Attaching Cladding with Long Screws

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Presented by: Michael Aoki-Kramer | LEED AP™

Outline

→ Why & How We are Insulating More
→ Long Screws through Insulation
→ Guideline Updates
Why We are Insulating More

→ Increasing energy efficiency expectations are changing insulation requirements in codes
→ Passive House thermal bridge free construction, super insulated
→ Effective R-18 to R-19 walls and CI requirements have lead to widespread change in approach
→ Better accounting for thermal bridging means not overlooking bridging by cladding attachments

How to Insulate More

Stuff It?

Wrap It?
More than one way to get there...

Exterior Insulation Approaches Gaining Popularity

- Vertical Z-girts
- Horizontal Z-girts
- Crossing Z-girts
- Galvanized/Stainless Clip & Rail
- Aluminum Clip & Rail
- Thermally Improved Clip & Rail
- Non-Conductive Clip & Rail
- Long Screws through Insulation
Exterior Insulation Approaches

Screws Through Insulation Highly Effective

Percent Effectiveness of Exterior Insulation (Typical Range)
**Screws through Insulation – Chi-Values**

<table>
<thead>
<tr>
<th>R-value Ext Insulation</th>
<th>Nominal R-value Wall in’X’R</th>
<th>C-h</th>
<th>Chi/Area A2/m2k</th>
<th>Effectiveness of Exterior Insulation %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2” x 16”</td>
</tr>
<tr>
<td>a) 2x6 Exterior Insulated Wood Framed Wall with R., 3.87 Cavity Fill, #10 screws</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>2.62</td>
<td>6.71</td>
<td>0.0010</td>
<td>0.0082</td>
</tr>
<tr>
<td>8”</td>
<td>5.64</td>
<td>9.51</td>
<td>0.0012</td>
<td>0.0098</td>
</tr>
<tr>
<td>12”</td>
<td>8.45</td>
<td>12.33</td>
<td>0.0013</td>
<td>0.0103</td>
</tr>
<tr>
<td>b) 7” Cross Laminated Timber (CLT) Exterior Insulated, #12 screws</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10”</td>
<td>7.04</td>
<td>8.84</td>
<td>0.0018</td>
<td>0.0145</td>
</tr>
<tr>
<td>c) 3 5/8” Steel Stud Wall no Cavity Fill, #10 screws</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>2.82</td>
<td>3.44</td>
<td>0.0078</td>
<td>0.0613</td>
</tr>
</tbody>
</table>

**Screws Through Insulation**

→ Rapidly gaining popularity to meet increasing R-value requirements

→ Uncertainty about:
  → How to do it
  → Allowable loads
  → Fastener types
  → Fastener spacing
  → Angle of installation
  → Deflection
Design and Forces

Service Load State
(Section View)

Testing
Testing

- 3”, 6”, 9” and 12” thicknesses of insulation
- Different insulation types (mineral wool and XPS) and different compressive strengths
- Different screw head types (pan and countersunk)
Testing – Insulation Type

Load Displacement for Different Insulation Types (6” Thick)

Cladding Weights

→ Most claddings are “light weight” with only a few select products being heavier
Testing – Insulation Type

Load Displacement for Different Insulation Types (6" Thick)

- Stucco
- Vinyl, Metal, Wood Siding
- Stone Veneer

Testing – Insulation Thickness

Load Displacement for Different Mineral Wool Thicknesses

- Stucco
- Stone Veneer

- 1/64" Rock Wool 8 lbs/ft³
- 1/64" Rock Wool 11 lbs/ft³
- 1/64" 11 over 8
- 1/64" XPS

- 3 inch
- 6 inch
- 9 inch
- 12 inch
Testing – Insulation Thickness

→ For the record, this is what 12" of insulation looks like...

Testing – Different Fastener Arrangements

- Horizontal (90°)
- 1:6 (80.5°)
- 45°
- Truss (90° + 45°)
Testing – Fastener Arrangements

Load Displacement for Different Fastener Arrangements

Displacement (mm)

Load (kg)

Load (lb)

Displacement (1/1000”)

- Countersunk @90°
- Pan Head @90°
- Countersunk @1 in 6
- Countersunk @45°
- Truss System (per truss)
Testing – Is this just the fastener?

![Graph showing load displacement for different fasteners and conditions.]

Testing – What if we miss the stud?

![Graph showing load displacement for screw penetration into framing vs. non-framing conditions.]

Load Displacement for Screw Penetration into Framing vs. Non-Framing (9" Insulation) and 8D Nail Rainscreen (No Insulation)
Deflection - How much is too much?

→ Difficult to define precise deflection limit but many claddings can easily accommodate 1/8” (125 mil, 3mm) deflection

→ Staged loading of the support system helps to “pre-deflect” the strapping prior to cladding completion

→ Can see it is different than rainscreen furring direct to sheathing, but not much

Deflection - How much is too much?

→ Comparison: Wood Shrinkage
  → One wood-frame story: Double top plate, single bottom plate, 8’ ceilings, rim joist
  → Assume 19% initial MC and 10% final MC at equilibrium with interior
  → Wood shrinkage due to drying
    › 0.25%/MC across grain
    › 0.0053%/MC with grain
  → Approximately 3/8” (375mil, 10mm) shrinkage in one story height
    › Roughly 10x more than measured deflection in test for any arrangement
Testing – Ultimate Failure Modes

Withdrawal
Tensile Failure
Pull-Through

4 ½" (115 mm) 807 lbs
5 1/8" (131 mm) 719 lbs
5 ¼" (133 mm) 0 lbs (failure)
Testing – Ultimate Failure Mode

½” Plywood: Fastener Pulled Out of Sheathing
(> 250 lbs per fastener)

Case Study – Bella Bella Passive House
R22+ Wall Guide Update

IIIUSTRATED GUIDE
R22+ Effective Walls in Wood-Frame Construction in British Columbia

Design Tables

Section View
Maximum Vertical Screw Spacing

Plan View

Stud Framing (140/124 on C)
Minimum Strapping Size (Thickness x Width)

Minimum Screw Embedment (through wood sheathing and into wood studs, discounting screw tip)

Insulation thickness (Rigid Foam/Rigid Mineral Wool)

Minimum Screw Size Number
## Design Tables

<table>
<thead>
<tr>
<th>Thickness of Exterior Insulation</th>
<th>Maximum Vertical Screw Spacing</th>
<th>Minimum Screw Size</th>
<th>Minimum Screw Embedment</th>
<th>Minimum Strapping Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Weight Cladding Below 5 lbs/ft² - 16° o.c. Stud Framing</td>
<td>1” to 2” “</td>
<td>24”</td>
<td>#10</td>
<td>1”</td>
</tr>
<tr>
<td>&gt;2” to 8”</td>
<td>16”</td>
<td></td>
<td></td>
<td></td>
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<tr>
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## Additional Guidance

Deflection Block

Installation Methods
Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT
→ www.rdh.com
→ www.buildingsciencelabs.com

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