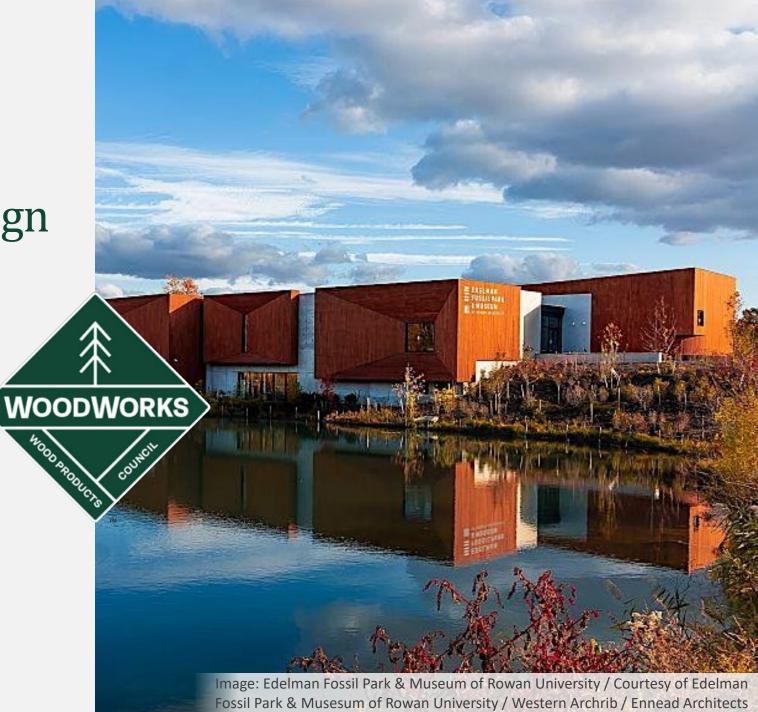
A New Path for Mass
Timber Construction:
Code Provisions & Design
Steps

September 26, 2025

Presented by

Shannon A. Williams, PE WoodWorks

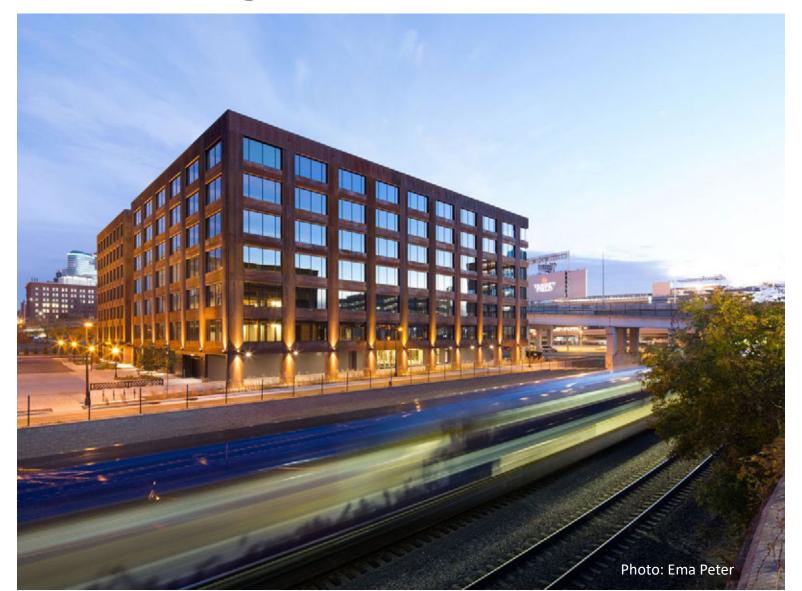


What is Tall Mass Timber?

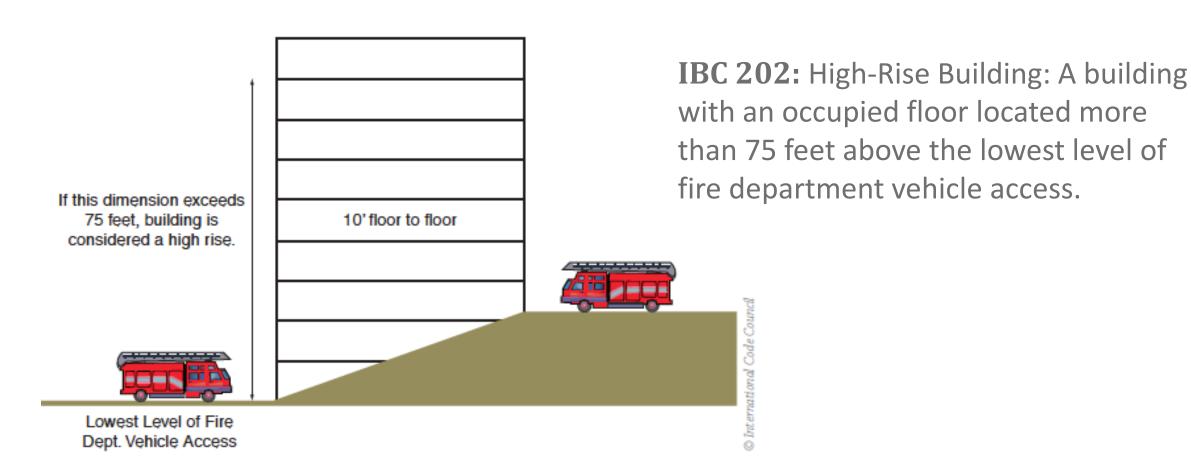


Photo: WoodWorks Architect/Developer: oWOW

Does Tall Wood = High Rise?



Mid-Rise vs. High-Rise Definition – 2018/2021 IBC 202



Determination of high-rise building

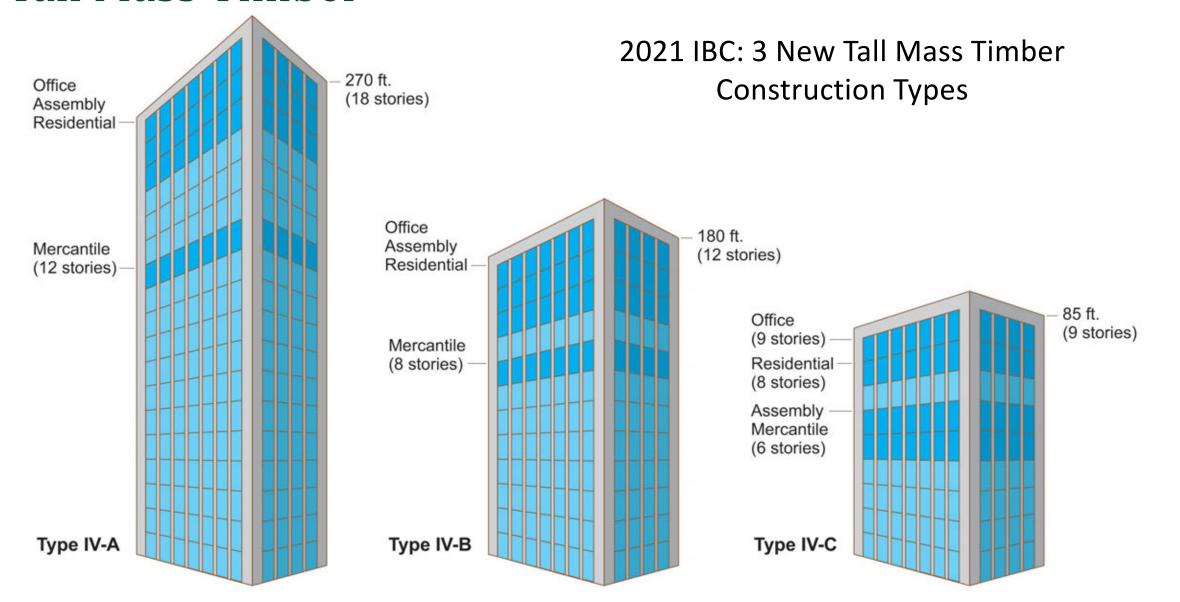
Tall Mass Timber

2021 IBC Introduces 3 new tall wood construction types:

- » IV-A
- » IV-B
- » IV-C
- » Previous type IV renamed type IV-HT

BUILDING TYPE I		TYPE II		TYPE III		TYPE IV			TYPE V			
ELEMENT	Α	В	Α	В	Α	В	Α	В	C	HT	Α	В

Tall Mass Timber



Tall Mass Timber in the U.S.

How DID WE ARRIVE HERE?



2008 – 2015: International Inspiration

8-18-Story Projects in Europe, Canada, Australia





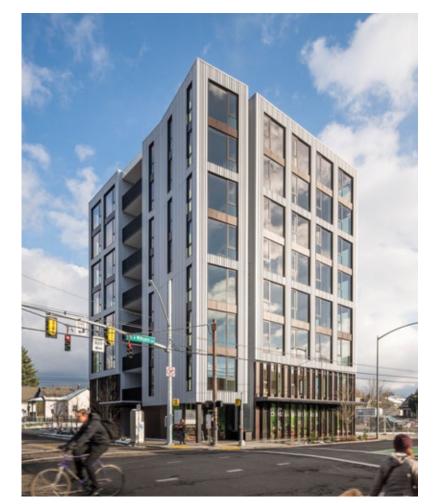


2015-2018: Domestic Innovation

TALL WOOD BUILDING COMPETITION, 8-STORY CARBON 12 IN PORTLAND, OR





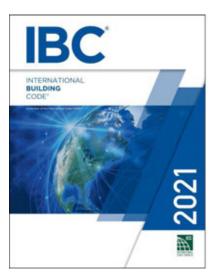


2015-2018: Building a Code Roadmap



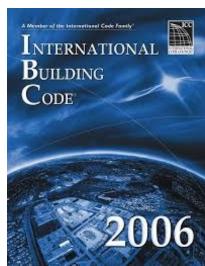
Photos: ICC

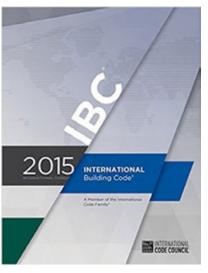
2015-2018: Building a Code Roadmap

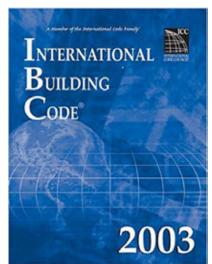


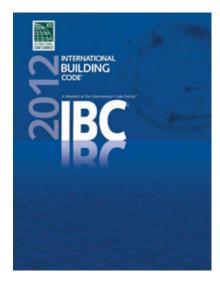


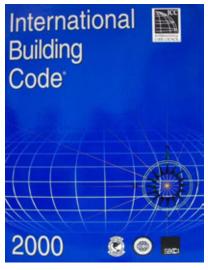












ages: ICC





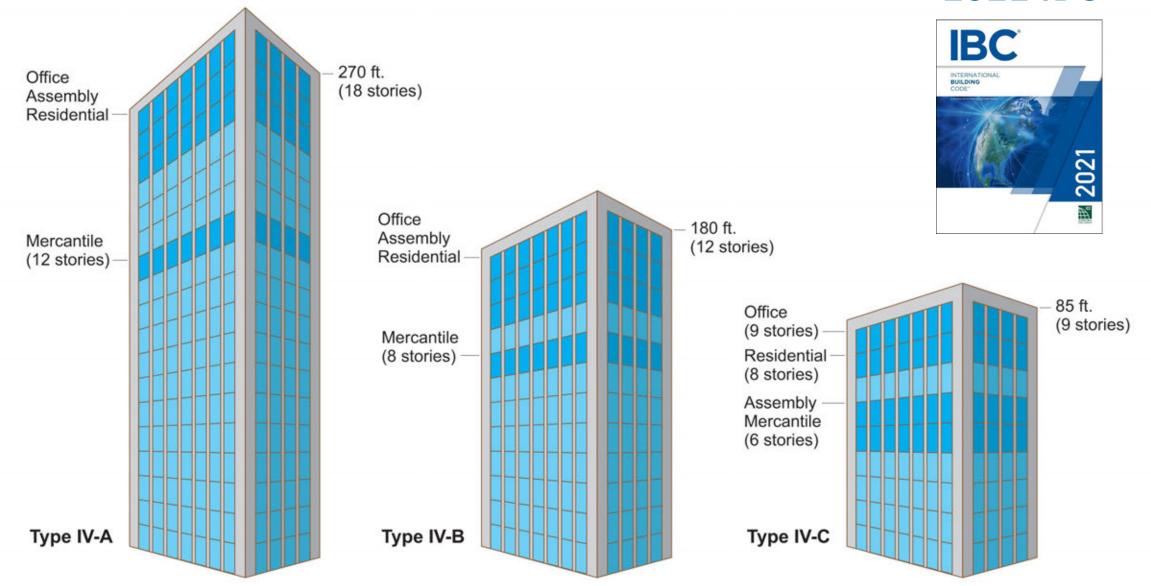




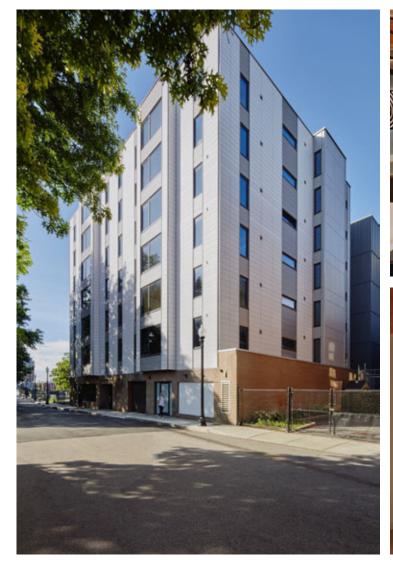


2018-2021: Rollout of a New Code Path

2021 IBC



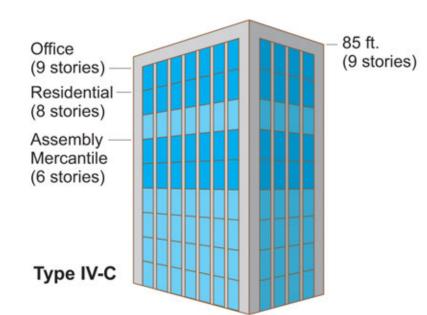
Type IV-C





Monte French Design Studio Photos: Jane Messinger





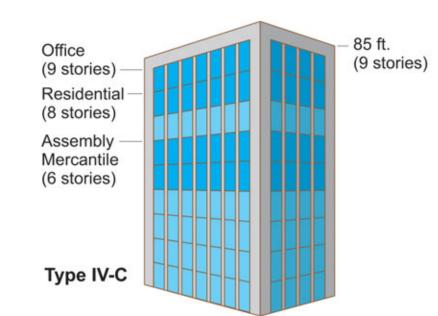
Type IV-C Exposure Limits

All Mass Timber surfaces may be exposed

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



Monte French Design Studio Photo: Jane Messinger



Type IV-C Building Size Limits

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

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
В	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

Office
(9 stories)

Residential
(8 stories)

Assembly
Mercantile
(6 stories)

Areas exclude potential frontage increase





CARBON12

PORTLAND, OR

First Modern Tall Mass Timber Building

in the US

8 stories

42,000 sqft

1st floor retail, 7 stories of condos

above

Completed in 2017





Kaiser + Path Munzing Structural Engineering Photo Andrew Pogue

Type IV-B





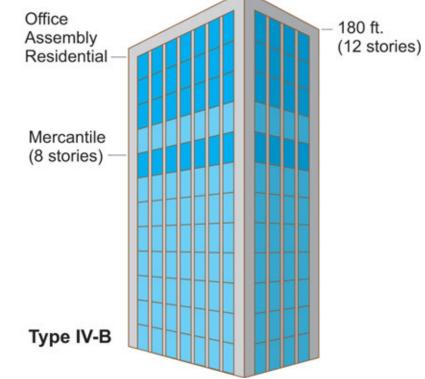


Photo: ©Prakash Patel

Photos: Nick Johnson, Tour D Space

Type IV-B Exposure Limits

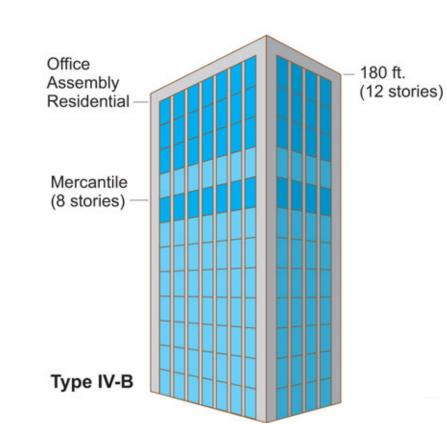
NC protection on some surfaces of Mass Timber

2021 IBC: 20% of ceilings or 40% of walls can be exposed

2024 IBC: 100% of ceilings or 40% of walls can be exposed



Photo: Nick Johnson, Tour D Space



Type IV-B Building Size Limits

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

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

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
В	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

Office 180 ft. Assembly (12 stories) Residential Mercantile (8 stories) Type IV-B

Areas exclude potential frontage increase





INTRO

Cleveland, OH

Building Facts 115 ft tall, 9 stories total (8 mass

timber)

Type IV-B

Multi-Family Mixed-Use

Completed 2022

Developer Harbor Bay Ventures

Architect Hartshorne Plunkard Architecture

Engineer Forefront Engineering, Fast + Epp

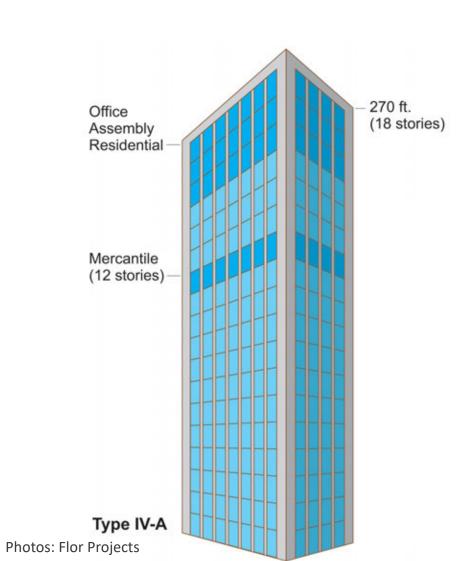
General Contractor Panzica Construction

Type IV-A







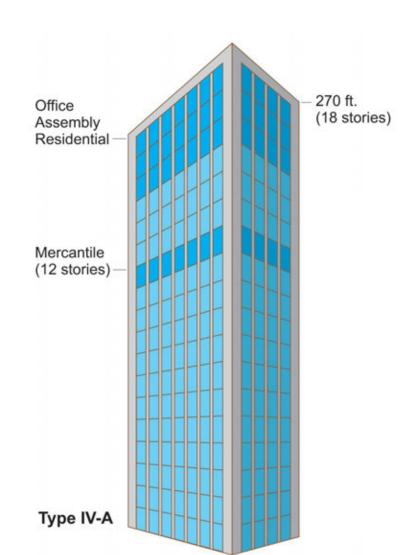


Type IV-A Exposure Limits

100% NC protection on all surfaces of Mass Timber



Photo: Flor Projects



Type IV-A Building Size Limits

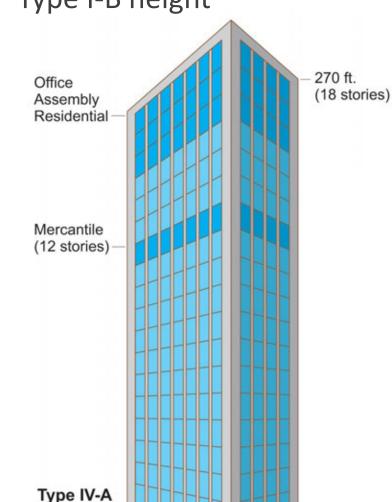
In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height

& story allowances

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

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
В	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



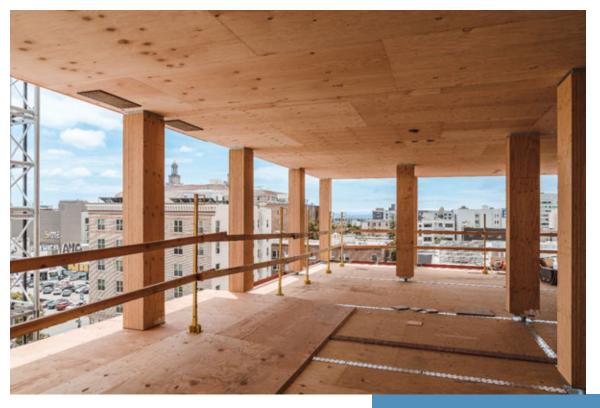


1510 Webster

Oakland, CA



- » 16 stories mass timber, 1 level steel over two-level concrete
- Designed with Tall Wood code provisions in the 2021 CBC
- » Mass timber with concrete cores and staircases



Photos: Flor Projects





Fire Safe Implementation of Mass Timber In Tall Buildings

Research of the fire performance of CLT and Glued Laminated Timber buildings, with visible wood surfaces.

The main aim of this research project was to identify safe limits of exposed mass timber surface areas that correspond with performance criteria used for previous U.S. Building Code Changes.

Source: RISE



Compartment Fire Testing of a Two-Story Mass Timber Building

Samuel L. Zelinka Laura E. Hasburgh Keith J. Bourne David R. Tucholski Jason P. Ouellette



Conservatism: ATF lab tests based on older generation CLT adhesives

 2018 ATF tests were initiated before the 2018 version of ANSI/APA PRG 320 was published and the tested CLT was not compliant with the new product standard.



In tall buildings, preventing fire re-growth is key.

Fire re-growth is a phenomenon in which the heat-release rate of a fire intensifies following a decay phase. Fire re-growth can be initiated when delamination occurs, as this exposes un-charred wood surfaces, thereby resulting in an influx of fuel available for consumption by the fire.





PRG 320 is manufacturing & performance standard for CLT

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

ANSI/APA PRG 320-2018

Standard for Performance-Rated Cross-Laminated Timber



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

Change to 2024 IBC: IV-B Ceiling Exposure



602.4.2.2.2 Protected area.

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

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

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

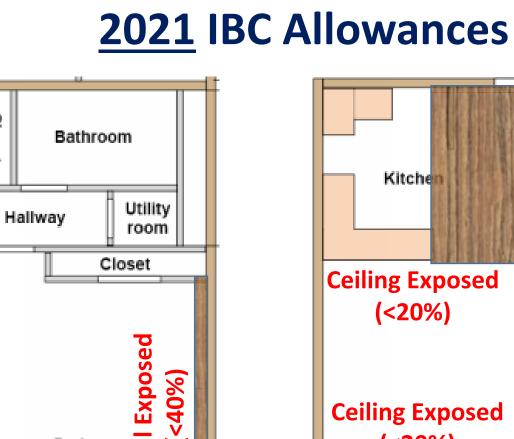
Change to 2024 IBC: IV-B Exposure Separation



602.4.2.2.4 Separation distance between unprotected *mass timber* elements.

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

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



Bedroom '

Min. 15 ft

Separation

Closet



IBC

Credit: AWC

Kitchen

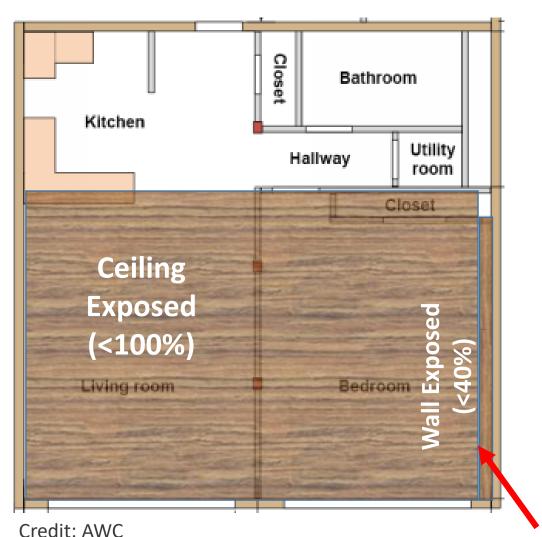
Ceiling

Exposed

(<20%)

Living room







24 **IBC**

No separation req'd between wall & ceiling



Min. 1" thick NC protection required on mass timber floors in IV-A and IV-B. Not required in IV-C



F174-21

Change to 2024 IBC: Sequencing of NC aymond O'Brocki, AWC, representing AWC (robrocki@awc.org) topping install

IFC: 3303.5

Proponents: David Tyree, representing AWC (dtyree@awc.org); Raymond O'Brocki, AWC, representing AWC (robrocki@awc.org)

2021 International Fire Code

Revise as follows:

3303.5 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 comply with 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 code official and the fire chief.
- 3. Where building construction exceeds six stories above *grade plane* and noncombustible protection is required by Section 602.4 of the *International Building Code*, at least one layer of noncombustible protection shall be installed on all building elements on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

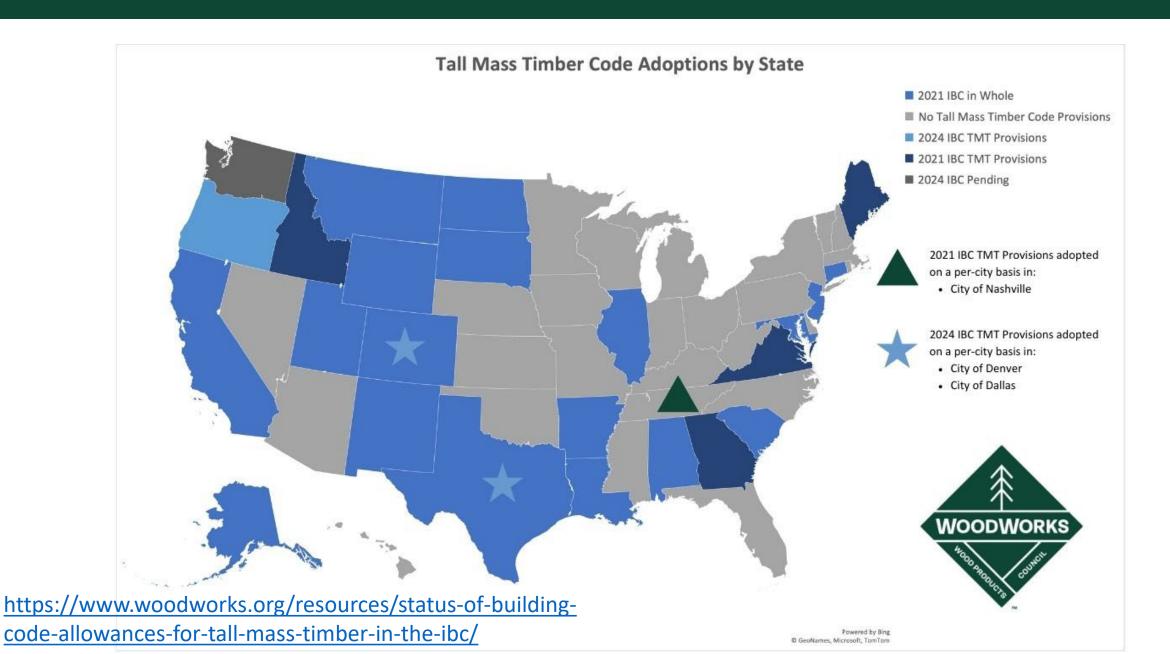
Exception Exceptions:

- 1. Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.
- 2. Noncombustible material on the top of mass timber floor assemblies shall not be required before erecting additional floor levels.
- 4. Where building construction exceeds six stories above *grade plane*, required exterior wall coverings shall be installed on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

Exception: Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.

Credit: ICC

TALL MASS TIMBER CODE ADOPTIONS





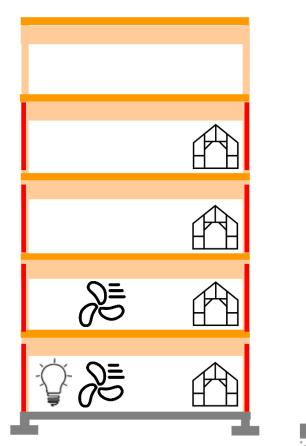
Mass Timber: Structural Warmth is a Value-Add

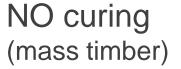


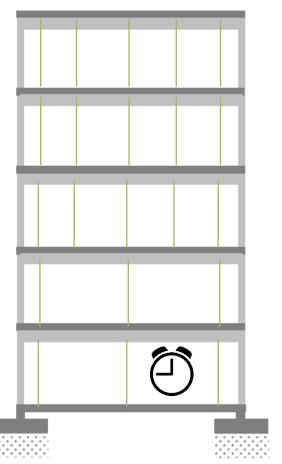


Schedule Savings for Rough-In Trades

Fast Construction





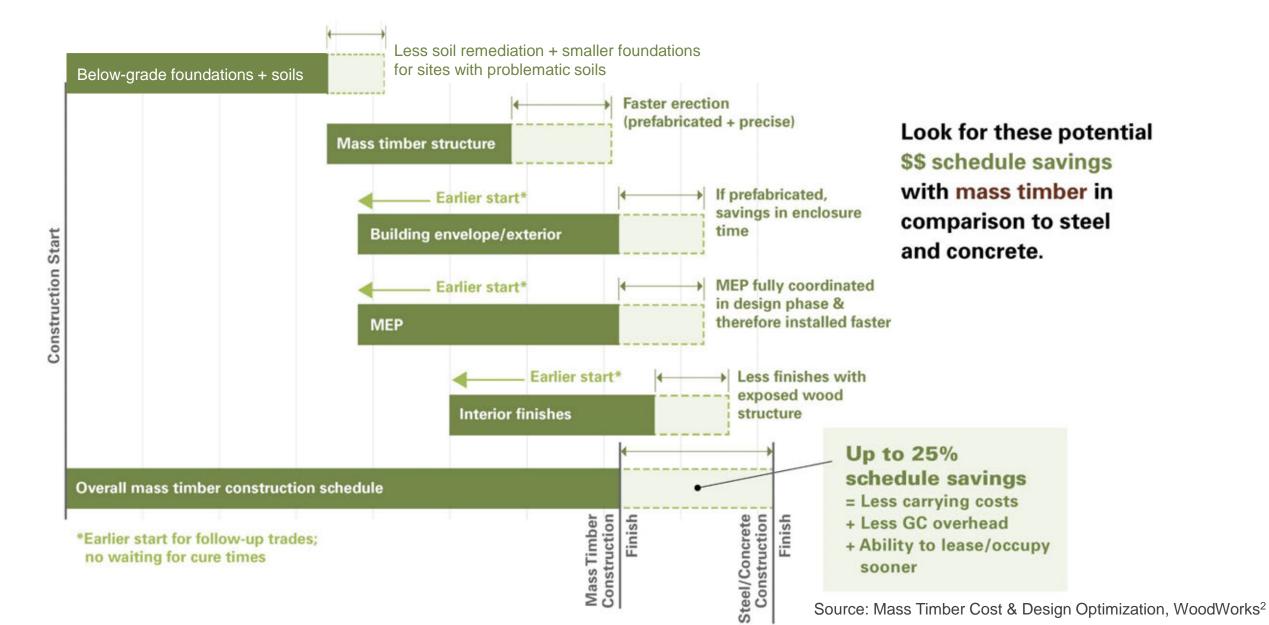


Curing & maze of shores (concrete)



Compressing the Typical Schedule

Fast Construction



Construction Impacts: Labor Availability







Need to Consider Holistic Costs, Not Structure Only





Image: GBD Architects

Risk Mitigation: Total Project Cost Analysis

CONSIDERATIONS:

- Ceiling Treatment
- Floor Topping
- HVAC System & Route
- Foundation Size
- Soil Improvements
- Exterior Skin Coordination
- Value of Time





How to Successfully Cost Manage a Mass Timber Project

Cost-Estimating Considerations for General Contractors



Apex Plaza William McDonough + Partners / Hourigan

A determining factor in the success of a mass timber project—and whether it goes forward at all—is the general contractor's ability to provide informed cost estimates from the earliest stage of design. However, unlike other materials, there isn't a hundred years of tradition and shared experience to guide budgeting, cost management, and competitive procurement, or readily available cost benchmarking.

This paper is intended to bridge that gap with guidance for minimizing whole project costs and maximizing the value of mass timber projects. It has been written with an emphasis on cross-laminated timber (CLT) and glue-laminated timber (glulam), but applies generally to all mass timber materials. Follow these steps to more confidently cost plan your next wood building.

This paper was developed collaboratively with a design and construction professional who specializes in mass timber construction and has worked on multiple projects for general contractors. Costs, percentages and other values are based on their experience and may differ for other projects.

Step 1: Do Your Homework

- Vetting potential subcontractors
- •Determining the procurement model (with details on common models used in the U.S.)

Step 2: Establish a Reliable Pre-Design Budget

- Basic timber pricing dynamics
 - Example of increasing detail recommended at different phases of project planning
 - Information to supply for better pricing
 - Insights for better budgeting
- Choosing your list of bidders
- Adjusting budgets for trades impacted by timber

Step 3: Manage Project Costs

- Establishing cost benchmarking
- •Understanding the largest non-timber design cost levers

Mass Timber Business Case Studies



















\$ Costs + \$ Returns Challenges, Lessons Learned, Successes

Scan code here to download the current package



Development Overview

- 9-story, 115' tall building
- 8 stories of CLT & glulam construction over a podium
- Strategy:
 - Create Cleveland's best, most distinctive urban living experience; a new level and bespoke brand
 - Combine best-in-city amenity package and contemporary interiors to appeal to health/ wellness & entertainment-focused young professionals

Property Information	
Property timing	Completed Feb 2022
Submarket	Cleveland's Ohio City neighborhood
Construction Type	4-B over 1-A retail & parking
Site size	2.1 acres (FAR 5.5)
Gross building area	512,000 SF
Net rentable area (total)	279,000 SF



Quantitative Overview

Costs				
Total project cost		\$147,000,000		
		\$494,950/ unit	_	
Land Cost		\$10,450,000	@ appraised value	
		Market Standard*	Pro Forma	Realized**
Construction costs		\$212 / GSF	\$200 / GSF	\$215 / GSF
NOI				
Apartment		Market	Realized	
Rental rates				
	Studio	\$1,279	\$1,500 -\$1,750 (P.H. \$2,000)	~26% higher
	1-BR	\$1,631	\$1,675 -\$2,500 (P.H. \$5,700)	~28% higher
	2-BR	\$2,301	\$2,500 -\$5,200 (P.H. \$7,800)	~67% higher
	3-BR	\$3,334	\$8,800 -\$19,500 P.H.	~324% higher
Occupancy at stabilization		91%	98%	~7% higher
Parking Revenue		Market	Pro Forma	Realized**
Included or in addition to lease?		Additional	Additional	Additional
Rate		\$175 / lot / month	\$185 -\$200 / lot / month	\$225 -\$375 / lot / month
Retail		Market	Pro Forma	Realized**
Retail rental rates		\$30 -\$40 / RSF/YR	\$45 / RSF/YR	\$45 / RSF/YR
Rent type (e.g., NNN)		NNN & Gross	NNN	NNN
Expenses		\$7 -\$10 / RSF/YR	\$8 / RSF/YR	\$8 / RSF/YR
Tenant improvement allowance		\$40 -\$50 / RSF	\$150 / RSF	\$150 / RSF
Occupancy after 12 months		60% -70%	90%	75%

^{**}Realized metrics at stabilization

Return Performance				
	Market	Pro Forma	Realized**	
Yield on cost – untrended	6.25%	7.00%	7.35%	Higher
Cap rate	4.75%	4.50%	TBD	
Value/rentable SF	\$550 / RSF	\$717/ RSF	TBD (\$800+ / RSF)	Higher
Leverage	65%	65%	N/A	

Timeline		
	Date	Context/Comment
Date of conception (first dollar spent)	Mid 2018	Mid-cycle
Date underwriting finalized (go/no-go decision)	Mid 2019	Mid-cycle
Date equity capital secured	N/A	Developer is equity
Permitting duration***	3 + 6 mo.	Demolition permit first, then building permit
GMP in place	Feb/March 2020	COVID
Construction start	April 2020	
Duration of construction	24 months	Faster by about 2 months
Construction completed	April 2022	Early-cycle
Date stabilized (80% occupancy, NOI, or at pro forma or refinanced)	June 2022	Faster

Project Context

Unparalleled leasing velocities at significant premiums

- The project was 90% leased 4 months after completion
- The premium product drives both velocity and rates with rents significantly higher than market counterparts
- · Leasing velocity allowed refinancing activities to start 3 months after completion

Unparalleled leasing velocities at significant premiums

Disclaimer: Information herein was provided by the developer and verified for reasonableness by a third-party expert. Market data and figures have been reviewed by an independent third party utilizing industry standard resources. For additional sources and disclaimers, see the *Basis of Information* page for this case study and the *Disclosures, Disclaimers and Confidentiality* page at the end of this case study package.

Mass Timber Business Case Study

^{***}Conversations with local building officials were held concurrent to land use entitlement approvals processes such that the overall building code review process was only slightly longer. This concurrent approach was essential given that Ohio was not adopting the 2021 IBC, so the Type 4 code path was performance-based, albeit a mirror of what other states have adopted.

What's the 'Sweet Spot' for Tall Mass Timber?

Depends on many factors:

- Project Use
- Site Constraints
- Local Zoning & FAR Limitations
- Budget
- Client Objectives for Sustainability, Exposed Timber
- And More...

But Some General Trends Could Be:

80 M Street, SE, Washington, DC Photo: Hickok Cole | Architect: Hickok Cole

Type IV-C Tall Mass Timber

Example R-2, Type IV-C Building

Not Likely to Utilize Podium Due to Overall Building Height Limit (85 ft) Relative to # of Timber Stories (8)

Same Overall Building Height Limit as IV-HT (85 ft) but higher Fire-Resistance Ratings Requiredd

3 Additional Stories Permitted Compared to IV-HT

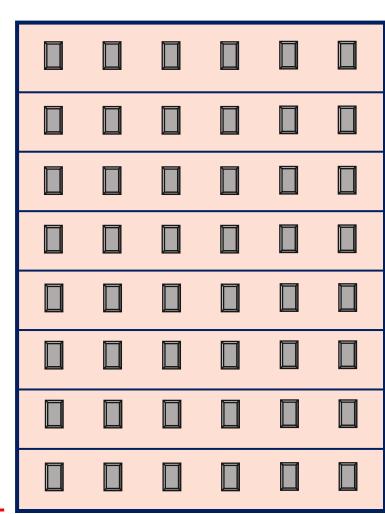
All Timber Exposed

8 Stories 85 ft

76,875 SF max per floor

230,625 SF bldg.

(areas noted assume no frontage increase)



Type IV-B Tall Mass Timber

Example Mixed-Use, Type IV-B Building

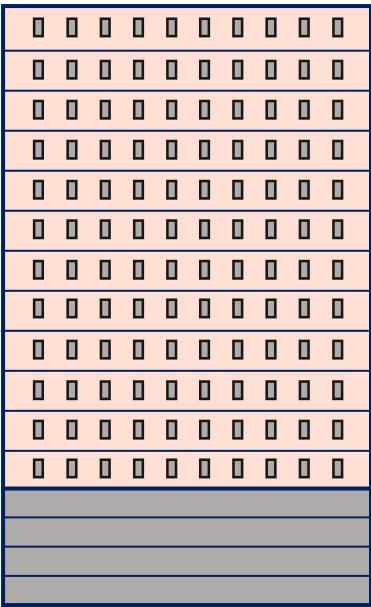
Likely to Utilize Podium Due to Overall Building Height Limit (180 ft) Relative to # of Timber Stories (12)

Same Fire-Resistance Ratings Required as IV-C But Limitations on Timber Exposed

4 Additional Stories Permitted Compared to IV-C

Limited Timber Exposed





Type IV-A Tall Mass Timber

Example Mixed-Use, Type IV-A Building

Likely to Utilize Podium Due to Overall Building Height Limit (270 ft) Relative to # of Timber Stories (18)

Higher Fire-Resistance Ratings Required than IV-B For Primary Frame

6 Additional Stories Permitted Compared to IV-B

No Exposed Timber Permitted

Timber, R-2: 18 Stories 184,500 SF Roof max per floor 553,500 SF Grad bldg. (areas noted assume no frontage increase) Multi-Story Type IA Podium

Tall Wood Building Size Limits

	Construction Type (All <u>Sprinklered Values</u>)								
	I-A	I-B	<u>IV-A</u>	<u>IV-B</u>	<u>IV-C</u>	IV-HT	III-A		
Occupancies	Allo	wable Build	ing Height al	bove Grade l	Plane, Feet ()	IBC Table 50	4.3)		
A, B, R	Unlimited	180	<u>270</u>	<u>180</u>	<u>85</u>	85	85		
	Al	lowable Nun	nber of Stori	es above Gra	ade Plane (IB	C Table 505	.4)		
A-2, A-3, A- 4	Unlimited	12	<u>18</u>	12	<u>6</u>	4	4		
В	Unlimited	12	<u>18</u>	<u>12</u>	9	6	6		
R-2	Unlimited	12	<u>18</u>	<u>12</u>	8	5	5		
		Allowable A	Area Factor ((At) for SM,	Feet ² (IBC 7	Table 506.2)			
A-2, A-3, A- 4	Unlimited	Unlimited	135,000	90,000	56,250	45,000	42,000		
В	Unlimited	Unlimited	324,000	216,000	135,000	108,000	85,500		
R-2	Unlimited	Unlimited	<u>184,500</u>	123,000	<u>76,875</u>	61,500	72,000		

Tall Wood Building Size Limits

	Construction Type (<u>Unsprinklered Values</u>)								
	I-A	I-B	<u>IV-A</u>	<u>IV-B</u>	<u>IV-C</u>	IV-HT			
Occupancies	Allowa	ble Building I	Height above G	Frade Plane, F	eet (IBC Table	504.3)			
A, B, R	Unlimited	160	<u>65</u>	<u>65</u>	<u>65</u>	65			
	Allov	Allowable Number of Stories above Grade Plane (IBC Table 505.4)							
A-2, A-3, A-4	Unlimited	11	3	<u>3</u>	<u>3</u>	3			
В	Unlimited	11	<u>5</u>	<u>5</u>	<u>5</u>	5			
R-2	Unlimited	11	4	4	4	4			
	Allowable Area Factor (At) for SM, Feet ² (IBC Table 506.2)								
A-2, A-3, A-4	Unlimited	Unlimited	45,000	30,000	18,750	15,000			
В	Unlimited	Unlimited	108,000	72,000	45,000	36,000			
R-2	Unlimited	Unlimited	61,500	41,000	<u>25,625</u>	20,500			

Even so, Sprinklers may be required by 903.2 (all occupancies) and definitely for residential (420.4)

Tall Wood Building Size Limits

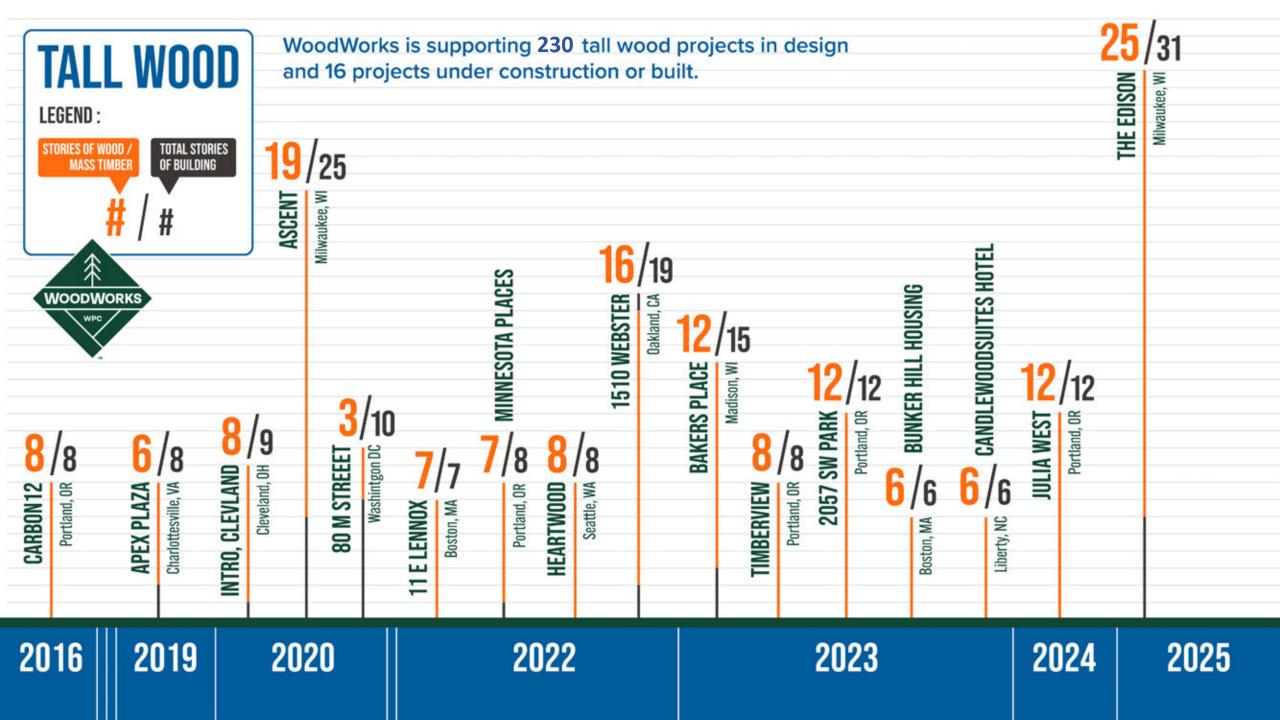
Construction Type (<u>Unsprinklered Values</u>)							
Unlimited	160	<u>65</u>					
Allo	nalmo	ostalla	cases,				
			requi				
Unin ited	ikieis	wiii be	regun				

Non-Tall Opportunities – Large Area

	Construction Type (All <u>Sprinklered Values</u>)								
	I-A	I-B	<u>IV-A</u>	<u>IV-B</u>	<u>IV-C</u>	IV-HT	III-A		
Occupancies	Allo	wable Build	ing Height a	bove Grade	Plane, Feet ()	IBC Table 50	4.3)		
A, B, R	Unlimited	180	<u>270</u>	<u>180</u>	<u>85</u>	85	85		
	Al	lowable Nun	nber of Stori	es above Gra	ade Plane (IE	BC Table 505	.4)		
A-2, A-3, A- 4	Unlimited	12	<u>18</u>	12	<u>6</u>	4	4		
В	Unlimited	12	<u>18</u>	<u>12</u>	9	6	6		
R-2	Unlimited	12	<u>18</u>	<u>12</u>	8	5	5		
		Allowable A	Area Factor ((At) for SM,	Feet ² (IBC '	Table 506.2)			
A-2, A-3, A- 4	Unlimited	Unlimited	135,000	90,000	<u>56,250</u>	45,000	42,000		
В	Unlimited	Unlimited	324,000	216,000	135,000	108,000	85,500		
R-2	Unlimited	Unlimited	<u>184,500</u>	123,000	<u>76,875</u>	61,500	72,000		

2022 AND BEYOND: PROJECTS RISING









Baker's Place

Madison, WI

304,800 sf,

15 stories total (12 mass timber)

Type IV-B

Multi-Family

Passive House



Angus-Young
Michael Green Architecture
Equilibrium Consulting
Photo Michael Green
Architecture





80MWASHINGTON, DC

3 story MT vertical addition on top of existing 7 story building
CLT panels / glulam frame
108,000 sqft
16 ft floor to floor



Hickok Cole Arup Photo Maurice Harrington





Ascent

Milwaukee, WI

493,000 sf, 25 stories total (19 mass

timber)

Type IV-HT with code modifications

Multi-Family

Completed 2022

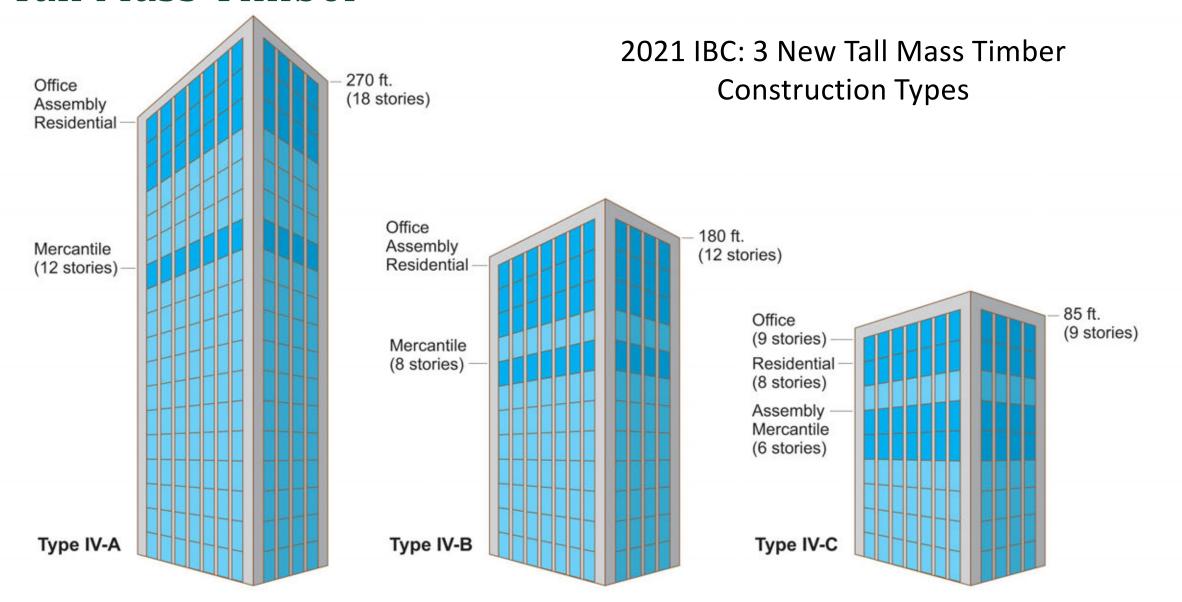






Korb + Associates Architects Thronton Tomasetti Photo: VRX Media Group

Tall Mass Timber



Tall Wood Fire Resistance Ratings (FRR)

FRR Requirements for Tall Mass Timber Structures (hours)

Building Element	IV-A	IV-B	IV-C
Primary Frame	3	2	2
Exterior Bearing Walls	3	2	2
Interior Bearing Walls	3	2	2
Roof Construction	1.5	1	1
Primary Frame at Roof	2	1	1
Floor Construction	2	2	2

Source: 2021 IBC Table 601

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



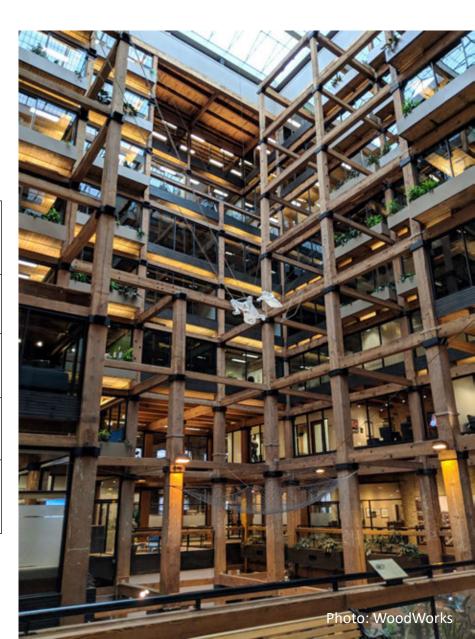
Photo:: Ema Peter

Type IV Minimum Sizes - Framing

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

Fr	Framing Solid Sawn (nominal)		Glulam (actual)	SCL (actual)	
Floor	Columns	8 x 8	$6^3/_4 \times 8\%$	7 x 7½	
Flo	Beams	6 x 10	5 x 10½	5¼ x 9½	
of	Columns	6 x 8 5 x 8¼		5¼ x 7½	
Roof	Beams*	4 x 6	$3 \times 6^{7}/_{8}$	3½ X 5½	

^{*3&}quot; nominal width allowed where sprinklered



Type IV Minimum Sizes - Floor/Roof Panels

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







Type IV Minimum Sizes - Walls

Exterior Walls for Type IV-A B C

» CLT or Non-combustible

Exterior Walls for Type IV-HT

- » CLT or FRTW or Non-combustible
- » IBC 2018 6" Thick Wall (FRTW or CLT)
- » IBC 2021 4" Thick CLT





MT Type IV Minimum Sizes - Walls

MT Interior Walls in all Type IV:

- » Laminated construction 4" thick
- » Solid wood construction min. 2 layers of 1" matched boards

Other Interior Walls in Type IV A,B,C

» Non-combustible (0 hr for nonbearing)

Other Interior Walls in Type IV HT

- » Non-combustible (1 hr min)
- » Wood stud wall (1 hr min)

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









	IV-A, IV-B, IV-C		IV-HT	IV-HT		
				IBC 2021	IBC 2018	
Fire Rating (bearing wall)	3 Hr	2 Hr 2 Hr		2 Hr	2 Hr	
Mass Timber	Mas	Mass Timber / CLT		4" min thick <u>CLT</u> *	6" <u>Wall</u> *	
Exterior NC Protection	40 Min NC & No Exterior Combustible Coverings			FRT Sheathing, Gyp, or other NC		
Interior NC Protection	Per Interior Requirements		Not Re	quired		
Light-Frame FRTW		No		Yes*	6" Wall*	

^{*}Changes in IBC 2015, 2018, and 2021 editions

Interior Wall Construction Recap



	IV-A	IV-B	IV-C	IV-HT		
Fire Rating (bearing wall)	3 Hr	2 Hr	2 Hr	1 Hr or HT*		
Construction – MT	Laminated construction 4" thick (CLT, NLT, etc) Solid wood construction min. 2 layers of 1" matched boards					
NC Protection	Per In	No				
Noncombustible non-bearing wall		1 Hr				
Wood Stud Wall		1 Hr				

^{*}IBC 2021 requires at least 1 Hr FRR for HT walls supporting 2 levels

Tall Wood Fire Resistance Ratings (FRR)

FRR Requirements for Tall Mass Timber Structures (hours)

Building Element	IV-A	IV-B	IV-C
Primary Frame	3	2	2
Exterior Bearing Walls	3	2	2
Interior Bearing Walls	3	2	2
Roof Construction	1.5	1	1
Primary Frame at Roof	2	1	1
Floor Construction	2	2	2

Source: 2021 IBC Table 601

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 703.6 (e.g., additional materials that delay the combustion of mass timber, such as gypsum board).







Noncombustible Protection (NC)

Where timber is required to be protected, NC must contribute at least 2/3 FRR

Required Noncombustible Contribution to FRR

FRR of Building Element (hours)	Minimum from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

Source: 2021 IBC Section 722.7

Noncombustible Protection (NC)

Prescriptive Noncombustible Contributions to FRR

Type of Protection	Contribution per Layer (minutes)
1/2" Type X gypsum board	25
5/8" Type X gypsum board	40

Source: 2021 IBC Section 722.7.1

Required Noncombustible Contribution to FRR

FRR of Building Element (hours)	Minimum from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

1 layer 5/8 Type X2 layers 5/8 Type X3 layers 5/8 Type X

Source: 2021 IBC Section 722.7

Noncombustible Protection



Noncombustible Protection Required

	IV-A	IV-B	IV-C	IV-HT
Roof Below Mass Timber	60 min	40 min*	Not Req.	Not Req.
Primary Frame @ Roof	80 min	40 min*	Not Req.	Not Req.
Primary Frame	120 min	80 min*	Not Req.	Not Req.
Below Mass Timber Floor	80 min	80 min*	Not Req.	Not Req.
Above Mass Timber Floor	1" Min NC Material	1" Min NC Material	Not Req.	Not Req.

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





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.







Credit: Urban One

However, FRR Doesn't always need to be from a combination of MT + NC. In some cases, just NC can be used, in other cases, just MT can be used: IBC 602.4

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.

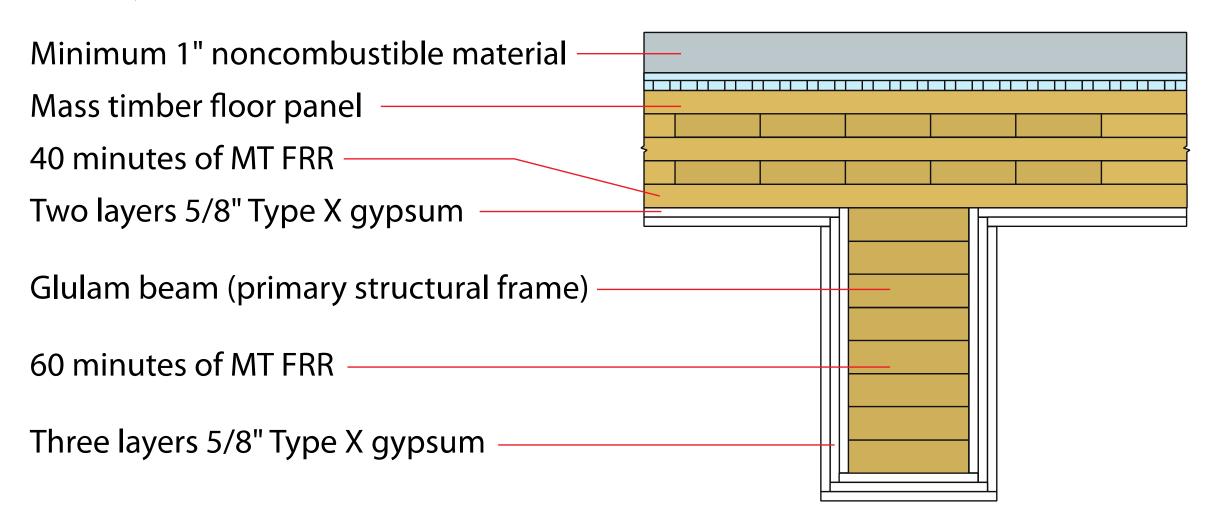




Credit: Urban One

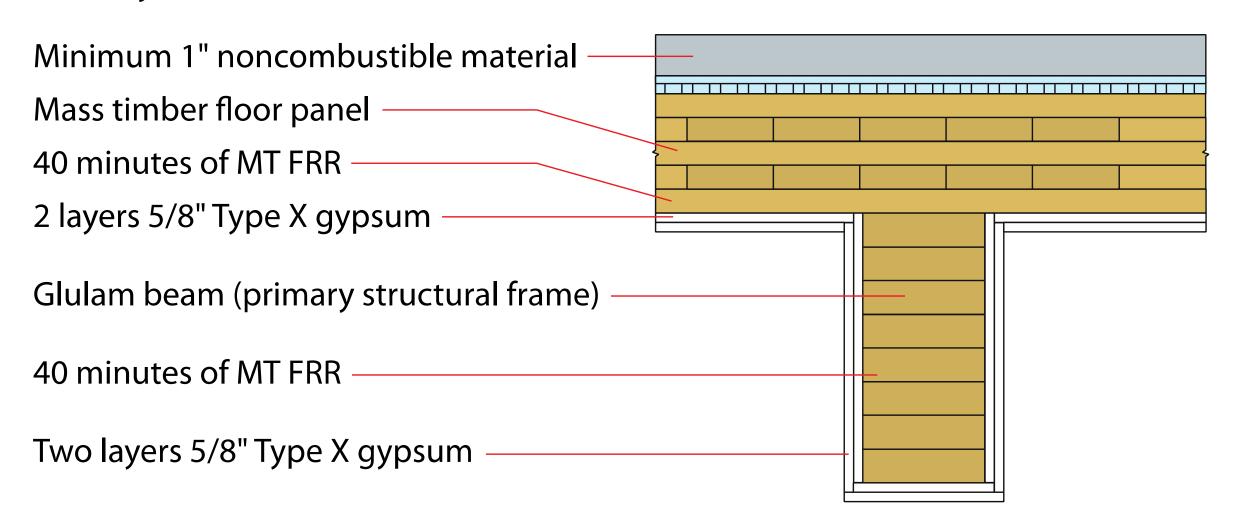
Type IV-A Fire Resistance Ratings (FRR)

Primary Frame (3-hr) + Floor Panel Example (2-hr):



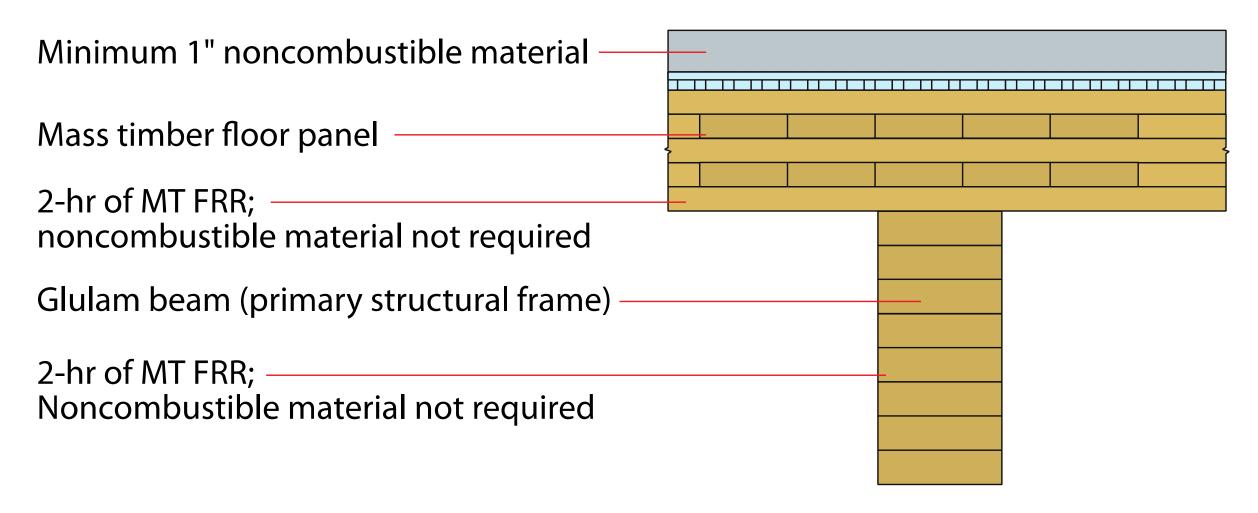
Type IV-B Fire Resistance Ratings (FRR)

Primary Frame (2-hr) + Floor Panel (2-hr)



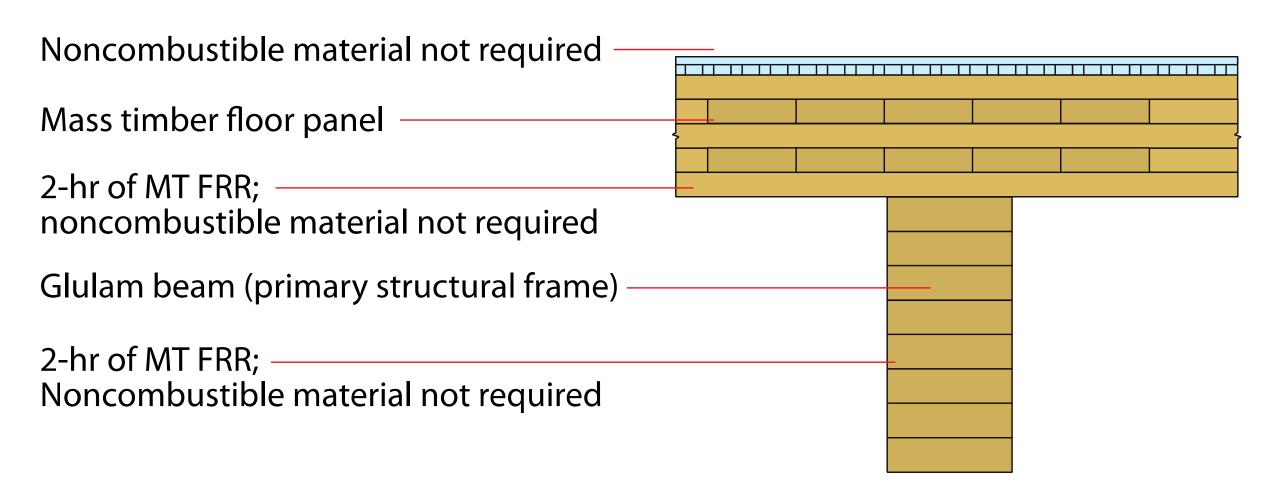
Type IV-B Fire Resistance Ratings (FRR)

Primary Frame (2-hr) + Floor Panel Example (2-hr)



Type IV-C Fire Resistance Ratings (FRR)

Primary Frame (2-hr) + Floor Panel Example (2-hr)

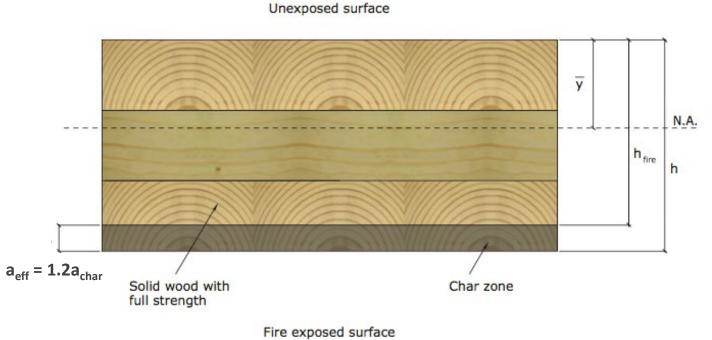


How do you determine FRR of MT?

2 Options:

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

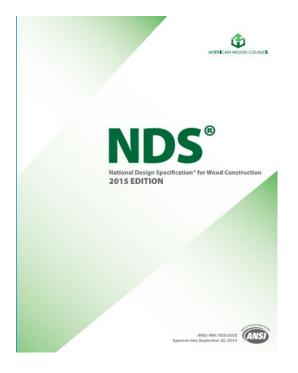




NDS Chapter 16 includes calculation of fire resistance of NLT, CLT, Glulam, Solid Sawn and SCL wood products

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

Required Fire Endurance	Fire (in.) Endurance lamination thicknesses, h _{lam} (in.)								
(hr.)	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







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



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



Credit: ARUP

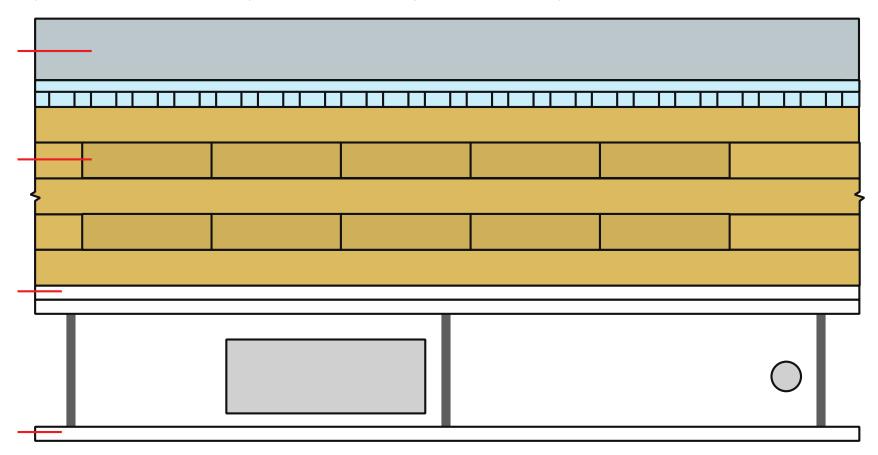
Table 16.2.1B Effective Char Depths (for CLT with β_n =1.5in./hr.)

Required Fire Endurance		Effective Char Depths, a _{char} (in.) lamination thicknesses, h _{lam} (in.)							
(hr.)	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

Concealed Spaces in Type IV

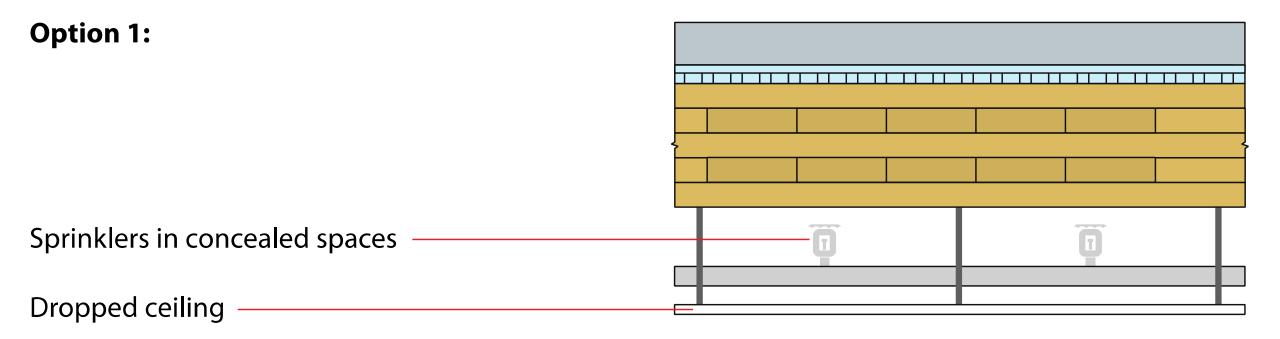
What if I have a dropped ceiling? Can I have a dropped ceiling?

» Impact on FRR, NC placement, sprinkler requirements



Concealed Spaces in Type IV-HT – 2021 IBC

CONCEALED SPACES: TYPE IV-HT



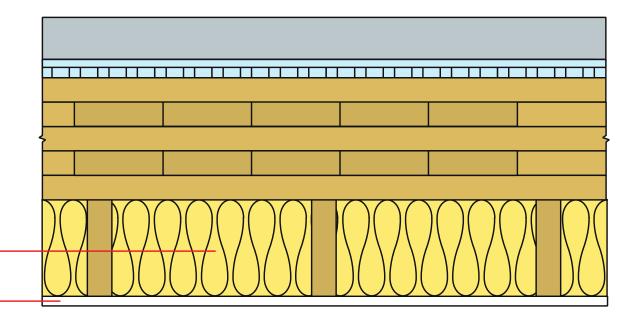
Concealed Spaces in Type IV-HT – 2021 IBC

CONCEALED SPACES: TYPE IV-HT

Option 2:

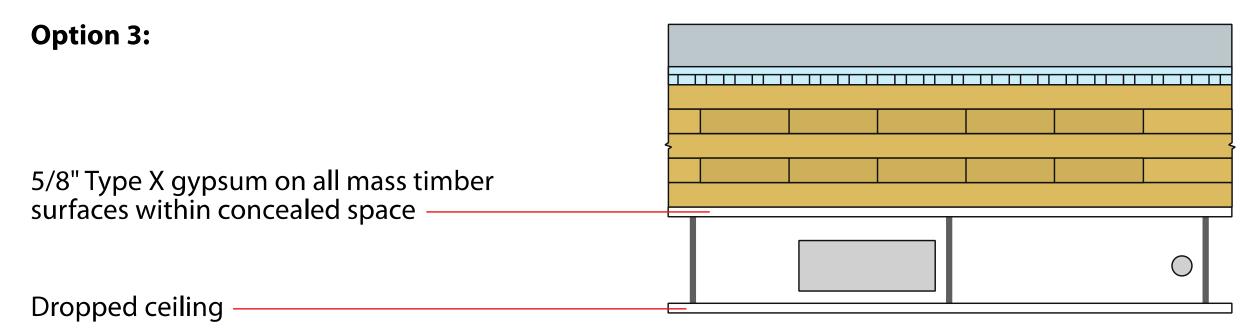
Noncombustible insulation

Dropped ceiling



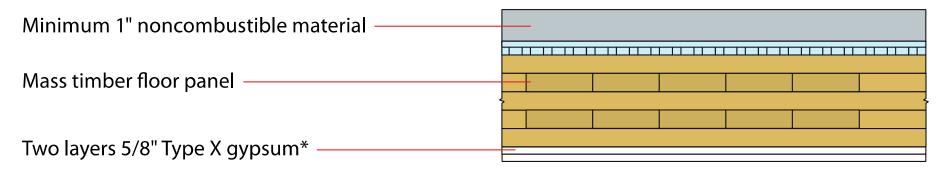
Concealed Spaces in Type IV-HT – 2021 IBC

CONCEALED SPACES: TYPE IV-HT



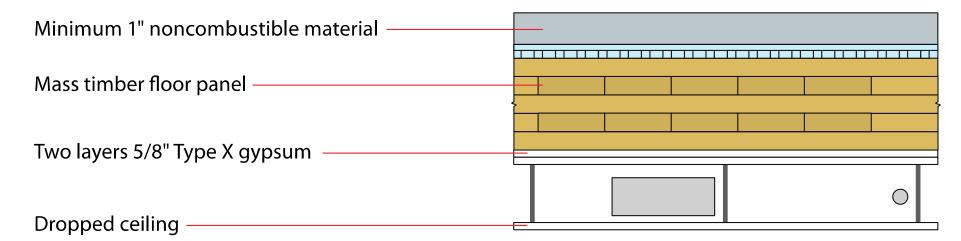
Concealed Spaces in Type IV-A and IV-B

Without Dropped Ceiling



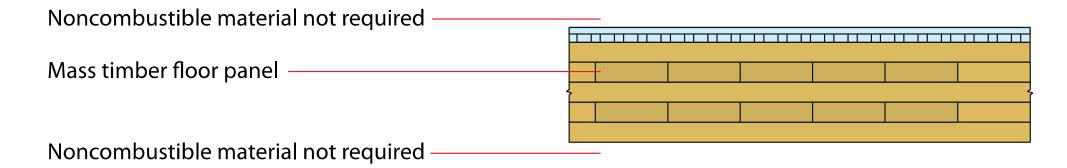
^{*}Applicable to most locations; limited exposed mass timber permitted in IV-B

With Dropped Ceiling

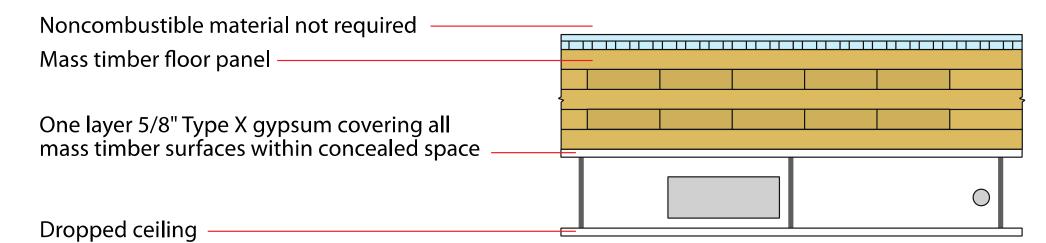


Concealed Spaces in Type IV-C

Without Dropped Ceiling



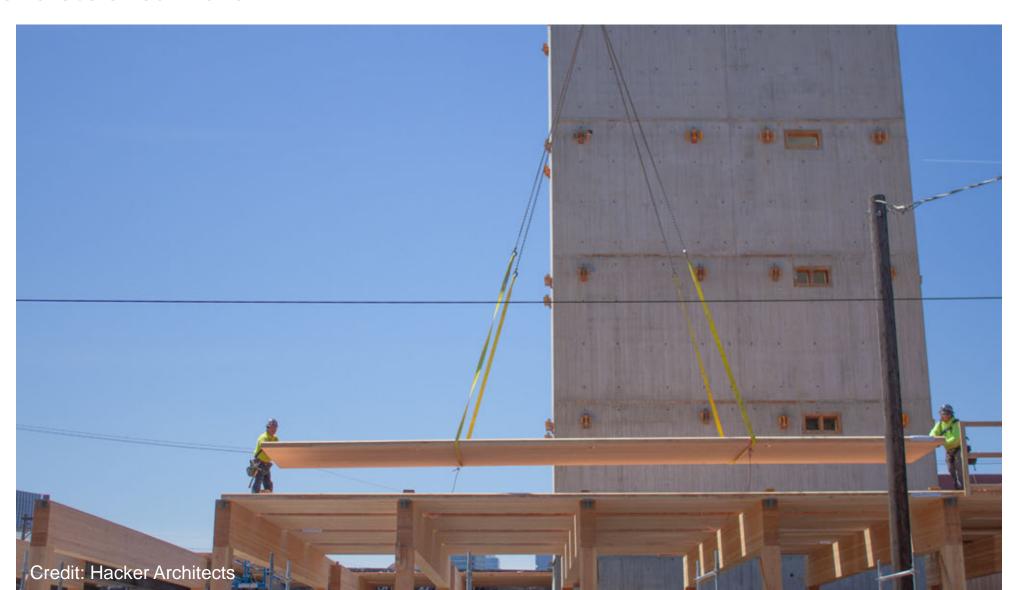
With Dropped Ceiling





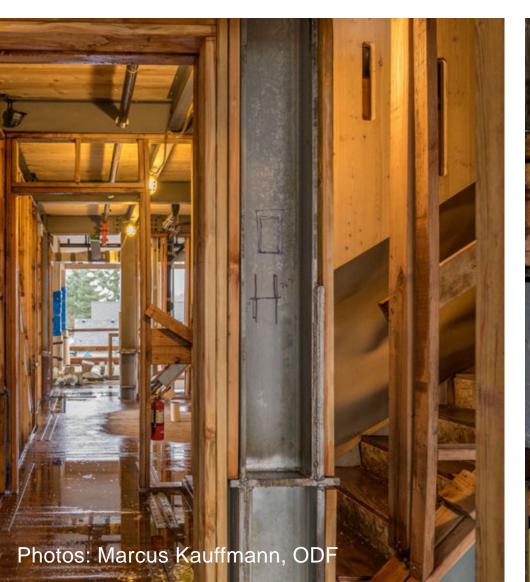
Lateral System Choices

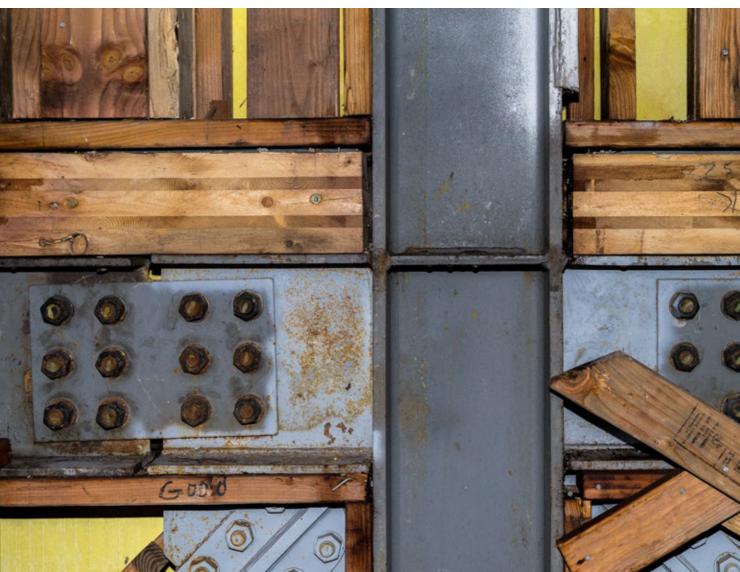
Concrete Shearwalls



Lateral System Choices

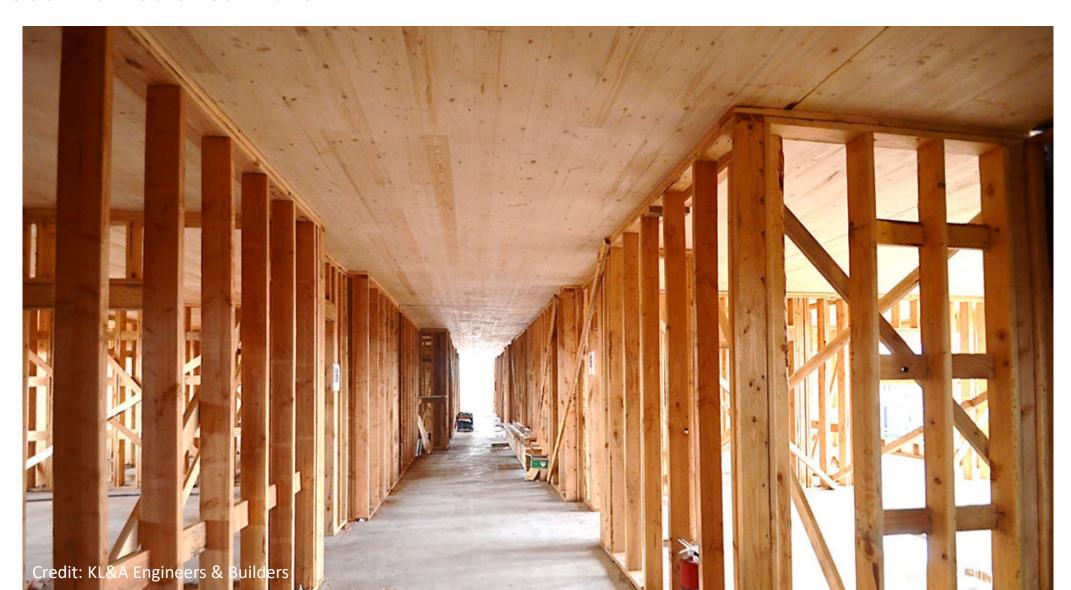
Steel Braced Frame





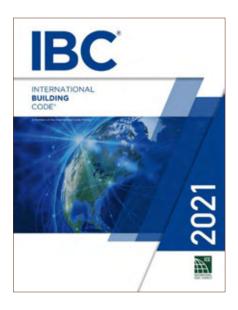
Lateral System Choices

Wood-Framed Shearwalls

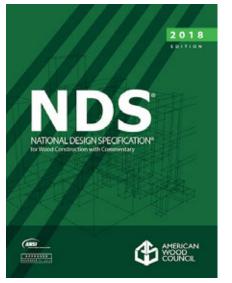




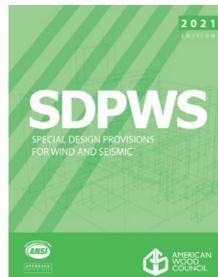
2021 IBC

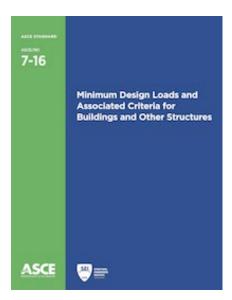


2018 NDS



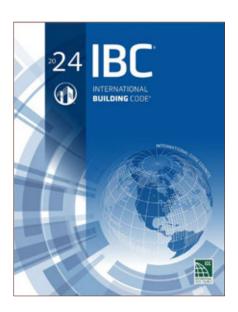
2021 SDPWS



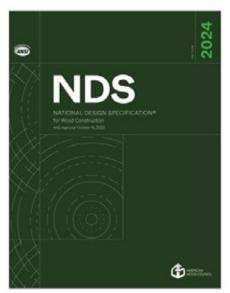


ASCE 7-16 (2016)

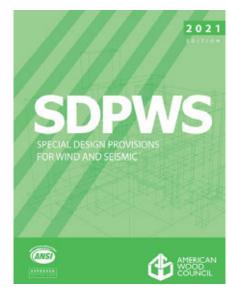
2024 IBC



2024 NDS



2021 SDPWS





ASCE 7-22 (2022)

CLT Shearwalls

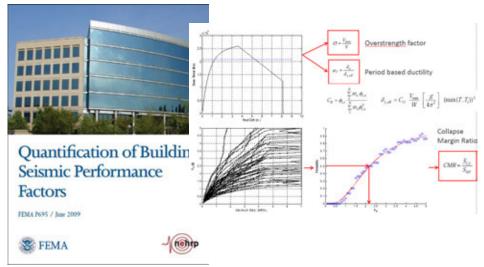
IBC 2021 SDPWS Update

- Platform Frame CLT Shear Walls
- Prescribed nailed metal plate connectors
- *Panel* aspect ratio, h:b_p from 2:1 to 4:1

IBC 2024 2022 ASCE 7 Update

- Include Platform Frame CLT Shear Walls
- R = 2, Omega = 3, Cd = 3.
- 65 ft height limit all Seismic Design Categories
- Panel aspect ratio, h:bp from 2:1 to 4:1



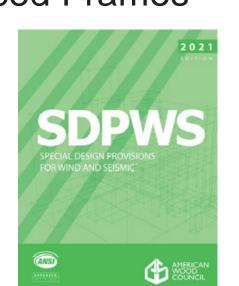


Lateral System Choices

Prescriptive Code Compliance

Concrete Shearwalls
Steel Braced Frames
Light Wood-Frame Shearwalls
CLT Shearwalls
CLT Rocking Walls
Timber Braced Frames









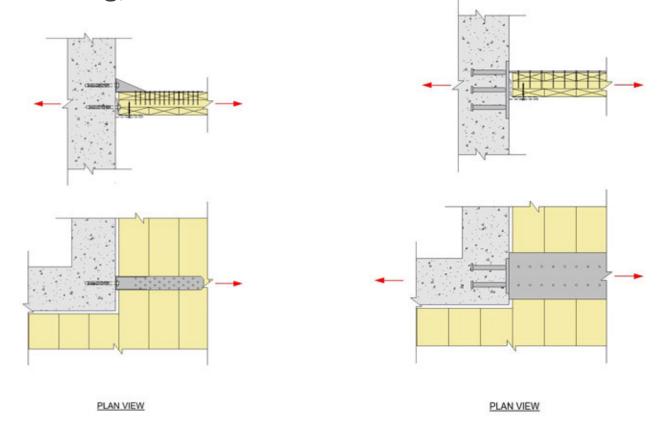




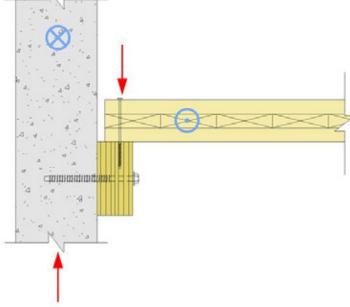
Considerations for Lateral Systems

Connections to concrete core

- » Tolerances & adjustability
- » Drag/collector forces



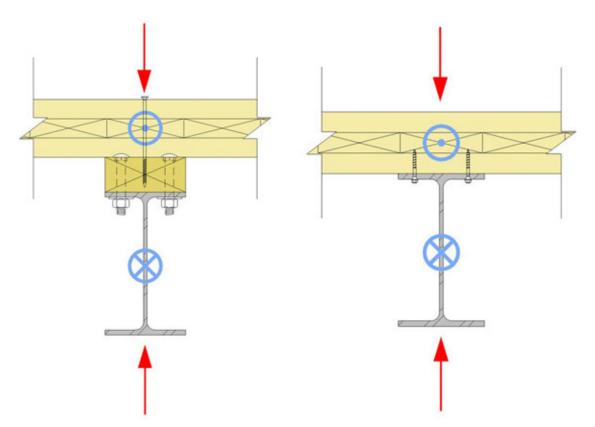




Considerations for Lateral Systems

Connections to steel frame

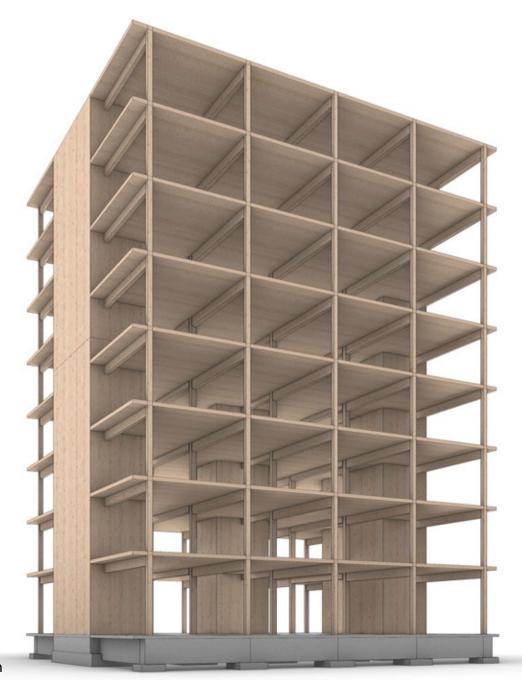
- » Tolerances & adjustability
- » Ease of installation





Shaft Enclosures in Tall Timber

- » When can shaft enclosures be MT?
- » What FRR requirements exist?
- » If shaft enclosure is MT, is NC required?



Tall Wood Shaft Enclosures





IV-A

IV-B

IV-C

Exit & Hoistway Enclosures

ft: MT protected with 2 layers 5/8" type X gyp (if 2 HR req'd) or 3 layers 5/8" type X gyp (if 3 HR req'd) both sides

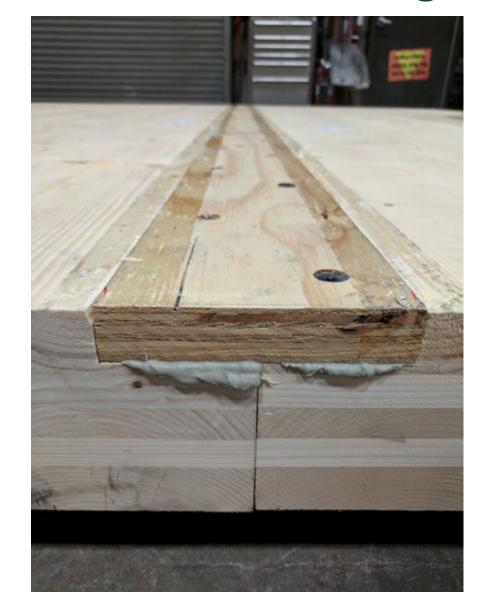
Above 12 Stories or 180 ft: Noncombustible shafts (IBC 2021 602.4)

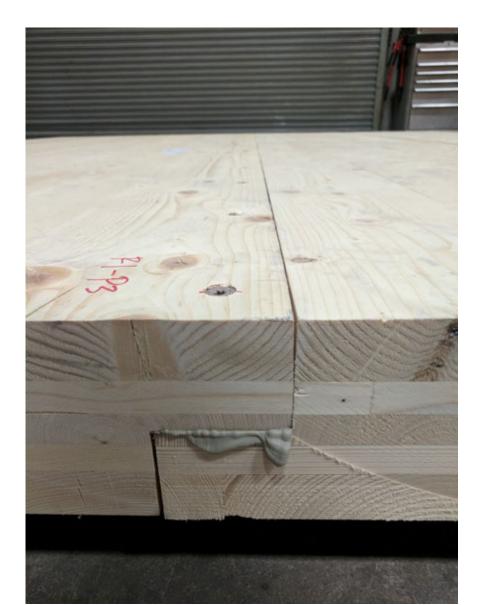
NC or MT protected with 2 layers 5/8" type X gyp (IBC 2021 602.4.2.6) both sides

NC or MT protected with 1 layer 5/8" type X gyp (IBC 602.4.3.6) both sides

E&H Enclosures FRR

2 HR (not less than FRR of floor assembly penetrated, IBC 713.4)



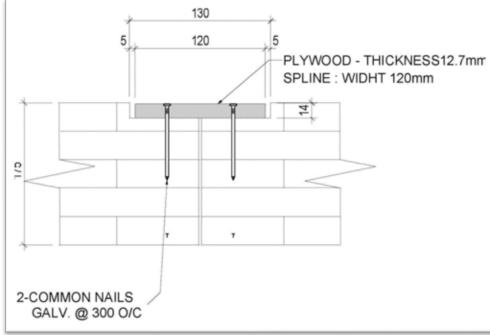


Photos: ARUP

703.7 Sealing of adjacent mass timber elements.

In buildings of Type IVA, IVB, and IVC construction, sealant or adhesive shall be provided to resist the passage of air in the following locations:

- 1. At abutting edges and intersections of mass timber building elements required to be fire resistance-rated
- 2. At abutting intersections of mass timber building elements and building elements of other materials where both are required to be fire resistance-rated.



Sealants shall meet the requirements of ASTM C920 (elastomeric joint sealants). Adhesives shall meet the requirements of ASTM D3498 (gap filling construction adhesives, i.e. not fire caulk).

Exception: Sealants or adhesives need not be provided where they are not a required component of a fire resistance- rated assembly.







Several MT fire tested assemblies have successfully been completed w/o adhesives/sealants at abutting panel edges

2021 IBC will require periodic special inspections of adhesive/sealant installation (when required to be installed)







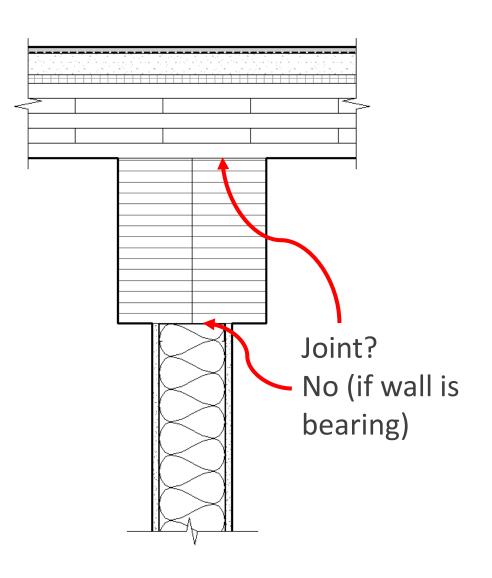
Joints & Intersecting Elements

Section 202 Definitions

Joint. The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.

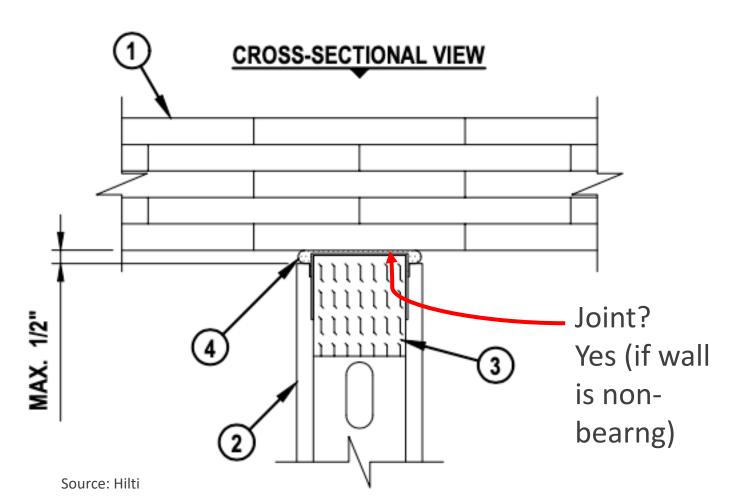
Considerations:

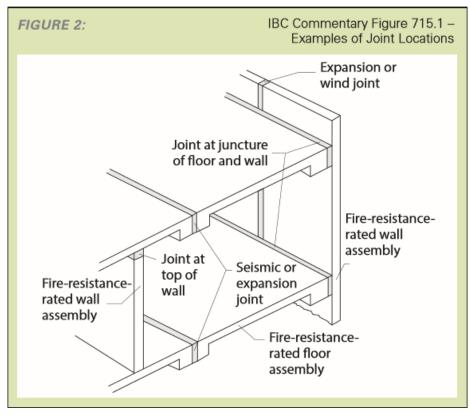
- » Is wall, beam and slab rated?
- » Required to prevent smoke passage?
- » Not a tall timber specific item, applicable to all mass timber construction



Joints & Intersecting Elements

Not a tall timber specific item, applicable to all mass timber construction





Source: International Building Code

Joints & Intersecting Elements

Section 715 Joints and Voids

715.3 Fire-resistance-rated assembly intersections.

Joints installed in or between fire-resistance-rated walls, floors or floor/ceiling assemblies and roofs or roof/ceiling assemblies shall be protected by an approved fire-resistant joint system designed to resist the passage of fire for a time period not less than the required fire-resistance rating of the wall, floor or roof in or between which the system is installed.

715.3.1 Fire test criteria.

Fire-resistant joint systems shall be tested in accordance with the requirements of either ASTM E1966 or UL 2079.

Not a tall timber specific item, applicable to all mass timber construction. Firestop manufacturers should be consulted for specific solutions.

Occupancy Separation

Protection of MT used for occupancy separation

Addition to IBC 508.4.4.1 requires:

Mass timber elements serving as fire barriers or horizontal assemblies to separate occupancies in Type IV-B or IV-C construction shall be separated from the interior of the building with a minimum of ½" gypsum board or a noncombustible equivalent.



Photo: MIT | John Klein

Incidental Use Separation

Protection of MT used for incidental use separation

New section 509.4.1.1 requires:

Where Table 509 specifies a fire- resistance-rated separation, mass timber elements serving as fire barriers or a horizontal assembly in Type IV-B or IV-C construction shall be separated from the interior of the incidental use with a minimum of ½" gypsum board or a noncombustible equivalent.



Photo: MIT | John Klein

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.

New code provisions in International Fire Code (IFC)

- 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

IFC 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.

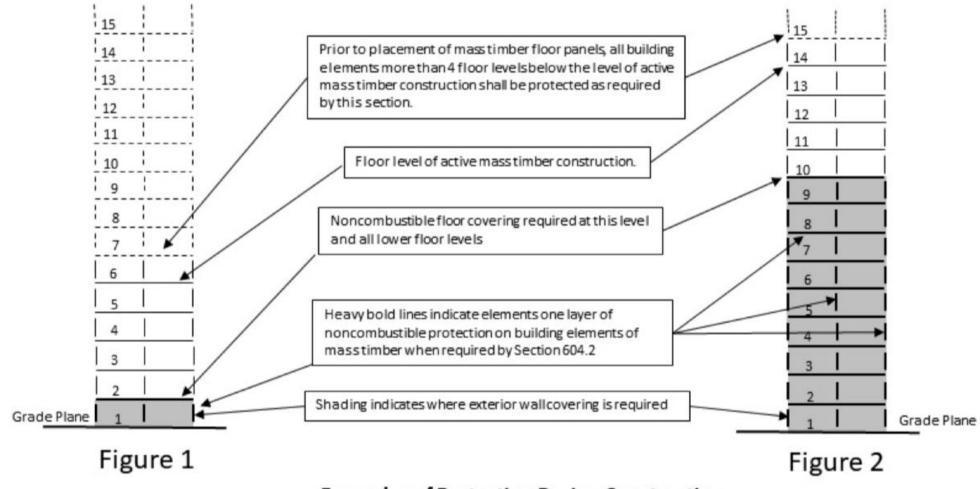
IFC 3308.4 Cont'd

- 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.

Exception: Shafts and vertical exit enclosures



Photo: Urban One



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

Connection Fire Protection

In Construction Types IV-A, IV-B & IV-C, building elements are required to be FRR as specified in IBC Tables 601 and 602.

Connections between these building elements must be able to maintain FRR no less than that required of the connected members.



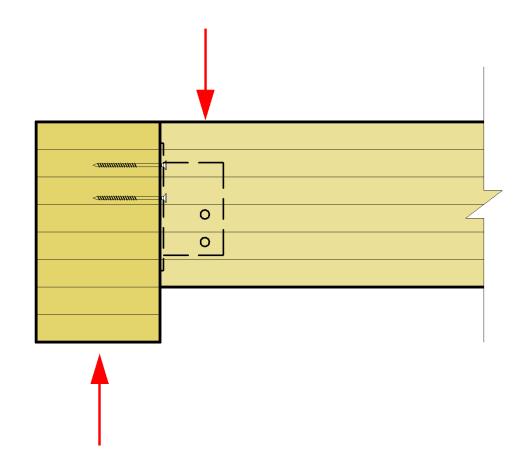
16.3 Wood Connections

Wood connections, including connectors, fasteners, and portions of wood members included in the connection design, shall be protected from fire exposure for the required fire resistance time. Protection shall be provided by wood, fire-rated gypsum board, other approved materials, or a combination thereof.

Source: NDS

Connection Fire Protection

Steel hangers/hardware fully concealed within a timber-to-timber connection is a common method of fire protection

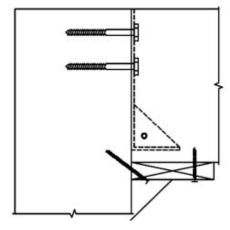


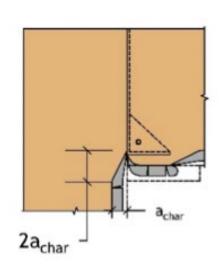


Connection Fire Protection

2304.10.1 Connection fire resistance rating. Fire resistance ratings in Type IV-A, IV-B, or IV-C construction shall be determined by one of the following:

- 1. Testing in accordance with Section 703.2 where the connection is part of the fire resistance test.
- 2. Engineering analysis that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 2500 F (1390 C), and a maximum temperature rise of 3250 F (1810 C), for a time corresponding to the required fire resistance rating of the structural element being connected. For the purposes of this analysis, the connection includes connectors, fasteners, and portions of wood members included in the structural design of the connection.





Tall Mass Timber Special Inspections

Table is only required for Type IV-A, IV-B, and IV-C

TABLE 1705.5.3 REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION

Туре	Continuous Special Inspection	Periodic Special Inspection
1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.		X
2. Inspect erection of mass timber construction		X
3. Inspection of connections where installation methods are required to meet design loads		
3.1. Threaded fasteners		
3.1.1. Verify use of proper installation equipment.		X
3.1.2. Verify use of pre-drilled holes where required.		X
3.1.3. Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.		X
3.2. Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads	X	
3.3. Adhesive anchors not defined in 3.2.		X
3.4. Bolted connections		X
3.5. Concealed connections		X

Tall Mass Timber Inspections

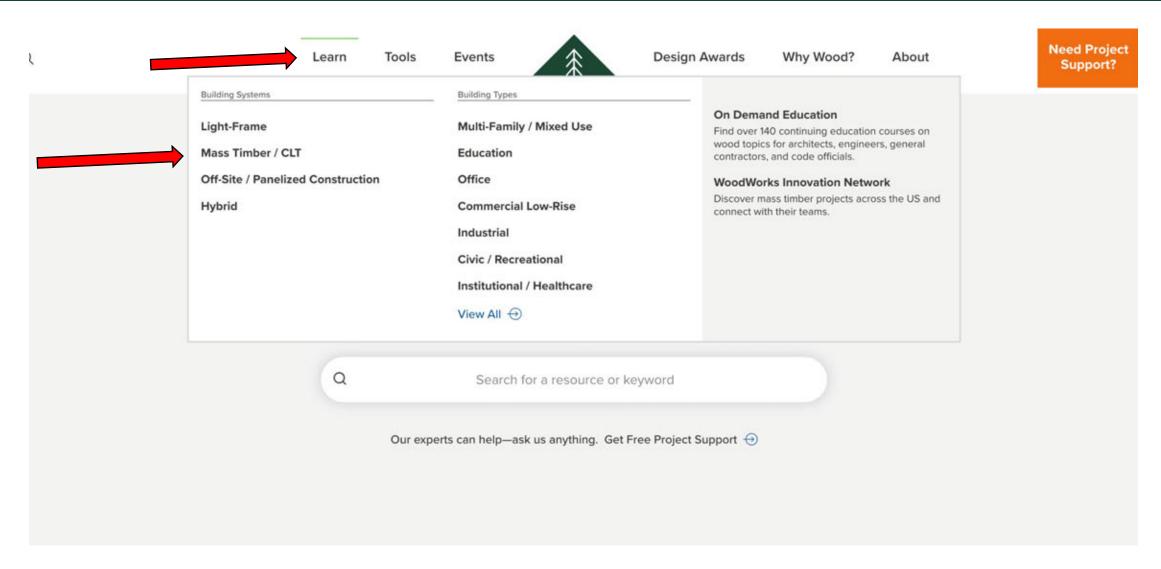
Wood Connection Coverings for Fire-Resistance

110.3.5 Type IV-A, IV-B, and IV-C connection protection inspection. In buildings of Type IV-A, IV-B, and IV-C Construction, where connection fire resistance ratings are provided by wood cover calculated to meet the requirements of Section 2304.10.1, inspection of the wood cover shall be made after the cover is installed, but before any other coverings or finishes are installed.



Inspection of Wood Coverings

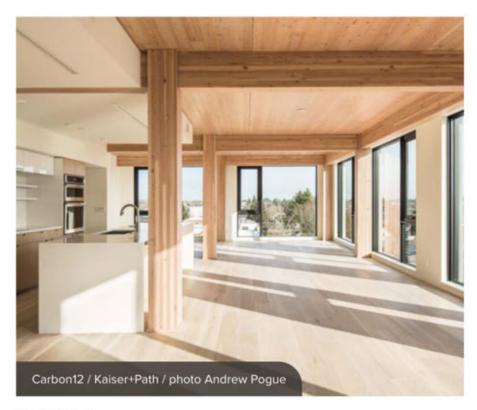
TALL MASS TIMBER RESOURCES



Woodworks.org > Learn > Mass Timber / CLT > Tall Mass Timber

TALL MASS TIMBER RESOURCES

Technical Design Guidance from WoodWorks



Solution Papers

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

Looking for information on the tall wood provisions in the 2021 International Building Code? This paper summarizes the provisions as well as the background and research that supported their adoption.



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

Solution Papers



Shaft Wall Requirements in Tall Mass Timber Buildings
Solution Papers



Concealed Spaces in Mass Timber and Heavy Timber Structures

Solution Papers



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



Fire Design of Mass Timber Members: Code Applications, Construction Types and Fire Ratings

Solution Papers

Questions? Ask us anything.



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