IMPACT OF CRACKS TO THE HYGROTHERMAL PERFORMANCE OF CROSS LAMINATED TIMBER

Villu Kukk, Martin Püssa, Heikko Kallakas, Prof. Jaan Kers

Riga 2016
Contents

• Introduction
• Background
• Materials and methods
• Results and discussion
• Conclusion

15 October, 2016
Problem and aim

- Cracks formation in CLT panels caused by moisture movement during initial service period

- To evaluate the impact of presumably set cracks to CLT panels performances of water vapour resistance.
Introduction

• Cross laminated timber (CLT)—structural timber consisting of at least three orthogonally bonded layers
• Developed in Switzerland, beginning of 1990s.
• Load-bearing elements for multi-storey buildings

Murray Grove
Residential, 8 stories
Background

• Dimensions:
  o Thickness 60-340 mm
  o Width 2950-3500 mm
  o Length 16-24 m

• Water vapour resistance factor $\mu$:
  o 50-108.5

• Impermeable to air

• Built-in moisture dries out within 1 month
Materials and methods

Cup test

- Method in accordance to ISO/DIS 12572
- Test specimens (spruce):
  - 5x solid wood panel (6x110x110 mm)
  - 5x glued panels (12x110x110 mm)
  - 5x glued panels with hole Ø 2 mm
  - 5x glued panels with hole Ø 6 mm
Materials and methods

(2)

Cup test

• Moisture curing one-component polyurethane adhesive
Materials and methods (3)

Cup test

- Pressing 125 min., load 0.6 – 1.0 N/mm²
Materials and methods (4)

Cup test

- Temp. of 23 (±5) °C and RH of 50 (±5) %
Materials and methods (5)
Cup test

- Process:
  - Dry test 23 °C & RH ≈0% / 50%
  - Desiccant CaCl₂
  - Sealing- hot melt adhesive (EVA copolymer)
  - Weighing interval 72 h
  - End of test- constant weighing change
Materials and methods (6)

Cup test

15 October, 2016
Results & discussion

Cup test

Specimen 4_Water vapour flow rate, $G$ (kg/s)

Specimen 20_Water vapour flow rate, $G$ (kg/s)
## Results & discussion

### Cup test

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Water vapour resistance factor, $\mu$</th>
<th>Change, based on result of S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1- solid wood panels (6 mm)</td>
<td>184.5</td>
<td></td>
</tr>
<tr>
<td>S2- glued solid wood panels (12 mm)</td>
<td>285.8</td>
<td></td>
</tr>
<tr>
<td>S3- glued panels with hole Ø 2 mm</td>
<td>259.1</td>
<td>-9%</td>
</tr>
<tr>
<td>S4- glued panels with hole Ø 6 mm</td>
<td>198.3</td>
<td>-30%</td>
</tr>
</tbody>
</table>

15 October, 2016
Results & discussion (2)

Cup test

- Through 6 mm diameter hole in CLT panel, area 0.0121 m²
- Through 2 mm diameter hole in CLT panel, area 0.0121 m²
- Solid CLT panel, areas: a) 3.8185 m²; b) 3.9153 m²; c) 3.9516 m²; d) 4 m²
Results & discussion (3)

Cup test

- Factors of 95mm thick CLT panel scenarios:
  - $\mu_{Sc1} = 36.7$
  - $\mu_{Sc2} = 36.9$
  - $\mu_{Sc3} = 36.9$
  - $\mu_{Sc4} = 37$

- Factors of simulated 95mm thick CLT panels:
  - $\mu_1 = 37$
  - $\mu_2 = 33.6$ (decrease of 9%)
  - $\mu_3 = 25.8$ (decrease of 30%)

Change is negligible
Conclusion

- Main findings of study:
  - $\mu$ value decreased 9 and 30% in holes ($\varnothing$ 2 & 6 mm) location of CLT panel
  - Results of simulation calculations to find holes impact to water vapour resistance of entire CLT panel were negligible
  - Further studies: to study possible effect of decrease of $\mu$ to CLT in exact location of crack

15 October, 2016
Thank you for your attention!