Laboratory investigation on the durability of taped joints in exterior air barrier applications

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Complex details of interior air barriers
• Traditional wood-frame construction: interior air barrier
  • Disadvantages:
    • Many joints make it labour intensive to seal
    • Risk of later penetration of the air barrier
    • Labour intensive
Introduction

• Traditional wood-frame construction: interior air barrier
  • Disadvantages:
    • Many joints make it labour intensive to seal
    • Risk of later penetration of the air barrier
    • Labour intensive
Exterior air barriers: potential to reduce labour costs
### Introduction

<table>
<thead>
<tr>
<th>$n_{50} \ (1/h)$</th>
<th>Wind barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>Foil</td>
</tr>
<tr>
<td>2</td>
<td>Bituminous wood fiber board</td>
</tr>
<tr>
<td>0.28</td>
<td>Gypsum board + foil</td>
</tr>
<tr>
<td>0.56</td>
<td>Gypsum board + foil</td>
</tr>
<tr>
<td>0.29</td>
<td>Gypsum board + foil</td>
</tr>
<tr>
<td>0.52</td>
<td>Bituminous wood fiber board</td>
</tr>
<tr>
<td>0.61</td>
<td>Bituminous wood fiber board + foil</td>
</tr>
</tbody>
</table>
But… exterior air barriers are exposed to more severe conditions!
Artificial aging

Air permeability testing
**Introduction**

**Method**

**Test-setup**

**Results**

**Conclusions**

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**TEST SAMPLES**

<table>
<thead>
<tr>
<th>TEST SERIES</th>
<th>TAPE</th>
<th>Spacer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Tape A</td>
<td>Aluminium</td>
</tr>
<tr>
<td>B</td>
<td>Tape B</td>
<td>Aluminium</td>
</tr>
<tr>
<td>C</td>
<td>Tape A</td>
<td>Wood</td>
</tr>
<tr>
<td>D</td>
<td>Tape B</td>
<td>Wood</td>
</tr>
</tbody>
</table>

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**Diagram**

- **Test-series diagram**
  - 2 mm joint (taped)
  - 70.7 cm / 35 cm
  - Metal/wooden spacer

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**Notes**

- **Test samples**
  - **Air permeability testing**
  - **Test series TAPE**
    - **A**
      - Tape A
      - Aluminium
    - **B**
      - Tape B
      - Aluminium
    - **C**
      - Tape A
      - Wood
    - **D**
      - Tape B
      - Wood
AIR PERMEABILITY TEST

27 x 27 cm²

70 x 70 cm²

\[ K_{\text{joint}} = \frac{(K_{\text{spec}} - K_{\text{mat}}) \cdot A_{\text{spec}}}{l_{\text{joint}}} \]
# ARTIFICIAL AGING

<table>
<thead>
<tr>
<th>Test</th>
<th>Type</th>
<th>Total time</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature</td>
<td>2 weeks</td>
<td>6 x (24h 70°C and 24h 15°C @30% RH)</td>
</tr>
<tr>
<td>2</td>
<td>Temperature, rain, frost</td>
<td>12 days</td>
<td>40 x (3h 70°C - 1h rain - 2h repose) - 2 x (8h 50°C - 16h -20°C)</td>
</tr>
<tr>
<td>3</td>
<td>UV-exposure, vapour</td>
<td>4 weeks</td>
<td>56 x (8h UV (40°C) and 4h vapour exposure ( 60°C))</td>
</tr>
</tbody>
</table>
BEFORE ARTIFICIAL AGING

- TAPE A: $3.1 \times 10^{-6} \text{ m}^3/\text{m/h/Pa}$
- TAPE B: $3.9 \times 10^{-7} \text{ m}^3/\text{m/h/Pa}$

EXTREMELY LOW VALUES
Results

TEST 1

Aluminium spacer

TEST 2

TEST 3

Wooden spacer
Results

- Aluminium spacer
- Wooden spacer

<table>
<thead>
<tr>
<th>TEST 1</th>
<th>TEST 2</th>
<th>TEST 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPE A</td>
<td>TAPE B</td>
<td>TAPE A</td>
</tr>
<tr>
<td>TAPE B</td>
<td>TAPE B</td>
<td>TAPE B</td>
</tr>
</tbody>
</table>

Air permeability (m$^3$/m$^2$/h/Pa)
BEFORE ARTIFICIAL AGING

• TAPE A: $3.1 \times 10^{-6} \text{ m}^3/\text{m/h/Pa}$
• TAPE B: $3.9 \times 10^{-7} \text{ m}^3/\text{m/h/Pa}$

EXTREMELY LOW VALUES
Results

Aluminium spacer

Wooden spacer

TEST 1

TEST 2

TEST 3

Air permeability (m³/m²/h/Pa)
### Results

**Aluminium spacer**

<table>
<thead>
<tr>
<th>Test</th>
<th>Tape A</th>
<th>Tape B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEST 1</strong></td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
</tr>
<tr>
<td><strong>TEST 2</strong></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
<tr>
<td><strong>TEST 3</strong></td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
</tr>
</tbody>
</table>

**Wooden spacer**

<table>
<thead>
<tr>
<th>Test</th>
<th>Tape A</th>
<th>Tape B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEST 1</strong></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
</tr>
<tr>
<td><strong>TEST 2</strong></td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
</tr>
<tr>
<td><strong>TEST 3</strong></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
</tr>
</tbody>
</table>
Conclusions

- Methodology to test the durability of taping products was proposed
  - Temperature cycles
  - Frost-thaw cycles
  - UV cycles
• Methodology to test the durability of taping products was proposed
  • Temperature cycles
  • Frost-thaw cycles
  • UV cycles

• Two tapes have been tested: \textit{impact} < 4-6 \times 10^{-5} \text{ m}^3/\text{m/h/Pa}
Methodology to test the durability of taping products was proposed:
- Temperature cycles
- Frost-thaw cycles
- UV cycles

Two tapes have been tested: \( \text{impact} < 4 \times 10^{-5} \text{ m}^3/\text{m/h/Pa} \)

\( n_{50} = 0.003 \text{ 1/h} \ll 0.6 \text{ 1/h (Passive house)} \)
Limitations of current study
  • Two taping products with high quality
  • Application of the tape in laboratory conditions

Further research
  • More products available in the market
  • Application of the tapes in worse conditions (freezing, dusty, …)