Energy Conservation in Buildings
→ Why and How?

Big picture → Establishing targets → Details

ASHRAE STANDARD
Energy Standard for Buildings Except Low-Rise Residential Buildings
Introduction

- Manufacturer of fiberglass construction products
  - Fiberglass windows
  - Fiberglass doors
  - Fiberglass cladding support systems
- Manufacturing plant located in Langley, BC
- In operation since 2008
- Current client base:
  - BC, Alberta, Yukon, NWT, Washington, Oregon, Alaska
- Expanding to:
  - Saskatchewan, Manitoba, Ontario,
  - California, other central US States
Background – Michael Bousfield

- **Logistics Specialist 2000 to 2007**
  - Versacold Group
  - Inventory Coordinator
  - Transportation Coordinator

- **BCIT Building Engineering Technology**
  - Part time studies – 2005 to 2007

- **BCIT Building Science Diploma – 2007 to 2009**
  - BCBEC Building Science Excellence Award - 2009

- **Building Envelope Consultant – 2007 to 2009**
  - RDH Building Engineering
  - Forensic Review of Building Envelope Failures
  - Rehab and New Construction Review
  - Rehabilitation Detailing and Design

- **Fiberglass Window Manufacturing – 2009 to 2012**
  - Technical Representative - Cascadia Windows and Doors
Balsa Wood Bridge
Effective Thermal Performance
Of The Building Enclosure

Exterior Walls

Let's resolve to use less energy!
Agenda

- Energy conservation – big picture
- Importance of limiting heat flow in buildings
  - Basic physics refresher & heat flow.
  - Types of wall insulation and uses.
- Thermal Bridging
  - Insulated construction assemblies.
- Identify code changes and their application
  - Building Code requirements for R-values of exterior walls.
  - If conventional assemblies no longer meet code requirements, what does work?

- The Cascadia Clip
Why is Cascadia Relevant?
The Energy Factor

- The energy supply side is limited, dirty, and increasingly expensive
- Across Canada and the USA, national, regional, and local governments have shifted their focus to optimizing utilization
- Going forward, increased demand is going to be met by conserving how much we use
  - **Demand Side Management**
Sixth Northwest Power Plan (2010)

Representative Resource Development Schedule

Cumulative Resource Additions (Avg Megawatts)

- Conservation
- New Wind
- Geothermal
- Single-Cycle Combustion Turbine (SCCT)
- Renewable Portfolio Standards (RPS) Wind
- Combined Cycle Combustion Turbine (CCCT)

Year: 2010 to 2029
Importance of Limiting Heat Flow in Buildings
Importance of Limiting Heat Flow in Buildings

- Thermal Comfort
- Condensation control

Energy
- Over 40% of all energy in North America is used in Buildings
- In residential buildings, 30-60% energy is used for space-heating
- Building enclosure must manage all mechanisms of heat-flow

Building codes require that heat flow be controlled
Heat Flow

- Fundamental Rule #1:
  
  **Heat Flows from HOT to COLD**

- There are no exceptions

- You **cannot prevent** heat flow with insulation, you can only **slow it down**
Mechanisms of Heat Flow

• **Conduction**  
  (Heat flow by touch)

• **Convection**  
  (Heat flow by air)  
  - **Within** Closed Air-spaces  
  - **Through** air, i.e. air-leakage

• **Radiation**  
  (Heat flow by waves)

* The focus of this presentation is on **conduction** and related thermal bridging.
Real World Example – What Heat Flow Mechanisms Are Occurring?

Photo credit to movie: *Dumb and Dumber*
Physics Refresher

- Fast physics refresher on heat flow.
Conduction

- **Conduction** is the transfer of energy through a solid material, and between materials that are in contact.

- **Practical Examples:**
  - Heating of a pot on an electric stove
  - Heat flow through a metal window frame
  - Heat flow through a steel Z-girt in a conventional exterior insulated wall assembly
  - Heat flow through a concrete balcony slab
Conduction

- The rate of heat flow through a material is dependent on its conductivity \( k \).
  - Metric units are \( \text{W/m} \cdot \text{K} \)
  - Imperial units are \( \text{Btu/hr} \cdot \text{ft} \cdot \text{F}^\circ \)

- For example:
  - Aluminum \(~160 \text{ W/mK}~\)
  - Steel \(~60 \text{ W/mK}~\)
  - Stainless Steel \(~14 \text{ W/mK}~\)
  - Fiberglass \(~0.15\) to \(~0.30 \text{ W/mK}~\)
  - Wood \(~0.10\) to \(~0.15 \text{ W/mK}~\)
  - Insulation Materials \(~0.022\) to \(~0.080 \text{ W/mK}~\)

- For building enclosure components to be thermally efficient – must **minimize highly conductive materials** extending through the insulation.
Conductivity Calculations

- The term, **Conductance** (C) is simply the **conductivity** (k) divided by the thickness of the material (t).
  - \[ C = \frac{k}{t} \]
  - The units are the same as U-value; this is the “U-value” for a specific material

- The inverse of a material’s conductance is its thermal resistance also called “R-value”
  - \[ \frac{1}{C} = R-value \]
How Building Insulation Works

- Heat flow is slowed down through insulation by reducing conduction, convection, and radiation.
- Insulation is low-conductivity compared to other construction materials.
- Insulation reduces or stops convection vs an empty air space.
- Radiation is prevented across an open space by filling it, or by using a low-emissivity coating/finish (radiation barrier).

- How much insulation do you need?
ASHRAE 90.1 Climate Zones
Types of Insulation and Uses

- raft-R-mate® Attic Rafter Vents
- EcoTouch™ PINK™ FIBERGLAS® Insulation R-20
- FOAMULAR® CodeBord® Extruded Polystyrene Rigid Insulation
- FoamSeal™ Sill Gasket Part of the CodeBord® Air Barrier System
- EcoTouch™ QuietZone PINK™ FIBERGLAS® Acoustic Insulation
- FOAMULAR® C-300 Extruded Polystyrene Rigid Insulation
- PROPINK® FIBERGLAS® Blown Insulation
- AttiCat® Expanding Blown-In Insulation System
- EcoTouch™ PINK™ FIBERGLAS® Insulation R-28
- EcoTouch™ PINK™ FIBERGLAS® Insulation R-31
- Multi-Purpose Insulation
- FOAMULAR® InsulPink™ Extruded Polystyrene Rigid Insulation
- FOAMULAR® C-200 Extruded Polystyrene Rigid Insulation

From Owens Corning
Fiberglass Insulation

R-3 to R-4 per inch

Owens Corning, Johns Manville, Certainteed and many others
Mineral Wool Insulation

R-3.5 to R-4.3/inch

Also called Rockwool or Stone wool

Roxul, Fibrex, ThermaFiber & others

Fire-resistant
Water-repellent
Semi-rigid, sag-free material
Extruded Polystyrene (XPS)

R-5 per inch

DOW – owns Trademark of Styrofoam

DOW also has a product with R-5.6/inch
Expanded Polystyrene (EPS)

R-4 per inch

Numerous Manufacturers
Various Densities
Polyisocyanurate (Polyiso)

R-6/inch

May be advertised with an initial R-value of R-7/inch -> degrades to R-6/inch long term

DOW, Johns Manville & Other Manufacturers
Open Cell Sprayfoam

R-3.5 to R-4.0 per inch

Icynene, Demilec and others
Closed Cell Sprayfoam

R-5.0 to R-6.0 per inch

DOW, BASF, Demilec and many others
Thermal Bridging
Thermal Bridging

• Through conduction, heat flow will occur at a faster rate through conductive materials that penetrate through the insulation.
• This reduces the effective thermal resistance of a building envelope and reduces surface temperatures.
• Building Examples:
  - Wood framing in insulation
  - Steel studs in insulation
  - Concrete slab edges
  - Window & door frames
  - Cladding support framing (conventional Z-girts)
  - Brick shelf-angles and brick ties
  - Etc.
Thermal Bridging

Steel Studs & Brick Shelf Angles
Thermal Bridging

Wood Frame
Two More Key Terms

- **Nominal R-value**
  - The R-value of just the insulation itself

- **Effective R-value**
  - The overall value of the assembly (wall), including all components, air films, and the effect of all thermal bridging.
Steel versus Wood Studs

<table>
<thead>
<tr>
<th>2x4@16&quot;</th>
<th>2x6@16&quot;</th>
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<tbody>
<tr>
<td>R-value</td>
<td>R-value</td>
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<tr>
<td>R-11</td>
<td>R-19</td>
</tr>
<tr>
<td>55%</td>
<td>44%</td>
</tr>
<tr>
<td>6.6</td>
<td>8.8</td>
</tr>
<tr>
<td>10.8</td>
<td>16.2</td>
</tr>
<tr>
<td>12.1</td>
<td>19.8</td>
</tr>
</tbody>
</table>

R-value (ft²·°F·hr/BTU)
Identify Code Changes and Their Application
ASHRAE 90.1

- ASHRAE 90.1 offers three methods for consultants to specify wall thermal performance requirements:
  - Prescriptive Path
  - Building Enclosure Trade-off Path
  - Energy Cost Budget Path
ASHRAE 90.1
A Novel Idea, and a Key Term

- ASHRAE 90.1 stipulates that wall R-values must consider the effect of thermal bridging, to be representative of actual thermal performance (i.e. consider effects of steel studs, girts, clips, slab-edges, balconies, eyebrows etc.).

- Continuous Insulation (CI): Well... this is what it sounds like – insulation free from thermal bridges (like structural elements).
  - The exceptions are “fasteners and service openings”. Service openings... ducts.
## ASHRAE 90.1 2004 – Climate Zone 5

### TABLE 5.5-5  Building Envelope Requirements For Climate Zone 5 (A,B,C)*

<table>
<thead>
<tr>
<th>Opaque Elements</th>
<th>Nonresidential</th>
<th>Residential</th>
<th>Semiheated</th>
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<tbody>
<tr>
<td></td>
<td>Assembly</td>
<td>Insulation Min.</td>
<td>Assembly</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>R-Value</td>
<td>Maximum</td>
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<tr>
<td><strong>Roofs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation Entirely above Deck</td>
<td>U-0.063</td>
<td>R-15.0 ci</td>
<td>U-0.063</td>
</tr>
<tr>
<td>Metal Building</td>
<td>U-0.065</td>
<td>R-19.0</td>
<td>U-0.065</td>
</tr>
<tr>
<td>Attic and Other</td>
<td>U-0.034</td>
<td>R-30.0</td>
<td>U-0.027</td>
</tr>
<tr>
<td><strong>Walls, Above-Grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>U-0.123</td>
<td>R-7.6 ci</td>
<td>U-0.090</td>
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<tr>
<td>Metal Building</td>
<td>U-0.113</td>
<td>R-13.0</td>
<td>U-0.057</td>
</tr>
<tr>
<td>Steel-Framed</td>
<td>U-0.084</td>
<td>R-13.0 + R-3.8 ci</td>
<td>U-0.064</td>
</tr>
<tr>
<td>Wood-Framed and Other</td>
<td>U-0.089</td>
<td>R-13.0</td>
<td>U-0.039</td>
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<td><strong>Wall, Below-Grade</strong></td>
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<td></td>
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<tr>
<td>Below-Grade Wall</td>
<td>C-1.140</td>
<td>NR</td>
<td>C-1.140</td>
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<td><strong>Floors</strong></td>
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<td></td>
</tr>
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<td>Mass</td>
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<td>R-8.3 ci</td>
<td>U-0.074</td>
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<tr>
<td>Steel-Joist</td>
<td>U-0.052</td>
<td>R-19.0</td>
<td>U-0.038</td>
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<tr>
<td>Wood-Framed and Other</td>
<td>U-0.033</td>
<td>R-30.0</td>
<td>U-0.033</td>
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<tr>
<td><strong>Slab-On-Grade Floors</strong></td>
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<tr>
<td>Unheated</td>
<td>F-0.730</td>
<td>NR</td>
<td>F-0.730</td>
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<tr>
<td>Heated</td>
<td>F-0.840</td>
<td>R-10 for 36 in.</td>
<td>F-0.840</td>
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</tbody>
</table>

*Overall U-value (inverse of Effective R-value)  Nominal R-values*
### TABLE 5.5-6 Building Envelope Requirements For Climate Zone 6 (A,B)*

<table>
<thead>
<tr>
<th>Opaque Elements</th>
<th>Nonresidential</th>
<th>Residential</th>
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<td>Assembly Max</td>
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<td>Insulation Entirely above Deck</td>
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<td>R-15.0 ci</td>
<td>U-0.063</td>
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<tr>
<td>Metal Building</td>
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<td>R-19.0</td>
<td>U-0.065</td>
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<tr>
<td>Attic and Other</td>
<td>U-0.027</td>
<td>R-38.0</td>
<td>U-0.027</td>
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<tr>
<td><strong>Walls, Above-Grade</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>U-0.104</td>
<td>R-9.5 ci</td>
<td>U-0.090</td>
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<tr>
<td>Metal Building</td>
<td>U-0.113</td>
<td>R-13.0</td>
<td>U-0.057</td>
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<tr>
<td>Steel-Framed</td>
<td>U-0.084</td>
<td>R-13.0 + R-3.8 ci</td>
<td>U-0.064</td>
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<td>Wood-Framed and Other</td>
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<td>U-0.064</td>
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<td><strong>Wall, Below-Grade</strong></td>
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<td>Below-Grade Wall</td>
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<td><strong>Floors</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>U-0.087</td>
<td>R-8.3 ci</td>
<td>U-0.064</td>
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<tr>
<td>Steel-Joist</td>
<td>U-0.038</td>
<td>R-30.0</td>
<td>U-0.038</td>
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<tr>
<td>Wood-Framed and Other</td>
<td>U-0.033</td>
<td>R-30.0</td>
<td>U-0.033</td>
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<tr>
<td><strong>Slab-On-Grade Floors</strong></td>
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<tr>
<td>Unheated</td>
<td>F-0.730</td>
<td>NR</td>
<td>F-0.730</td>
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<tr>
<td>Heated</td>
<td>F-0.840</td>
<td>R-10 for 36 in.</td>
<td>F-0.780</td>
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## TABLE 5.5-7  Building Envelope Requirements For Climate Zone 7*

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<td>Assembly</td>
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<td>Maximum</td>
<td>Min. R-Value</td>
<td>Maximum</td>
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<td><strong>Roofs</strong></td>
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<td>Insulation Entirely above Deck</td>
<td>U-0.063</td>
<td>R-15.0 ci</td>
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<tr>
<td>Metal Building</td>
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<td>R-19.0</td>
<td>U-0.065</td>
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<tr>
<td>Attic and Other</td>
<td>U-0.027</td>
<td>R-38.0</td>
<td>U-0.027</td>
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<td><strong>Walls, Above-Grade</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
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<td>R-11.4 ci</td>
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<td>Metal Building</td>
<td>U-0.057</td>
<td>R-13.0 + R-13.0</td>
<td>U-0.057</td>
</tr>
<tr>
<td>Steel-Framed</td>
<td>U-0.064</td>
<td>R-13.0 + R-7.5 ci</td>
<td>U-0.064</td>
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<tr>
<td>Wood-Framed and Other</td>
<td>U-0.089</td>
<td>R-13.0</td>
<td>U-0.051</td>
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<td><strong>Wall, Below-Grade</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Below-Grade Wall</td>
<td>C-0.119</td>
<td>R-7.5 ci</td>
<td>C-0.119</td>
</tr>
<tr>
<td><strong>Floors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>U-0.087</td>
<td>R-8.3 ci</td>
<td>U-0.064</td>
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<tr>
<td>Steel-Joist</td>
<td>U-0.038</td>
<td>R-30.0</td>
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<td>Wood-Framed and Other</td>
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<td>R-30.0</td>
<td>U-0.033</td>
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<td>Unheated</td>
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<td>R-10 for 36 in.</td>
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## Table 5.5.8 Building Envelope Requirements for Climate Zone 8

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<tbody>
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<td>Assembly</td>
<td>Insulation Min. R-Value</td>
<td>Assembly</td>
</tr>
<tr>
<td><strong>Roofs</strong></td>
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<td>U-0.048</td>
<td>R-20.0 ci</td>
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<td>Metal Building</td>
<td>U-0.049</td>
<td>R-13.0 + R-19.0</td>
<td>U-0.049</td>
</tr>
<tr>
<td>Attic and Other</td>
<td>U-0.027</td>
<td>R-38.0</td>
<td>U-0.027</td>
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<tr>
<td><strong>Walls, Above-Grade</strong></td>
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<td></td>
<td></td>
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<td>Mass</td>
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<td>R-13.0 + R-7.5 ci</td>
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<td>Wood-Framed and Other</td>
<td>U-0.051</td>
<td>R-13.0 + R-7.5 ci</td>
<td>U-0.051</td>
</tr>
<tr>
<td><strong>Wall, Below-Grade</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Below-Grade Wall</td>
<td>C-0.119</td>
<td>R-7.5 ci</td>
<td>C-0.119</td>
</tr>
<tr>
<td><strong>Floors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>U-0.064</td>
<td>R-12.5 ci</td>
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<tr>
<td>Steel-Joist</td>
<td>U-0.038</td>
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<td>Wood-Framed and Other</td>
<td>U-0.033</td>
<td>R-30.0</td>
<td>U-0.033</td>
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<tr>
<td><strong>Slab-On-Grade Floors</strong></td>
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<td></td>
</tr>
<tr>
<td>Unheated</td>
<td>F-0.540</td>
<td>R-10 for 24 in.</td>
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<td>Heated</td>
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<td>R-10 for 48 in.</td>
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<tr>
<td><strong>Opaque Doors</strong></td>
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<td></td>
</tr>
<tr>
<td>Swinging</td>
<td>U-0.500</td>
<td></td>
<td>U-0.500</td>
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<tr>
<td>Non-Swinging</td>
<td>U-0.500</td>
<td></td>
<td>U-0.500</td>
</tr>
</tbody>
</table>
What are we doing?
Does it work?
Conventional Exterior Insulated Wall Assemblies

- **Stud Insulated**
  - R-5.5 $\text{ft}^2\cdot{}^\circ\text{F}\cdot\text{hr}/\text{Btu}$

- **Vertical Z-Girts**
  - R-7.0 $\text{ft}^2\cdot{}^\circ\text{F}\cdot\text{hr}/\text{Btu}$

- **Horizontal Z-Girts**
  - R-7.8 $\text{ft}^2\cdot{}^\circ\text{F}\cdot\text{hr}/\text{Btu}$

- **Galvanized Clips**
  - R-11.0 $\text{ft}^2\cdot{}^\circ\text{F}\cdot\text{hr}/\text{Btu}$
Single Continuous Z-girt

- Simulations:
  - 3.5” insulation
  - 4” insulation
  - 8” insulation
Single Continuous Z-girt

HEAT 3D model

Temperature Isotherms
Single Continuous Z-girt

Temperature Isotherms

Temperature Isotherms at screw fastener
Single Continuous Z-girt

Effective R-values

<table>
<thead>
<tr>
<th>Exterior Insulation</th>
<th>Galvanized Z-Girt</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 ½” Mineral Fiber (R-14.7)</td>
<td>7.4</td>
</tr>
<tr>
<td>4” Mineral Fiber (R-16.9)</td>
<td>7.8</td>
</tr>
<tr>
<td>8” Mineral Fiber (R-33.6)</td>
<td>9.8</td>
</tr>
</tbody>
</table>

- **Not feasible** to meet ASHRAE 90.1 minimum prescriptive requirement of R-15.6 effective with continuous girts.
Thermal Weight of Girts

- How much heat is flowing through steel vs field of wall?
- Use U-values for calculation – isolate effect of steel:
  - Nominal U-value: \( \frac{1}{33.6} = 0.030 \)
  - Effective U-value: \( \frac{1}{9.8} = 0.102 \)
  - Effect of presence of girt: \( 0.102 - 0.030 = 0.0723 \)
  - Thermal weight of girt: \( \frac{0.0723}{0.102} = 71\% \)
- 71% of the total heat loss flows through the steel girt.
- Diminishing returns.

<table>
<thead>
<tr>
<th>Exterior Insulation</th>
<th>Galvanized Z-Girt</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” Mineral Fiber (R-33.6)</td>
<td>9.8</td>
</tr>
</tbody>
</table>
Crossing Z-girts

- Simulations:
  - 4” total insulation
  - 4” total insulation + thermal shim
  - R-15.6 solution
Crossing Z-girts

HEAT 3D model

Temperature Isotherms
Crossing Z-girts

Temperature Isotherms through horizontal cut

Temperature Isotherms through vertical cut
**Crossing Z-girts**

**Effective R-values**

<table>
<thead>
<tr>
<th>Clip Assembly, Exterior Insulation</th>
<th>Purchased Insulation R-value</th>
<th>Effective Insulation R-value</th>
<th>% Effectiveness of Insulation</th>
<th>Effective Wall R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4” Mineral Fiber (R-16.9), Crossing Z-Girt</td>
<td>16.9</td>
<td>8.2</td>
<td>49%</td>
<td>11.4</td>
</tr>
<tr>
<td>4” Mineral Fiber (R-16.9), Crossing Z-Girt (w/ ¼ thermal shim between girts)</td>
<td>16.9</td>
<td>10.0</td>
<td>59%</td>
<td>13.1</td>
</tr>
<tr>
<td>6” Sprayfoam* (~R-36), Crossing Z-Girt</td>
<td>36.0</td>
<td>12.5</td>
<td>35%</td>
<td>15.6</td>
</tr>
</tbody>
</table>

- R-36 insulation was required to achieve R-15.6 effective
Steel Clips

- Simulations:
  - 3.5” insulation
  - 4” insulation
  - 6” insulation

- This is laborious to build... but let’s not worry about that right now.
Steel Clips

HEAT 3D model

Temperature Isotherms
Steel Clips

Temperature Isotherms through horizontal cut

Temperature Isotherms through vertical cut
Steel Clips

Effective R-values

<table>
<thead>
<tr>
<th>Exterior Insulation</th>
<th>Galvanized Steel Clip</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 ½” Mineral Fiber (R-14.7)</td>
<td>11.3</td>
</tr>
<tr>
<td>4” Mineral Fiber (R-16.9)</td>
<td>12.4</td>
</tr>
<tr>
<td>6” Mineral Fiber (R-25.1)</td>
<td>15.6 *</td>
</tr>
</tbody>
</table>

- R-25 insulation was required to achieve R-15.6 effective
So what's the answer? How do we actually meet R-15.6? Well, if steel reduces the insulation value by half, then obviously, we just need twice as much of everything, right?
Metal Furring

Conductive Steel

- Z-girits
- Hat track
- Angles
If we can solve this, what’s an appropriate target?
Figure 4.5: Effects of variations of opaque wall thermal resistance on space heating for a mid-rise high efficiency MURB
OK, let’s solve this...
Materials

• Focus on improving material selection and sequencing
• Not just adding more insulation

• Use lower conductivity materials in key locations to improve effective R-values
• Careful – don’t sacrifice other essential material attributes
Must-haves list

- Need to reduce thermal bridging of cladding supports, while keeping the following characteristics:
  - Acceptable in non-combustible
  - Appropriate substrate for cladding fasteners
  - Rigid enough for cladding attachment, and other loading
  - Inorganic (won’t rot)
  - Low thermal expansion/contraction
  - Won’t creep or deform over time (this might eliminate thermoplastics)
  - Easy to construct
  - Cost effective
Step 1

- OK, so we have a conductivity problem...

- Let’s use a material with very low conductivity – like fiberglass.
Step 2

- **Problem:**
  - Screw pull-out

Make this leg steel – solves pull-out issue.
Connection problem though…
Step 3

- Problem:
  - Combustibility

Use long screw to attach outer steel directly to stud
Step 4

- Problem:
  - Rotation at inner leg

Make inner leg on both sides.
Step 5

- Problem:
  - Interference between screws and web
Step 6

- Problems:
  - Cost of continuous member too high
  - Thermal performance could be better

Backup wall

Section

Make pieces intermittent
Step 7

- Problem:
  - Installation is inconvenient – too many pieces

Backup wall

Provide retainer clip to clip pieces onto continuous steel
Step 8

• Problems:
  - Need exterior drainage cavity
  - Need steel to be more rigid for cladding attachment

Backup wall

Use Z-girt …
Is it done?
This concludes the educational portion of the presentation

- Now we’re going to look at some of Cascadia’s offerings, along the lines that we’ve been discussing.
Low-conductivity fiberglass material reduces thermal bridging. This greatly improves the effective thermal performance of the wall.
Awards

- This has been getting some attention...

Awards of Excellence 2011
Sustainable Construction and Innovation
SILVER Award

Cascadia in Top 10 Most Innovative Companies
Fiberglass Thermal Spacer

R-15.7
Exceeds the ASHRAE 90.1 minimum prescriptive requirement of R-15.6 ft²·°F·hr/Btu for steel frame walls

R-7.0
Common wall with exterior steel girts; not ASHRAE 90.1 compliant (needs to meet R-15.6 effective)
Field Comparison of Vertical Z-Girt and Fiberglass Girt Spacer System

Vertical Z-Girt Wall System

Warm areas visible on exterior wall that correspond with the conductive Vertical Z-girts.

Fiberglass Thermal Spacer Wall System

Essentially no warm areas visible on exterior wall because fiberglass spacers limit the heat flow.
Installation

**FAST INSTALLATION**

**STEP 1**
Attach clips to steel girt

**STEP 2**
Fasten girts and clips to the wall with screws

**STEP 3**
Install insulation and fasten next girt
Installation – On Site

**STEP 1**
Layout spacers by clipping to steel girt

**STEP 2**
Fasten to wall with screw through spacer
Installation

STEP 3
Place insulation between spacers

COMPLETE
Finished installation of fiberglass spacer
Examples
Vertical Application
Horizontal Application
### THERMAL PERFORMANCE DATA

**Assembly information**
- Full Height Wall
- Insulation: Stone Wool by Roxul (R4.2/in)
- Values are for 16" O.C. Stud Spacing

Cascadia strongly recommends that the design team retain the services of a qualified building science consultant to review any split insulation applications.

<table>
<thead>
<tr>
<th>Clip width</th>
<th>3 5/8&quot; Steel Studs</th>
<th>Effective R-Value [FT²°F·HR/ BTU]</th>
<th>Wood Studs</th>
<th>Effective R-Value [FT²°F·HR/ BTU]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2x4 Studs</td>
</tr>
<tr>
<td>3.5&quot;</td>
<td>Empty</td>
<td>14.1</td>
<td>Empty</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>With R-12 Batt Insulation</td>
<td>18.0</td>
<td>With R-12 or R-19 Batt Insulation</td>
<td>24.4</td>
</tr>
<tr>
<td>4&quot;</td>
<td>Empty</td>
<td><strong>15.7</strong></td>
<td>Empty</td>
<td>18.0</td>
</tr>
<tr>
<td></td>
<td>With R-12 Batt Insulation</td>
<td>19.5</td>
<td>With R-12 or R-19 Batt Insulation</td>
<td>26.1</td>
</tr>
<tr>
<td>5&quot;</td>
<td>Empty</td>
<td>18.5</td>
<td>Empty</td>
<td>21.1</td>
</tr>
<tr>
<td></td>
<td>With R-12 Batt Insulation</td>
<td>22.4</td>
<td>With R-12 or R-19 Batt Insulation</td>
<td>29.3</td>
</tr>
<tr>
<td>6&quot;</td>
<td>Empty</td>
<td>21.4</td>
<td>Empty</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>With R-12 Batt Insulation</td>
<td>25.2</td>
<td>With R-12 or R-19 Batt Insulation</td>
<td>32.4</td>
</tr>
</tbody>
</table>
Design

1" Typ.

16" O.C.

26" Typ.
Cost Comparisons

**CASCADIA CLIP® SYSTEM**

**R-15.7 EFFECTIVE**

Easily increased to R-20+

5”

Interior

Exterior

4” of insulation

Cascadia Clip®

Z-girt

Insulation

**Cost of clips and girts**

~$0.13 per ft² / per R-value

**Additional indirect costs**

+ One layer of insulation

**VERTICAL + HORIZONTAL DOUBLE GIRT SYSTEM**

**R-15 EFFECTIVE**

Not easily increased

9”

Interior

Exterior

8” of insulation

Z-girts

Insulation

**Cost of girts**

~$0.16 per ft² / per R-value

**Additional indirect costs**

+ Twice the insulation

+ Twice the labour

+ Twice the flashing

+ More lost floor space that the owner cannot use or sell
How To Specify

This part’s easy! It’s a........Thermal Washer

Cascadia Clips® – Fiberglass Thermal Spacers
3.5", 4", 5", or 6" depth

Steel Z-girts
18 gauge; sizing and coating by engineer/specifier.
Most common configuration: 18 gauge with
Galvalume AZM 150 coating 1.5" x 1" x 1.25" size.

Screws
Master Gripper screws, with DT 2000 coating
by Leland Industries
Available from Cascadia Windows Ltd.
#14 x 5" (or 6", 7", 8")

Insulation
CavityRock® DD by Roxul, or approved alternative
3.5" thick (or 4", 5", 6")

Spray Foam Insulation Various types may be used
## Structural Information

### Screw Fastener Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Thickness</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheathing thickness</td>
<td>12.7 mm</td>
<td>0.5 in</td>
</tr>
<tr>
<td>Vertical girt depth</td>
<td>25.4 mm</td>
<td>1 in</td>
</tr>
<tr>
<td>Cladding thickness</td>
<td>19.05 mm</td>
<td>0.75 in</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cascadia Clip® size</th>
<th>Depth</th>
<th>Length</th>
<th>Screw edge distance</th>
<th>Screw spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Varies</td>
<td>101.6 mm</td>
<td>12.7 mm</td>
<td>76.2 mm</td>
</tr>
<tr>
<td></td>
<td>Varies</td>
<td>4.0 in</td>
<td>0.5 in</td>
<td>3.0 in</td>
</tr>
</tbody>
</table>

### Allowable Fastener Loads (Factor of Safety: 3.5)

<table>
<thead>
<tr>
<th>Condition</th>
<th>$T_{ALLOW}$</th>
<th>$V_{ALLOW}$</th>
<th>$T_{perm}$</th>
<th>$V_{perm}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 20 gauge studs</td>
<td>559 N</td>
<td>602 N</td>
<td>126 lb</td>
<td>135 lb</td>
</tr>
<tr>
<td>Leland Industries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For 18 gauge studs</td>
<td>851 N</td>
<td>892 N</td>
<td>191 lb</td>
<td>201 lb</td>
</tr>
<tr>
<td>Interpolated from Leland Industries data for 20 ga and 16 ga</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leland Industries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For wood studs + plywood sheathing</td>
<td>838 N</td>
<td>560 N</td>
<td>189 lb</td>
<td>126 lb</td>
</tr>
<tr>
<td>Values from Leland Master Gripper 14 x 10 with 1&quot; effective penetration into douglas fir</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Structural Information - Charts

WIND VERSUS DEAD LOAD INTERACTION DIAGRAMS: METAL STUDS

ALLOWABLE WIND LOAD VERSUS CLADDING DEAD LOAD

18 ga Metal Studs at 16" O.C.

Cascadia Clips®
- 3.5"
- 4.0"
- 5.0"
- 6.0"

Design Parameters
- Stud spacing – horizontal = 16" [406mm]
- Clip vertical spacing = 26" [660mm]
Minor Combustible Component

While fiberglass is combustible, the clip functions within non-combustible wall assemblies as a minor combustible component, in accordance with Article 3.1.5.2 of the Model National Building Code.

The clip is enclosed within the non-combustible insulation and the fasteners attach the cladding directly to the structure. Fire protection and building code professionals support the clip as a minor combustible component, in compliance with the building code.

The Building and Safety Standards Branch of the BC Ministry of Energy and Mines confirmed that the Cascadia Clip® is a minor combustible component, acceptable for use in non-combustible construction.
So.....

12” of Insulation

4” of Insulation
Bullitt Center
Seattle, WA
Bullitt Center
Seattle, WA

The greenest commercial building in the world.
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