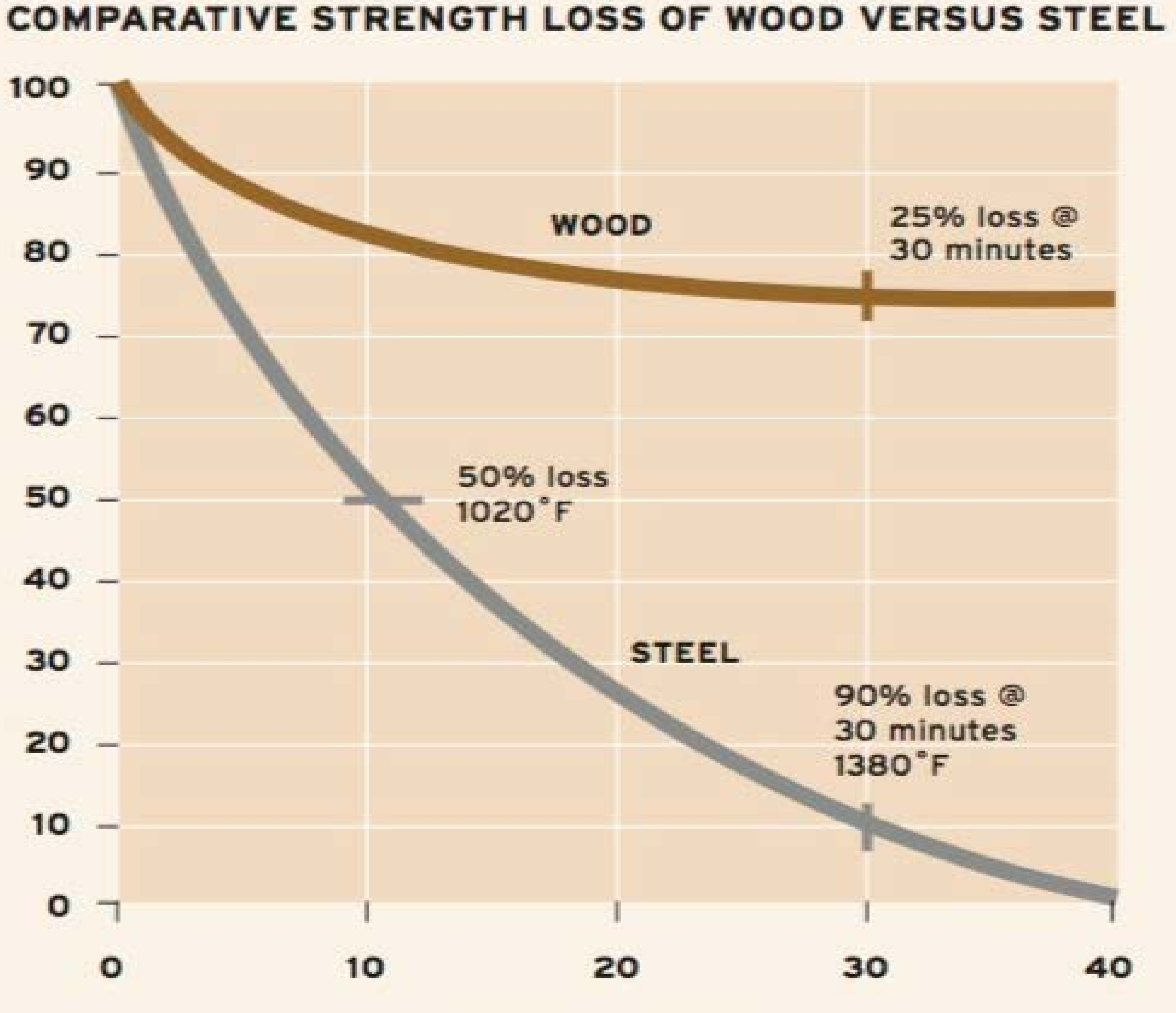
BUILDING ELEMENT	TYPE I		TYPE II	
	A	B	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602			
Nonbearing walls and partitions Interior[d]	0	0	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0
Roof construction and associated secondary members (see Section 202)	$1\frac{1}{2}$[b]	1[b,c]	1[b,c]	0[c]

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

Source: 2018 IBC

Mass Timber Design

Fire resistance



Results from test sponsored by National Forest Products Association at the Southwest Research Institute

SOURCE: AITC

Construction Types

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

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

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

*3” nominal width allowed where sprinklered

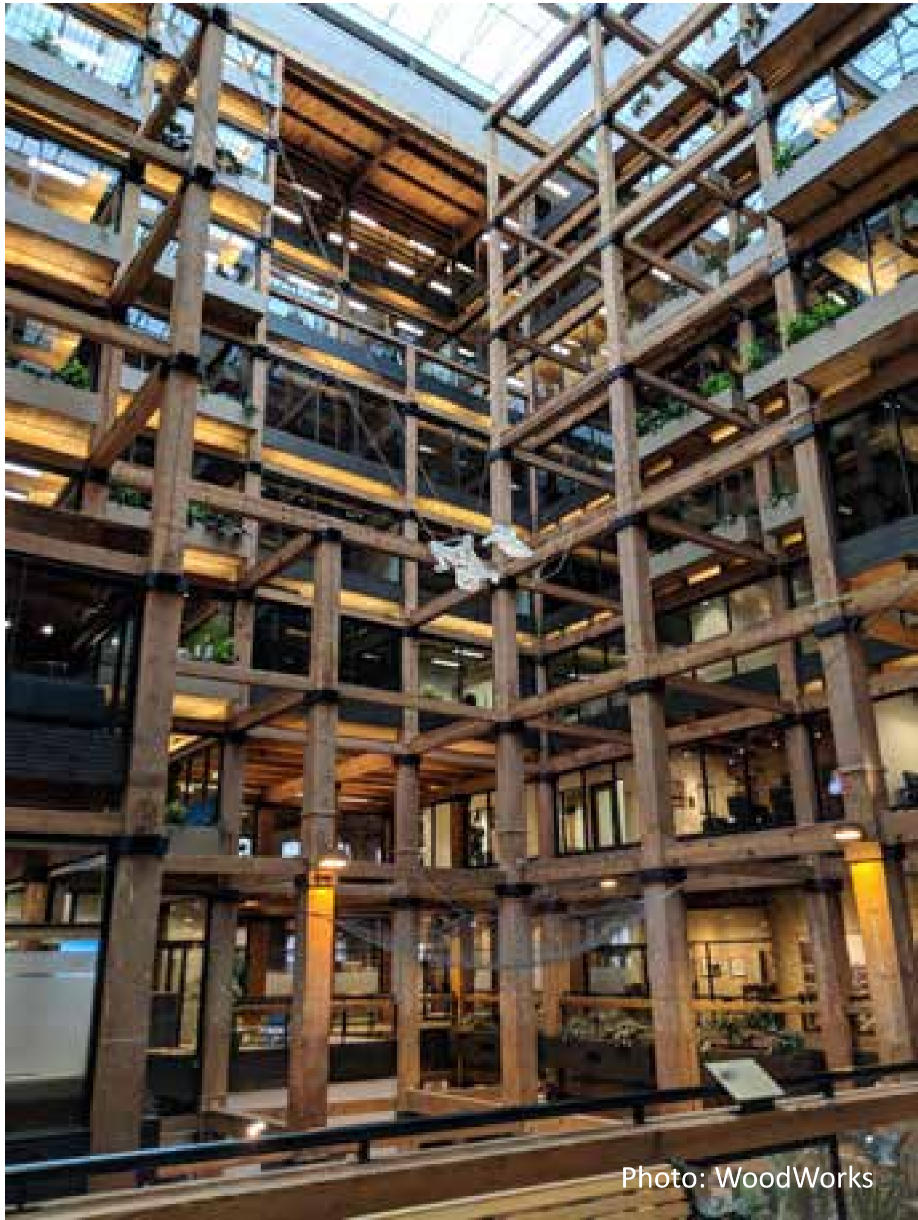


Photo: WoodWorks

Key Early Design Decisions

Construction type influences FRR

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

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

Key Early Design Decisions

Construction type influences FRR

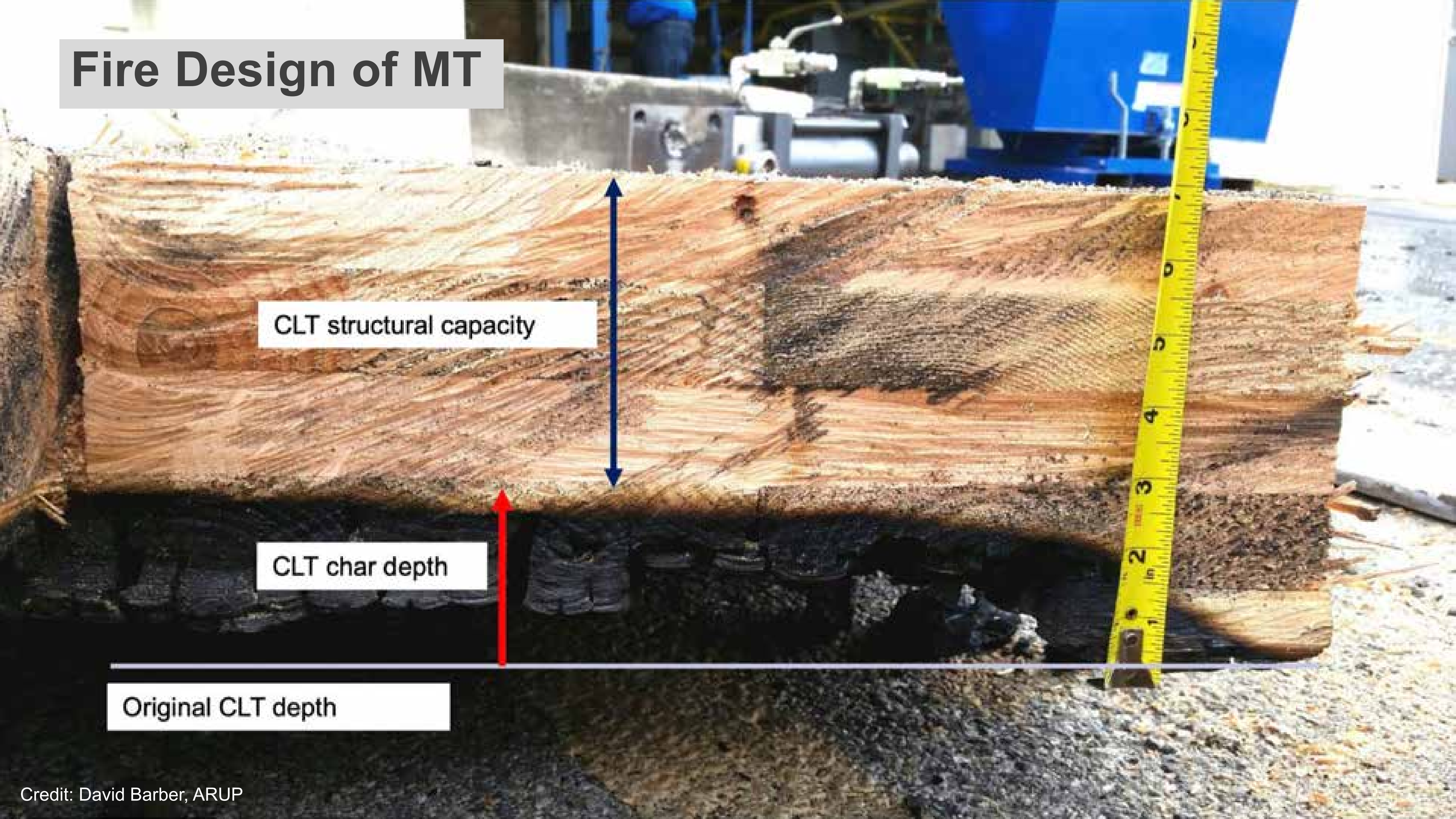
TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

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

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

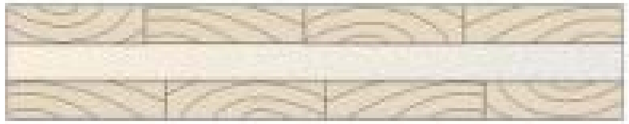
Source: 2021 IBC

Fire Design of MT



Credit: David Barber, ARUP

Key Early Design Decisions



Member Sizes

- Impact of FRR on sizing
- Impact of sizing on efficient spans
- Consider connections – can drive member sizing

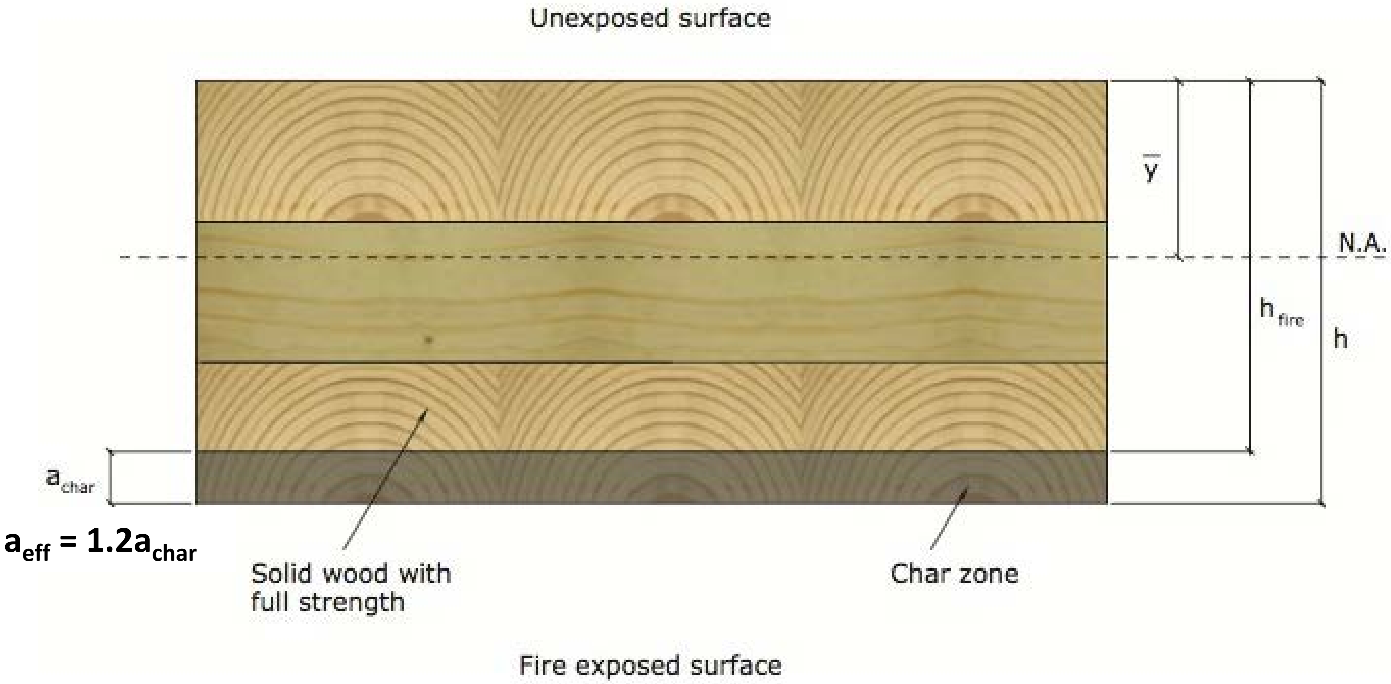
Credit: ARUP

Credit: Kaiser+Path

Key Early Design Decisions

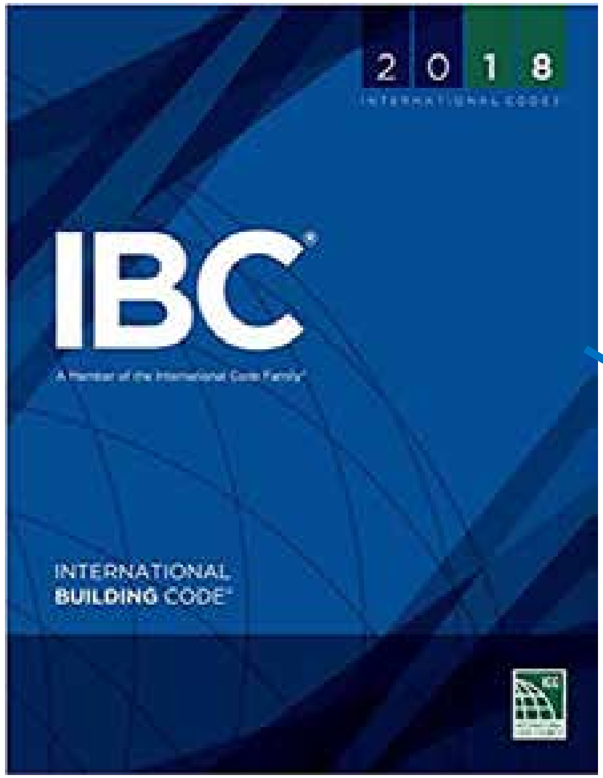
Which Method of Demonstrating FRR of MT is Being Used?

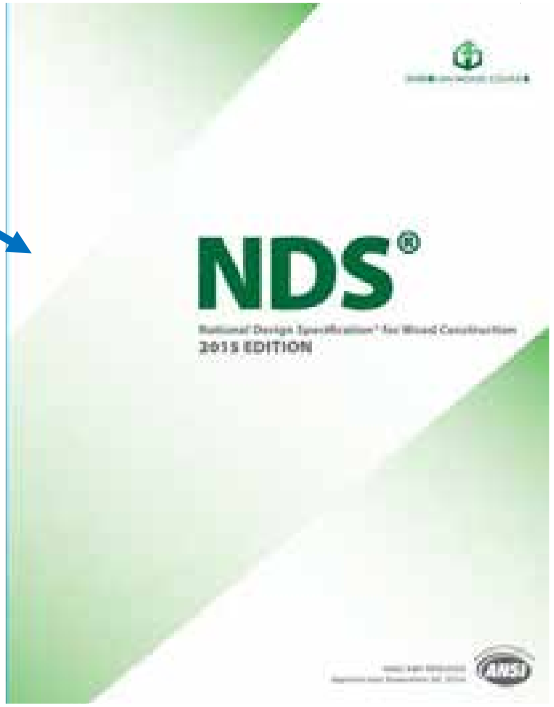
1. Calculations in Accordance with IBC 722 → NDS Chapter 16
2. Tests in Accordance with ASTM E119



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

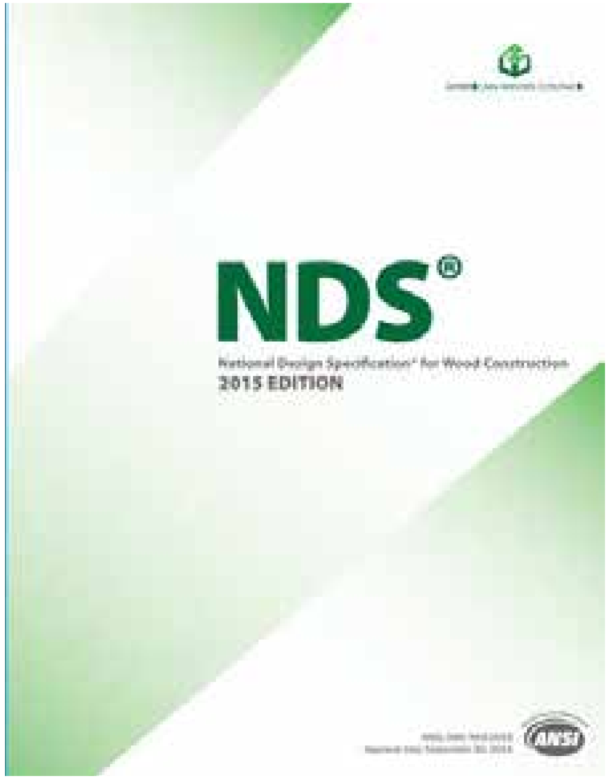
IBC 722
Calculated Fire Resistance

"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

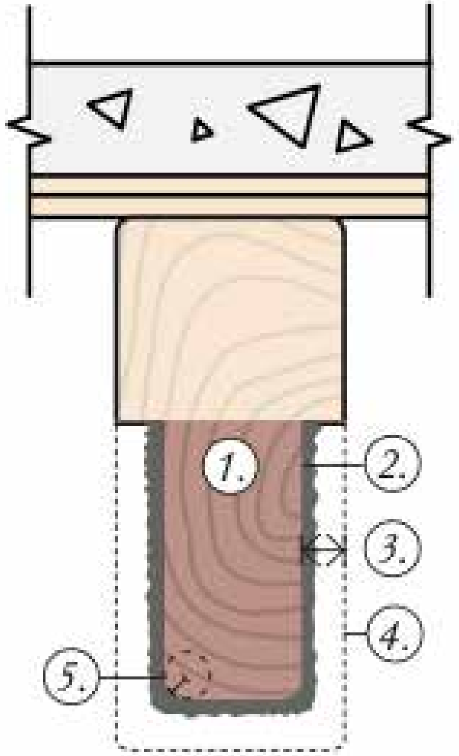
Table 16.2.1B Effective Char Depths (for CLT with β_n=1.5in./hr.)

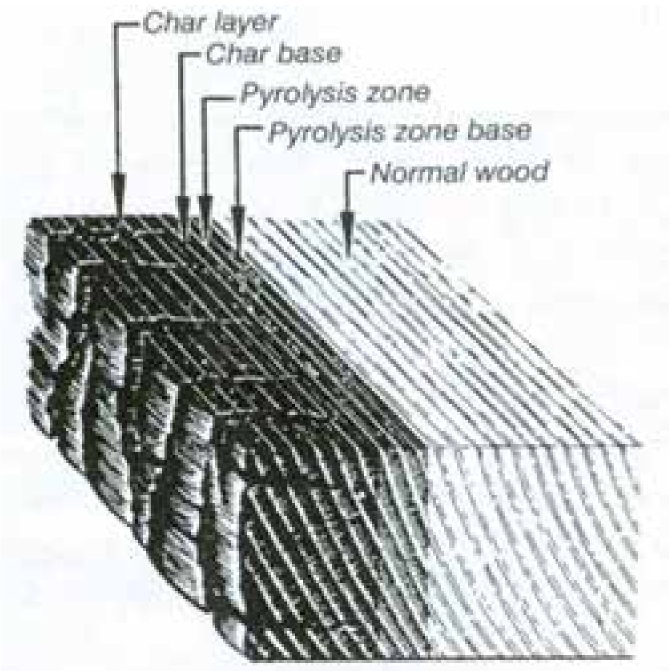
Required Fire Endurance (hr.)	Effective Char Depths, a_{char} (in.)								
	lamination thicknesses, h_{lam} (in.)								
	5/8	3/4	7/8	1	1-1/4	1-3/8	1-1/2	1-3/4	2
1-Hour	2.2	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.8
1½-Hour	3.4	3.2	3.1	3.0	2.9	2.8	2.8	2.8	2.6
2-Hour	4.4	4.3	4.1	4.0	3.9	3.8	3.6	3.6	3.6

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

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

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

FRR Design of MT

NDS Table 16.2.2 Design stress adjustment factors applied to adjust to average ultimate strength under fire design conditions

Table 16.2.2 Adjustment Factors for Fire Design[1]

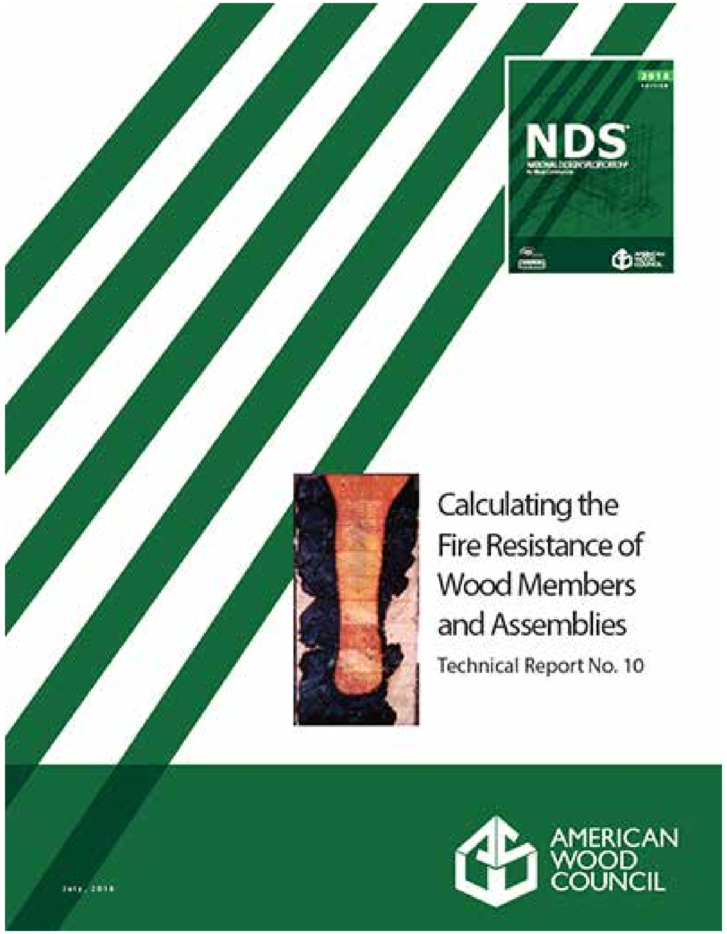
			ASD					
			Design Stress to Member Strength Factor	Size Factor[2]	Volume Factor[2]	Flat Use Factor[2]	Beam Stability Factor[3]	Column Stability Factor[3]
Bending Strength	F_b	x	2.85	C_F	C_V	C_{fu}	C_L	-
Beam Buckling Strength	F_{bE}	x	2.03	-	-	-	-	-
Tensile Strength	F_t	x	2.85	C_F	-	-	-	-
Compressive Strength	F_c	x	2.58	C_F	-	-	-	C_P
Column Buckling Strength	F_{cE}	x	2.03	-	-	-	-	-

1. See 4.3, 5.3, 8.3, and 10.3 for applicability of adjustment factors for specific products.
2. Factor shall be based on initial cross-section dimensions.
3. Factor shall be based on reduced cross-section dimensions.

Source: AWC's NDS

FRR Design of MT

AWC's TR10 is a technical design guide, aids in the use of NDS Chapter 16 calculations



Example 5: Exposed CLT Floor - *Allowable Stress Design*

Simply-supported cross-laminated timber (CLT) floor spanning L=18 ft in the strong-axis direction. The design loads are q_{live}=80 psf and q_{dead}=30 psf including estimated self-weight of the CLT panel. Floor decking, nailed to the unexposed face of CLT panel, is spaced to restrict hot gases from venting through half-lap joints at edges of CLT panel sections. Calculate the required section dimensions for a 1-hour structural fire resistance time when subjected to an ASTM E119 fire exposure.

For the structural design of the CLT panel, calculate the maximum induced moment.

Calculate panel load (per foot of width):

W_{load} = (q_{dead} + q_{live}) = (30 psf +80 psf)(1ft width) =110 plf/ft of width

Calculate maximum induced moment (per foot of width):

$M_{max} = w_{load}\, L^2 / 8 = (110)(18^2)/8$ = 4,455 ft-lb/ft of width

From PRG 320, select a 5-ply CLT floor panel made from 1-3/8 in x 3-1/2 in. lumber boards (CLT thickness of 6-7/8 inches). For CLT grade V2, tabulated properties are:

Bending moment, $F_bS_{eff,0}$ = 4,675 ft-lb/ft of width (PRG 320 Annex A, Table A2)

Calculate the allowable design moment (assuming C_D=1.0: C_M=1.0: C_t=1.0: C_L=1.0)

$M_s' = F_b(S_{eff})(C_D)(C_M)(C_t)(C_L)$ = 4,675 (1.0)(1.0)(1.0) = 4,675 ft-lb/ft of width (NDS 10.3.1)

Structural Check: $\mathbf{M_s' \geq M_{max}}$ **4,675 ft-lb/ft > 4,455 ft-lb/ft** √

(note: serviceability check is not performed to simplify the design example, but should be done in typical structural design).

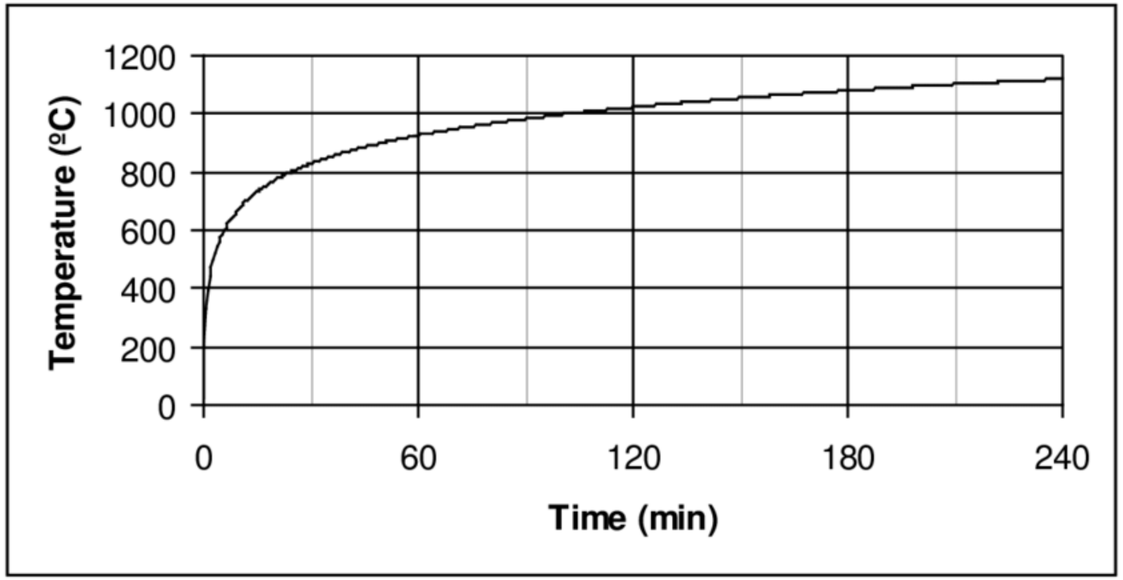
Source: AWC's TR10

FRR Design of MT

Tested FRR of Exposed MT:

- IBC 703.2 notes the acceptance of FRR demonstration via testing in accordance with ASTM E119

703.2 Fire-resistance ratings. The *fire-resistance rating* of building elements, components or assemblies shall be determined in accordance with the test procedures set forth in ASTM E119 or UL 263 or in accordance with Section 703.3. The *fire-resistance rating* of penetrations and *fire-resistant joint systems* shall be determined in accordance Sections 714 and 715, respectively.



Standard ASTM E119 test time-temperature curve

FRR Design of MT

Tested FRR of Exposed MT:

- Many successful Mass Timber ASTM E119 fire tests have been completed by industry & manufacturers

NGC Testing Services

Fire Testing Laboratory

IAS ACCREDITED Testing Laboratory TL-216

TEST REPORT

Page 1 of 83

for

American Wood Council

222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

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

Test Report No: WP-1950

Assignment No: K-1089

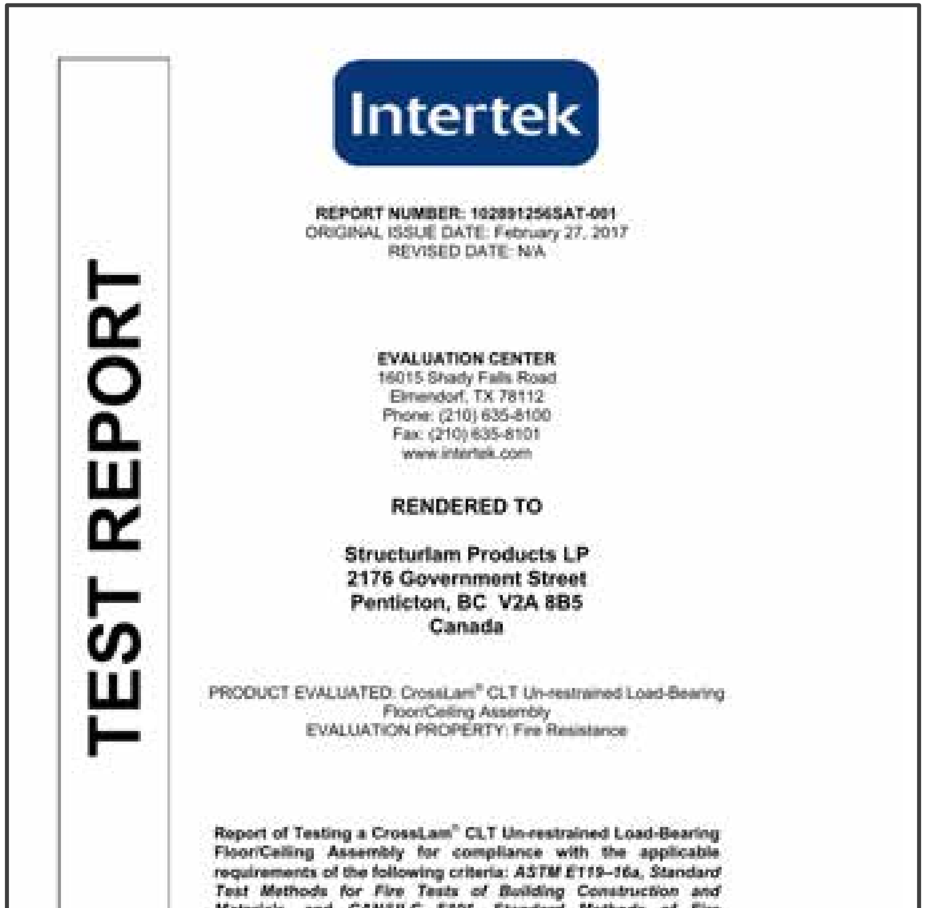
Subject Material: Cross-Laminated Timber and Gypsum Board Wall Assembly (Load-Bearing)

Test Date: October 4, 2012

Report Date: October 15, 2012

Prepared by:
Michael J. Rizzo
Test Engineer

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



TEST REPORT

Intertek

REPORT NUMBER: 102891256SAT-001
ORIGINAL ISSUE DATE: February 27, 2017
REVISED DATE: N/A

EVALUATION CENTER
16015 Shady Falls Road
Elmendorf, TX 78112
Phone: (210) 635-8100
Fax: (210) 635-8101
www.intertek.com

RENDERED TO

Structurlam Products LP
2176 Government Street
Penticton, BC V2A 8B5
Canada

PRODUCT EVALUATED: CrossLam® CLT Un-restrained Load-Bearing Floor/Ceiling Assembly
EVALUATION PROPERTY: Fire Resistance

Report of Testing a CrossLam® CLT Un-restrained Load-Bearing Floor/Ceiling Assembly for compliance with the applicable requirements of the following criteria: *ASTM E119–16a, Standard Test Methods for Fire Tests of Building Construction and*

FPInnovations

NRC-CNRC

Project No. 301006155
Final Report 2012/13

Preliminary CLT Fire Resistance Testing Report

by

Lindsay Osborne, M.A.Sc.
Christian Dagenais, Eng., M.Sc.
Scientists
Advanced Building Systems – Serviceability and Fire Group

and

Noureddine Bénichou, Ph.D.
Senior Research Officer
National Research Council of Canada – Fire Research Resource Centre

July 2012

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 1.5EMSR x SPF #3	2 layers 1/2" Type X gypsum	Half-Lap	None	Reduced 36% Moment Capacity	1	1 (Test 1)	NRC Fire Laboratory
3-ply CLT (105mm 4.133 in)	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Reduced 75% Moment Capacity	1	1 (Test 5)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	2	NRC Fire Laboratory March 2016
5-ply CLT (175mm 6.875")	Nordic	E1	1 layer of 5/8" Type X gypsum under Z-channels and furring strips with 3 5/8" fiberglass batts	Topside Spline	2 staggered layers of 1/2" cement boards	Loaded, See Manufacturer	2	5	NRC Fire Laboratory Nov 2014
5-ply CLT (175mm 6.875")	Nordic	E1	None	Topside Spline	3/4 in. proprietary gypcrete over Maxxon acoustical mat	Reduced 50% Moment 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 50% 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	E1M5 MSR 2100 x SPF #2	None	Topside Spline	1-1/2" Maxxon Cyp-Crete 2000 over Maxxon Reinforcing Mesh	Loaded, See Manufacturer	2.5	6	Intertek, 2/22/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap & Topside Spline	2" gypsum topping	Loaded, See Manufacturer	2	7	SwRI (May 2016)
5-ply CLT (175mm 6.875")	Nordic	SPF 1950 Fb MSR x SPF #3	None	Half-Lap	None	Reduced 59% Moment Capacity	1.5	1 (Test 3)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	Structurlam	SPF #1/#2 x SPF #1/#2	1 layer 5/8" Type X gypsum	Half-Lap	None	Unreduced 101% Moment Capacity	2	1 (Test 6)	NRC Fire Laboratory
7-ply CLT (245mm 9.65")	Structurlam	SPF #1/#2 x SPF #1/#2	None	Half-Lap	None	Unreduced 101% Moment Capacity	2.5	1 (Test 7)	NRC Fire Laboratory
5-ply CLT (175mm 6.875")	SmartLam	SL-V4	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 4)	Western Fire Center 10/26/2016
5-ply CLT (175mm 6.875")	SmartLam	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 5)	Western Fire Center 10/28/2016
5-ply CLT (175mm 6.875")	DR Johnson	V1	None	Half-Lap	nominal 1/2" plywood with 8d nails.	Loaded, See Manufacturer	2	12 (Test 6)	Western Fire Center 11/01/2016
5-ply CLT [illegible]	KLH	CV3M1	None	Half-Lap & [illegible]	None	Loaded, [illegible]	1	18	SwRI [illegible]

FRR Design of MT

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

Each has unique benefits:

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

Fire-Resistive Design of MT

WoodWorks™
WOOD PRODUCTS COUNCIL

Fire-Resistive Design of Mass Timber Members

Code Applications, Construction Types and Fire Ratings

Richard McLain, PE, SE • Senior Technical Director • WoodWorks
Scott Breneman, PhD, PE, SE • Senior Technical Director • WoodWorks

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

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

This paper has been written to support architects and engineers exploring the use of mass timber for commercial and multi-family construction. It focuses on how to meet fire-resistance requirements in the International Building Code (IBC), including calculation and testing-based methods. Unless otherwise noted, references refer to the 2018 IBC.

Mass Timber & Construction Type

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

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

Type III (IBC 602.3) – Timber elements can be used in floors, roofs and interior walls. Fire retardant-treated wood (FRTW) framing is permitted in exterior walls with a fire-resistance rating of 2 hours or less.

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

Type IV (IBC 602.4) – Commonly referred to as "Heavy Timber" construction, this option

Carbon12 | Portland, Oregon
Kaiser Group | Path Architecture
Munzing Structural Engineering

Mass Timber Fire Design Resource

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

Questions?

Bruce Lindsey

Senior Technical Director

bruce@woodworks.org

(704) 877-6255

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

Session II – Code Compliance Part III – Tall Wood

Chelsea Drenick, SE

Regional Director

chelsea.drenick@woodworks.org

(303) 588-1300

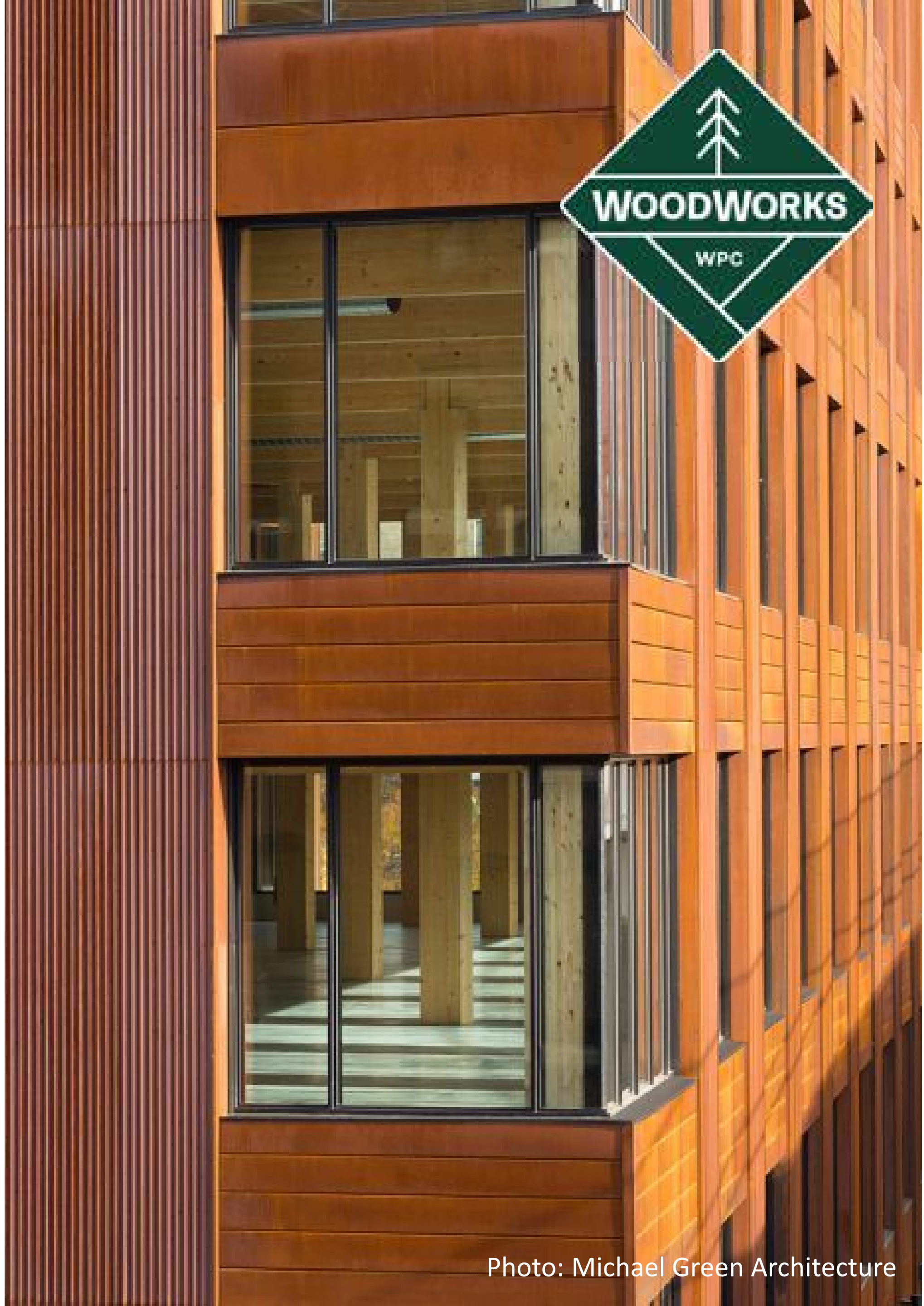


Photo: Michael Green Architecture

BROCK COMMONS, BRITISH COLUMBIA **18 STORIES | 174 FT**

MJOSTARNET, NORWAY

18 STORIES | 280 FT

Photos: *RLP Rüdiger Lainer + Partner, RWTplus*

HOHO, AUSTRIA

24 STORIES | 275 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

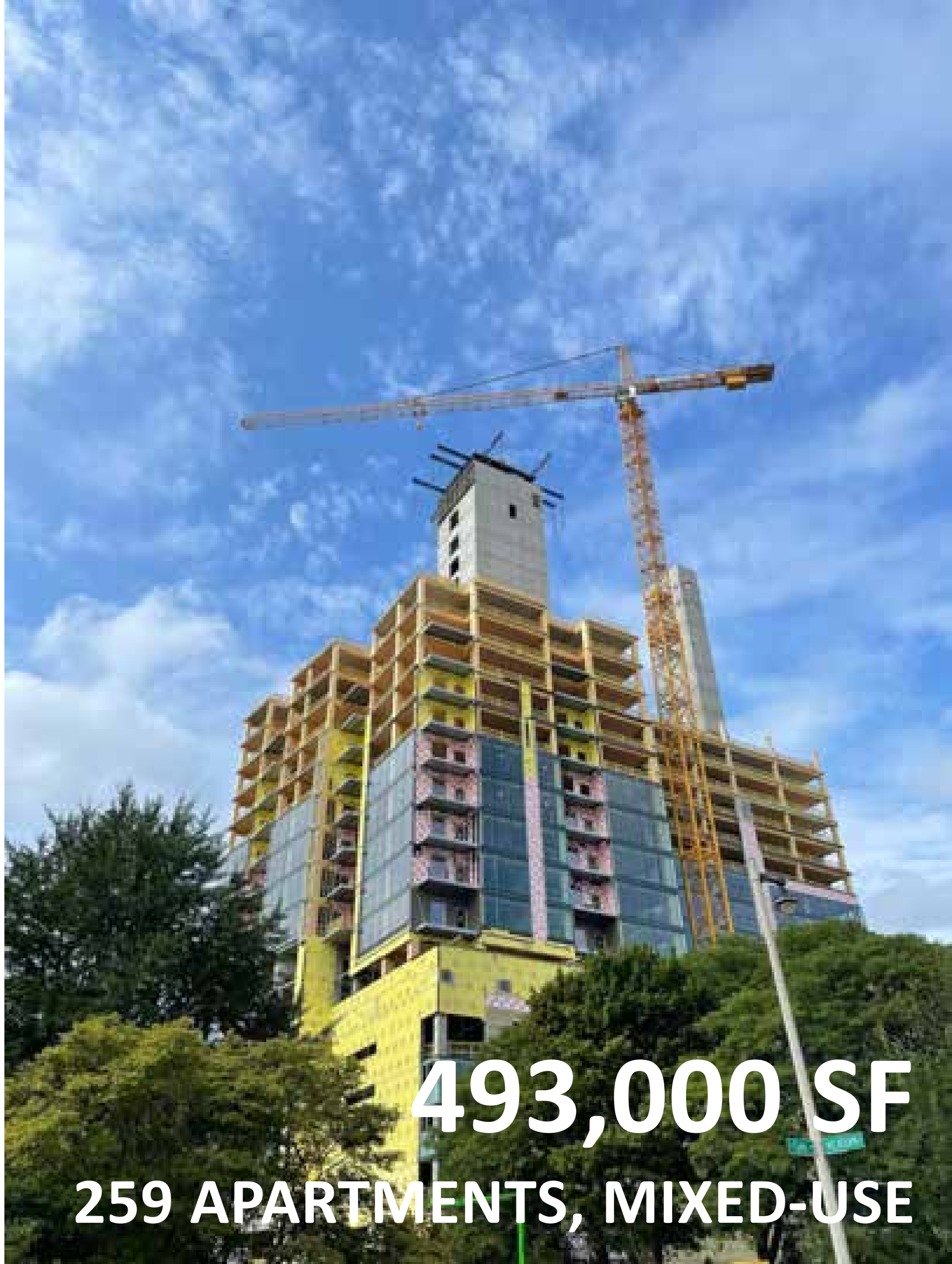
Type IV-B

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



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

Photo: Hickok Cole | Architect: Hickok Cole

80 M ST, WASHINGTON, DC

3 STORY VERTICAL ADDITION
7 STORY EXISTING BUILDING

Photo: WoodWorks | Architect: Hickok Cole


APEX PLAZA
CHARLOTTESVILLE, VA
187,000 SF
Photo: WoodWorks | Architect: William McDonough + Partners

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

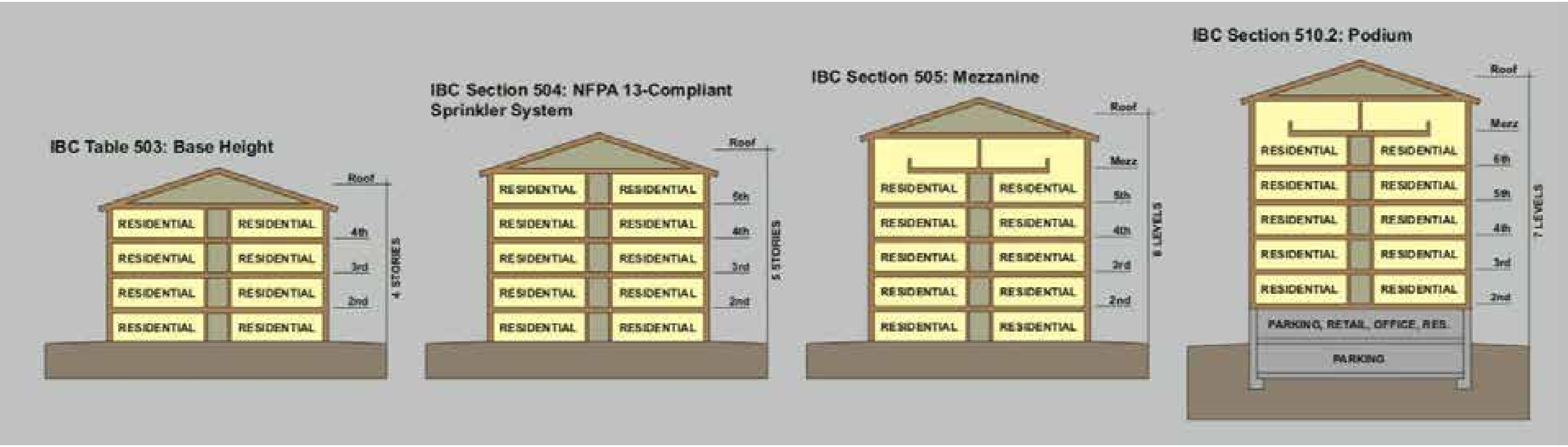
11 E LENOX, BOSTON, MA

Credit: H+O Structural Engineering

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

Over 6 Stories:

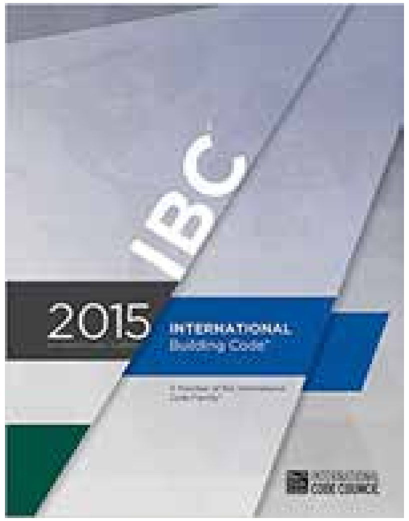
Alternate Means and Methods Request (AMMR) through performance based design

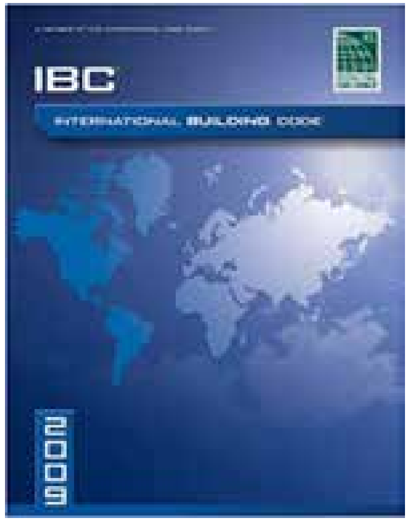


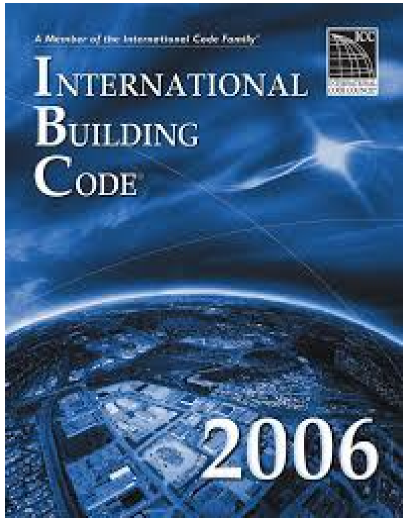
Type V → Type III / Type IV (HT) → + Mezzanines → + Podiums

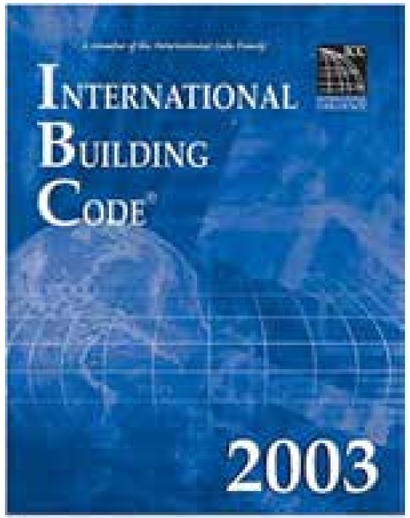
ICC INTERNATIONAL CODE COUNCIL®

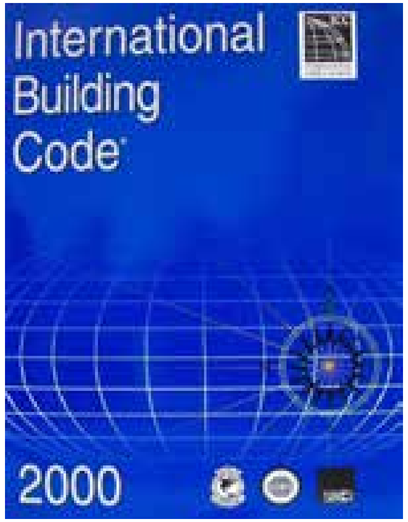
3 YEAR CODE CYCLE











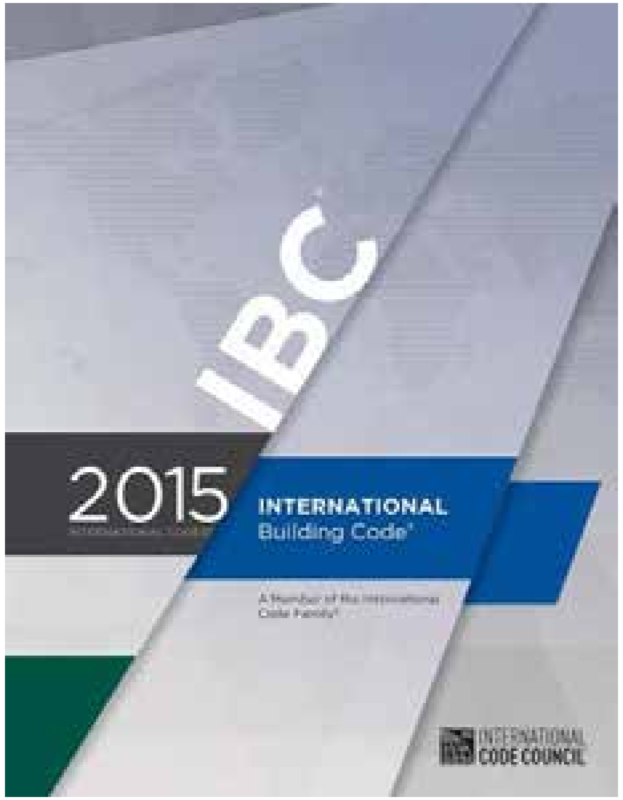
U.S. TALL WOOD

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

Interest in tall wood projects in the US was rapidly increasing. Some building officials were reluctant to approved proposed plans, primarily due to lack of code direction and precedent

Empire State Bulding, New York City, New York, 1931

UBC Brock Commons Student Residence, Vancouver, British Columbia, 2016

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.

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

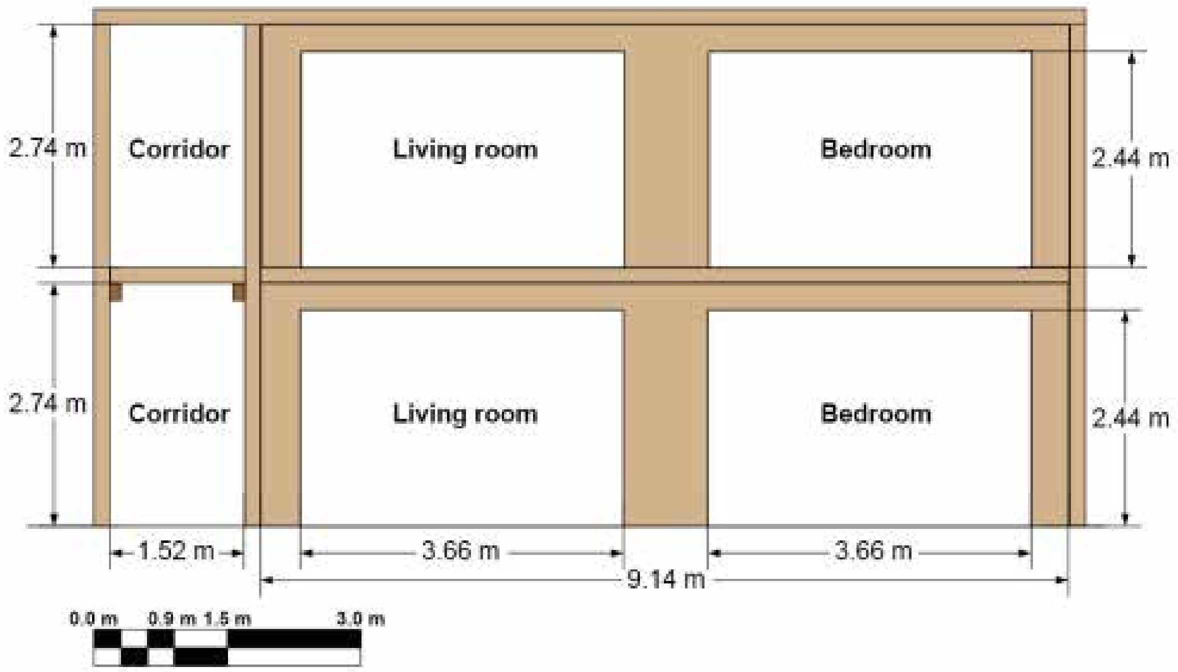


Figure 2. Elevation view of the front of the cross-laminated timber test structure.

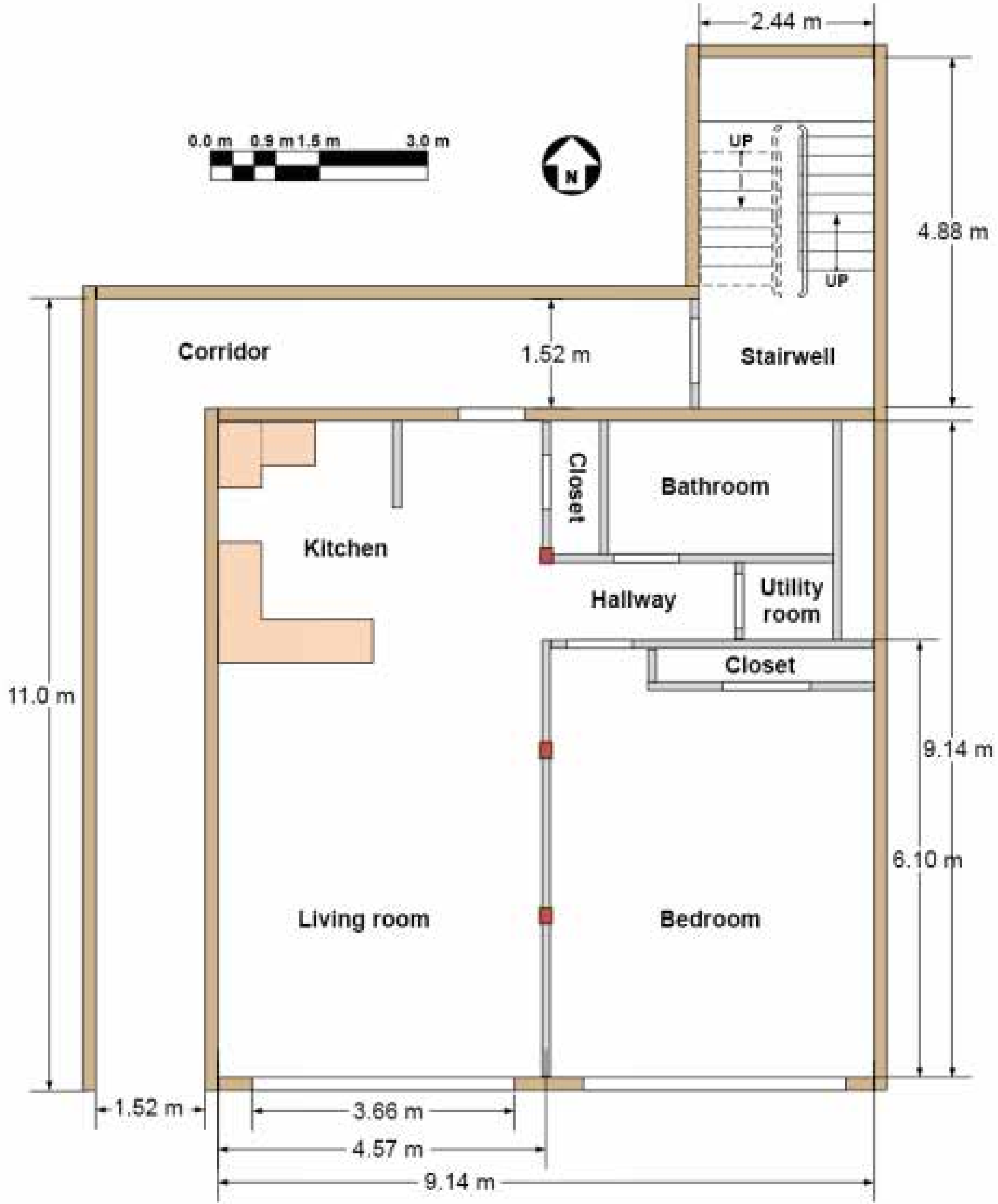


Figure 1. General plan view of cross-laminated timber test structure.

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

U.S. BUILDING CODES

Tall Wood Ad Hoc Committee

Test	Description	Construction Type
Test 1	All mass timber surfaces protected with 2 layers of 5/8" Type X Gypsum. No Sprinklers.	IV-A
Test 2	30% of CLT ceiling area in living room and bedroom exposed. No Sprinklers.	IV-B
Test 3	Two opposing CLT walls exposed – one in bedroom and one in living room. No Sprinklers.	IV-B
Test 4	All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – normal activation	IV-C
Test 5	All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – 20 minute delayed activation	IV-C

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

Type IV-A

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

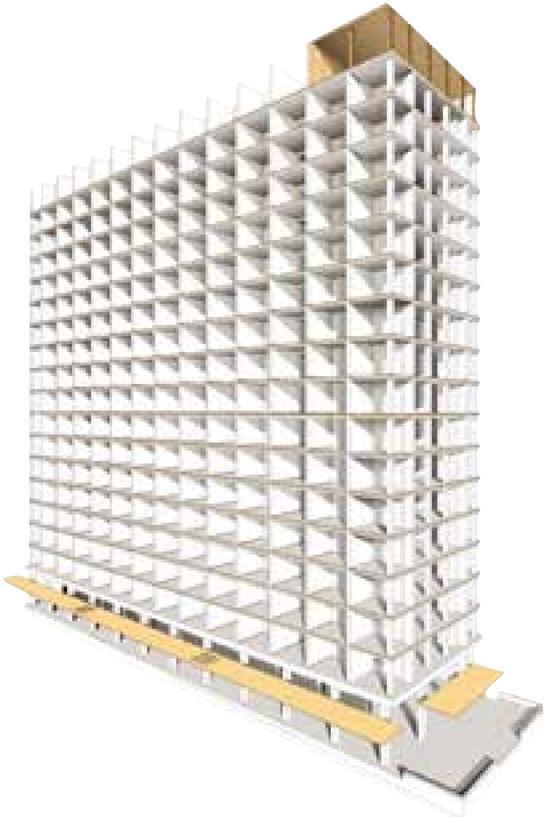
TYPE IV-A

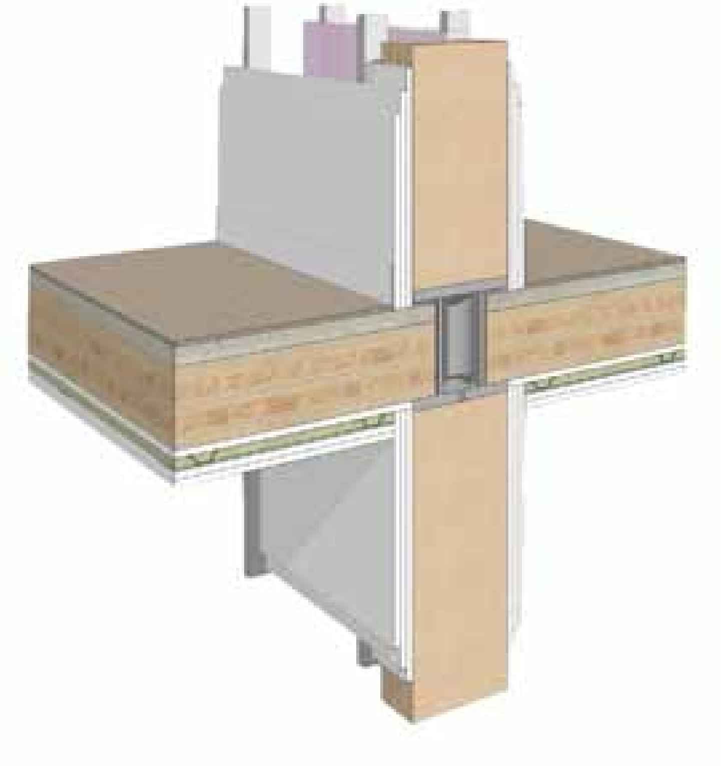
Credit: Susan Jones, atelierjones

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

IV-A

IV-A

Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Protection vs. Exposed

Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

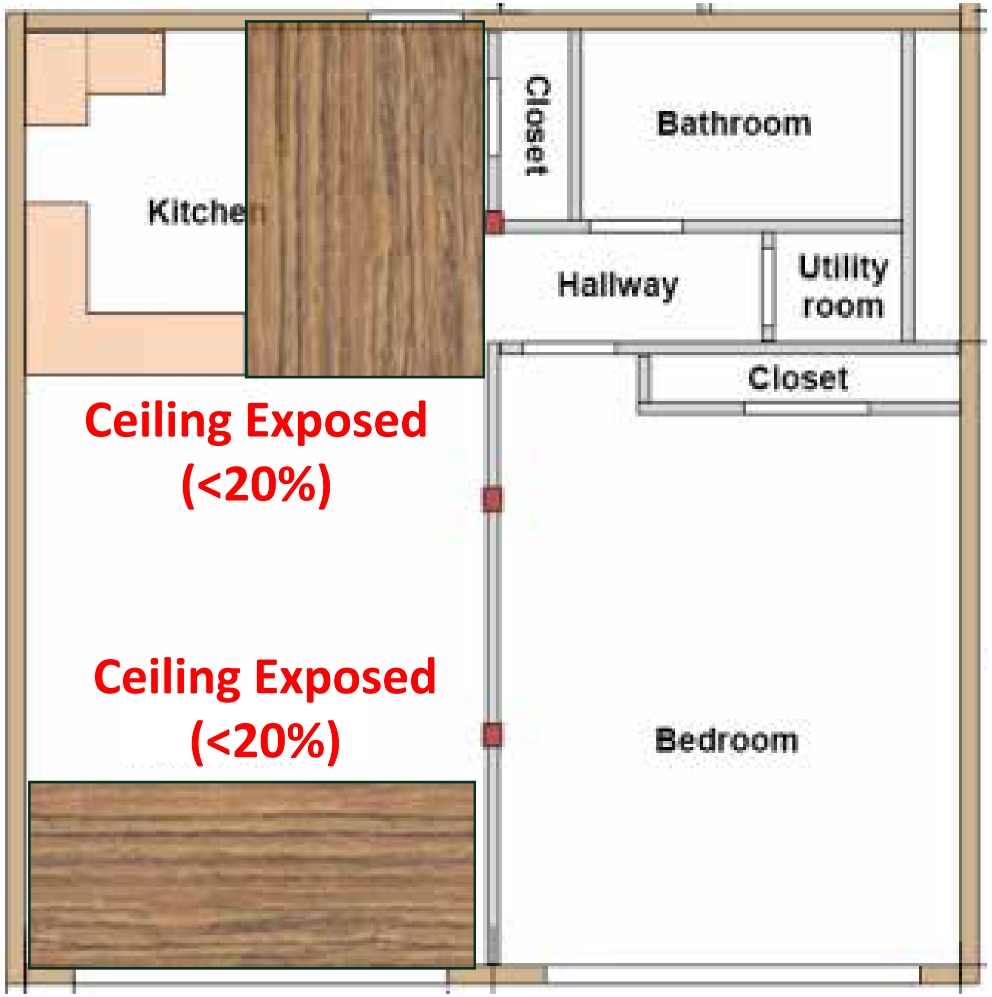
NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed, see code for requirements

IV-B

Type IV-B Protection vs. Exposed

IV-B



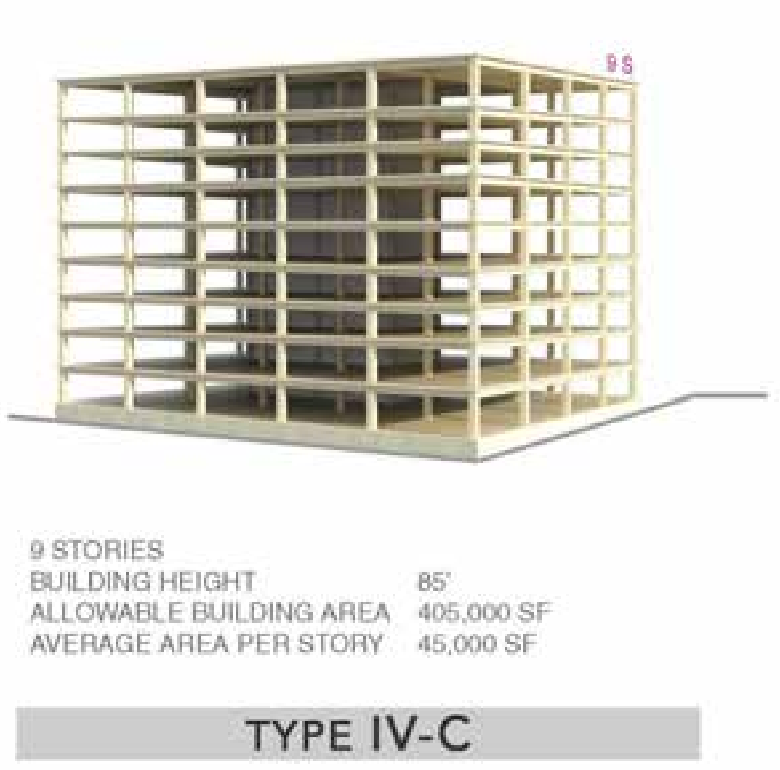
Credit: AWC

Type IV-C

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Credit: Susan Jones, atelierjones

Type IV-C Protection vs. Exposed



Credit: Kaiser+Path, Ema Peter

All Mass Timber surfaces may be exposed

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

Credit: Susan Jones, atelierjones

IV-C

IV-C


IV-C
IV-B
IV-A

Mid-Rise vs. High-Rise

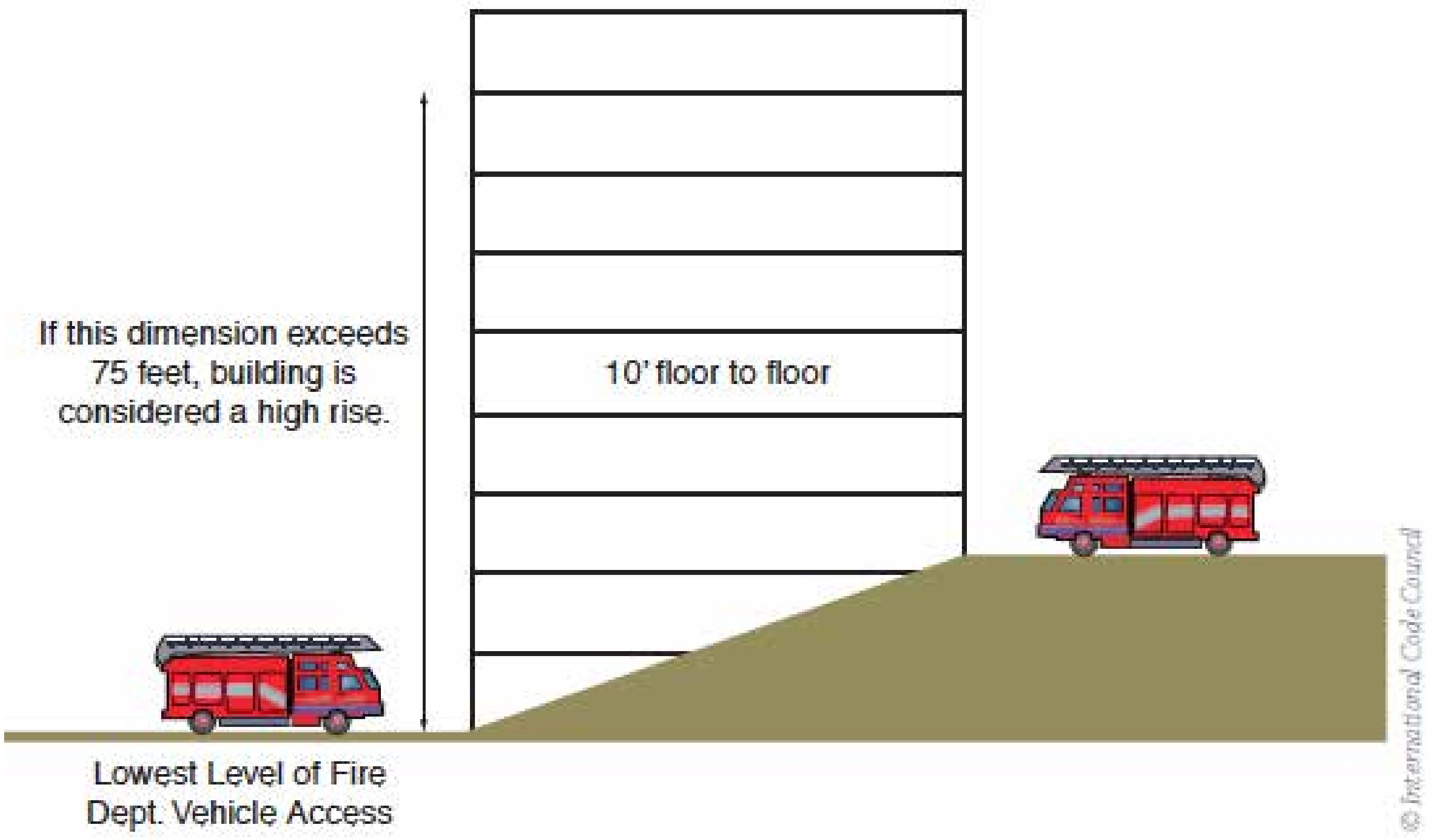


FIGURE 6-6 Determination of high-rise building

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

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

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

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

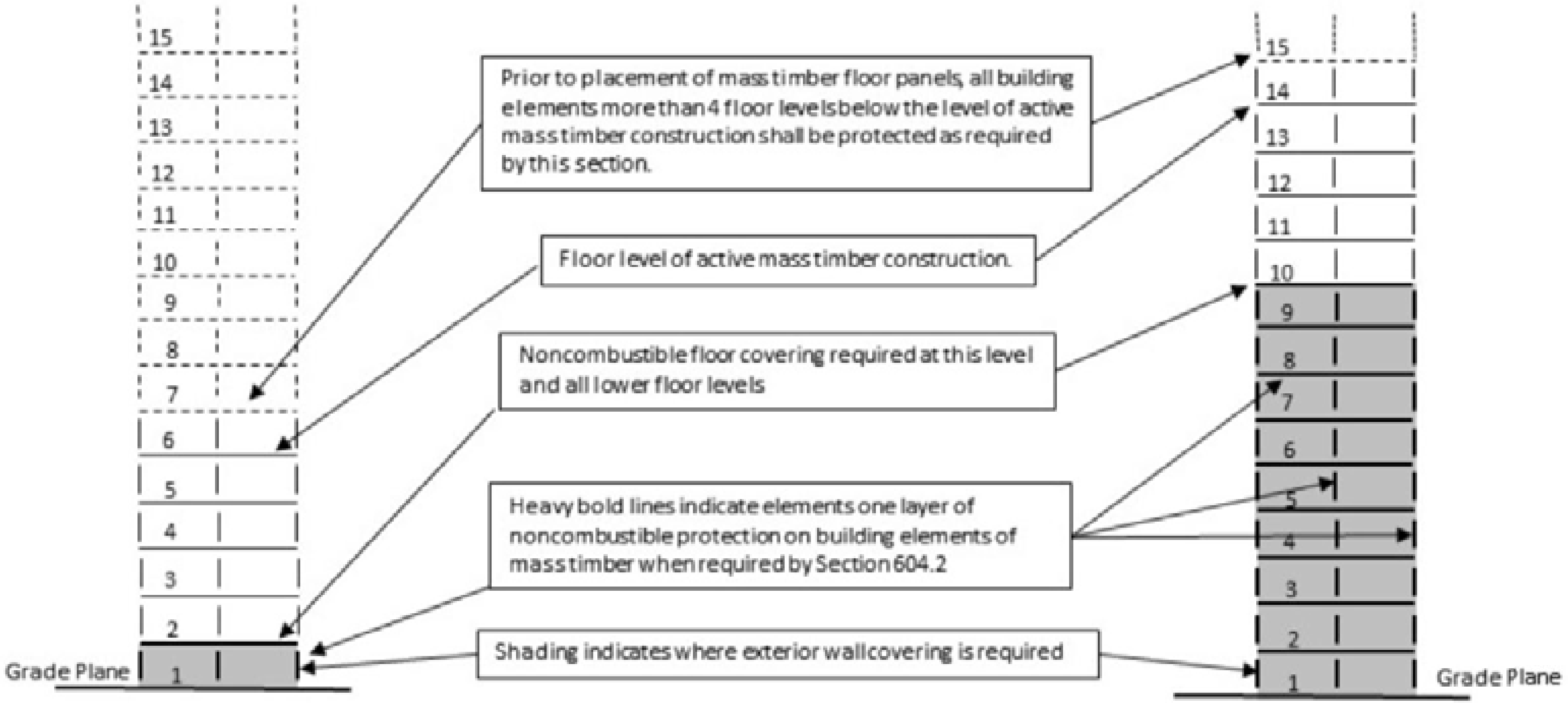


Figure 1

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) 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 (Breneman 2013, Timmers 2015). Around the world there

WoodWorks Tall Wood Design Resource

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

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

Tall Mass Timber Code Adoption

Status as of April 2022 The following jurisdictions have adopted the tall mass timber provisions in the 2021 IBC, either whole or with local amendments.

•Oregon – Appendix P Tall Wood Buildings within the 2019 Oregon Structural Specialty Code
•Washington – Washington State Building Code
•City of Denver, Colorado – Appendix U Tall Wood Buildings (page 187) within the 2019 Denver Building Code
•Utah – Chapter 2a: Tall Wood Buildings of Mass Timber Construction, incorporated as part of the State Construction Code
•California – Supplement to the 2019 California Building Code
•Virginia – Supplement 2021 IBC Mass Timber Provisions within the 2018 state building code
•City of Austin, Texas – Ordinance No 20210603-059, adoption of the 2021 IBC (effective September 1, 2021)
•Maine – Emergency Rule 3, amendments to the Maine Uniform Building and Energy Code (Section 5, item 25)
•City of Bryan, TX adoption of the 2021 IBC
•Georgia – Appendix P to the 2018 IBC
•Idaho – Amendments to the Idaho Building Code
•City of Fort Worth, TX – Fort Worth Construction Codes

Other jurisdictions are considering adoption of the tall mass timber provisions

See: https://www.woodworks.org/resources/status-of-building-code-allowances-for-tall-mass-timber-in-the-ibc/

California Building Standards Commission Passes Tall Wood Code Change Proposals

Source: Softwood Lumber Board

"The early adoption of mass timber codes can be a benefit to California in many ways, but I would like to highlight three of those advantages in this proposal.

1. *It has the potential to increase the market demand for mass timber production in California to meet the needs of the construction industry.*
2. *It will increase the pace and scale of our wildland fire prevention and forest management goals of treating 500 thousand acres per year by thinning the forest of smaller diameter trees that can be used in the production of cross laminated timber and other mass timber assemblies.*
3. *While wood products provide the benefit of storing carbon, another benefit or advantage is that mass timber construction can also help reduce the carbon footprint of concrete and steel production."*

– Chief Mike Richwine, State Fire Marshal

Questions?

Chelsea Drenick, SE

Regional Director

(303) 588-1300

chelsea.drenick@woodworks.org

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

Copyright Materials

Disclaimer: The information in this presentation, including, without limitation, references to information contained in other publications or made available by other sources (collectively "information") should not be used or relied upon for any application without competent professional examination and verification of its accuracy, suitability, code compliance and applicability by a licensed engineer, architect or other professional. Neither the Wood Products Council nor its employees, consultants, nor any other individuals or entities who contributed to the information make any warranty, representative or guarantee, expressed or implied, that the information is suitable for any general or particular use, that it is compliant with applicable law, codes or ordinances, or that it is free from infringement of any patent(s), nor do they assume any legal liability or responsibility for the use, application of and/or reference to the information. Anyone making use of the information in any manner assumes all liability arising from such use.