Fire Life Safety – Mass Timber Buildings

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

Robert Gerard, PE, Holmes Fire
December 2016
Fire Life Safety

• Agenda
  - Fire life safety
  - Performance based fire engineering
  - Tall timber case study
Fire Life Safety

- Performance requirements
  - Occupant safety
  - Fire fighter safety
  - Structural stability
Fire Life Safety

- Code compliance
  - Prescriptive design
  - Performance design
Fire Life Safety

- Prescriptive limits
  - 2015 International Building Code
  - Combustible vs. non-combustible
  - R-1 or R-2 Occupancy

Type IIIA, IV

Type IB

- Mass timber
- Mass timber (FRT)
- Concrete/Steel
Fire Life Safety

• Timber renaissance
  - Sustainability
  - Aesthetic
  - Structure
  - Cost
Fire Life Safety

• Case for Tall Wood, MGA
  - 30-story residential hybrid
• Timber Tower Research Project, SOM
  - 42-story office hybrid
• Timber Tower, Perkins + Will
  - 80-story timber tower
Performance Based Fire Engineering

• Compliance
  - Prescriptive design
  - Performance design

• Alternative means and methods
  - 2016 CBC 104.11
    - Quality
    - Strength
    - Effectiveness
    - Fire resistance
    - Durability
    - Safety
Performance Based Fire Engineering

- PBD methodology
  - ICC Performance Code
  - NFPA 5000
  - International Fire Engineering Guidelines (IFEG)

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Performance Based Fire Engineering

- Acceptance criteria
  - Society of Fire Protection Engineering (SFPE) Handbook
  - Fire Engineering Design Guide (FEDG)
  - NFPA
Performance Based Fire Engineering

- Risk identification
  - Performance requirements
  - Combustible vs. Non-combustible
Performance Based Fire Engineering

• Risk identification
  - Exposed timber
    - How does it contribute to fire?
    - Are there issues with delamination?
    - Does it self-extinguish?
Performance Based Fire Engineering

• Risk identification
  - Fire resistance
  - Listed assemblies
  - Penetrations

Acceptance Criteria
Risk Identification
Fire Strategy
Supplemental Justification
Performance Based Fire Engineering

- Risk identification
  - Structural robustness
  - Stability
  - Connections

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Performance Based Fire Engineering

• Fire protection strategies
  - Active protection
    - Enhanced sprinkler system
    - Enhanced detection
    - Smoke control

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Performance Based Fire Engineering

- Fire protection strategies
  - Passive protection
    - Enhanced fire resistance rating
    - Encapsulation
    - Non-combustible construction
Performance Based Fire Engineering

- Supplemental justification
  - Existing fire testing
    - Small-scale
    - Full-scale
    - Standard

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Performance Based Fire Engineering

- Supplemental justification
  - Structural fire engineering
  - Evacuation analysis
  - Smoke modelling

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Performance Based Fire Engineering

• Supplemental justification
  - Case study buildings
Performance Based Fire Engineering

• Design resources
Case Study

- Museum Tower
  - 20-story residential building
  - Mass timber construction
  - Two stairs
  - Two elevators
Case Study

• Performance based design
  - Design team agreement
  - Pre-agreement
  - Peer review
  - Methodology
## Case Study

- Construction type
  - Alternative solution

<table>
<thead>
<tr>
<th>Code Provision</th>
<th>Type I-A</th>
<th>Type I-A Alternate</th>
<th>Type III-A</th>
<th>Type IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stories above grade (sprinklered)</td>
<td>UL</td>
<td>20</td>
<td>5 (6 w/ special provisions)</td>
<td>5</td>
</tr>
<tr>
<td>Height above grade (sprinklered)</td>
<td>UL</td>
<td>~200-ft</td>
<td>85-ft (75’ w/ special provisions)</td>
<td>85-ft</td>
</tr>
<tr>
<td>Building area (sprinklered)</td>
<td>UL</td>
<td>~240,000-ft²</td>
<td>72,000-ft² (w/out frontage)</td>
<td>61,500-ft² (w/out frontage)</td>
</tr>
<tr>
<td>Fire-Resistance Ratings:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Structure</td>
<td>3-HR</td>
<td>3-HR (Heavy Timber)</td>
<td>1-HR (Any material)</td>
<td>Heavy Timber</td>
</tr>
<tr>
<td>(Non-combustible)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Case Study

- Acceptance criteria
  - Occupant safety
  - Firefighter safety
  - Property protection
Case Study

• Risk identification
  - Exposed timber
Case Study

• Risk identification
  - Combustibility
  - Structural stability
  - Compartmentation

Acceptance Criteria

Risk Identification

Fire Strategy

Supplemental Justification
Case Study

• Fire protection strategy
  - Active systems

<table>
<thead>
<tr>
<th>Element</th>
<th>Type I-A</th>
<th>Alternate</th>
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</thead>
<tbody>
<tr>
<td>Sprinkler system</td>
<td>LH</td>
<td>OH1</td>
</tr>
<tr>
<td>Detection</td>
<td>Spot-type</td>
<td>VESDA</td>
</tr>
<tr>
<td>Secondary water</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Fire command center</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Smoke control</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Emergency power</td>
<td>√</td>
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</tbody>
</table>
Case Study

- Fire protection strategy
  - Passive systems

<table>
<thead>
<tr>
<th>Element</th>
<th>Type I-A</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary structure</td>
<td>3-hr Non-combustible</td>
<td>3-hr Combustible</td>
</tr>
<tr>
<td>Nonbearing wall (int)</td>
<td>1-hr</td>
<td>2-hr</td>
</tr>
<tr>
<td>Floor</td>
<td>2-hr Non-combustible</td>
<td>2-hr Combustible</td>
</tr>
<tr>
<td>Roof</td>
<td>1-1/2-hr Non-combustible</td>
<td>1-1/2-hr Combustible</td>
</tr>
<tr>
<td>Core</td>
<td>2-hr Non-combustible</td>
<td>2-hr Combustible</td>
</tr>
<tr>
<td>Finish rating</td>
<td>B/C</td>
<td>A/C</td>
</tr>
</tbody>
</table>

Risk Identification

Acceptance Criteria

Supplemental Justification

Fire Strategy

CLT

Non-combustible
Case Study

- Supplemental justification
  - Fire resistance
Case Study

- Supplemental justification
  - Fire testing
Case Study

- Supplemental justification
  - Structural fire engineering

Acceptance Criteria
Risk Identification
Fire Strategy
Supplemental Justification
Case Study

• Supplemental justification
  - Structural fire engineering
Case Study

• Supplemental justification
  - Additional testing
Case Study

- Supplemental justification
  - Precedent projects
Case Study

- Supplemental justification
  - Construction fire risk
Case Study

• Holistic performance based assessment
Timber Renaissance

• Emerging trends
Timber Renaissance

• Technical feasibility
Timber Renaissance

• Pushing the limits
Thank you!

- Which projects could be designed with mass timber?
- What are some challenges for tall timber?
- What are some opportunities for tall timber?

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