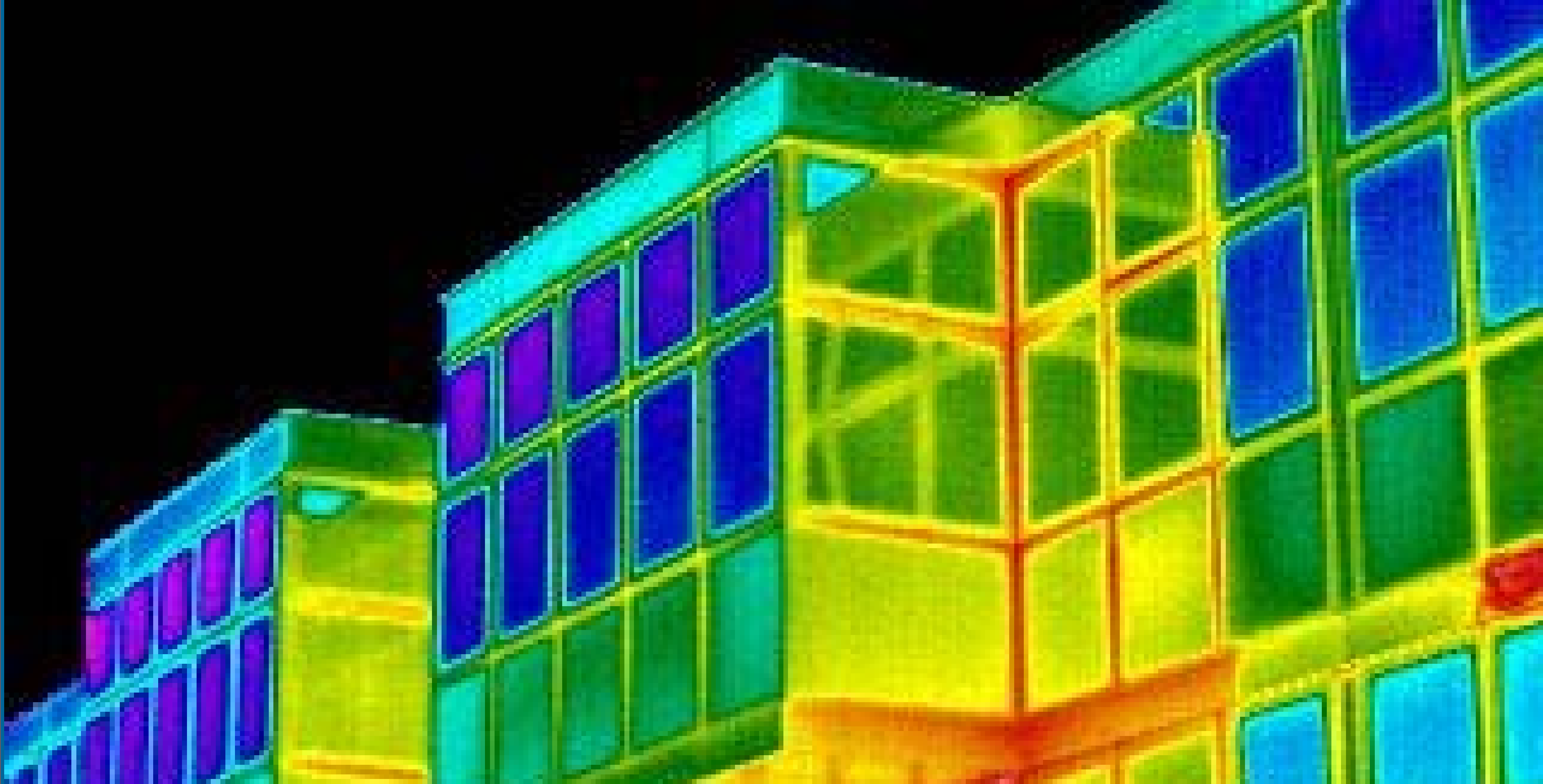

Thermal Bridging Solutions

Improving Building Envelope Performance

ARMATHERM™
THERMAL BREAK SOLUTIONS

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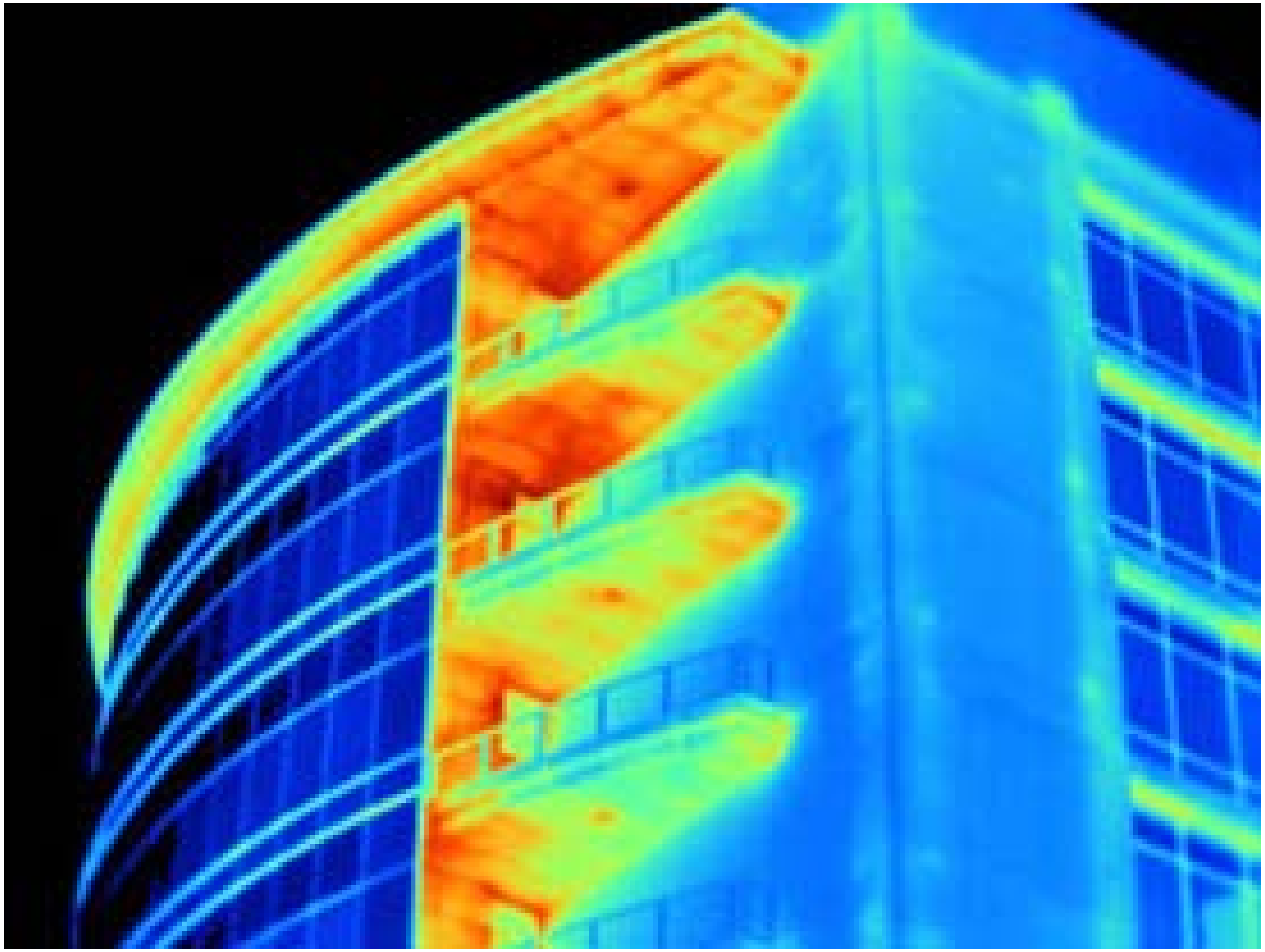
Course Summary



Learning Objectives

By the end of this online learning module, you should be able to:

- Define thermal bridging
- Describe why thermal bridging occurs
- Explain the effects of thermal bridging
- Describe how to calculate effective wall assembly U values
- Describe the different solutions available to prevent thermal bridging

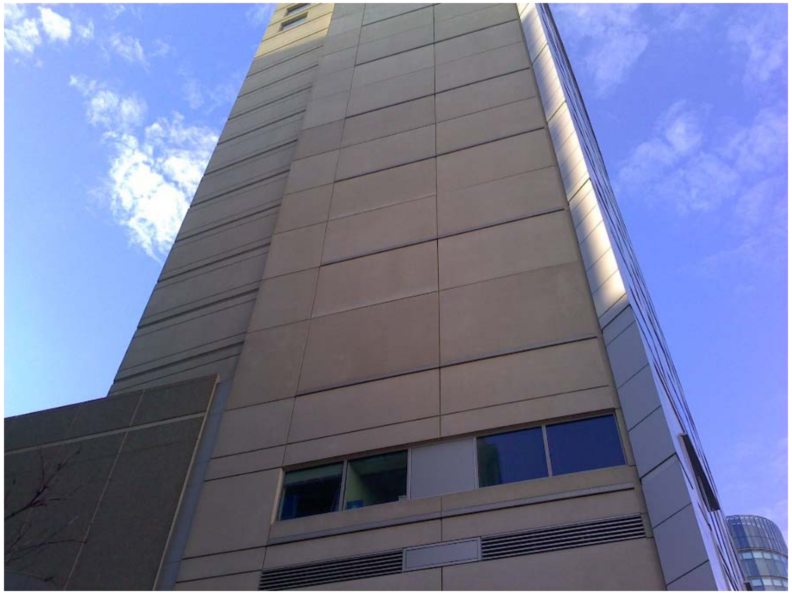
Thermal Bridging

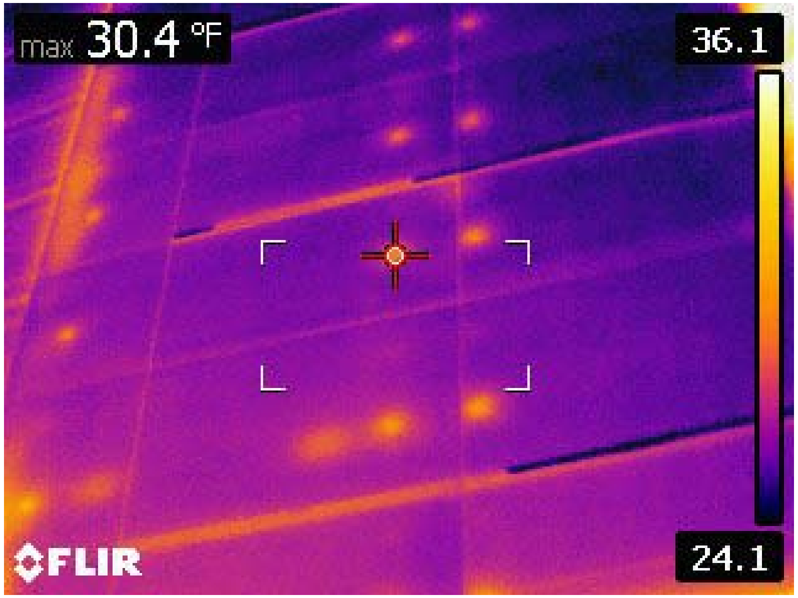
What is Thermal Bridging?

- Canopies
- Balconies
- Cladding

How is Thermal Bridging Identified

- Thermal imaging cameras





Key Terms

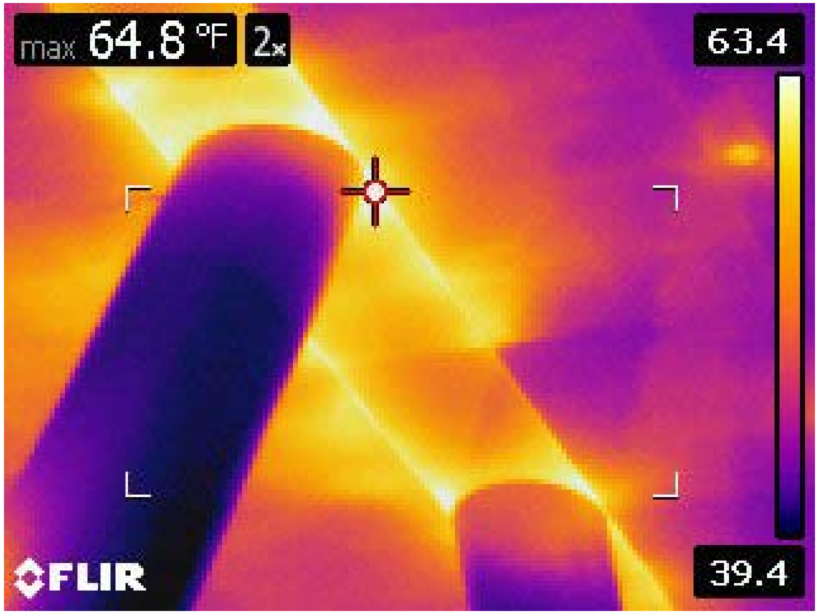
- **Thermal envelope** - all building elements that totally encase the heated or cooled spaces of a building to resist heat flow between the interior and exterior.

- **Thermal break** - element of low thermal conductivity placed in a system or assembly to reduce or prevent the flow of thermal energy between conductive materials.

- **Thermal conductivity** - Thermal conductivity (k) is the amount of energy a material will conduct in BTU (British Thermal Unit) per hour, per square foot, per inch of thickness, per degree Fahrenheit.

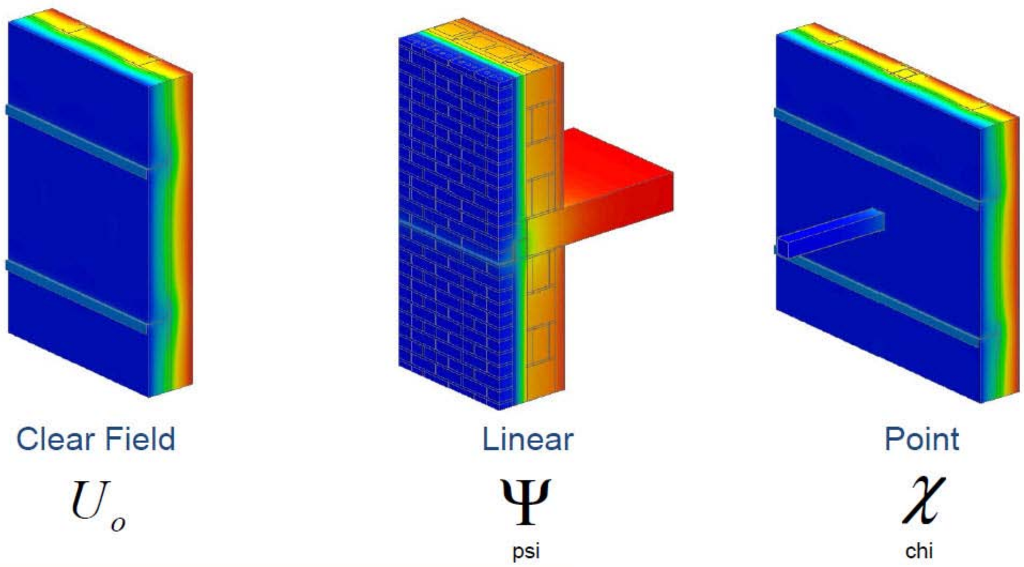
Area Weighted Calculations

- **U value** - U value measures the rate of heat flow through an assembly per unit area per temperature difference.
- **R value** - R value measures a material's resistance to heat flow.



Linear and Point Transmittances

- **Clear field transmittance** – heat flow through an assembly without thermal irregularities. *The clear field transmittance is a heat flow per unit area.*
- **Linear transmittance** – the additional heat flow caused by details that can be defined by a characteristic length. *The linear transmittance is a heat flow per unit length.*
- **Point transmittance** – the additional heat flow caused by thermal bridges that only occur at a single location. *The point transmittance is a single additive amount of heat loss.*



Examples of Thermal Bridging

Why is Thermal Bridging a Concern?

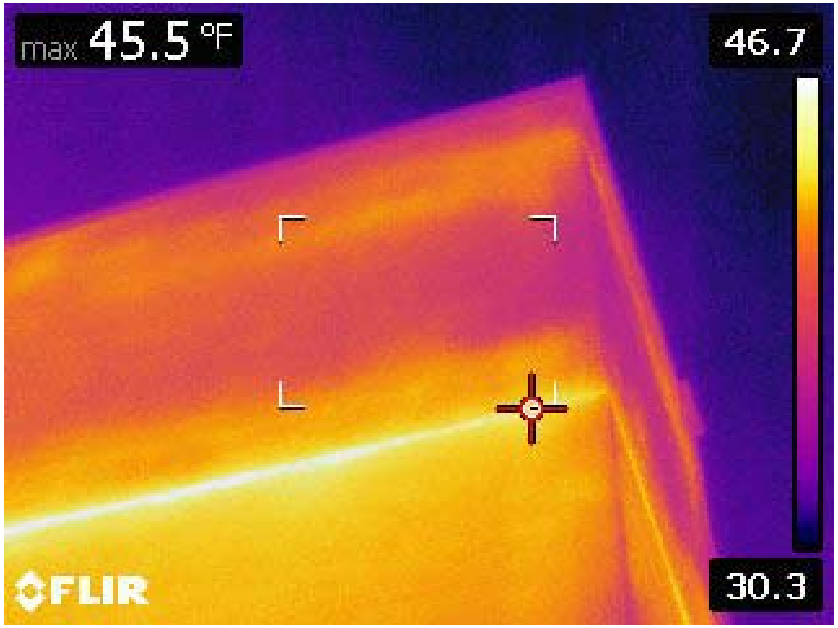
- Potential condensation issues
- Creates significant energy losses
- Reduces insulation effectiveness by up to 50%.

Thermal Bridging Facts

- Reduces the R value and insulation effectiveness of a wall assembly by as much as 50%
- 18 quadrillion BTU were used in commercial buildings. 19% of total national energy use.
- Commercial buildings <25,000ft2 consume 45% of energy used by structures in America.
- Thermal bridging is not area dependent

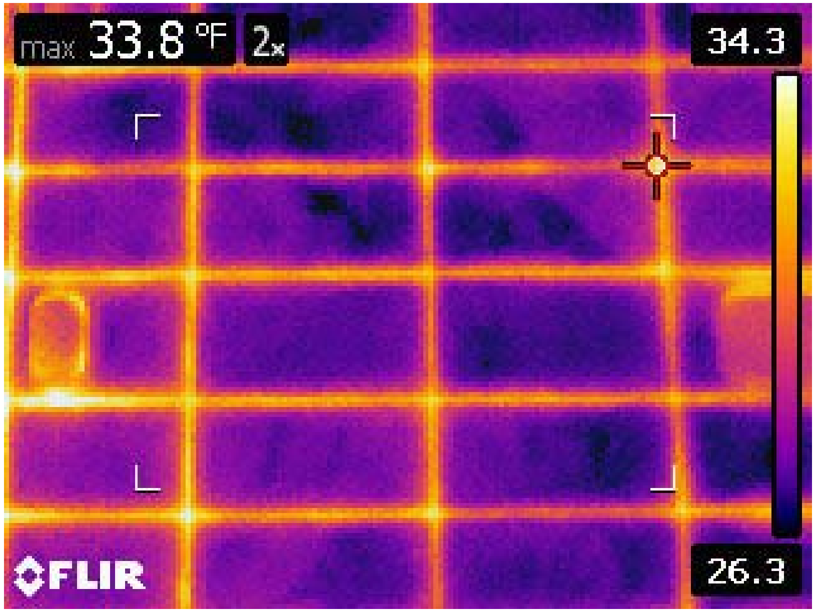
Examples of Thermal Bridging

- Masonry Shelf Angles



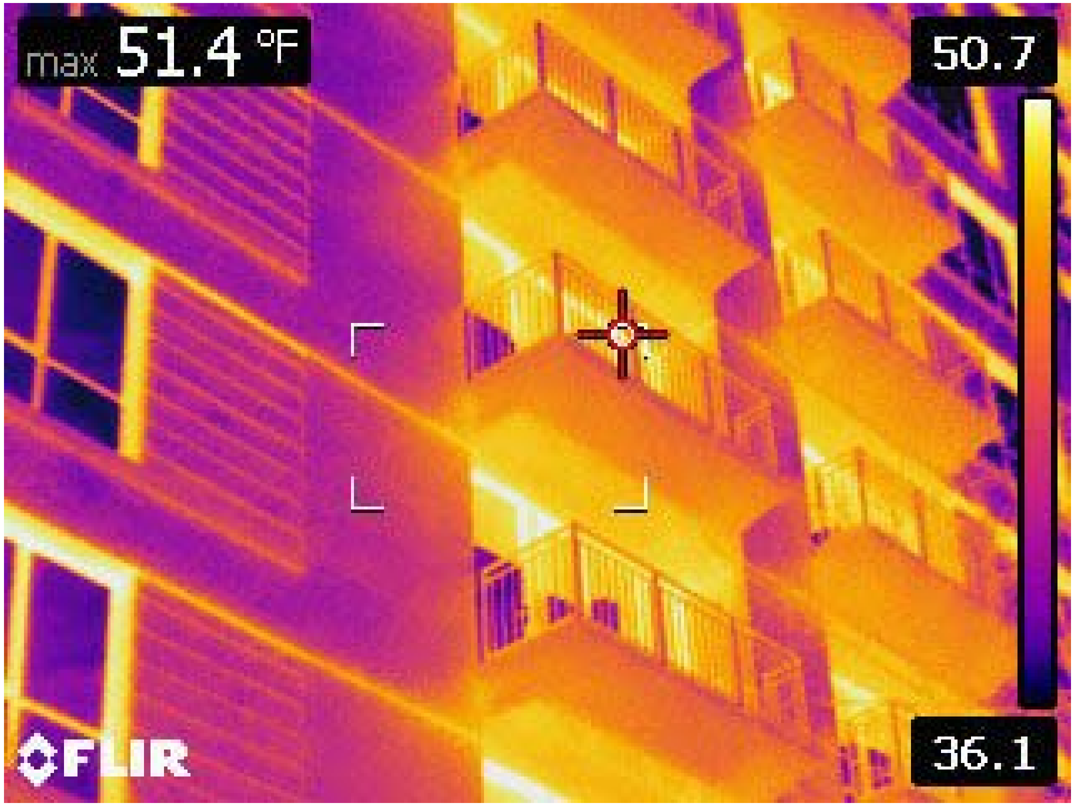
Examples of Thermal Bridging

- Z girt/cladding attachment



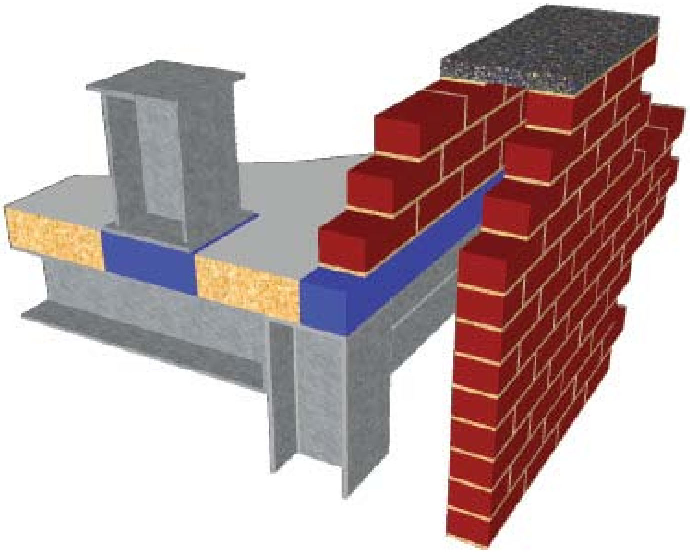
Examples of Thermal Bridging

- Balconies



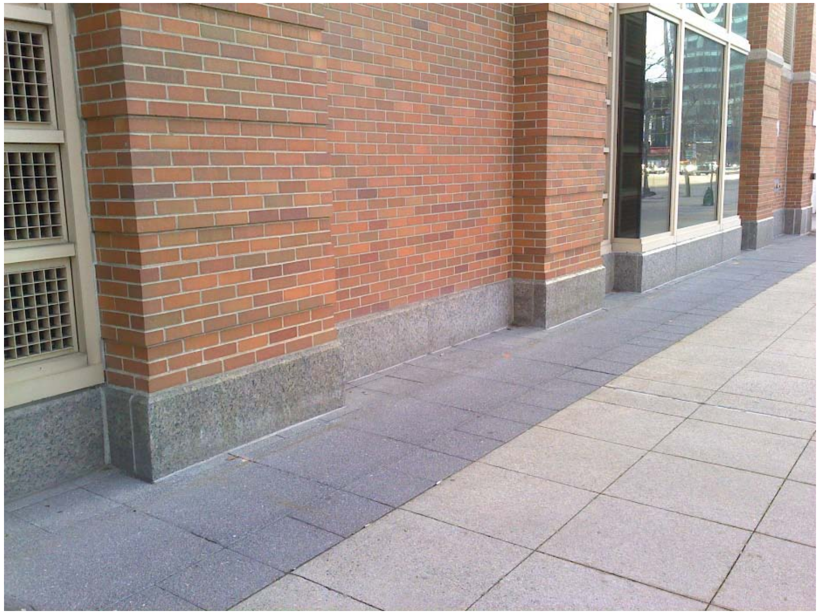
Examples of Thermal Bridging

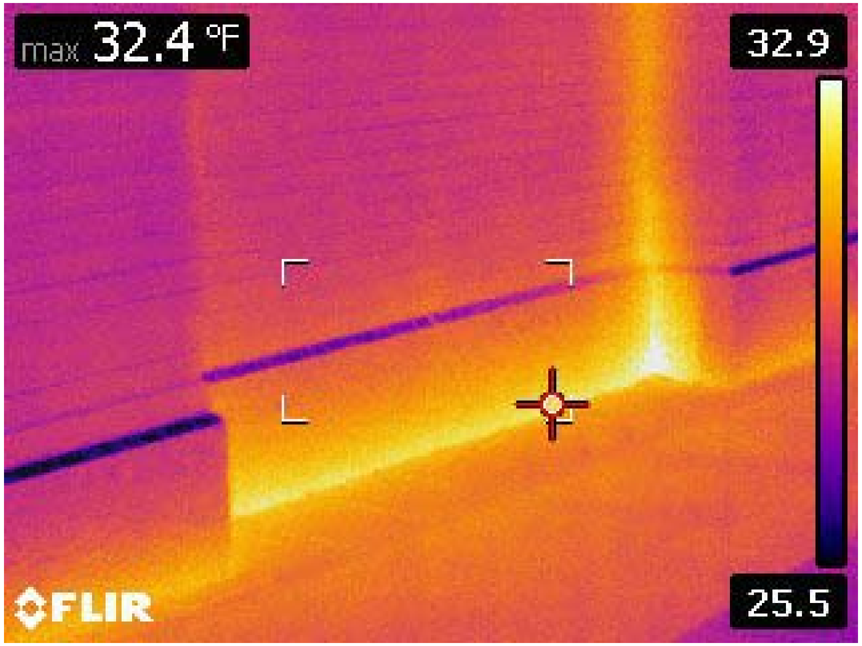
- Roof Penetration and Parapets



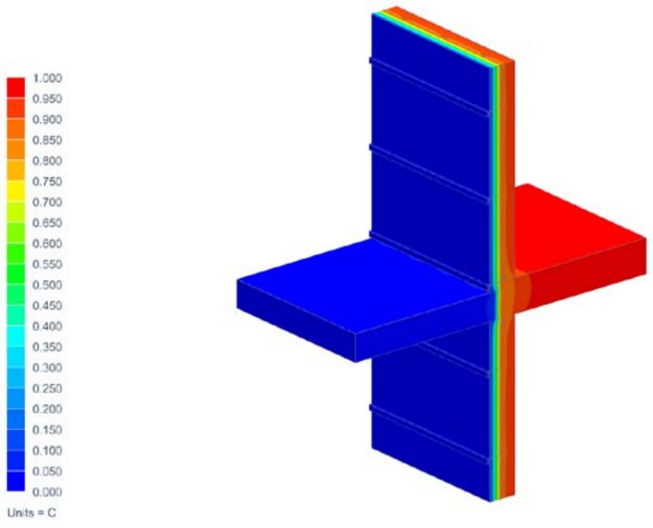
Examples of Thermal Bridging

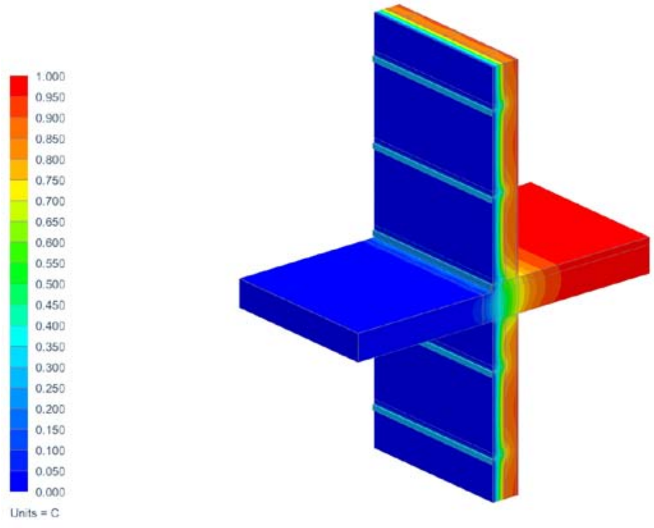
- Wall to Foundation Transition





Concrete Balcony





Concrete Balcony
With Thermal Break

Concrete Balcony
Without Thermal Break

Effects of Thermal Bridging

Effects of Thermal Bridging

- Reduces energy efficiency, higher energy consumption
- Oversizing of HVAC systems
- Operational inefficiencies
- Condensation

Condensation

- Appears when the temperature at the internal surface of an external wall is at or below the dew point temperature.

- How can we reduce the risk of condensation?
  - Using thermal break materials and vapor barriers
  - Force the dew point outward of the thermal envelope

Assessing the Condensation Risk

- Use the temperature index (TI)

$$TI = \frac{T_s - T_o}{T_i - T_o}$$

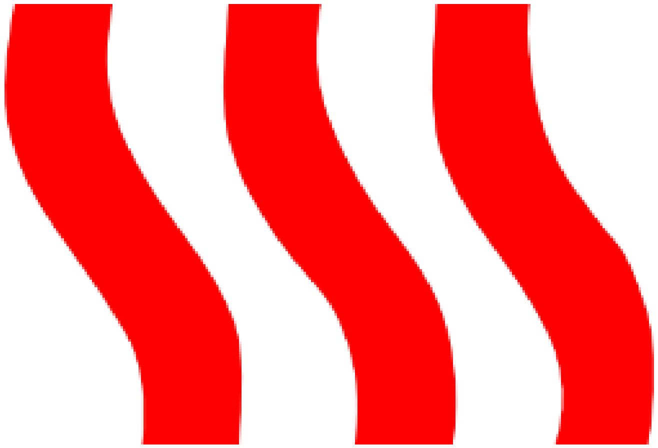
T_s: temperature of the coldest internal surface

T_o: outdoor air temperature

T_i : -Internal air temperature

Quantifying the Effect of Thermal Bridging

Quantifying Impact of Heat Loss



Measuring Thermal Performance

Overall heat flow: $Q = \Sigma Q_{thermalbridge} + Q_o = \Sigma(\Psi \cdot L) + \Sigma(\chi) + Q_o$

Per area: $$U = \frac{\Sigma(\Psi \cdot L) + \Sigma(\chi)}{A_{Total}} + U_o$$

Thermal Break Solutions

Solutions to Prevent Thermal Bridging

- Low thermal conductivity materials
- Thermoplastics
- High strength materials
- Thermoset materials

Thermoplastics vs Thermoset Materials

Thermoplastics

- Nylon
- PVC
- Teflon
- Rubber materials – neoprene and nitrile

Cons

Creep

Permanent set under load

Thermosets

- Polyurethanes
- Epoxy resins

Pros

- More resistant to creep
- Low thermal conductivities

Low thermal conductivity materials vs High Strength Materials

Low Thermal Conductivity Materials

- Plastic composites
- Foam based compounds

Con

- Low strength materials

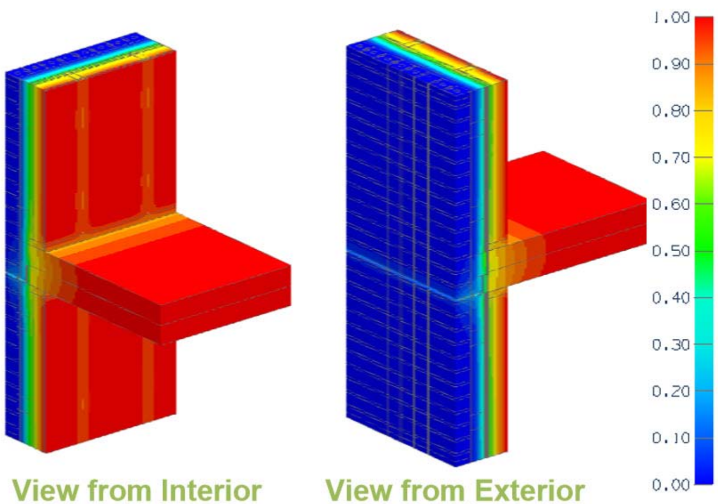
High Strength Materials

- High thermal conductivity values

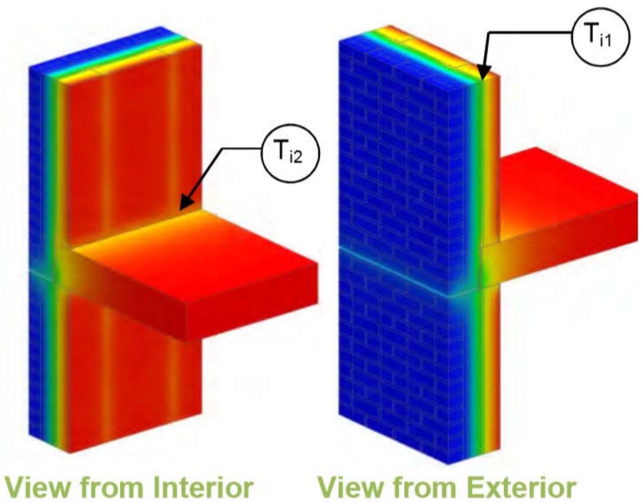
Pro

Sufficient strength for structural support

Masonry Shelf Angles



Shelf Angle
With Thermal Break

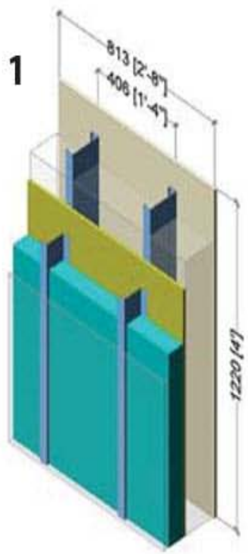


Shelf Angle
Without Thermal Break

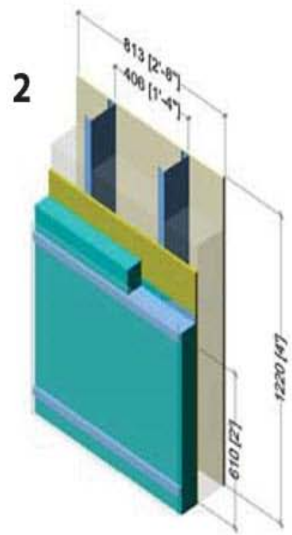
Thermal Break Solution for Shelf Angle

Source	Scenario	Exterior + Cavity Insulation 1D R-Value BTU/ft²·hr·°F (W/m² K)	Clear Wall R-Value BTU/ft²·hr·°F (W/m² K)	Assembly with Shelf Angle R-Value BTU/ft²·hr·°F (W/m² K)	Linear Transmittance of Shelf Angle BTU/hr.ft.°F (W/mK)
BETB 5.2.9	Continuous Steel Shelf Angle	R-15 + R-12 (2.64 +2.11)	R-19.8 (3.48)	R-9.9 (1.74)	**0.314 (0.544)**
BETB 5.2.10	Spaced Steel Shelf Angle with Flashing	R-15 + R-12 (2.64 +2.11)	R-19.8 (3.48)	R-12.6 (2.17)	**0.188 (0.326)**
Armadillo Modelling	Steel Shelf Angle with 25mm Armatherm FRR and washer with metal Flashing	R-15 + R-12 (2.64 +2.11)	R-19.8 (3.48)	R-11.3 (1.98)	**0.234 (0.405)**
Armadillo Modelling	Steel Shelf Angle with 25mm Armatherm FRR and washer with S.A.M. Flashing	R-15 + R-12 (2.64 +2.11)	R-19.8 (3.48)	R-13.8 (2.43)	**0.135 (0.234)**

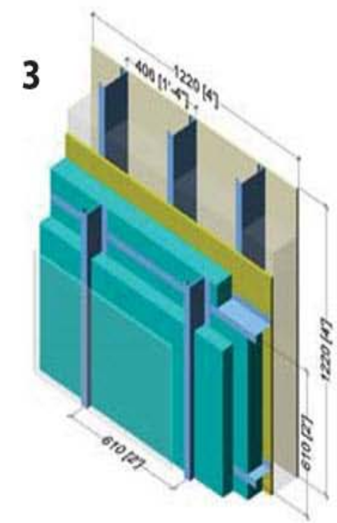
Metallic Clip And Girt Attachments



VERICAL Z-GRITS



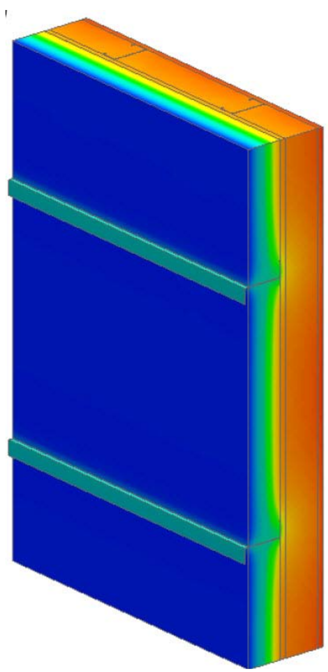
HORIONTAL Z-GRITS



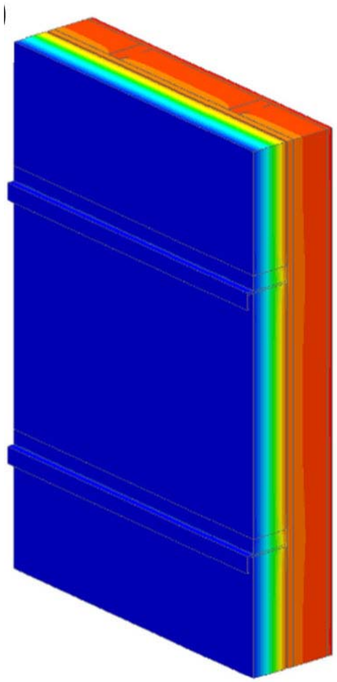
VERTICAL and

HORIZONTAL Z-GRITS

Thermal Break Solution For Cladding Attachments

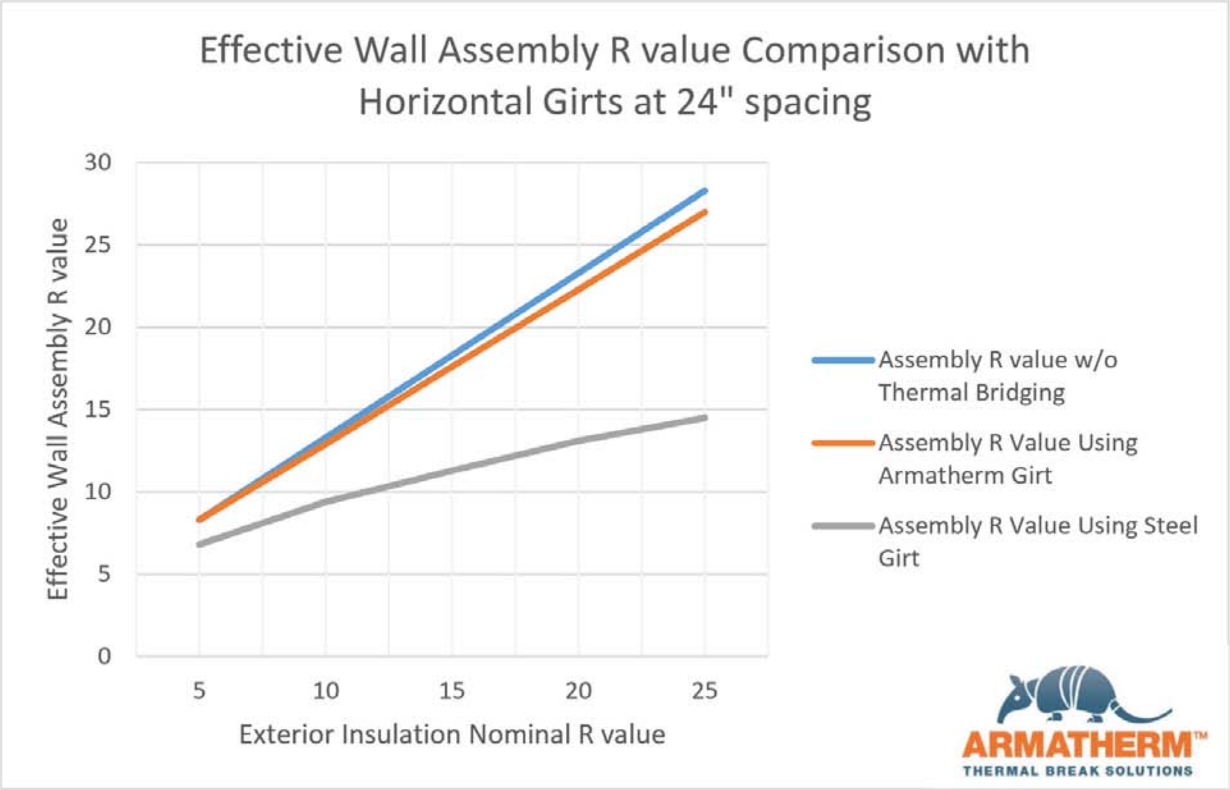


Cladding Using Steel Z Girts Creating Linear Thermal Bridges

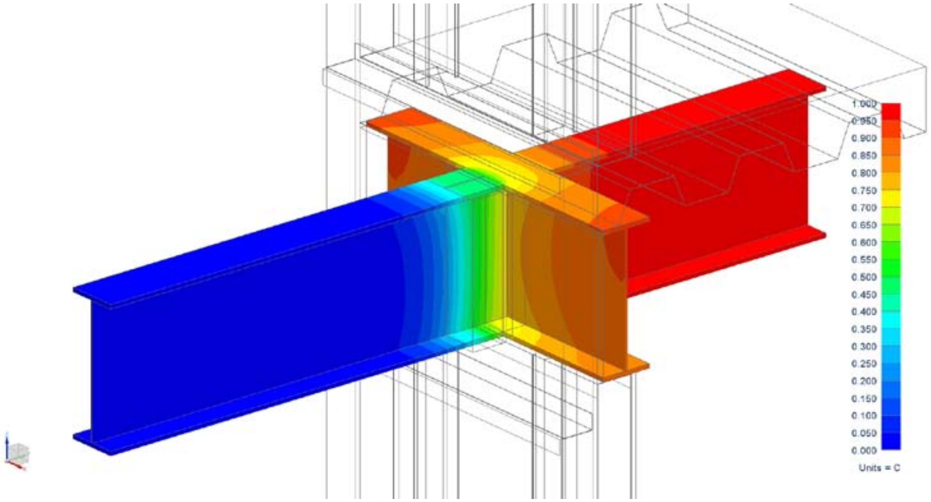


Cladding Using Thermally Broken Z Girts

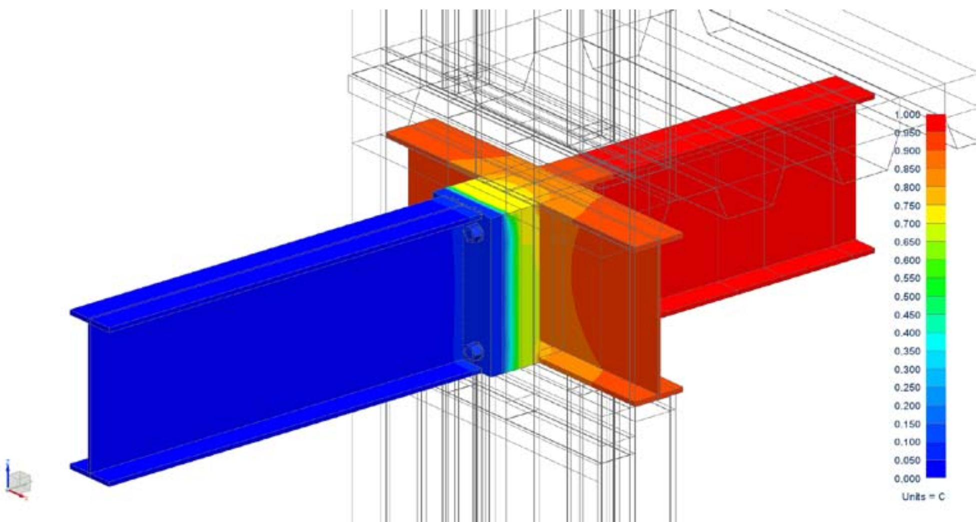
Thermal Break Solution For Cladding Attachments



Balcony/Canopy Through Beam



Steel Balcony Beam Without Thermal Break

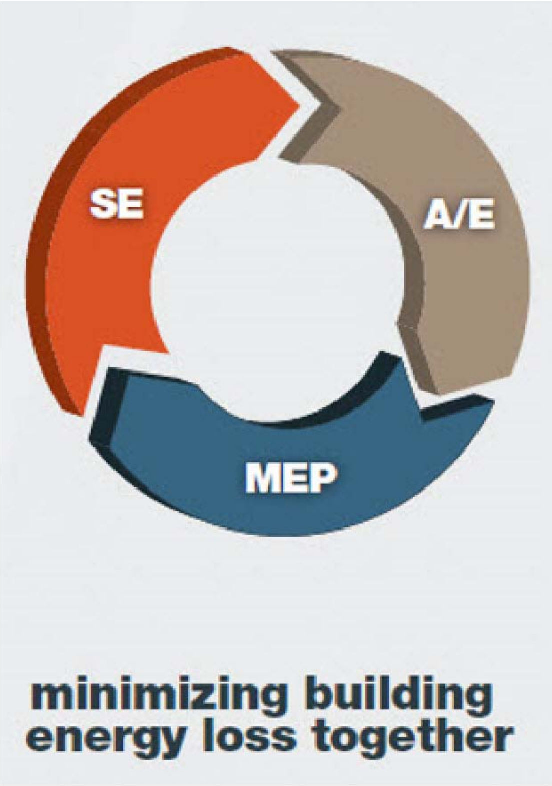


Steel Balcony Beam With Thermal Break

Thermal Break Solution For Balcony/Canopy Through Beam

Scenario	Exterior Insulation 1D R-Value ft²·hr·°F/BTU (m² K/W)	Clear Wall R-Value (R_O) ft²·hr·°F/BTU (m² K/W)	U_O BTU/ft²·hr·°F (W/m² K)	R *effective* with Slab and Beam ft²·hr·°F/BTU (m² K/W)	U *effective* with Slab and Beam BTU/ft²·hr·°F (W/m² K)	Point Transmittance of Beam BTU/hr·°F (W/K)
Continuous Beam	R-15 (2.64)	R-18.5 (3.25)	0.054 (0.31)	R-6.9 (1.21)	**0.145 (0.83)**	**1.73 (0.92)**
1" Armatherm FRR using steel bolts	R-15 (2.64)	R-18.5 (3.25)	0.054 (0.31)	R-7.3 (1.28)	**0.138 (0.78)**	**1.56 (0.83)**
1" Armatherm FRR using stainless steel bolts	R-15 (2.64)	R-18.5 (3.25)	0.054 (0.31)	R-8.4 (1.48)	**0.119 (0.68)**	**1.16 (0.62)**
1" Armatherm FRR using stainless steel bolts and FRR washers and bushings	R-15 (2.64)	R-18.5 (3.25)	0.054 (0.31)	R-9.2 (1.61)	**0.109 (0.62)**	**0.95 (0.50)**
2" Armatherm FRR using stainless Steel bolts and FRR washers and bushings	R-15 (2.64)	R-18.5 (3.25)	0.054 (0.31)	R-10.2 (1.79)	**0.098 (0.56)**	**0.72* (0.38)**

Summary



Thank You

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Quiz Instructions

You will now complete a 10-question quiz. To earn credit on this learning unit, you must answer 8 of 10 questions correctly to achieve a passing score. You will receive feedback immediately after each question. If you answer more than two questions incorrectly you will be able to finish the quiz, but upon completion you will be given the opportunity to return to the beginning of the quiz for another attempt.

Click Next to begin.

Completion

You have completed this course attempt. If you did not pass the quiz, you may go back and retry by clicking on the “Retry Quiz” button. If you passed the quiz, you may exit the course by clicking on the “x” in the top right corner of the course player window.