Thermal Bridging of Masonry Veneer Claddings and Energy Code Compliance

Graham Finch, MASc, P.Eng
Mike Wilson, MEng, P.Eng
James Higgins, Dipl.T
RDH Building Engineering Ltd.
Vancouver, BC

Presentation Outline

- Energy Code Requirements within Canada for the Thermal Performance of Masonry Walls
- Effective R-value Thermal Modeling of Various Common Masonry Tie Configurations
- Impact of Masonry Shelf Angle Supports
- Comparison of Masonry Veneer to Other Cladding Systems
Building and Energy codes within Canada require the effective thermal performance (R-values) of building enclosure assemblies to meet minimum standards.

Nominal R-values = Rated R-values of insulation which do not include impacts of how they are installed.
- For example R-20 batt insulation

Effective R-values include impacts of insulation installation and thermal bridges.
- For example nominal R-20 batts within steel studs becoming ~R-9 effective, or in wood studs ~R-15 effective

Masonry ties and shelf angles are thermal bridges that reduce effective R-values significantly (even though a small area)
Thermal bridging occurs when a conductive material (e.g. aluminum, steel, concrete, wood etc.) provides a path for heat to flow around insulation. The bypassing “bridging” of the less conductive material significantly reduces its effectiveness as an insulator.

Examples:

→ Wood framing (studs, plates) in insulated wall
→ Steel framing in insulated wall
→ Concrete slab edge (balcony, exposed slab edge) through a wall
→ Masonry ties and other methods to attach cladding through exterior insulation
→ Masonry shelf angles and other methods to support masonry walls
Overview: Canadian Energy Codes

→ Part 9 (small buildings)
  → National Building Code of Canada (NBC), 2010
  → New energy provisions within 2012 update to Section 9.36
  → Provinces adopt the NBC with modifications
  → City of Vancouver (VBBL) is adoption of BCBC
  → Compliance is generally prescriptive (R-value tables)

→ Part 3 (large buildings)
  → NBC and Provincial codes reference both:
  → ASHRAE Standard 90.1 (Energy Code for Buildings Except Low-Rise Residential)
  → Compliance path options (prescriptive, trade-off, modeling)
### Prescriptive Energy Code Requirements for Walls in Canada

#### Climate Zone

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Wall (Mass, Wood, Steel): Min R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>19.2, 27.8, 27.0</td>
</tr>
<tr>
<td>7A/7B</td>
<td>14.1, 19.6, 23.8</td>
</tr>
<tr>
<td>6</td>
<td>12.5, 19.6, 15.6</td>
</tr>
<tr>
<td>5</td>
<td>11.1, 19.6, 15.6</td>
</tr>
</tbody>
</table>

#### Wall – Above Grade: Minimum R-value (IP)

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Min R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>31.0</td>
</tr>
<tr>
<td>7</td>
<td>27.0</td>
</tr>
<tr>
<td>6</td>
<td>23.0</td>
</tr>
<tr>
<td>5</td>
<td>20.4</td>
</tr>
<tr>
<td>4</td>
<td>18.0</td>
</tr>
</tbody>
</table>

*7A/7B combined in ASHRAE 90.1

No climate zone 4 in ASHRAE 90.1 – bumped to zone 5
Effective R-values of Building Enclosure Assemblies can be determined by:

- Hand methods – simple wood frame walls, not suitable for brick ties
- Laboratory (Guarded hot-box testing) – good for confirmation, expensive and not efficient for multiple configurations
- Two-dimensional finite element thermal modeling – not accurate for modeling discrete or intermittent elements such as brick ties or fasteners
- Three-dimensional finite element thermal modeling – most accurate and cost effective. Calibrated with laboratory testing to improve accuracy.

Heat3 (Blocon) – 3D finite element software used for this analysis
Modeling performed to look at effective R-values of alternate ties

Over different back-up wall configurations
  - Cast-in place concrete (6” thick)
  - Steel Stud framing (3 5/8” uninsulated)
  - Wood framing (2x4 insulated)

With Alternate masonry ties and varying depths of exterior insulation (0-6”)
  - 2” x 16 gauge L-brick ties in galvanized and stainless steel (holes and no holes)
  - 2” x 16 gauge side mounted to stud
  - Basalt fiber tie (concrete backup)
Results – Masonry Ties over 6” Concrete Wall Backup

Effective R-value of Masonry Walls with Different Masonry Ties - 6” Concrete Wall Backup

- No Ties
- Stainless Steel
- Stainless Steel with holes
- Galvanized Steel
- Galvanized Steel with holes
- Basalt Fiber Ties

Percentage Degredation of Exterior Insulation due to Masonry Ties - 6” Concrete Wall Backup

- Nominal R-value of Exterior Insulation

Results – Masonry Ties Attached to Steel Stud Backup

Effective R-value of Masonry Walls with Different Masonry Ties - Empty 3 5/8” Steel Stud Backup

Percentage Degredation of Exterior Insulation due to Masonry Ties - Empty 3 5/8” Steel Stud Wall Backup
Results – Masonry Ties Attached to Wood Frame Backup

Effective R-value of Masonry Walls with Different Masonry Ties - 2x4 Wood Stud Backup (R-12 insulation)

- No Ties
- Stainless Steel
- Stainless Steel with holes
- Galvanized Steel
- Galvanized Steel with holes
- Side Mount Tie - Stainless

Percentage Degredation of Exterior Insulation due to Masonry Ties - 2x4 Stud Wall Backup (R-12 Insulation)

- Nominal R-value of Exterior Insulation
- Percent Thermal Degredation of Exterior Insulation due to Ties
Summary of Results

- Masonry ties occupy 0.04% of the walls surface area.
- Effective reduction of exterior insulation is between 5-30% for typical insulation depths.
  - Must be accounted for in energy calculations.
- Punched holes help (difference of up to 6% insulation reduction for galvanized, 4% stainless steel).
- Stainless steel ties offer less than half the thermal reduction as galvanized ties.
- Basalt fiber ties very low reductions ~1%.
- Shelf angle support impact covered in detail within separate presentation by Mike Wilson.
Results – Impact of Shelf Angle Support

Include here or with Mikes?
How Does Masonry Stack Up vs Other Cladding Supports?
Masonry Veneer vs Other Cladding Support Strategies

Effective R-value of Typical Masonry and Other Cladding Support Strategies over empty 3 5/8" Steel Studs

Percentage Thermal Degredation of Exterior Insulation due to Cladding Attachment Strategy
Thermal bridging through masonry veneer ties is important – and needs to be accounted for in energy calculations

- Reduction of exterior insulation R-value ranges from 5% up to 30% depending on stainless vs galvanized and punched holes.
- Shelf angle supports can have reductions in the 45-55% range if not de-bridged.

Masonry veneer has the potential to be one of the most thermally efficient cladding attachment strategies on market (stainless steel and de-bridged shelf angles).

- Can result in thinner walls (allow for thickness of masonry) – most code requirements can be met with 3-6” of exterior insulation.
Questions

→ Graham Finch – gfinch@rdhbe.com