CLT – The new use of timber in Australia
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Is Timber the Future?

We listen, explore, create, deliver.
What is CLT

Cross-Laminated Timber (CLT) is ‘a great addition to the “wood product toolbox” and [will lead to] the re-introduction of wood-based applications such as 5 to 10 story buildings where heavy timber systems were used a century ago’
Forté - Lend Lease, Melbourne
Forté - World’s tallest timber structure
What is CLT

- Uneven number of layers (in general three, five, seven or even more)
- Side-by-side placed boards (or beams),
  - Crosswise arranged to each other normally under an angle of 90°
  - Quasi rigidly connected by adhesive bonding.
What is CLT

We
listen,
explore,
create,
deliver.
Continuous bonding = quasi rigid composite action between the single layers = a very compact and versatile product

- Large-sized walls, floor elements and other large-sized load-bearing plane-like- as well as linear structural components.

- Modular dimensions can be neglected as window and door openings can be freely placed.
Panels are prefabricated with features such as doors, windows, and connections already cut to specification when they arrive at the construction site using computer numerical control (CNC) technology.
Advantages

• Pre-fabrication
  • Doors, windows, and connections already cut to specification using computer numerical control (CNC) technology.

• Dry and clean construction technique

• Short erection times on site
• Two-dimensional load transfer
• Low self-weight
• Excellent resistance to exceptional loadings
• Key components for reconstruction and upgrading of existing buildings
The components
All together
Fire Properties

- Flame and smoke propagation
- Compartment temperature
- Fire spread through the building
Protective char layer
### Flame and Smoke Propagation

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Botanical Name</th>
<th>Ignitability Index</th>
<th>Spread of Flame Index</th>
<th>Heat Evolved Index</th>
<th>Smoke Developed Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpine Ash</td>
<td>Eucalyptus delegatensis</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Australian Red Cedar</td>
<td>Toona australis</td>
<td>14</td>
<td>9</td>
<td>8</td>
<td>3</td>
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<tr>
<td>Blackbutt</td>
<td>Eucalyptus pilularis</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>3</td>
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<tr>
<td>Brush Box</td>
<td>Lophostemon confertus</td>
<td>14</td>
<td>3</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Cypress</td>
<td>Callitris columellaris</td>
<td>13</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Messmate</td>
<td>Eucalyptus obliqua</td>
<td>13</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mountain Ash</td>
<td>Eucalyptus regnans</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Spotted Gum</td>
<td>Corymbia citriodora</td>
<td>13</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Tallowwood</td>
<td>Eucalyptus microcorys</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Tasmanian Oak</td>
<td>E. regnans E. obliqua E. delegatensis</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Victorian Ash</td>
<td>E. regnans E. delegatensis</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>3</td>
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</tbody>
</table>
## Class 2 Requirements

<table>
<thead>
<tr>
<th>Location</th>
<th>Surface</th>
<th>Spread of Flame</th>
<th>Smoke Developed</th>
<th>Permitted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire isolated exits</td>
<td>Ceilings Walls Floors</td>
<td>0</td>
<td>&lt; 2</td>
<td>No</td>
</tr>
<tr>
<td>Public corridors to an exit</td>
<td>Ceilings Walls</td>
<td>0</td>
<td>&lt; 5</td>
<td>Fire retardant</td>
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<tr>
<td></td>
<td>Floors</td>
<td>&lt; 9</td>
<td>&lt; 8 if SOF(^1) &gt; 5</td>
<td>Yes</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>Ceilings Walls Floors</td>
<td>&lt; 9</td>
<td>&lt; 8 if SOF &gt; 5</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\(^1\)Spread of Flame

Surface flame spread

One approach is to line CLT with plasterboard.

In Forté, 13 mm plaster board lining used.
Post flashover compartment fire size

Because the fire size is proportional to the square root of the thermal inertia, all other factors being the same, the time needed to reach the heat release rate needed for flashover in a plasterboard lined room is about 1.4 greater than that in a CLT lined room.

That is, flashover is easier to achieve in a CLT room.
Effect of plasterboard lining
Effect of plasterboard lining

Room Temperatures in Gypsum Lined and Unlined CLT Room Tests

- Plate Thermometer in Gypsum Lined Room
- Plate Thermometer in Unlined Room

Temperature (°C)

Time (minutes)
In general, the barrier effectiveness of CLT should be better than that of traditional construction.

- Manufactured off site
- Easy control of tolerances
- Excellent connections
Fire spread through a CLT panel

This is a function of the FRL of the timber panel.
How to achieve an FRL

Walls:
- 90/90/90 128 mm plus 13 mm plasterboard
- 90/90/90 158 mm

Floor/ceilings:
- 60/60/60 146 mm
- 90/90/90 146 mm plus 16 mm plasterboard
- 120/120/120 146 mm plus 2x 16 mm plasterboard
Fire spread through barrier openings

- Large failure (open door): same in CLT or non-CLT construction
- Small or thermal failure: typically due to penetration failures
  - Lack of listed (tested) penetration seals (3M penetration sealant excepted)
  - Ductwork
  - Pipes
  - Doors/windows
Testing of CRT - FRL

The equivalent to AS 1530.4

- Test data from North America and Europe; need to ensure tests are for the same or similar species of wood and same or similar adhesives

- FRL for CRT has been easy to calculate and verified with full scale tests
Why does this matter?

BCA: Life safety (occupants including brigade) & impact on neighbor; not property protection
Occupant impact

• Minor impact on time to flashover, therefore some impact within room of origin

• If barrier is successful, no impact on spaces outside of room of origin
Fire brigade’s objectives are not the same as the BCA (life safety and protection of the environment).

FB needs to be able to

• conduct search and rescue
• suppression
Fire brigade challenge

• Lack of familiarity with construction (barrier performance and structural stability)
• Need to manage additional fuel load
• Potential of combustible interior finish in corridors and stairs.
Potential ‘solutions’

• Small or large scale testing for construction assemblies common to Australia

• Automatic sprinkler systems (required for MFB acceptance in Victoria)
Conclusion

CLT does not create a new risk but does create a new opportunity.

Details of design are critical.

There is general acceptance by the AHJ in Victoria

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