Cladding Attachment Through Exterior Insulation Using Long Screws

PHIUS 10TH ANNUAL NAPHC, CHICAGO
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11 SEPTEMBER 2015
→ Understand of the impacts of thermal bridging from cladding attachments on thermal performance of wall assemblies
→ Review multiple types of cladding attachment systems and their effective thermal resistance
→ Learn about cladding attachment with discrete fasteners through exterior insulation, including discussion of thermal efficiency, air and water tightness, and structural resistance
→ Review several case studies to understand practicality of discrete cladding attachment with long screws
Caution! Lots of Insulation & Innovation
→ Control of exterior moisture/rainwater & detailing
→ Thermal insulation continuity & effectiveness
→ Airflow control/airtightness
→ Control of condensation and vapor diffusion
→ More insulation = less heat flow to dry out moisture
  → Amount, type and placement of insulations matters, for vapor, air and moisture control
  → Greater need to more robust and better detailed assemblies
What do you See?
What do you See?
Thermal Bridging

→ Thermal bridging occurs when a more conductive material (e.g. metal, concrete, wood etc.) bypasses a less conductive material (insulation)
→ Minimizing thermal bridging is key to passive building design
  → Use of exterior continuous insulation with thermally improved cladding attachments
  → Minimizing the big thermal bridges
→ Have historically focused on assembly R-values, however more attention is now being placed on interface and detail R-values, and cladding attachments
→ Address the weakest links first
Getting to Higher R-values - Walls

‘Traditional’
2x6 w/ R-22 batts = R-16 effective

Exterior Insulation: R-20 to R-60+ effective
• Constraints: cladding attachment, wall thickness
• Good for wood/steel/concrete

Deep/Double Stud: R-20 to R-40+ effective
• Constraints: wall thickness
• Good for wood, wasted for steel

Split Insulation: R-20 to R-60+ effective
• Constraints: cladding attachment
• Good for wood, palatable for steel
Building enclosure is key element in passive design.
Exterior insulation is only as good as the cladding attachment strategy.
What attachment system works best thermally?
Need to also consider:
  - Structural
  - Air / water tightness
  - Constructibility
Many Cladding Attachment Options & Counting
Vertical & Horizontal Continuous Z-Girts
Intermittent Metal Clips - Better
Thermally Improved Clip & Rail Systems
Screws Through Insulation Layer
Thermal FE Modelling

Exterior
- Fiber Cement Board Cladding
- 3/4” Air Space (Rainscreen)
- Cladding Attachment System
- R-4.2/in Exterior MW Insulation
- Plywood Sheathing
- 2x6 Wood Framing @ 16” OC with
- R-22 Batt Insulation
- Interior Gypsum

Interior

Exterior
- Fiber Cement Board Cladding
- 3/4” Air Space (Rainscreen)
- Cladding Attachment System
- R-4.2/in Exterior MW Insulation
- Gypsum Sheathing
- 3 5/8” Steel Studs @ 16” OC with
- R-12 Batt Insulation
- Interior Gypsum

Interior
Thermal Results – Insulated Wood Frame Wall

Effective R-Value

Nominal R-Value of Exterior Insulation (ft²·°F·hr/BTU)

- Continuous Vertical Z-Girt - 16" OC
- Continuous Horizontal Z-Girt - 24" OC
- Aluminium T-Clip - 16" x 48"
- Aluminium T-Clip - 16" x 24"
- Intermittent Galvanized Z-Girt - 16" x 48"
- Intermittent Galvanized Z-Girt - 16" x 24"
- Galvanized Screws - 16" x 16"
- Galvanized Screws - 16" x 12"
- SS Screws - 16" x 16"
- SS Screws - 16" x 12"
- Fiberglass Clip - 16" x 48"
- Fiberglass Clip - 16" x 24"
Thermal Results – Insulated Wood Frame Wall

Percent Thermal Degradation

Nominal R-Value of Exterior Insulation (ft^2·°F·hr/BTU)

- Continuous Vertical Z-Girt - 16" OC
- Continuous Horizontal Z-Girt - 24" OC
- Aluminium T-Clip - 16" x 48"
- Aluminium T-Clip - 16" x 24"
- Intermittent Galvanized Z-Girt - 16" x 48"
- Intermittent Galvanized Z-Girt - 16" x 24"
- Galvanized Screws - 16" x 16"
- Galvanized Screws - 16" x 12"
- Fiberglass Clip - 16" x 48"
- Fiberglass Clip - 16" x 24"
Thermal Results – Insulated Steel Stud Wall

Effective R-Value of Whole Wall Assembly (ft²·°F·hr/BTU)

- Continuous Vertical Z-Girt - 16" OC
- Continuous Horizontal Z-Girt - 24" OC
- Aluminium T-Clip - 16" x 48"
- Aluminium T-Clip - 16" x 24"
- Intermittent Galvanized Z-Girt - 16" x 48"
- Intermittent Galvanized Z-Girt - 16" x 24"
- Galvanized Screws - 16" x 16"
- Galvanized Screws - 16" x 12"
- Intermittent SS Z-Girt - 16" x 48"
- Intermittent SS Z-Girt - 16" x 24"
- SS Screws - 16" x 16"
- SS Screws - 16" x 12"
- Fiberglass Clip - 16" x 48"
- Fiberglass Clip - 16" x 24"
Thermal Results – Insulated Steel Stud Wall

Percent Thermal Degradation

Nominal R-Value of Exterior Insulation (ft²·°F·hr/BTU)

- Continuous Vertical Z-Girt - 16" OC
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- Intermittent Galvanized Z-Girt - 16" x 24"
- Fiberglass Clip - 16" x 48"
- Fiberglass Clip - 16" x 24"
- Galvanized Screws - 16" x 16"
- Galvanized Screws - 16" x 12"
- SS Screws - 16" x 16"
- SS Screws - 16" x 12"
“I spent all this time making my air and water barrier perfect, and now I’m going to turn it into Swiss cheese!”

How much does this matter?
- Historically with continuous girts – not a lot
- With only screws?
Procedure

- Test the self-sealing ability of membranes around screw and nail (insulation pin) fasteners (i.e. represent cladding attachment & insulation retaining fasteners used in exterior insulated walls)

- Qualitative testing of water and air leakage
  - Fluorescent dye used to identify water leakage
  - Theatrical smoke used to identify air leakage
Test Wall and Test Chamber

Insulated Wall types

1. Steel stud + Densglass with liquid AB
2. Steel stud + Densglass with SAM

Interior and exterior views of test chamber
1 Air Leakage

16 – 13 = 3 CFH

2 Smoke

3 Water Penetration
Impact of Fasteners on Membrane Airtightness?

Impact of Exterior Insulation Fasteners on the Airtightness of Liquid & Self-Adhered Membranes

Maximum allowable air leakage rate for air-barrier material

Negligible

CMU - self-adhered membrane
CMU - liquid applied membrane
Steel stud - self-adhered membrane
Steel stud - liquid applied membrane

CMU - self-adhered membrane - Screws
CMU - liquid applied membrane - Screws
Steel Stud - self-adhered membrane - Screws
Steel stud - liquid applied membrane - Screws
Insulated Walls - Water Penetration

→ ASTM E1105 Test Conditions

→ 0 Pascals

→ 200 Pascals (4.8 psf)

→ 700 Pascals (14.6 psf)

→ 700 Pascals (insulation removed)
Steel stud with SAM – 1 location
Airtightness of adhered/liquid membranes is negligibly impacted by fasteners into structure or even misfired (as long as left in place)

Net impact is well below 0.004 cfm/ft² @ 75Pa target (typically in 0.0005 cfm/ft² range)
→ Water tightness not practically impacted

→ Some fasteners could leak where membrane exposed to full ASTM E1105 water load applied to WRB
  ➔ Not a real world scenario (why we clad)
  ➔ Cladding buffers 95% water, insulation buffers remaining 4%, possibly 1% getting behind/through insulation
  ➔ No anecdotal evidence to suggest a problem
  ➔ Thickness and self-sealing of WRB/AB membrane matters here
Common Concerns - Structural
And many others!
Lab Examples and Testing

± 25 psf
Figure 5: Deflection Testing of 3" ComfortBoard IS
How heavy is cladding?
- Vinyl siding – 2 psf
- Fiber cement – 5 psf
- Cement plaster – 10 psf
- Stone veneer – 25 psf
- Brick – 40 psf

Typical Example
- 16 inches x 16 inches screw spacing
- Fiber Cement → 9 lbs per screw

Very small forces for many typical arrangements
→ Screw bending resistance easy to calculate from established calculation methods
→ ASTM F1575 – Standard Test Method for Determining Bending Yield Moment of Nails
→ For small insulation thickness (< 2 in) and lightweight cladding (< 5 psf), screw bending generally sufficient to resist cladding loads alone - conservative
→ Strapping compresses insulation layer, creating friction
→ Often ignored for design purposes, but research has shown it can provide significant resistance
→ Over 20 lbs of vertical resistance per fastener has been reported
→ Strapping required to develop strut and tie forces
→ Strap compresses insulation as cladding deflects downward
→ Resulting tension resisted by screws
Still Not Convinced – Use Shear Blocks

→ With heavy or brittle claddings – may consider shear blocks to limit deflection and creep
  → Not necessary with light-weight claddings

→ Shear block material:
  → Continuous or intermitted wood blocks, metal clips, clip and rail system, etc.
→ Modular construction for a remote site in a cold climate
→ Highly insulated walls with screws through 6 inches of exterior insulation
Discussion + Questions

→ rdhbe.com