Tall Timber Buildings
The US Experience

High Rise Fire Safety Conference
October 7, 2020

Present by

Sean DeCrane, Manager Industry Relations BLST
History of CLT

- 1985 First patent for CLT in France
- 1993 First projects in CLT in Switzerland and Germany
- 1995-1996 Development of press technology
- 1998 First multi-story residential building in Styria, Austria
- CLT use (Europe) increased significantly in the early 2000s
  - Driven by the green building movement
  - Due to better efficiencies, product approvals, and improved marketing and distribution channels
- Over 500 CLT buildings in England
- US and Canadian use of CLT
Current Structures

Mühlweg Apartments, Austria

Svartlamoen, Norway
CLT = Jinga
Disconnect
Modern vs Legacy

Comparison of Room Furnishings

Natural Room

Synthetic Room

00:00

UL
Heat Release Rate vs Temperature

One candle vs ten candles - same flame temperature but 10 times the energy

HRR:
Approx. 80 W
Temperature Range:
500 C to 1400 C
(930 F to 2500 F)

HRR: Approx. 800 W
Preliminary Results

FPRF’s CLT Compartment Fire Tests

Joseph Su, PhD
Principal Research Officer, Fire Safety
# CLT Compartment Fire Tests

## Interior dimensions
- **9.1 m x 4.6 m x 2.7 m**

<table>
<thead>
<tr>
<th>Opening in W2</th>
<th>W1 (9.1 m x 2.7 m)</th>
<th>W2 (4.6 m x 2.7 m)</th>
<th>W3 (9.1 m x 2.7 m)</th>
<th>W4 (4.6 m x 2.7 m)</th>
<th>Ceiling (9.1 m x 4.6 m)</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.8 m x 2.0 m</strong></td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>1-1</td>
</tr>
<tr>
<td></td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>exposed</td>
<td>1-4</td>
</tr>
<tr>
<td></td>
<td>exposed</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>1-5</td>
</tr>
<tr>
<td></td>
<td>exposed</td>
<td>3GB</td>
<td>3GB</td>
<td>3GB</td>
<td>exposed</td>
<td>1-6</td>
</tr>
<tr>
<td><strong>3.6 m x 2.0 m</strong></td>
<td>2GB</td>
<td>2GB</td>
<td>2GB</td>
<td>2GB</td>
<td>2GB</td>
<td>1-2</td>
</tr>
<tr>
<td></td>
<td>exposed</td>
<td>2GB</td>
<td>2GB</td>
<td>2GB</td>
<td>3GB</td>
<td>1-3</td>
</tr>
</tbody>
</table>
Ignition with 50 kW gas burner
Time = 0 min
Baseline Test 1-1 (Narrow Opening)
Post Test
Sealing The Joints
Test 1-4 (Exposed Ceiling, Narrow Opening) Post Test
Ceiling Delamination
Test 1-6 (One Wall & Ceiling Exposed, Narrow Opening)
Heat Release Rate (HRR)
Test 1-6 (One Wall & Ceiling Exposed, Narrow Opening) Post Test
ICC TWB Ad Hoc Committee Meeting

• Includes stakeholders, code officials and other interested parties

• Developed to study tall wood construction

• May develop code changes for the 2021 International Building Code

• Four workgroups
  o Fire
  o Structural
  o Standards/Definitions
  o Code: Height and Area
<table>
<thead>
<tr>
<th>No.</th>
<th>Test Floor / Construction Type</th>
<th>Wall A</th>
<th>Wall B</th>
<th>Wall C</th>
<th>Wall D</th>
<th>Floor/Ceiling</th>
<th>Interior Partition</th>
<th>Active Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1st / IV-A Completed</td>
<td>60% openings with 2 layers Type X GWB elsewhere</td>
<td>2 Layers Type X GWB</td>
<td>2 Layers Type X GWB</td>
<td>2 Layers Type X GWB</td>
<td>Floor: 2 layers cement board Ceiling: 2 layers GWB</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2nd / IV-B Completed</td>
<td>Livingroom: Exposed CLT Kitchen: 2 Layers GWB</td>
<td>2 Layers Type X GWB</td>
<td>2 Layers Type X GWB</td>
<td>2 Layers Type X GWB</td>
<td>Floor: 2 layers cement board Ceiling: 2 layers GWB with 30% exposed CLT</td>
<td>Non-fire rated ½” GWB on each side</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2nd / IV-B Week of June 19</td>
<td>Livingroom: Exposed CLT Kitchen: 2 Layers GWB</td>
<td>2 Layers Type X GWB</td>
<td>Bedroom: Exposed CLT Bathroom: 2 Layers Type X GWB</td>
<td>2 Layers Type X GWB</td>
<td>Floor: 2 layers cement board Ceiling: 2 layers GWB</td>
<td>NFPA 13, Ordinary Hazard</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1st / IV-C Week of June 26</td>
<td>60% openings with glazing with 2 layers Type X GWB</td>
<td>Exposed CLT</td>
<td>Exposed CLT</td>
<td>Exposed CLT</td>
<td>Floor: 2 layers cement board Ceiling: Exposed CLT</td>
<td>NFPA 13, Ordinary Hazard with 20-minute</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1st / IV-C Week of June 26</td>
<td>Exposed CLT</td>
<td>Exposed CLT</td>
<td>Exposed CLT</td>
<td>Exposed CLT</td>
<td>Floor: 2 layers cement board Ceiling: Exposed CLT</td>
<td>NFPA 13, Ordinary Hazard with 20-minute</td>
<td></td>
</tr>
</tbody>
</table>
Test 2 (4 hour Test)

Photos courtesy of USDA FS Forest Products Laboratory
Ceiling Damage - Replacement
Brock Common Tower
British Columbia
Tall Wood CLT Winning Building
Planned for New York City

A 10-story building in New York will be the first high rise there constructed with cross laminated timber.
475 W 18th Street
ICC Code Development Process

Photo courtesy of www.iccsafe.org
### 2021 International Code Council Edition Committee Actions - Stories

<table>
<thead>
<tr>
<th></th>
<th>NS=Nonsprinklered</th>
<th>Type IV-A</th>
<th>Type IV-B</th>
<th>Type IV-C</th>
<th>Type IV-HT</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-1</td>
<td>S</td>
<td>18</td>
<td>12</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>R-2</td>
<td>NS</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>R-3</td>
<td>S</td>
<td>18</td>
<td>12</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>R-4</td>
<td>NS</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

NS = Nonsprinklered  
S = Sprinklered  
Type IV-A  
Type IV-B  
Type IV-C  
Type IV-HT
## 2021 International Code Council Edition
### Committee Actions - Area

<table>
<thead>
<tr>
<th>Use Group</th>
<th>NS - non sprinkled</th>
<th>S1 - 1 story sprinkled</th>
<th>SM - &gt;1 story sprinkled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type I-A</strong></td>
<td>15,500</td>
<td>62,000</td>
<td>46,500</td>
</tr>
<tr>
<td><strong>Type I-B</strong></td>
<td>8,500</td>
<td>34,000</td>
<td>25,500</td>
</tr>
<tr>
<td><strong>Type II-A</strong></td>
<td>45,000</td>
<td>180,000</td>
<td>135,000</td>
</tr>
<tr>
<td><strong>Type II-B</strong></td>
<td>30,000</td>
<td>120,000</td>
<td>90,000</td>
</tr>
<tr>
<td><strong>Type IV-A</strong></td>
<td>18,750</td>
<td>75,000</td>
<td>56,250</td>
</tr>
<tr>
<td><strong>Type IV-B</strong></td>
<td>15,000</td>
<td>60,000</td>
<td>45,000</td>
</tr>
<tr>
<td><strong>Type IV-C</strong></td>
<td>11,500</td>
<td>46,000</td>
<td>34,500</td>
</tr>
<tr>
<td><strong>Type IV-HT</strong></td>
<td>5,500</td>
<td>22,000</td>
<td>16,500</td>
</tr>
<tr>
<td><strong>Type V-A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type V-B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UL and the UL logo are trademarks of UL LLC © 2019. Proprietary & Confidential.
Exterior Walls

Permits exterior walls of mass timber

Exterior walls are required to have 40 minutes of protection

No combustible materials are permitted outside of mass timber

• Except water barrier that meets the requirements of Exception 2 for Section 1402
<table>
<thead>
<tr>
<th>Type</th>
<th>Continuous Special Inspection</th>
<th>Periodic Special Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1. Inspect erection and sequence of mass timber construction</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1. Inspection of connections where installation methods are required to meet design loads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Threaded fasteners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Verify use of proper installation equipment.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1. Verify use of pre-drilled holes where required.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1. Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>a. Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>c. Bolted connections</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>d. Concealed connections</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
403.3.2 Water supply to required fire pumps. In all buildings that are more than 420 feet (128 m) in building height, and buildings of Type IVA and IVB that are more than 120’ in building height, required fire pumps shall be supplied by connections to not fewer than two water mains located in different streets. Separate supply piping shall be provided between each connection to the water main and the pumps. Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

Exception: Two connections to the same main shall be permitted provided that the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through not fewer than one of the connections.
701.6 **Owner’s responsibility.** The owner shall maintain an inventory of all required fire-resistance-rated construction, construction installed to resist the passage of smoke and the construction included in Sections 602.4.1, 602.4.2 and Sections 703 through 707. Such construction shall be visually inspected by the owner annually and properly repaired, restored or replaced where damaged, altered, breached or penetrated. Records of inspections and repairs shall be maintained. Where concealed, such elements shall not be required to be visually inspected by the owner unless the concealed space is accessible by the removal or movement of a panel, access door, ceiling tile or similar movable entry to the space.
3314.7 Fire safety requirements for buildings of Types IVA, IVB, and IVC construction. Buildings of Types IVA, IVB, and IVC 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 during construction in accordance with Section 3311.

2. A water supply for fire department operations, as approved by the fire chief.

3. Where building construction exceeds six stories ABOVE GRADE PLANE, at least one layer of the noncombustible protection where required by Section 602.4 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.
Prior to placement of mass timber floor panels, all building elements more than 4 floor levels below shall be protected as required by this section.

Noncombustible floor topping
Where required per 604.2, one layer noncombustible protection on interior exposed mass timber.

Examples of Protection During Construction for Types IV-A, IV-B, and IV-C Mass Timber Buildings
Adhesive Qualification Tests

Large-scale Compartment Test Protocol

• Validation of adhesive qualification test protocol
  • Validation test performed on same CLT used in FPRF tests to verify similar performance

Prior to flashover (11 minutes)  
Flashover (~14 minutes)
Milwaukee – Proposed Project
River Beech – Proposed
Chicago, IL
The Goal No More Names