Exposed Wood in Fire Resistive Applications

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

- Why wood?
- IBC Requirements
- Questions?
- Fire fundamentals
- Applications to code compliant buildings
- Connections
- Summary

USDA: www.tallwoodbuildingcompetition.org
Why wood?

- Sustainability
- Aesthetics, innovation
- Changing technology
- Efficient construction
- Prefabrication
- A differentiator
Current approach

CLT
Glulam
NLT
Structural composite lumber (LVL, LSL, PSL)
What is a Fire Resistance Rating?

Structural resistance

Integrity

Insulation

What is Interior Finish Flammability?

Flame spread and smoke development – Classes A, B and C

Wood Construction and the IBC

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

Wood is combustible construction
Code compliant use in Types III, IV, V
Wood Construction and the IBC

Type IIIA:
- Up to 6 stories (B), 5 stories (R)
- 1 hr FRR load bearing frame
- 2 hr FRR load bearing external walls

Type IV (heavy timber):
- As for Type III

Type V:
- Low rise, limited area, few restrictions
What Does a Type IIIA Building Look Like?

- Podium construction with concrete to lower floors
- Wood floors and framing (interior)
- Exterior walls are non-combustible, or wood covering (to 40ft) or FRT wood (to 60ft)
- Up to 6 floors, with sprinklers
What Does a Type IV “HT” Building Look Like?

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

Up to 6 floors, with sprinklers

Exposed wood

Use of steel or concrete, where appropriate (hybrid construction)

Glulam beams, columns; CLT floors and walls
### Wood Construction and the IBC

#### TABLE 602.4
**WOOD MEMBER SIZE EQUIVALENCIES**

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Width, inch</strong></td>
<td><strong>Depth, inch</strong></td>
<td><strong>Width, inch</strong></td>
</tr>
<tr>
<td>8</td>
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<td>10</td>
<td>5</td>
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<tr>
<td>4</td>
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</table>

#### 803.3 Heavy timber exemption. Exposed portions of building elements complying with the requirements for buildings of Type IV construction in Section 602.4 shall not be subject to interior finish requirements.

#### Types III, IV, V – wood can be exposed
# Wood Construction and the IBC

<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>
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<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>HT</td>
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<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Bearing walls</td>
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<tr>
<td>Exterior&lt;sup&gt;e,f&lt;/sup&gt;</td>
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<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Nonbearing walls and partitions</td>
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<td></td>
<td></td>
<td></td>
<td>See Table 602</td>
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<tr>
<td>Exterior</td>
<td></td>
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<tr>
<td>Nonbearing walls and partitions</td>
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<tr>
<td>Interior&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Floor construction and associated secondary members</td>
<td>2</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>(see Section 202)</td>
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<tr>
<td>Roof construction and associated secondary members</td>
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<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b,c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Exposed Wood and Fire

- Questions?
All materials are vulnerable to fire:
Combustibility - Just another engineering problem?
Wood - Fire fundamentals

- Charring
- Well understood and researched

Schaffer, 1966, Forest Products Laboratory
Wood - Fire fundamentals

History of fire tests:
- Standard furnace tests
- Tests in real fires
- Carried out internationally
- Documented correlations

Wood performance in fire is predictable

Design for fire resistance, through increasing wood cover
Wood - Fire fundamentals

1hr exposure = 1.8in/hr
2hrs exposure = 1.58in/hr

90 minute FRR fire test on 270mm x 415mm glulam beam (from APA)
Wood - Fire fundamentals

Calculating an FRR

What is the area (b x d) needed?

What additional wood cover is required, for an FRR (B x D)

The difference (B – b) is the sacrificial char layer

TR-10 Fig 1-2
Wood – Fire guidance

FRR of wood – NDS Chapter 16

Method explained in detail in TR-10

NDS is a compliant methodology for determining exposed wood FRR

Includes method for CLT
Wood – Fire calculations

- **Glulam, LVL, sawn lumber**: Follow NDS

- **CLT**: Follow NDS

- **IBC**: NDS → TR-10

Section 722.1  
Chapter 16  
Part 3
Exposed Wood

- Not all authorities are supportive of exposed wood
- Sometimes an alternative materials submission is required to support use
- Significant variance in interpretation of the IBC, with regard to Type IV
- Type IV construction is the most straightforward approach
Connections

Can be expressed where no fire rating is required

Where exposed and need a 1 hr FRR:
  - Concealed steel plates
  - Concealed bolts or dowels

Design to conceal the whole connection

Some connections will need detailed analysis
CLT Connections

Proven through fire testing

Half lap joint

Spline splice

From KLH
Glulam Connection Fire Testing

Beam 1 = 8.75” x 18” (222mm x 457mm)

Beam 2 & 3 = 10.75” x 24” (273mm x 610mm)

Column = 15” square (381mm)

CLT = 5ply 6.7” (170mm) thick

Beam 1 = Loaded to 4,700 lbs (21kN)

Beam 2 & 3 = Loaded to 20,000 lbs (90kN)
Beam 1 = Ricon 290

Beam 2 = 2 x Ricon 200
Beam 3 = Megant 430
### Proven Fire Rated Glulam Beam – Column Connections (ASTM E119)

<table>
<thead>
<tr>
<th>TEST</th>
<th>BEAM</th>
<th>CONNECTOR</th>
<th>FRR</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>8.75” x 18” (222mm x 457mm)</td>
<td>1 x Ricon 290</td>
<td>1 hr</td>
</tr>
<tr>
<td>2</td>
<td>10.75” x 24” (273mm x 610mm)</td>
<td>2 x Ricon 200</td>
<td>1.5hr</td>
</tr>
<tr>
<td>3</td>
<td>10.75” x 24” (273mm x 610mm)</td>
<td>Megant 430</td>
<td>1.5hr</td>
</tr>
</tbody>
</table>

Test reports issued – see ReThink Wood website

Partners: Softwood Lumber Board, Arup, MyTiCon, DR Johnson