Session 2: Code Compliance

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Session 2: Code Compliance

Topics

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

**Primarily based on building size & occupancy**

<table>
<thead>
<tr>
<th>Occupancies</th>
<th>Allowable Building Height above Grade Plane, Feet (IBC Table 504.3)</th>
<th>Allowable Number of Stories above Grade Plane (IBC Table 505.4)</th>
<th>Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, R</td>
<td>270 180 85 85 85 85 70 60</td>
<td>18 12 6 4 4 3 3 2</td>
<td>135,000 90,000 56,250 45,000 42,000 28,500 34,500 18,000</td>
</tr>
<tr>
<td>A-2, A-3, A-4</td>
<td>18 12 6 4 4 3 3 2</td>
<td>18 12 9 6 6 4 4 3</td>
<td>324,000 216,000 135,000 108,000 85,500 57,000 54,000 27,000</td>
</tr>
<tr>
<td>B</td>
<td>18 12 9 6 6 4 4 3</td>
<td>18 12 8 5 5 4 3</td>
<td>184,500 123,000 76,875 61,500 72,000 48,000 36,000 21,000</td>
</tr>
<tr>
<td>R-2</td>
<td>18 12 8 5 5 4 3</td>
<td>18 12 8 5 5 4 3</td>
<td>184,500 123,000 76,875 61,500 72,000 48,000 36,000 21,000</td>
</tr>
</tbody>
</table>
## Construction Types

Primarily based on building size & occupancy

<table>
<thead>
<tr>
<th>Construction Type (All Sprinklered Values)</th>
<th>IV-A</th>
<th>IV-B</th>
<th>IV-C</th>
<th>IV-HT</th>
<th>III-A</th>
<th>III-B</th>
<th>V-A</th>
<th>V-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A, B, R</td>
<td>270</td>
<td>180</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>70</td>
<td>60</td>
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<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-2</td>
<td>18</td>
<td>12</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Allowable Area Factor (At) for SM, Feet² (IBC Table 506.2)</th>
<th>A-2, A-3, A-4</th>
<th>B</th>
<th>R-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2, A-3, A-4</td>
<td>135,000</td>
<td>90,000</td>
<td>184,500</td>
</tr>
<tr>
<td>B</td>
<td>324,000</td>
<td>216,000</td>
<td>123,000</td>
</tr>
<tr>
<td>R-2</td>
<td>184,500</td>
<td>123,000</td>
<td>76,875</td>
</tr>
</tbody>
</table>
Construction Types
Construction Types

When does the code allow mass timber to be used?

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

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

IBC defines 5 construction types:

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

Further broken down into subcategories

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

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

However, there are exceptions including several for mass timber
Construction Types

Where does the code allow MT to be used?

• **Type I-B & II-A/II-B**: Roof Decking
Construction Types

All wood framed building options:

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

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

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

**Type IV (Heavy Timber)**
Exterior walls non-combustible (may be FRTW OR CLT)
Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces except in 2021 IBC)
### Type III-A Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>4</td>
<td>85 ft</td>
<td>42,000 SF</td>
<td>126,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>85 ft</td>
<td>85,500 SF</td>
<td>256,500 SF</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>85 ft</td>
<td>55,500 SF</td>
<td>166,500 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>5</td>
<td>85 ft</td>
<td>72,000 SF</td>
<td>216,000 SF</td>
</tr>
</tbody>
</table>

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

5-story residential / 6-story office
2-hour rating for exterior bearing walls
1-hour rating for other building elements
### Type III-B Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>3</td>
<td>75 ft</td>
<td>28,500 SF</td>
<td>85,500 SF</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>75 ft</td>
<td>57,000 SF</td>
<td>171,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>75 ft</td>
<td>37,500 SF</td>
<td>112,500 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>5</td>
<td>75 ft</td>
<td>48,000 SF</td>
<td>144,000 SF</td>
</tr>
</tbody>
</table>

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

**4-story office / 5-story residential**

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

Where does the code allow MT to be used?

• **Type III**: Interior elements (floors, roofs, partitions/shafts) and exterior walls if FRT
## Type IV-HT Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>4</td>
<td>85 ft</td>
<td>45,000 SF</td>
<td>135,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>85 ft</td>
<td>108,000 SF</td>
<td>324,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>85 ft</td>
<td>61,500 SF</td>
<td>184,500 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>5</td>
<td>85 ft</td>
<td>61,500 SF</td>
<td>184,500 SF</td>
</tr>
</tbody>
</table>

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

### 5-story residential / 6-story office

### 2-hour rating for exterior bearing walls

### Interior elements must qualify as Heavy Timber
Construction Types

Where does the code allow MT to be used?
• **Type IV**: Any exposed interior elements & roofs, must meet min. sizes; exterior walls if CLT or FRT. Concealed space limitations (varies by code version)
# Construction Types

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

<table>
<thead>
<tr>
<th>Framing</th>
<th>Solid Sawn (nominal)</th>
<th>Glulam (actual)</th>
<th>SCL (actual)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floor</strong></td>
<td>8 x 8</td>
<td>6 3/4 x 8¼</td>
<td>7 x 7½</td>
</tr>
<tr>
<td>Columns</td>
<td>6 x 10</td>
<td>5 x 10½</td>
<td>5¼ x 9½</td>
</tr>
<tr>
<td>Beams</td>
<td>6 x 8</td>
<td>5 x 8¼</td>
<td>5¼ x 7½</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td>4 x 6</td>
<td>3 X 6 7/8</td>
<td>3½ X 5½</td>
</tr>
</tbody>
</table>

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

*3” nominal width allowed where sprinklered
Construction Types

Type IV min. sizes:

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
Construction Types

Type IV min. sizes:

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

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

Type IV concealed spaces

Can I have a dropped ceiling? Raised access floor?
Construction Types

Type IV concealed spaces

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

Type IV concealed space options within 2021 IBC

Option 1:

Sprinklers in concealed spaces

Dropped ceiling
Construction Types

Type IV concealed space options within 2021 IBC

Option 2:

Noncombustible insulation
Dropped ceiling
Construction Types

Type IV concealed space options within 2021 IBC

Option 3:

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

Dropped ceiling
Construction Types

Concealed spaces solutions paper

Concealed Spaces in Mass Timber and Heavy Timber Structures

Concealed spaces, such as those created by a dropped ceiling in a floor/ceiling assembly or by a stud wall assembly, have unique requirements in the International Building Code (IBC) to address the potential of the spread of non-visible areas of a building, Section 178 of the 2018 IBC includes prescriptive requirements for protection and compartmentalization of concealed spaces through the use of draft stopping, fire blocking, sprinklers and other means. For information on these requirements, see the WoodWorks G&Q. Are sprinklers required in concealed spaces such as floor and roof cavities in multi-family wood frame buildings?

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

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

- Type III — Floors, roofs and interior walls may be any material permitted by code, including mass timber; exterior walls are required to be noncombustible or fire retardant treated wood.
- Type V — Floors, roofs, interior walls and exterior walls (i.e., the entire structure) may be constructed of mass timber.
- Types I and II — Mass timber may be used in use-condition circumstances such as roof construction—including the primary frame in the 2021 IBC—in Types I, II, B & A.

Exterior columns and arches when 20 feet or more of horizontal separation is provided; and balconies, canopies and similar projections.

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

### Type V-A Height and Area Limits

#### Occupancy # of Stories Height Area per Story Building Area

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>3</td>
<td>70 ft</td>
<td>34,500 SF</td>
<td>103,500 SF</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>70 ft</td>
<td>54,000 SF</td>
<td>162,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
<td>70 ft</td>
<td>42,000 SF</td>
<td>126,000 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>4</td>
<td>70 ft</td>
<td>36,000 SF</td>
<td>108,000 SF</td>
</tr>
</tbody>
</table>

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

3 to 4-story residential/office

1-hour fire resistance rating required for most building elements
### Type V-B Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>2</td>
<td>60 ft</td>
<td>18,000 SF</td>
<td>36,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>60 ft</td>
<td>27,000 SF</td>
<td>81,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
<td>60 ft</td>
<td>27,000 SF</td>
<td>54,000 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>3</td>
<td>60 ft</td>
<td>21,000 SF</td>
<td>63,000 SF</td>
</tr>
</tbody>
</table>

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

- 1-story retail and restaurants
- 2 to 3-story residential/office
- No fire resistance ratings required
Construction Types

Where does the code allow MT to be used?

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

New Options in 2021 IBC
Allowable mass timber building size for group B occupancy with NFPA 13 Sprinkler
## Type IV-A Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>18</td>
<td>270 ft</td>
<td>135,000 SF</td>
<td>405,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>18</td>
<td>270 ft</td>
<td>324,000 SF</td>
<td>972,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>270 ft</td>
<td>184,500 SF</td>
<td>553,500 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>18</td>
<td>270 ft</td>
<td>184,500 SF</td>
<td>553,500 SF</td>
</tr>
</tbody>
</table>

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

Credit: Susan Jones, atelierjones
### Type IV-B Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>12</td>
<td>180 ft</td>
<td>90,000 SF</td>
<td>270,000 SF</td>
</tr>
<tr>
<td>B</td>
<td>12</td>
<td>180 ft</td>
<td>216,000 SF</td>
<td>648,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>8</td>
<td>180 ft</td>
<td>123,000 SF</td>
<td>369,000 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>12</td>
<td>180 ft</td>
<td>123,000 SF</td>
<td>369,000 SF</td>
</tr>
</tbody>
</table>

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**
### Type IV-C Height and Area Limits

<table>
<thead>
<tr>
<th>Occupancy</th>
<th># of Stories</th>
<th>Height</th>
<th>Area per Story</th>
<th>Building Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>6</td>
<td>85 ft</td>
<td>56,250 SF</td>
<td>168,750 SF</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>85 ft</td>
<td>135,000 SF</td>
<td>405,000 SF</td>
</tr>
<tr>
<td>M</td>
<td>6</td>
<td>85 ft</td>
<td>76,875 SF</td>
<td>230,625 SF</td>
</tr>
<tr>
<td>R-2</td>
<td>8</td>
<td>85 ft</td>
<td>76,875 SF</td>
<td>230,625 SF</td>
</tr>
</tbody>
</table>

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
Key Early Design Decisions

Construction Type Early Decision Example

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

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

**Construction Type Early Decision Example**

MT Construction Type Options:

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

- **If Building is > 85 ft**
  - 7 stories of IV-B

**Implications of construction type choice in this example:**

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

Construction Type Early Decision Example

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

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

Construction Type Early Decision Example

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

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

Construction Type Early Decision Example

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

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

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Regional Director
214-679-1874
mark.bartlett@woodworks.org
### Key Early Design Decisions

Construction type influences FRR

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Primary structural frame $^f$ (see Section 202)</td>
<td>3$^a$</td>
<td>2$^a$</td>
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<td>0</td>
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<tr>
<td>Bearing walls</td>
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<tr>
<td>Exterior $^e,f$</td>
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<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>3$^a$</td>
<td>2$^a$</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td>See Table 602</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions $^d$</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Floor construction and associated secondary members</td>
<td>2</td>
<td>2</td>
<td>1</td>
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</tr>
<tr>
<td>(see Section 202)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and associated secondary members</td>
<td>1$^{1/2}$$^b$</td>
<td>1$^{b,e}$</td>
<td>1$^{b,e}$</td>
<td>0$^e$</td>
<td></td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: 2018 IBC
Mass Timber Design

Fire resistance

Comparative Strength Loss of Wood versus Steel

- Wood: 25% loss @ 30 minutes
- Steel: 50% loss at 1020°F, 90% loss @ 30 minutes 1380°F

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

Source: AITC
**Construction Types**

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

<table>
<thead>
<tr>
<th>Framing</th>
<th>Solid Sawn (nominal)</th>
<th>Glulam (actual)</th>
<th>SCL (actual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columns</td>
<td>8 x 8</td>
<td>6³/₄ x 8¼</td>
<td>7 x 7½</td>
</tr>
<tr>
<td>Beams</td>
<td>6 x 10</td>
<td>5 x 10½</td>
<td>5¼ x 9½</td>
</tr>
<tr>
<td>Roof</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columns</td>
<td>6 x 8</td>
<td>5 x 8¼</td>
<td>5¼ x 7½</td>
</tr>
<tr>
<td>Beams*</td>
<td>4 x 6</td>
<td>3 X 6⁷/₈</td>
<td>3½ X 5½</td>
</tr>
</tbody>
</table>

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

*3” nominal width allowed where sprinklered
Key Early Design Decisions

Construction type influences FRR

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

Method of demonstrating FRR (calculations or testing) can impact member sizing
# Key Early Design Decisions

Construction type influences FRR

---

### Table 607

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3(^a,,b)</td>
<td>2(^a,,b,,c)</td>
<td>1(^b,,c)</td>
<td>0(^c)</td>
<td>1(^b,,c)</td>
</tr>
<tr>
<td>Bearing walls</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Exterior</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Interior</td>
<td>3(^a)</td>
<td>2(^a)</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interior</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Floor construction and associated secondary structural members (see Section 202)</td>
<td>1(^b,,c)</td>
<td>0</td>
<td>1(^1/2)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Roof construction and associated secondary structural members (see Section 202)</td>
<td>1(^b,,c)</td>
<td>1(^b,,c)</td>
<td>1(^b,,c)</td>
<td>0(^c)</td>
<td>1(^b,,c)</td>
</tr>
</tbody>
</table>

Source: 2021 IBC
Fire Design of MT

CLT structural capacity

CLT char depth

Original CLT depth

Credit: David Barber, ARUP
Key Early Design Decisions

**Member Sizes**

- Impact of FRR on sizing
- Impact of sizing on efficient spans
- Consider connections – can drive member sizing
Key Early Design Decisions

Which Method of Demonstrating FRR of MT is Being Used?
1. Calculations in Accordance with IBC 722 → NDS Chapter 16
2. Tests in Accordance with ASTM E119
FRR Design of MT

Calculated FRR of Exposed MT: IBC to NDS code compliance path

**IBC 703.3**
Methods for determining fire resistance
- Prescriptive designs per IBC 721.1
- Calculations in accordance with IBC 722
- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Alternate protection methods as allowed by 104.11

**IBC 722**
Calculated Fire Resistance
“The calculated fire resistance of exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AWC National Design Specification for Wood Construction (NDS).”

**NDS Chapter 16**
Fire Design of Wood Members
- Limited to calculating fire resistance up to 2 hours
- Char depth varies based on exposure time (i.e., fire-resistance rating), product type and lamination thickness. Equations and tables are provided.
- TR 10 and NDS commentary are helpful in implementing permitted calculations.
FRR Design of MT

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

Table 16.2.1B  Effective Char Depths (for CLT with $\beta_n=1.5\text{in./hr.}$)

<table>
<thead>
<tr>
<th>Required Fire Endurance (hr.)</th>
<th>Effective Char Depths, $a_{\text{char}}$ (in.)</th>
<th>lamination thicknesses, $h_{\text{lam}}$ (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5/8</td>
<td>3/4</td>
</tr>
<tr>
<td>1-Hour</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>1½-Hour</td>
<td>3.4</td>
<td>3.2</td>
</tr>
<tr>
<td>2-Hour</td>
<td>4.4</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Credit: FPInnovations
FRR Design of MT

Nominal char rate of 1.5”/HR is recognized in NDS. Effective char depth calculated to account for duration, structural reduction in heat-affected zone.

<table>
<thead>
<tr>
<th>Required Fire Resistance (hr.)</th>
<th>Char Depth, ( a_{\text{char}} ) (in.)</th>
<th>Effective Char Depth, ( a_{\text{eff}} ) (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Hour</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>1½-Hour</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>2-Hour</td>
<td>2.6</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Table 16.2.1A  Char Depth and Effective Char Depth (for \( \beta_n = 1.5 \text{ in./hr.} \))

<table>
<thead>
<tr>
<th>Required Fire Endurance (hr.)</th>
<th>Effective Char Depths, ( a_{\text{char}} ) (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lamination thicknesses, ( h_{\text{lam}} ) (in.)</td>
</tr>
<tr>
<td></td>
<td>5/8</td>
</tr>
<tr>
<td>1-Hour</td>
<td>2.2</td>
</tr>
<tr>
<td>1½-Hour</td>
<td>3.4</td>
</tr>
<tr>
<td>2-Hour</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Table 16.2.1B  Effective Char Depths (for CLT with \( \beta_n=1.5\text{in./hr.} \))
FRR Design of MT

Two structural capacity checks performed:
1. On entire cross section neglecting fire effects
2. On post-fire remaining section, with stress increases

Solid Sawn, Glulam, SCL

CLT

Effective Char Depth

Credit: Forest Products Laboratory

\[ a_{\text{char}} = \beta_t t^{0.813} \]

\[ a_{\text{char}} = n_{\text{lam}} h_{\text{lam}} + \beta_t \left( t - \left( n_{\text{lam}} t_{gj} \right) \right)^{0.813} \]

\[ a_{\text{eff}} = 1.2 a_{\text{char}} \]
FRR Design of MT

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

<table>
<thead>
<tr>
<th>Property</th>
<th>Symbol</th>
<th>Design Stress to Member Strength Factor</th>
<th>ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bending Strength</td>
<td>$F_b$</td>
<td>x</td>
<td>2.85</td>
</tr>
<tr>
<td>Beam Buckling Strength</td>
<td>$F_{be}$</td>
<td>x</td>
<td>2.03</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>$F_t$</td>
<td>x</td>
<td>2.85</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>$F_c$</td>
<td>x</td>
<td>2.58</td>
</tr>
<tr>
<td>Column Buckling Strength</td>
<td>$F_{ce}$</td>
<td>x</td>
<td>2.03</td>
</tr>
</tbody>
</table>

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

Source: AWC’s NDS
FRR Design of MT

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

Example 5: Exposed CLT Floor - Allowable Stress Design

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

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

Calculate panel load (per foot of width):

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

Calculate maximum induced moment (per foot of width):

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

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

Bending moment, $F_{b,\text{eff},0} = 4,675 \text{ ft-lb/ft of width}$  \hspace{1cm} \text{(PRG 320 Annex A, Table A2)}

Calculate the allowable design moment (assuming $C_{p}=1.0; C_{w}=1.0; C_{t}=1.0; C_{L}=1.0$)

$M_{a} = F_{b}(S_{a})(C_{p})(C_{w})(C_{t})(C_{L}) = 4,675 \times (1.0)(1.0)(1.0)(1.0) = 4,675 \text{ ft-lb/ft of width}$  \hspace{1cm} \text{(NDS 10.3.1)}

Structural Check:

$M_{a} \geq M_{max} \hspace{1cm} 4,675 \text{ ft-lb/ft} > 4,455 \text{ ft-lb/ft} \hspace{1cm} \checkmark$

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

Source: AWC’s TR10
FRR Design of MT

Tested FRR of Exposed MT:
• IBC 703.2 notes the acceptance of FRR demonstration via testing in accordance with ASTM E119

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

Standard ASTM E119 test time-temperature curve
FRR Design of MT

Tested FRR of Exposed MT:
• Many successful Mass Timber ASTM E119 fire tests have been completed by industry & manufacturers
# FRR Design of MT

**WoodWorks Inventory of Fire Tested MT Assemblies**

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

<table>
<thead>
<tr>
<th>CLT Panel</th>
<th>Manufacturer</th>
<th>CLT Grade or Major x Minor Grade</th>
<th>Ceiling Protection</th>
<th>Panel Connection in Test</th>
<th>Floor Topping</th>
<th>Load Rating</th>
<th>Fire Resistance Achieved (Hours)</th>
<th>Source</th>
<th>Testing Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-ply CLT</td>
<td>Nordic</td>
<td>SPF 16/50 FB 15/EMSR x SPF 3</td>
<td>2 inch 1/2&quot; Type X Gypsum</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1 (Test 1)</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>3-ply CLT</td>
<td>Nordic</td>
<td>SPF 65/32 x SPF 3/2</td>
<td>1 layer of 5/8&quot; Type X Gypsum</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1 (Test 5)</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8&quot; Type X Gypsum under 1/2&quot; cement board</td>
<td>Topside Splice</td>
<td>None</td>
<td>Loaded</td>
<td>2</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8&quot; Type X Gypsum under Z-channels and lathing strips with 3/8&quot; furring strips</td>
<td>Topside Splice</td>
<td>None</td>
<td>Loaded</td>
<td>3</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8&quot; normal gypsum</td>
<td>Topside Splice</td>
<td>None</td>
<td>Reduced</td>
<td>2</td>
<td>UL</td>
<td>UL</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 10&quot; Type X Gypsum under Boarded Channel under 7/8&quot; furring with 3/12&quot; Mineral Wool Screen Joint</td>
<td>Half-Lap</td>
<td>None</td>
<td>Loaded</td>
<td>2</td>
<td>InterTek 8/24/2012</td>
<td>InterTek 8/24/2012</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Scanwood</td>
<td>EI</td>
<td>None</td>
<td>Topside Splice</td>
<td>1 1/2&quot; Matico Cup-Glue 2000 &amp; over Mastic Reshaping Mat</td>
<td>Loaded, See Manufacturer</td>
<td>2.5</td>
<td>InterTek 2/11/2016</td>
<td>InterTek, 2/2/2016</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>DR Johnson</td>
<td>V6</td>
<td>None</td>
<td>Half-Lap &amp; Topside Splice</td>
<td>2&quot; gypsum wrapping</td>
<td>Loaded, See Manufacturer</td>
<td>2</td>
<td>InterTek 8/24/2012</td>
<td>InterTek, 2/2/2016</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Structurlam</td>
<td>SPF 65/32 x SPF 3/2</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Structurlam</td>
<td>SPF 65/32 x SPF 3/2</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>Smartlam</td>
<td>SL-V4</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>DIY безопасн</td>
<td>V6</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5-ply CLT</td>
<td>XLD</td>
<td>CV3M1</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced</td>
<td>1</td>
<td>NRC Fire Laboratory</td>
<td>NRC Fire Laboratory</td>
</tr>
</tbody>
</table>
FRR Design of MT

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

Each has unique benefits:

- **Testing:**
  - Can result in higher FRR for some assemblies when compared to calculations (i.e. 2-hr FRR with 5-ply CLT panel).
  - Seen as more acceptable by some building officials

- **Calculations:**
  - Can provide more design flexibility
  - Allows for project span and loading specific analysis
Fire-Resistive Design of MT

Mass Timber Fire Design Resource
- Code compliance options for demonstrating FRR
- Free download at woodworks.org
Questions?

Bruce Lindsey  
Senior Technical Director  
bruce@woodworks.org  
(704) 877-6255
Session II – Code Compliance
Part III – Tall Wood

Chelsea Drenick, SE
Regional Director
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BROCK COMMONS, BRITISH COLUMBIA

Photos: Michael Elkan | Naturally Wood | UBC

18 STORIES | 174 FT
MJOSTARNET, NORWAY

18 STORIES | 280 FT

Photos: Bygg Mesteren | Voll Arkitekter
HOHO, AUSTRIA

Photos: RLP Rüdiger Lainer + Partner, RWTplus

24 STORIES | 275 FT
CARBON12, PORTLAND, OR

8 STORIES | 85 FT
INTRO, CLEVELAND

9 Stories  |  115 ft
8 Timber Over 1 Podium

512,000 SF
297 Apartments, Mixed-Use

Photo: Harbor Bay Real Estate Advisors, Purple Film  |  Architect: Hartshorne Plunkard Architecture
INTRO, CLEVELAND

9 Stories | 115 ft
8 Timber Over 1 Podium

Type IV-B
Variance to expose ~50% ceilings

Photo: Harbor Bay Real Estate Advisors, Image Fiction | Architect: Hartshorne Plunkard Architecture
ASCENT, MILWAUKEE

493,000 SF
259 APARTMENTS, MIXED-USE
ASCENT, MILWAUKEE

Tallest Mass Timber Building in the World

Photo: CD Smith Construction | Architect: Korb & Associates Architects
ASCENT, MILWAUKEE

25 STORIES

19 TIMBER OVER 6 PODIUM, 284 FT

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
80 M ST, WASHINGTON, DC

3 STORY VERTICAL ADDITION
ON EXISTING 7-STORY CONCRETE BUILDING

Photo: Hickok Cole | Architect: Hickok Cole
80 M ST, WASHINGTON, DC

3 STORY VERTICAL ADDITION
7 STORY EXISTING BUILDING

Photo: WoodWorks | Architect: Hickok Cole
APEX PLAZA
CHARLOTTESVILLE, VA

187,000 SF

Photo: WoodWorks  |  Architect: William McDonough + Partners
APEX PLAZA
CHARLOTTESVILLE, VA
8 STORIES
6 TIMBER OVER 2 PODIUM, 100 FT
PRIMARILY OFFICE SPACE
11 E LENOX, BOSTON, MA

7 STORIES
70 FT
Passive House
Multi-Family

Credit: Monte French Design Studio

Credit: H + O Structural Engineering
11 E LENOX, BOSTON, MA

Credit: H+O Structural Engineering
BEFORE 2021 IBC Code Limit for wood - 6 stories (business) 5 stories (residential) and 85 feet

Over 6 Stories:
Alternate Means and Methods Request (AMMR) through performance based design
Seen as the catalyst for the mass timber revolution, CLT first recognized in US codes in the 2015 IBC

[BS] CROSS-LAMINATED TIMBER. A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or structural composite lumber where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.
Interest in tall wood projects in the US was rapidly increasing. Some building officials were reluctant to approved proposed plans, primarily due to lack of code direction and precedent.
In December 2015, the ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings. Objectives:
1. Explore the building science of tall wood buildings
2. Investigate the feasibility, and
3. Take action on developing code changes for tall wood buildings.
Taller wood buildings create new set of challenges to address:

AHC established 6 performance objectives:

1. No collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered.
2. Highly reliable fire suppression systems to reduce the risk of failure during reasonably expected fire scenarios. The degree of reliability should be proportional to evacuation time (height) and the risk of collapse.
AHC established 6 performance objectives:

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

4. No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.
AHC established 6 performance objectives:

5. No unusual fire department access issues
6. Egress systems designed to protect building occupants during the design escape time, plus a factor of safety.
Commissioned series of 5 full-scale tests on 2-story mass timber structure at ATF lab in MD, May-June 2017.

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

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

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

Majority of flames seen are from contents, not structure
<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Construction Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>All mass timber surfaces protected with 2 layers of 5/8” Type X Gypsum. No Sprinklers.</td>
<td>IV-A</td>
</tr>
<tr>
<td>Test 2</td>
<td>30% of CLT ceiling area in living room and bedroom exposed. No Sprinklers.</td>
<td>IV-B</td>
</tr>
<tr>
<td>Test 3</td>
<td>Two opposing CLT walls exposed – one in bedroom and one in living room. No Sprinklers.</td>
<td>IV-B</td>
</tr>
<tr>
<td>Test 4</td>
<td>All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – normal activation</td>
<td>IV-C</td>
</tr>
<tr>
<td>Test 5</td>
<td>All mass timber surfaces fully exposed in bedroom and living room. Sprinklered – 20 minute delayed activation</td>
<td>IV-C</td>
</tr>
</tbody>
</table>
TALL WOOD APPROVED!
Unofficial results posted Dec 19, 2018
Final votes ratified Jan 31, 2019

AWC: Tall Mass Timber code changes get final approval
Dec 19, 2018

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

“Mass timber has been capturing the imagination of architects and developers, and the ICC result means they can now turn sketches into reality. ICC’s rigorous study, testing and voting process now means innovation can go where alternative traditional tall building materials used to be limited.”
2021 IBC Introduces 3 new tall wood construction types:
IV-A, IV-B, IV-C
Previous type IV renamed type IV-HT
Type IV-A

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

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp, Urban One
Type IV-A Protection vs. Exposed

100% NC protection on all surfaces of Mass Timber

Credit: Susan Jones, atelierjones
No timber surfaces may be exposed
Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture
Type IV-B Protection vs. Exposed

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

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

Credit: Susan Jones, atelierjones
Type IV-B Protection vs. Exposed

Credit: AWC
Type IV-C

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH
Architecture/Marcus Kauffman
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

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

Credit: Susan Jones, atelierjones
All timber surfaces may be exposed
Mid-Rise vs. High-Rise

If this dimension exceeds 75 feet, building is considered a high rise.

10' floor to floor

Lowest Level of Fire Dept. Vehicle Access

FIGURE 6-6 Determination of high-rise building
Sprinklers in High Rises

• Two Water Mains Required if:
  • Building Height Exceeds 420 ft, or
  • Type IV-A and IV-B buildings that exceed 120 ft in height
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.
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
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).
Tall Wood Materials & Protection

- **IV-A**: Mass Timber, exterior surface protected with 1 layer 5/8" type X gyp
- **IV-B**: Mass Timber or Non-combustible
  - Permitted, requires NC protection on MT surfaces
- **IV-C**: Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies

**Exterior Walls**
- All MT is protected
  - 3 HR: 3 layers 5/8" type X gyp
  - 2 HR or less: 2 layers 5/8" type X gyp

**Structural Materials**
- All MT permitted may be exposed except as noted
# Tall Wood Fire Resistance Ratings (FRR)

<table>
<thead>
<tr>
<th>Primary Frame or Brng Wall FRR</th>
<th>Floor Construction FRR</th>
<th>Roof Construction FRR</th>
<th>Floor Surface Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 HR (2 HR at Roof)</td>
<td>2 HR (1 HR at Roof)</td>
<td>2 HR (1 HR at Roof)</td>
<td>1 inch of NC protection</td>
</tr>
<tr>
<td>2 HR</td>
<td>2 HR</td>
<td>2 HR</td>
<td>1 inch of NC protection</td>
</tr>
<tr>
<td>1.5 HR</td>
<td>1 HR</td>
<td>1 HR</td>
<td>No protection req’d</td>
</tr>
<tr>
<td>1 inch of NC protection</td>
<td>1 inch of NC protection</td>
<td>No protection req’d</td>
<td></td>
</tr>
</tbody>
</table>
MT Fire Resistance Ratings (FRR)

IBC 722.7
The fire resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element (MT) added to the protection time of the noncombustible (NC) protection.

Mass Timber + Non-Combustible = Fire Resistance Rating

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

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

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

SECTION 3313
STANDPIPES

3313.1 Where required.
In buildings required to have standpipes by Section 905.3.1, not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipe shall be provided with fire department hose connections at accessible locations adjacent to usable stairways. Such standpipes shall be extended as construction progresses to within one floor of the highest point of construction having secured decking or flooring.

3313.2 Buildings being demolished.
Where a building is being demolished and a standpipe is existing within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

3313.3 Detailed requirements.
Standpipes shall be installed in accordance with the provisions of Section 905.

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

Figure 1

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

Floor level of active mass timber construction.

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

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

Shading indicates where exterior wall covering is required.

Figure 2

Examples of Protection During Construction

For Mass Timber Buildings Greater Than 6 Stories Above Grade Plane

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

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-HT1) but with additional fire-resistance ratings and levels of required noncombustible protection. The code will include provisions for up to 18 stories of Type IV-A construction for Business and Residential Occupancies.

Based on information first published in the Structural Engineers Association of California (SEAOC) 2018 Conference Proceedings, this paper summarizes the background to these proposals, technical research that supported their adoption, and resulting changes to the IBC and product-specific standards.

Background: ICC Tall Wood Building Ad Hoc Committee
Over the past 10 years, there has been a growing interest in tall buildings constructed from mass timber material (Breneman 2013, Timmers 2015). Around the world there

WoodWorks Tall Wood Design Resource

Tall Mass Timber Code Adoption

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

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

Other jurisdictions are considering adoption of the tall mass timber provisions

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

1. It has the potential to increase the market demand for mass timber production in California to meet the needs of the construction industry.

2. It will increase the pace and scale of our wildland fire prevention and forest management goals of treating 500 thousand acres per year by thinning the forest of smaller diameter trees that can be used in the production of cross laminated timber and other mass timber assemblies.

3. While wood products provide the benefit of storing carbon, another benefit or advantage is that mass timber construction can also help reduce the carbon footprint of concrete and steel production.”

– Chief Mike Richwine, State Fire Marshal
Questions?

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