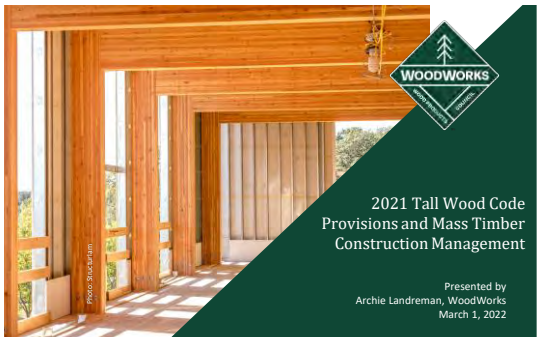
WOODWORKS
2021 Tall Wood Code Provisions and Mass Timber Construction Management
Presented by
Archie Landreman, WoodWorks
March 1, 2022
Photo: Structurlam

1


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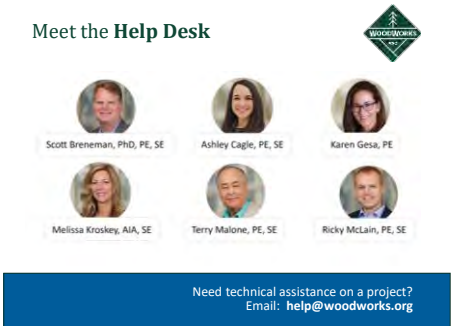
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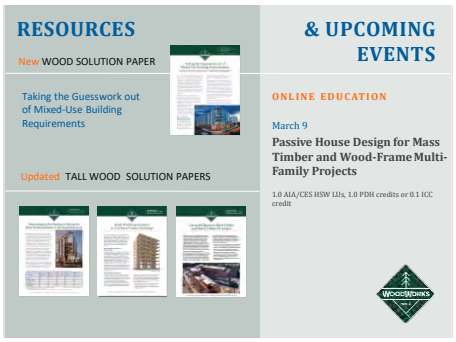
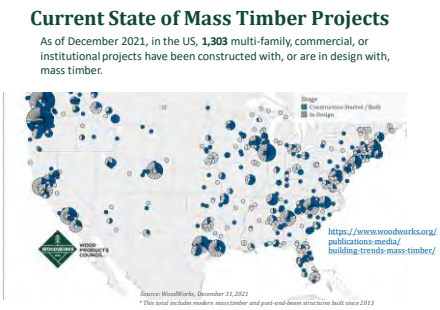

RESOURCES
New WOOD SOLUTION PAPER
Taking the Guesswork out of Mixed-Use Building Requirements
Updated TALL WOOD SOLUTION PAPERS
& UPCOMING EVENTS
ONLINE EDUCATION
March 9
Passive House Design for Mass Timber and Wood-Frame Multi-Family Projects
1.0 AIA/CES HSW LUs, 1.0 PDH credits or 0.1 ICC credit

5


Current State of Mass Timber Projects
As of December 2021, in the US, 1,303 multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.
https://www.woodworks.org/publications-media/building-trends-mass-timber/
Source: WoodWorks, December 31, 2021
* This total includes modern mass timber and post-and-beam structures built since 2013

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## Watch the Chat Window, Ask Questions through the Q&A Box

- During today's event will be sending links, files and other pertinent information through the Chat window, located at the bottom of your screen.
- Submit questions in the Q&A box at the bottom of your screen as they come up in the presentations. We will get to as many questions as possible.

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## Questions? Ask us anything.

Archie Landreman
Regional Director | WI, IA, IL, MN
(262) 497-5550

archie@woodworks.org


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

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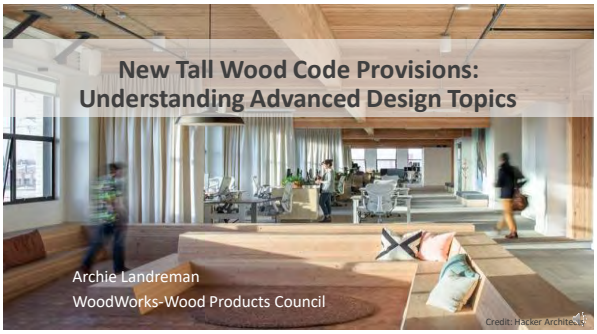


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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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## Course Description

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. This presentation will take a detailed look at the new code provisions and methods of addressing the new requirements. Topics will include tall-wood specific high rise and sprinkler requirements, methods of demonstrating fire-resistance ratings, fire design for penetrations, connections and abutting panels, allowances for exposed timber, exterior walls, concealed spaces and more.

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## Learning Objectives

1. Explore the three new tall wood construction types and discuss related code provisions such as allowable heights and fire-resistance ratings.
2. Discuss code-compliant options for exposing mass timber, where up to 2-hour fire-resistance ratings are required, and demonstrate design methodologies for achieving these ratings.
3. Review code requirements unique to tall wood buildings, focusing on items such as sprinklers, shaft construction and concealed spaces.
4. Highlight design options for addressing topics such as fire stops at penetrations through mass timber assemblies and exterior walls fire-resistance in tall timber structures.

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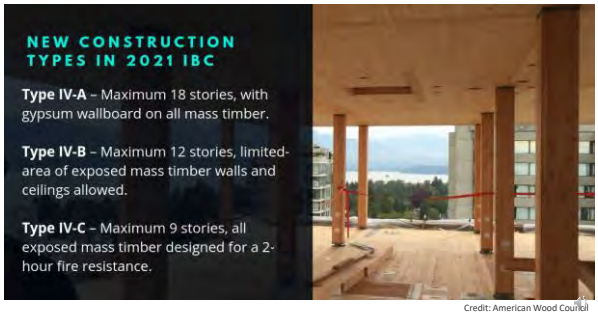
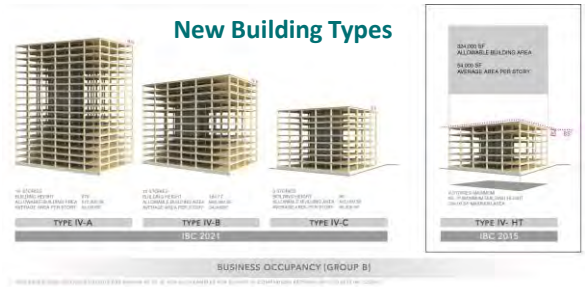



Credit: American Wood Council

15




Credit: Susan Jones, atelierjones

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## Tall Wood Building Size Limits

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

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## Tall Wood Building Size Limits

| | Construction Type (Unsprinklered Values) | | | | | |
|---|---|---|---|---|---|---|
| | I-A | I-B | IV-A | IV-B | IV-C | IV-HT |
| **Occupancies** | **Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)** | | | | | |
| A, B, R | Unlimited | 160 | **65** | **65** | **65** | **65** |
| | **Allowable Number of Stories above Grade Plane (IBC Table 505.4)** | | | | | |
| A-2, A-3, A-4 | Unlimited | 11 | **3** | **3** | **3** | **3** |
| B | Unlimited | 11 | **5** | **5** | **5** | **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** |
| B | Unlimited | Unlimited | **108,000** | **72,000** | **45,000** | **36,000** |
| R-2 | Unlimited | Unlimited | **61,500** | **41,000** | **25,625** | **20,500** |

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

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## Tall Wood Building Size Limits

| | Construction Type (Unsprinklered Values) | | | | | |
|---|---|---|---|---|---|---|
| | I-A | I-B | IV-A | IV-B | IV-C | IV-HT |
| Occupancies | Allowable Building Height above Grade Plane, Feet (IBC Table 504.3) | | | | | |
| A, B, R | Unlimited | 160 | 65 | 65 | 65 | 65 |
| | Allowable Number of Stories above Grade Plane (IBC Table 505.4) | | | | | |
| A-2, A-3, A-4 | Unlimited | 11 | 4 | 4 | 3 | 3 |
| B | Unlimited | 11 | 4 | 4 | 3 | 5 |
| R-2 | Unlimited | 11 | 4 | 4 | 4 | 4 |
| | Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2) | | | | | |
| A-2, A-3, A-4 | Unlimited | Unlimited | 45,000 | 30,000 | 18,750 | 15,000 |
| B | Unlimited | Unlimited | 108,000 | 72,000 | 45,000 | 36,000 |
| R-2 | Unlimited | Unlimited | 61,500 | 41,000 | 25,625 | 20,500 |

**In almost all cases, sprinklers will be required**

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

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## Non-Tall Opportunities – Large Area

| | Construction Type (All Sprinklered Values) | | | | | | |
|---|---|---|---|---|---|---|---|
| | I-A | I-B | IV-A | IV-B | IV-C | IV-HT | III-A |
| Occupancies | Allowable Building Height above Grade Plane, Feet (IBC Table 504.3) | | | | | | |
| A, B, R | Unlimited | 180 | 270 | 180 | 85 | 85 | 85 |
| | Allowable Number of Stories above Grade Plane (IBC Table 505.4) | | | | | | |
| A-2, A-3, A-4 | Unlimited | 12 | 18 | 12 | 6 | 4 | 4 |
| B | Unlimited | 12 | 18 | 12 | 9 | 6 | 6 |
| R-2 | Unlimited | 12 | 18 | 12 | 8 | 5 | 5 |
| | Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2) | | | | | | |
| A-2, A-3, A-4 | Unlimited | Unlimited | 135,000 | 90,000 | 56,250 | 45,000 | 42,000 |
| B | Unlimited | Unlimited | 324,000 | 216,000 | 135,000 | 108,000 | 85,500 |
| R-2 | Unlimited | Unlimited | 184,500 | 123,000 | 76,875 | 61,500 | 72,000 |

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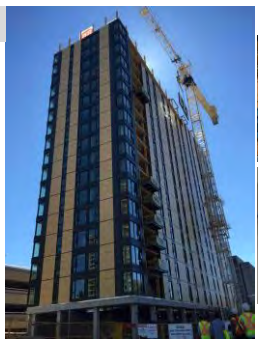
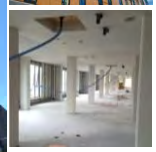
## Type IV-A


Credit: Susan Jones, atelierjones





Photos: Structurlam, naturally:wood Fast + Epp

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## 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**

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## 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**

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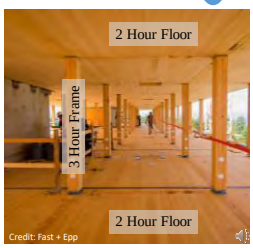
## Type IV-A Fire Resistance Ratings (FRR)

IV-A

| | |
|---|---|
| Primary Frame FRR | 3 HR (2 HR at Roof) |
| Ext or Int Bearing Wall FRR | 3 HR |
| Floor Construction FRR | 2 HR |
| Roof Construction FRR | 1.5 HR |




Credit: Fast + Epp

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## Type IV-A Fire Resistance Ratings (FRR)

IV-A

| | FRR | Min. NC Protection |
|---|---|---|
| Primary Frame FRR | 3 HR (2 HR at Roof) | 120 min (80 min at Roof) |
| Ext or Int Bearing Wall FRR | 3 HR | 120 min |
| Floor Construction FRR | 2 HR | 80 min |
| Roof Construction FRR | 1.5 HR | 80 min |

**½" Type X Gypsum = 25 min | 5/8" Type X Gypsum = 40 min**


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## Noncombustible Protection (NC)

**TABLE 722.7.1(a)**
**PROTECTION REQUIRED FROM NONCOMBUSTIBLE COVERING MATERIAL**

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

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

| Noncombustible Protection | Protection Contribution (minutes) |
|---|---|
| 1/2 Inch Type X Gypsum Board | 25 |
| 5/8 Inch Type X Gypsum Board | 40 |

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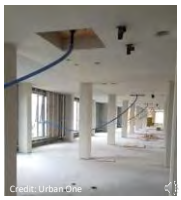
## Noncombustible Protection (NC)

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).

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## 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.**


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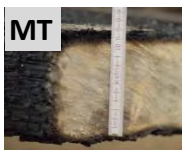
## MT Fire Resistance Ratings (FRR)

**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.**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## 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**

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## Type IV Minimum Sizes - Framing

| 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

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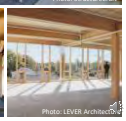
## Type IV Minimum Sizes – Floor/Roof Panels

**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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## MT 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 (FTW or CLT)
- IBC 2021 - 4" Thick CLT

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## 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)

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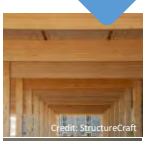
## Type IV-A Fire Resistance Ratings (FRR)

IV-A

**FRR Examples:**

**Primary Structural Frame (Beam, Column, Bearing Wall):**
**3 HR Required**
**NC protection = at least 120 min**
- Use 3 layers of 5/8" type X Gypsum = 120 min (2 HR)
  Mass Timber FRR req'd = 3 HR – 2 HR = 1 HR





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## Type IV-A Fire Resistance Ratings (FRR)

IV-A

**FRR Examples:**

**Floor Panels:**
**2 HR Required**
**NC Protection = at least 80 min**
- Use 2 layers of 5/8" type X Gypsum = 80 min (1.33 HR), plus:
  - Mass Timber FRR req'd = 2 HR – 1.33 HR = 0.67 HR, or
- Use 3 layers of 5/8" Type X Gypsum = 120 min (2 HR) and no FRR from MT req'd


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## Type IV-A Protection

IV-A

| | |
|---|---|
| Floor Surface Protection | Min. 1 inch of NC protection |
| Roof Construction Protection | Min. 2 layers 5/8" type X gyp on inside face |
| Ext Wall Protection | Min. 1 layer 5/8" type X gyp on outside face<br>Min. 2 layers 5/8" type X gyp on inside face (non-brng)<br>Min. 3 layers 5/8" type X gyp on inside face (brng) |


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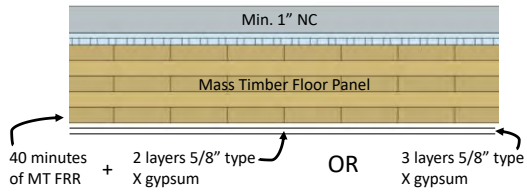
## Type IV-A Fire Resistance Ratings (FRR)

IV-A

**FRR & NC Floor Panel Example: 2 HR**

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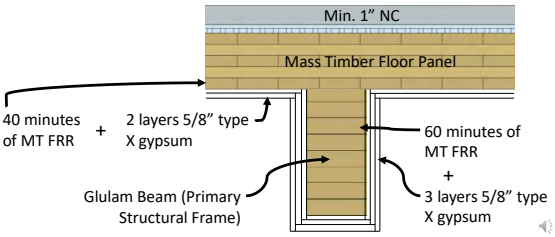
## Type IV-A Fire Resistance Ratings (FRR)

IV-A

**Primary Frame (3 HR) + Floor Panel Example (2 HR):**

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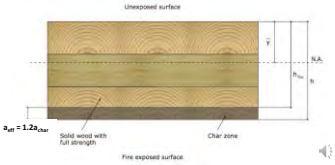
## MT Fire Resistance Ratings (FRR)

**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**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## MT Fire Resistance Ratings (FRR)

**MT FRR Calculations Method:**

- **IBC 703.3 allows several methods of determining FRR. One is calculations per 722.**
- **722.1 refers to NDS Chpt 16 for exposed wood FRR**

**703.3 Methods for determining fire resistance.** The application of any of the methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263. The required *fire resistance* of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures:

3. Calculations in accordance with Section 722.

**722.1 General.** The provisions of this section contain procedures by which the *fire resistance* of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated *fire resistance* of concrete, concrete masonry and clay masonry assemblies shall be permitted in accordance with ACI 216.1/TMS 0216. The calculated *fire resistance* of steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 29. The calculated *fire resistance* of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AF&PA *National Design Specification for Wood Construction (NDS)*.

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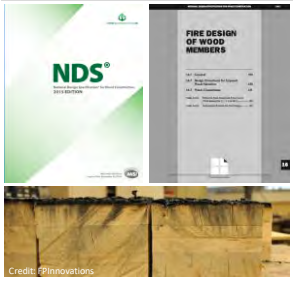
## MT Fire Resistance Ratings (FRR)




**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 $\beta_n$=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 |

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## MT Fire Resistance Ratings (FRR)

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 $\beta_n$ = 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 $\beta_n$=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 |

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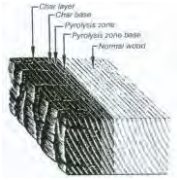
## MT Fire Resistance Ratings (FRR)

Structural capacity check performed on remaining section, with stress increases




Credit: Forest Products Laboratory

**Table 16.2.2 Adjustment Factors for Fire Design[1]**

| | | | ASD |
|---|---|---|---|
| Bending Strength | $F_b$ | x | 2.85 |
| Beam Buckling Strength | $F_{bE}$ | x | 2.03 |
| Tensile Strength | $F_t$ | x | 2.85 |
| Compression Strength | $F_c$ | x | 2.58 |
| Column Buckling Strength | $F_{cE}$ | x | 2.03 |

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

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

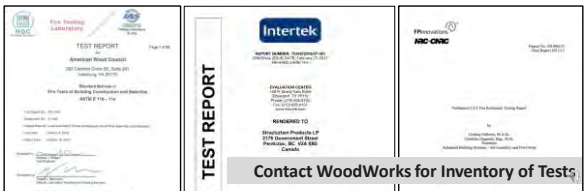
$$a_{eff} = 1.2 a_{char}$$ Effective Char Depth

44

## MT Fire Resistance Ratings (FRR)

**Tested Assemblies Method:**

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




Contact WoodWorks for Inventory of Tests

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## MT Fire Resistance Ratings (FRR)


**Mass Timber Fire Design Resource**

- **Code compliance options for demonstrating FRR**
- **Updated as new tests are completed**
- **Free download at woodworks.org**

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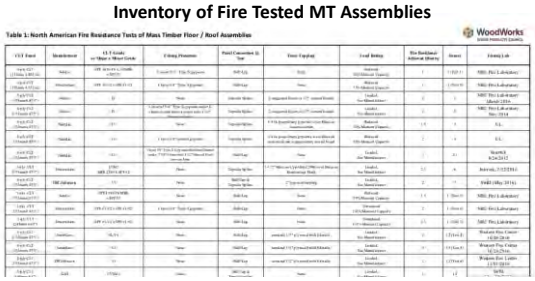
## MT Fire Resistance Ratings (FRR)

**Inventory of Fire Tested MT Assemblies**

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## 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..

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## Type IV-B


Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

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## 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**

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## Type IV-B Protection vs. Exposed

IV-B


Credit: Susan Jones, atelierjones

Credit: Kaiser+Path

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

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

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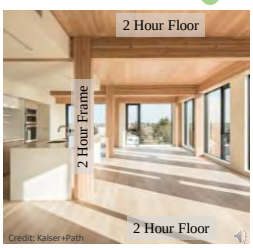
## Type IV-B Fire Resistance Ratings (FRR)

IV-B

| | |
|---|---|
| Primary Frame FRR | 2 HR (1 HR at Roof) |
| Ext or Int Bearing Wall FRR | 2 HR |
| Floor Construction FRR | 2 HR |
| Roof Construction FRR | 1 HR |




Credit: Kaiser+Path

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## Type IV-B Fire Resistance Ratings (FRR)

IV-B

***Applicable to most locations. Limited exposed MT permitted**

| | FRR | Min. NC Protection |
|---|---|---|
| Primary Frame FRR | 2 HR (1 HR at Roof) | 80 min* (40 min* at Roof) |
| Ext or Int Bearing Wall FRR | 2 HR | 80 min* |
| Floor Construction FRR | 2 HR | 80 min* |
| Roof Construction FRR | 1 HR | 40 min* |

**½" Type X Gypsum = 25 min | 5/8" Type X Gypsum = 40 min**

Credit: Urban One

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## Type IV-B Protection

IV-B

| | |
|---|---|
| Floor Surface Protection | Min. 1 inch of NC protection |
| Roof Construction Protection | Min. 1 layer 5/8" type X gyp on inside face* |
| Ext Wall Protection | Min. 1 layer 5/8" type X gyp on outside face<br>Min. 2 layers 5/8" type X gyp on inside face* |

***Applicable to most locations**
**Limited exposed MT permitted**

Credit: Maxxon

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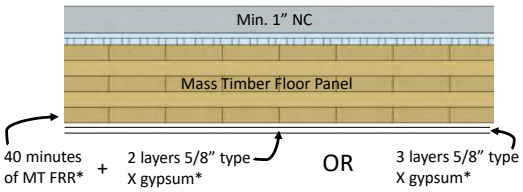
## Type IV-B Fire Resistance Ratings (FRR)

IV-B

**FRR & NC Floor Panel Example: 2 HR**




***Applicable to most locations. Limited exposed MT permitted**

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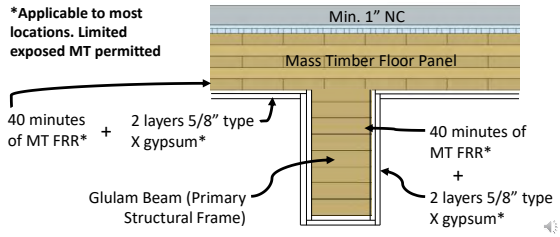
## Type IV-B Fire Resistance Ratings (FRR)

IV-B

**Primary Frame (2 HR) + Floor Panel Example (2 HR):**

***Applicable to most locations. Limited exposed MT permitted**

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## Type IV-B Protection vs. Exposed

IV-B

**Limited Exposed MT allowed in Type IV-B for:**

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

Credit: Kaiser+Path

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## Type IV-B Protection vs. Exposed

IV-B

**Mixed unprotected areas, exposing both ceilings and walls:**

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

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

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

Credit: Kaiser+Path

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## Type IV-B Protection vs. Exposed

IV-B

**Design Example: Mixing unprotected MT walls & ceilings**


Credit: AWC

**800 SF dwelling unit**

- **$U_{ac}$ = (800 SF)*(0.20) = 160 SF**
- **$U_{aw}$ = (800 SF)*(0.40) = 320 SF**
- **Could expose 160 SF of MT ceiling, <u>OR</u> 320 SF of MT Wall, <u>OR</u>**
- **If desire to expose 100 SF of MT ceiling in Living Room, determine max. area of MT walls that can be exposed**

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## Type IV-B Protection vs. Exposed

IV-B

**Design Example: Mixing unprotected MT walls & ceilings**


Credit: AWC

$(U_{tc}/U_{ac}) + (U_{tw}/U_{aw}) \leq 1.0$
$(100/160) + (U_{tw}/320) \leq 1.0$
$U_{tw}$ = 120 SF

- **Can expose 120 SF of MT walls in dwelling unit in combination with exposing 100 SF of MT ceiling**

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## Type IV-B Protection vs. Exposed

IV-B

**Horizontal separation of unprotected areas:**

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

Credit: Kaiser+Path

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## Type IV-C


Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

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## Type IV-C Height and Area Limits

IV-C


Credit: Susan Jones, atelierjones

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

Areas exclude potential frontage increase

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

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

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## Type IV-C Protection vs. Exposed

IV-C


Credit: Susan Jones, atelierjones

Credit: Kaiser+Path, Ema Peter

**All Mass Timber surfaces may be exposed**

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

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## Type IV-C Fire Resistance Ratings (FRR)

IV-C

| | |
|---|---|
| Primary Frame FRR | 2 HR (1 HR at Roof) |
| Ext or Int Bearing Wall FRR | 2 HR |
| Floor Construction FRR | 2 HR |
| Roof Construction FRR | 1 HR |

**Same FRR as IV-B, but all MT in IV-C may be exposed***


Credit: Ema Peter

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## Type IV-C Protection

IV-C

| | |
|---|---|
| Floor Surface Protection | None req'd |
| Roof Construction Protection | None req'd |
| Ext Wall Protection | Min. 1 layer 5/8" type X gyp on outside face<br>None req'd on inside face |

Credit: Maxxon

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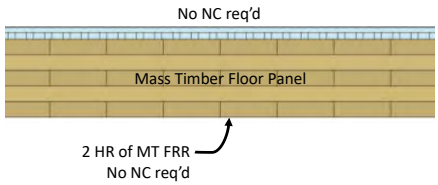
## Type IV-C Fire Resistance Ratings (FRR)

IV-C

**FRR & NC Floor Panel Example: 2 HR**

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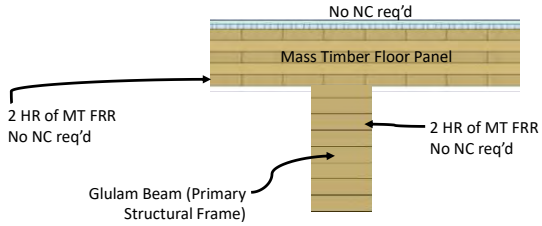
## Type IV-C Fire Resistance Ratings (FRR)

IV-C

**Primary Frame (2 HR) + Floor Panel Example (2 HR):**

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## Fire Resistance Ratings (FRR) Recap

| | IV-A | IV-B | IV-C | IV-HT |
|---|---|---|---|---|
| Roof Construction | 1.5 | 1 | 1 | HT |
| Primary Frame @ Roof | 2 | 1 | 1 | HT |
| Floor Construction | 2 | 2 | 2 | HT |
| Primary Frame | 3 | 2 | 2 | HT |
| Exterior Bearing Walls | 3 | 2 | 2 | 2 |
| Interior Bearing Walls | 3 | 2 | 2 | 1 or HT |

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

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## Noncombustible Protection (NC) Recap

Noncombustible Protection Required

IV-A IV-B IV-C IV-HT

Credit: LEVER Architecture

Credit: PATH Architecture

Photo: Blaine Brownell

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## 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 Interior Requirements | | | No |
| Noncombustible non-bearing wall | 0 Hr | | | 1 Hr |
| Wood Stud Wall | No | | | 1 Hr |

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

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## Exterior Wall Construction Recap

IV-A IV-B IV-C IV-HT

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

*Changes in IBC 2015, 2018, and 2021 editions

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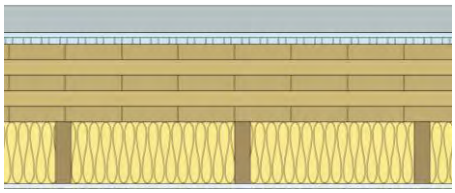
## Concealed Spaces in Type IV

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

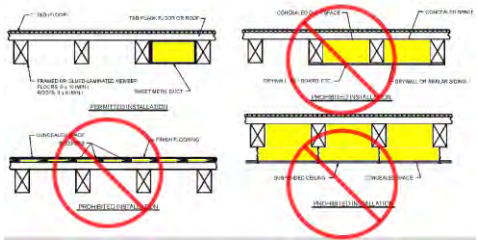
- **Impact on FRR, NC placement, sprinkler requirements**



73

## Concealed Spaces in Type IV

**Previous Type IV (now IV-HT) provisions prohibited concealed spaces**

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## Concealed Spaces in Type IV

**Type IV-HT (IBC 2021) permits concealed spaces where one of the following conditions exists:**

1. The building is sprinklered throughout with an NFPA 13 Sprinkler and automatic sprinklers are provided in the concealed space.
2. The concealed space is completely filled with noncombustible insulation.
3. Surfaces within the concealed space are fully sheathed with not less than 5/8" Type X gypsum.

Concealed spaces within interior walls and partitions with a one hour or greater fire resistance rating complying Section 2304.11.2.2 do not require additional protection.

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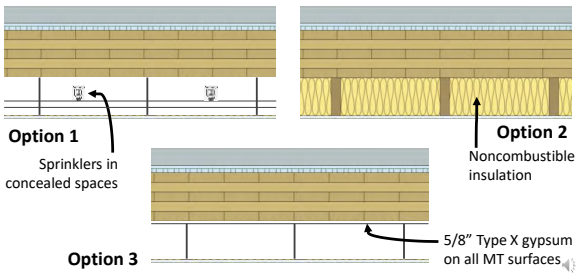
## Concealed Spaces in Type IV-HT

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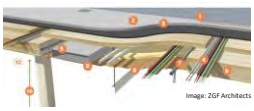
## Concealed Spaces in Type IV-A, IV-B, IV-C

**New IV-HT concealed space provisions do not apply to IV-A, IV-B or IV-C**

**But, can still have concealed spaces in IV-A, IV-B, IV-C:**

- **IV-A and IV-B:** Combustible construction forming concealed spaces protected with NC of 80 minutes (2 layers of 5/8" Type X Gypsum)
- **IV-C:** Combustible construction forming concealed spaces protected with NC of 40 minutes (1 layer of 5/8" Type X Gypsum)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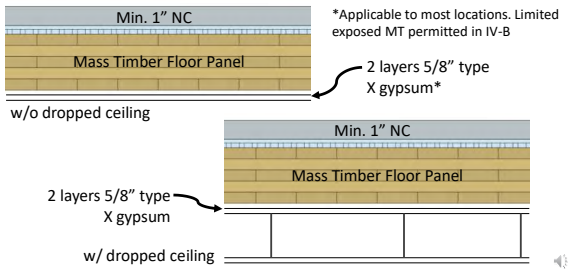
## Concealed Spaces in Type IV-A, IV-B

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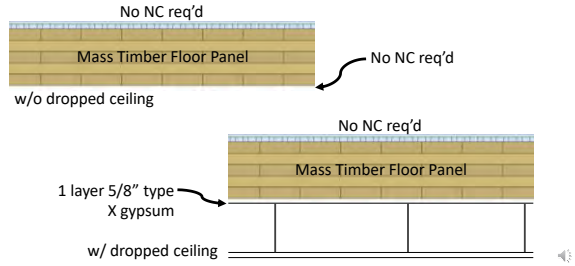
## Concealed Spaces in Type IV-C

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## Tall Wood Shaft Enclosures

- **When can shaft enclosures be MT?**
- **What FRR requirements exist?**
- **If shaft enclosure is MT, is NC req'd?**


80

## Tall Wood Shaft Enclosures

| | IV-A | IV-B | IV-C |
|---|---|---|---|
| Exit & Hoistway Enclosures | Up to 12 Stories or 180 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<br>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) | | |

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## Mid-Rise vs. High-Rise

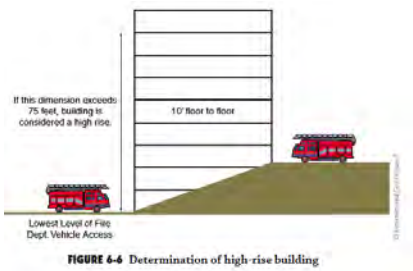


FIGURE 6-6 Determination of high-rise building

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## 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**


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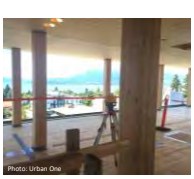
## CLT Fire Performance – Char Fall Off

**CLT char fall off or heat induced delamination occurs when laminations (or pieces thereof) fall off the underside of a CLT panel under extended fire conditions.**





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## CLT Fire Performance – Fire Re-Growth

**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.**



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## CLT Fire Performance – Char Fall Off

**Facts about CLT char fall off:**

- **Only an item to consider in tall buildings. Important to avoid in high-rise construction where required performance is containment of fire within compartment of origin with no sprinkler or fire service suppression**
- **Not applicable when discussing mid-rise mass timber (or any building under types II, III, IV-HT or V)**
- **Largely a function of adhesive performance under high temps**
- **Has been addressed in PRG 320-18 (required for all CLT under 2021 IBC, not just tall wood)**


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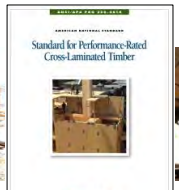
## CLT Fire Performance – PRG 320

**2021 IBC Section 602.4 added:**
Cross-laminated timber shall be labeled as conforming to PRG 320 - 18 as referenced in Section 2303.1.4.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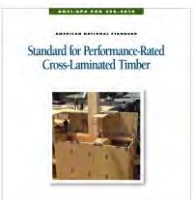
## CLT Fire Performance – PRG 320

**PRG 320 is manufacturing & performance standard for CLT.**
**2018 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**

**When designing tall wood – specify CLT per PRG 320-18 (req'd in IBC 2021 for all CLT)**





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## 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

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## Connection Fire Protection

**Many ways to demonstrate connection fire protection: calculations, prescriptive NC, test results, others as approved by AHJ**




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## Connection Fire Protection

**2017 Glulam Beam to Column Connection Fire Tests under standard ASTM E119 time-temperature exposure**



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## Connection Fire Protection

**Fire Test Results**

| Test | Beam | Connector | Applied Load | FRR |
|---|---|---|---|---|
| 1 | 8.75" x 18" (222mm x 457mm) | 1 x Ricon S VS 290x80 | 3,905lbs (17.4kN) | 1hr |
| 2 | 10.75" x 24" (273mm x 610mm) | Staggered double Ricon S VS 200x80 | 16,620lbs (73.9kN) | 1.5hrs |
| 3 | 10.75" x 24" (273mm x 610mm) | 1 x Megant 430 | 16,620lbs (73.9kN) | 1.5hrs |

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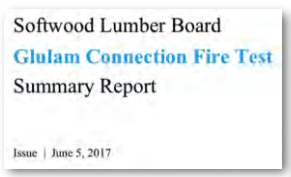
## Connection Fire Protection


Softwood Lumber Board
Glulam Connection Fire Test
Summary Report
Issue | June 5, 2017


SOUTHWEST RESEARCH INSTITUTE

FIRE PERFORMANCE EVALUATION OF A LOAD BEARING GLULAM BEAM TO COLUMN CONNECTION, INCLUDING A CLT PANEL, TESTED IN GENERAL ACCORDANCE WITH ASTM E119-16a, STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS.

FINAL REPORT
Consisting of 52 Pages

**Full Report Available at:**

https://www.thinkwood.com/wp-content/uploads/2018/01/reThink-Wood-Arup-SLB-Connection-Fire-Testing-Summary-web.pdf

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## Penetration Fire Protection

**Although not a new code requirement or specific to tall wood, more testing & information is becoming available on firestopping of penetrations through MT assemblies**


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## Penetration Fire Protection

**Most firestopping systems include combination of fire safing (eg. noncombustible materials such as mineral wool insulation) plus fire caulk**


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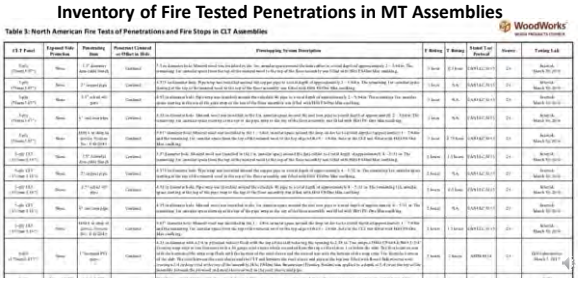
## Penetration Fire Protection

**Firestop systems tests on Mass Timber**
**Contact WoodWorks for information**


100

## Penetration Fire Protection

**Inventory of Fire Tested Penetrations in MT Assemblies**

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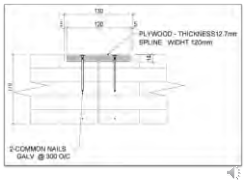
## Sealants at MT Panel Edges

**703.9 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.

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## Sealants at MT Panel Edges

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.


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## Sealants at MT Panel Edges

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)


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## 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.


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## 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.


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## Fire Safety During Construction

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

**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.


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## Fire Safety During Construction

**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.

Credit: IFC

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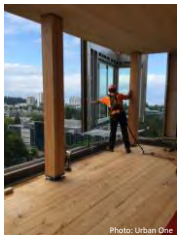
## Fire Safety During Construction

**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.

**Exception**: Shafts and vertical exit enclosures

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## Fire Safety During Construction

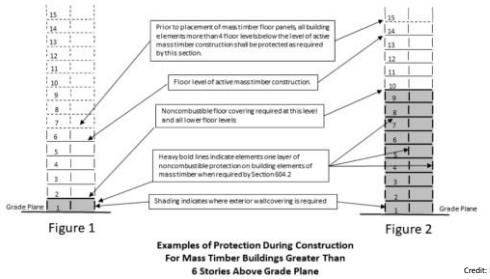


Figure 1 Figure 2

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

Credit: ICC

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## QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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## WoodWorks Online Event

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