Detailing Mass Timber Buildings for Fire Safety

Chicago Wood Design Symposium

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Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
What is Mass Timber?

- Glulam
- Cross Laminated Timber (CLT)
- Nail Laminated Timber (NLT)
- Mass plywood panels (MPP)
- Dowel laminated timber (DLT and DCLT)
- Timber-Concrete composites
Why Mass Timber?

- **Sustainability**
  - Low carbon footprint
  - Possible local material
  - Lightweight solutions

- **Aesthetics**
  - Structure = finish
  - Biophilia & natural patterns
  - Market differentiator

- **Speed**
  - Pre-fabrication of engineered wood composite & hybrid solutions
  - Speed on site
What is a Fire Resistance Rating (FRR)?

Structural resistance

Integrity

Insulation
What is a Fire Resistance Rating (FRR)?
What is a fire?

NRC, Canada
Schaffer, 1966, Forest Products Laboratory

\[ a_{eff} = 1.2 \beta_t t^{0.813} \]
1 hr exposure = 1.8 in/hr
2 hrs exposure = 1.58 in/hr
1 hr exposure = 1.8 in/hr
2 hrs exposure = 1.58 in/hr

Original CLT depth

CLT structural capacity

CLT char depth

Original CLT depth
What is a Fire Resistance Rating (FRR)?
National Research Council, Canada

Tall Wood Building Institute
Mass timber and the IBC

Simple Banking HQ, Portland
IBC limits for mass timber construction

Non-combustible construction – Type I, II
Combustible construction – Type III, IV, V

Mass timber - Code compliant use in Types III, IV, V

Type IV – Heavy Timber:
- Up to 6 floors (office) 5 floors (resi)
- Additional floors with “podium construction”
- 85ft in building height
Type IV building

- Exterior walls are non-combustible, or FRT wood
- Timber beams, columns, floors, roof permitted
- Code sets minimum dimensions for members
- Up to 6 floors, with sprinklers
Modern Type IV building

Up to 6 floors, with sprinklers

Exposed mass timber

Glulam beams, columns; CLT floors and walls

Use of steel or concrete, where appropriate (hybrid construction)
IBC: Heavy timber = mass timber

Solid or laminated timber (Chapter 23) – LVL, glulam, CLT
Type IV – mass timber can be exposed (Chapter 8)
### Mass timber construction

<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>Primary structural frame (see Section 202)</td>
<td>A 3²</td>
<td>B 2²</td>
<td>A 1 0</td>
<td>B 1 0</td>
<td>HT 1</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3²</td>
<td>2²</td>
<td>1 0</td>
<td>1 0</td>
<td>1/HT 1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td>See Table 602</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
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<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>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction and associated secondary members (see Section 202)</td>
<td>2</td>
<td>2</td>
<td>1 0</td>
<td>1 0</td>
<td>HT 1</td>
</tr>
<tr>
<td>Roof construction and associated secondary members (see Section 202)</td>
<td>$1^{1/2}$</td>
<td>$1^{b,c}$</td>
<td>$1^{b,c}$</td>
<td>0$^{c}$</td>
<td>$1^{b,c}$</td>
</tr>
</tbody>
</table>
Detailing in mass timber buildings for fire safety
Be careful of:

Concealed spaces within Type IV

4th floor and above:

- 2hr shafts connecting to 1hr or HT, for mass timber

- Assembly use – 4th floor limit
Exterior walls:

- Can CLT be used in an exterior wall?
  - Chapter 6 – CLT can be used in Type IV (not Type III)
  - Chapter 14 – limits timber to 40ft, or 60ft with FRT, or pass NFPA 285

- Keep timber columns and beams out the exterior wall
Fire resistance for glulam connectors:

Fire test reports – very few to choose from and only one for 2hrs (Framework connector)

Calculation methodology – see TR-10 (Part V, Example 9)

Cannot just add “char layer” to a concealed connector

Intumescent paint on steel connectors does not work

Gyp can work, if properly detailed
And there are also:

Joints between concrete slabs and CLT
Fire barrier or partition wall meeting glulam or CLT
Curtain wall edge details
Kitchen exhaust shafts
CLT encapsulation by gyp ceiling - edge details

and many more……
This concludes The American Institute of Architects Continuing Education Systems Course.

Please contact me with any mass timber fire questions:

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Photo credits:
Type IV
• Max 85ft
• 6 floors (timber)
• Timber fully exposed

Type IV-C
• Max 85ft
• 8 floors
• Timber fully exposed
• 2hr FRR

Type IV-B
• Max 180ft
• 12 floors
• Timber partly exposed
• Protected timber shafts
• 2hr FRR

Type IV-A
• Max 270ft
• 18 floors
• Timber fully protected
• Concrete shafts
• 3hr FRR
E119 test, CLT floor after 2hrs, with char fall-off

E119 test, CLT floor after 2hrs, with no char fall-off