Attaching Cladding with Long Screws

Passive House Northwest Conference
April 6th, 2017

Presented by: Lorne Ricketts | MASc, P.Eng.
Outline

→ Why & How We are Insulating More
→ Long Screws through Insulation
→ R-22+ Wall Guide Update
Why We are Insulating More

→ Increasing energy efficiency expectations are **changing** insulation requirements in codes
  → Passive House
  → R-22 walls requirement for Part 9 in CoV has instigated 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

<table>
<thead>
<tr>
<th>Continuous Vertical Z-Girt</th>
<th>Stainless Steel Screws</th>
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</thead>
<tbody>
<tr>
<td>Continuous Horizontal Z-Girt</td>
<td></td>
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<tr>
<td>Aluminum T-Clip</td>
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<tr>
<td>Intermittent Galvanized Clip</td>
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<tr>
<td>Stainless Steel Clip</td>
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<tr>
<td>Isolated Galvanized Clip</td>
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<tr>
<td>Galvanized Screws</td>
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<tr>
<td>Fiberglass Clip Galv. Screws</td>
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<td>Fiberglass Clip SS Screws</td>
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<tr>
<td>Stainless Steel Screws</td>
<td></td>
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<tr>
<td>Fiberglass Clip No Through Screws</td>
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</tbody>
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Percent Effectiveness of Exterior Insulation (Typical Range)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
# Screws through Insulation – Chi-Values

<table>
<thead>
<tr>
<th>Rsi-Value Ext. Insulation (m²K/W)</th>
<th>Nominal Rsi-Value Wall (m²K/W)</th>
<th>Chi (W/K)</th>
<th>Chi/Area (W/m²K)</th>
<th>Effectiveness of Exterior Insulation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>12”x16”</td>
</tr>
<tr>
<td>a) 2x6 Exterior Insulated Wood Framed Wall with Rsi 3.87 Cavity Fill, #10 screws</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>2.82</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>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10”</td>
<td>7.04</td>
<td>8.84</td>
<td>0.0018i</td>
<td>0.0145</td>
</tr>
<tr>
<td>c) 3 5/8” Steel Stud Wall no Cavity Fill, #10 screws</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>2.82</td>
<td>3.44</td>
<td>0.0076a</td>
<td>0.0613</td>
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</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 – Initial Testing
Testing

Figure 9: Short term deflection testing results (4” thick insulation)
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)

Displacement (mm)  
0.0  2.5  5.1  7.6  10.2  12.7  15.2  17.8  20.3  22.9  25.4

Load (lb)  
0  50  100  150  200  250  300

Displacement (1/1000")  
0  200  400  600  800  1000

Load (kg)  
0  23  45  68  91  113  136

- Rock Wool 8 lbs/ft³
- Rock Wool 11 lbs/ft³
- 11 over 8
- XPS
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)

Displacement (mm)

Load (lb)

0.00 0.13 0.25 0.38 0.51 0.64 0.76

30 25 20 15 10 5 0

13.6 11.3 9.1 6.8 4.5 2.3 0.0

Displacement (1/1000")

0 5 10 15 20 25 30

RDH BUILDING SCIENCE

- Rock Wool 8 lbs/ft³
- Rock Wool 11 lbs/ft³
- 11 over 8
- XPS

- Stone Veneer
- Thick Stone Veneer, Very Heavy Cladding
- Thin Stone Veneer

- Vinyl, Metal, Wood Siding
- 1/64”
- Stucco
- Stucco
Testing – Insulation Thickness

Load Displacement for Different Mineral Wool Thicknesses

- Vinyl, Metal, Wood Siding
- Stucco
- Thin Stone Veneer
- Thick Stone Veneer, Very Heavy Cladding

Displacement (mm)

Displacement (1/1000")

- 3 inch
- 6 inch
- 9 inch
- 12 inch

Load (lb)

Load (kg)
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)

Displacement (1/1000")

Load (lb)

Load (kg)

- Countersunk @90°
- Pan Head @90°
- Countersunk @1 in 6
- Countersunk @45°
- Truss System (per truss)
Testing – Fastener Arrangements

Load Displacement for Different Fastener Arrangements

- Vinyl, Metal, Wood Siding
- Stucco
- Thin Stone Veneer
- Thick Stone Veneer, Very Heavy Cladding

Testing – Fastener Arrangements

Load Displacement for Different Fastener Arrangements

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

The image shows a graph with two axes: Displacement (mm) on the x-axis and Load (kg) on the y-axis. The graph compares different conditions:

- **No Insulation @90°**
- **Countersunk @90°**
- **Countersunk @45°**
- **Countersunk @1 in 6**

Each condition is represented by a different line on the graph, allowing for a visual comparison of how each condition affects load and displacement.
Testing – What if we miss the stud?

Load Displacement for Screw Penetration into Framing vs. Non-Framing (9” Insulation) and 8D Nail Rainscreen (No Insulation)

- Rainscreen 8D Nail
- 2x6 SPF Framing
- 3/4” Plywood - Test #2
- 5/8” Plywood
- 1/2” Plywood - Test #1

Displacement (mm)

Displacement (1/1000")

Load (lb)

Load (kg)
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 strapping direct to sheathing, but not much
Deflection - How much is too much?

→ Comparison: Wood Shrinkage

→ One wood-frame storey: 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 storey height
  › Roughly 10x more than measured deflection in test for any arrangement
Testing – Ultimate Failure Modes

Withdrawal

Tensile Failure

Pull-Through
Testing – Ultimate Failure Mode

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

ILLUSTRATED GUIDE

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

This guide was developed to assist home designers and builders in the City of Vancouver build walls with R22 or greater thermal performance. The information included in this guide is relevant for low-rise wood-frame residential buildings across British Columbia.
Design Tables

Section View

Plan View

- Maximum Vertical Screw Spacing
- Stud Framing (16"/24" o.c.)
- Minimum Screw Embedment (through wood sheathing and into wood studs, discounting screw tip)
- Insulation thickness (Rigid Foam/Rigid Mineral Wool)
- Minimum Strapping Size (Thickness x Width)
- 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>
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<tbody>
<tr>
<td><strong>Light Weight Cladding Below 5 lbs/ft(^2) - 16” o.c. Stud Framing</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1” to 2” *</td>
<td>24”</td>
<td>#10</td>
<td>1”</td>
<td>3/8” x 1-1/2”</td>
</tr>
<tr>
<td>&gt;2” to 8”</td>
<td>16”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Light Weight Cladding Below 5 lbs/ft(^2) - 24” o.c. Stud Framing</strong></td>
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</tr>
<tr>
<td>1” to 2” *</td>
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Additional Guidance

Deflection Block →

Installation Methods
Discussion + Questions

FOR FURTHER INFORMATION PLEASE VISIT

→ www.rdh.com
→ www.buildingsciencelabs.com

→ Lorne Ricketts - lricketts@rdh.com