A Case for Continuous Insulation

Building Science, Market Demand and Common Sense

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Course: BASF-GPS02

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We create chemistry

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Learning Objectives

- Understand the building science principles behind thermal comfort
- Review thermal resistance of assemblies vs. materials which translate to building occupant comfort
- Explain practical solutions for working with continuous insulation to ensure building envelope integrity.
- Review third-party testing proving thermal performance of wall assemblies



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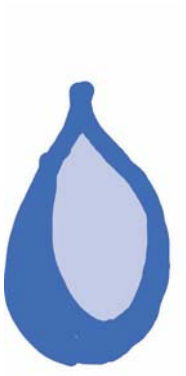
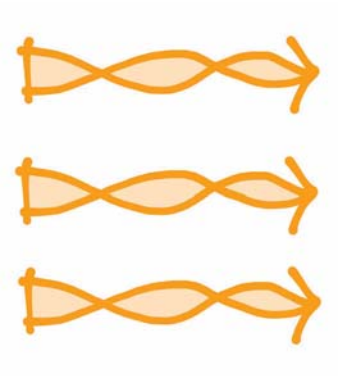
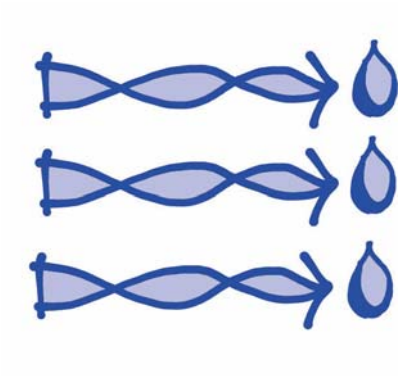
Control Layers and Building Science



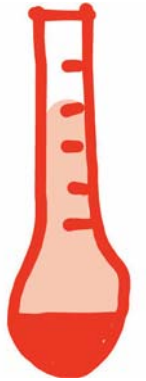
Bulk Water



Air

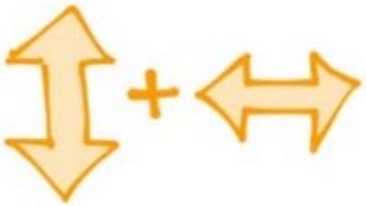


Vapor / Moisture



Thermal

Our Discussion Focus

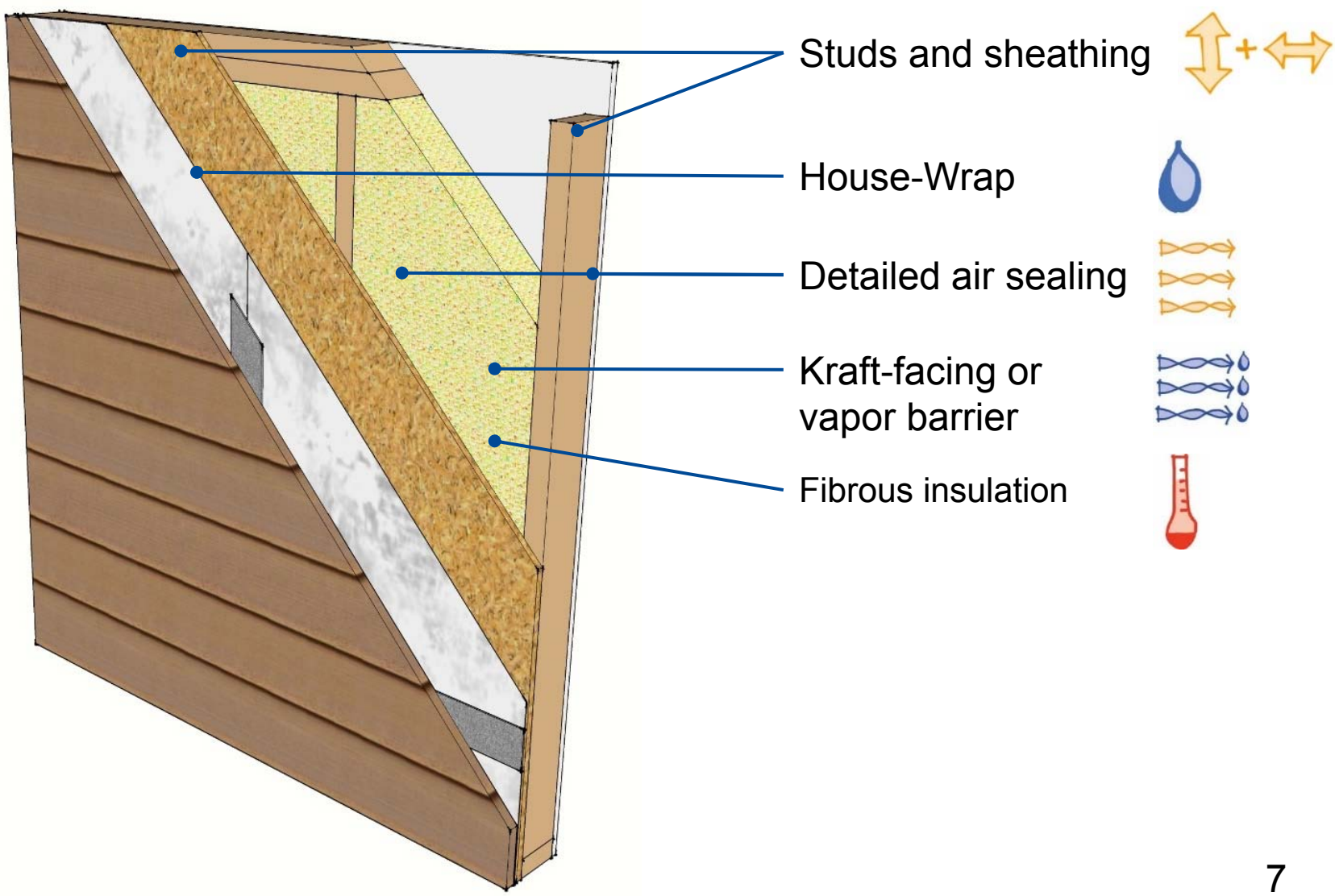


Structure

Bonus Topic

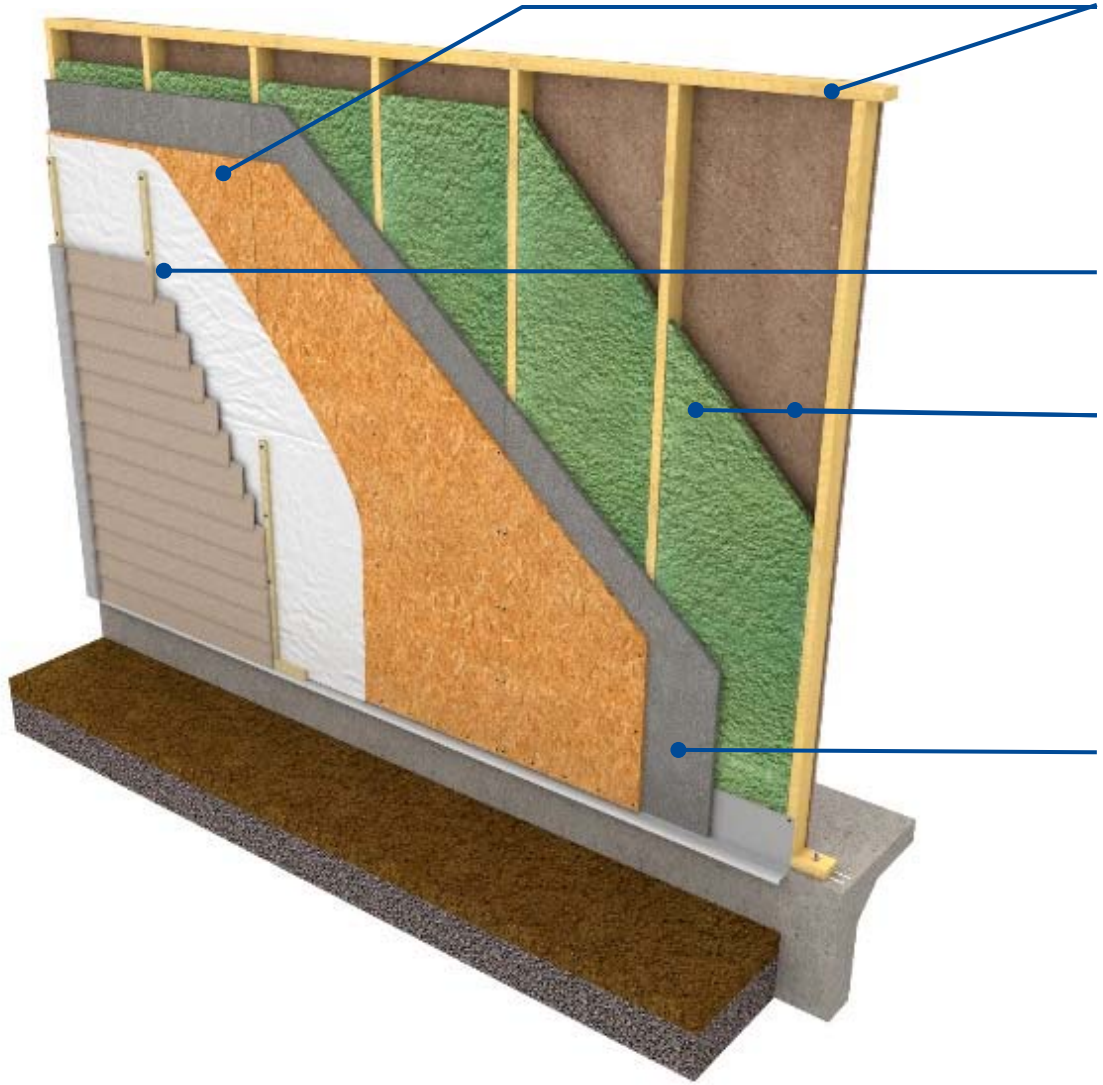
Control Layers and Building Science

Standard Construction

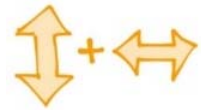


Control Layers and Building Science

High-Performance Construction

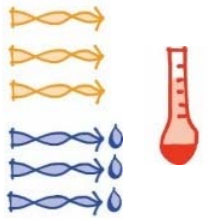


Advanced framing,
optional sheathing,
optional panelizing

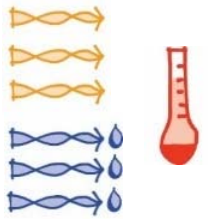


House-Wrap and
Rain Screen

Air-Sealing,
Vapor Retarder,
Thermal Insulation,
optional additional
fill insulation



Continuous Insulation,
Air Sealing,
Vapor Impermeable or
Vapor Permeable



Common types of continuous insulation

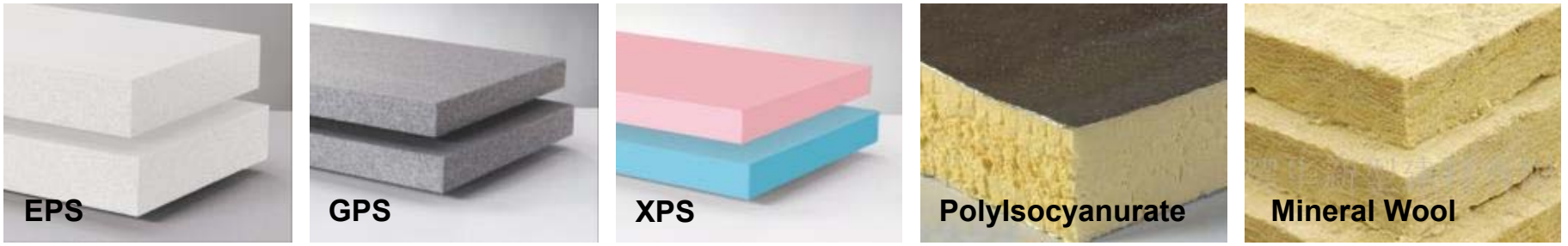
Expanded Polystyrene (EPS)

Graphite-Enhanced Expanded Polystyrene (GPS)

Extruded Polystyrene (XPS)

Polylsocyanurate – Polyiso

Mineral Wool

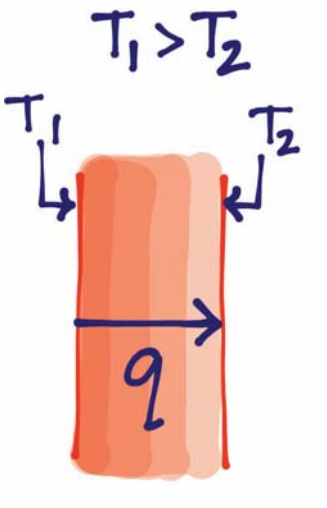


Graphite Polystyrene (GPS) – continuous insulation

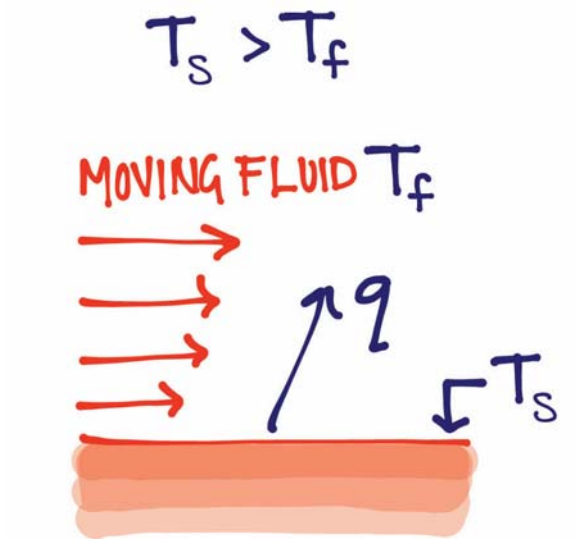
GPS rigid thermal insulation

- **Graphite** improves thermal performance by reducing radiant heat transfer
- Comparable R-value to XPS (**R-5 per 1”** nominal) at lower cost
- **Non HCFC** blowing agent (more ecofriendly than XPS)
- Optional termiticide
- **Facers** available for durability, drainage, and vapor control

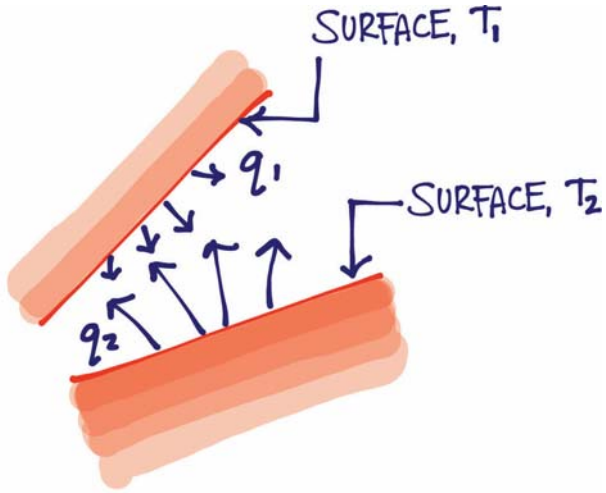
Heat Transfer



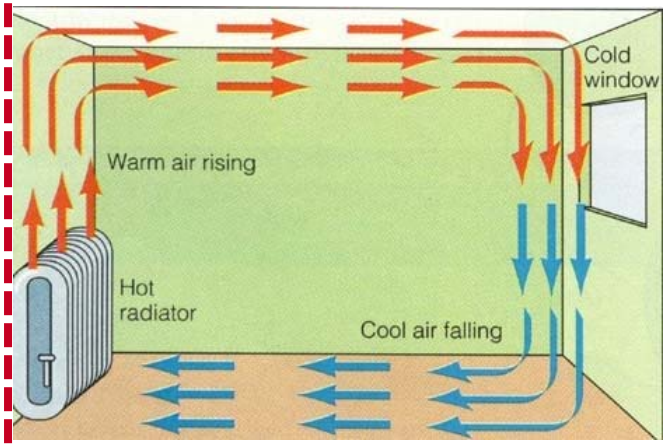
Conduction

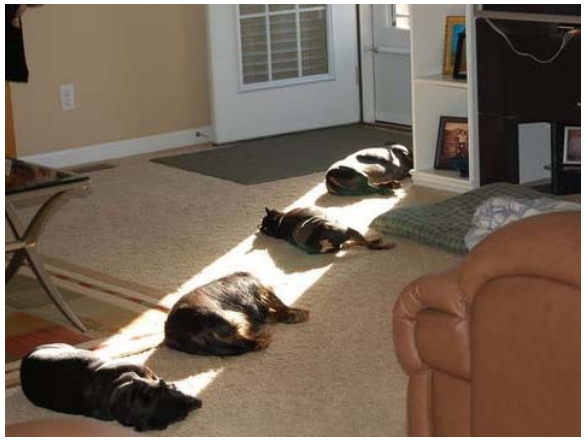


Convection



Radiation





Thermal Technology – Visual Thermal Bridge

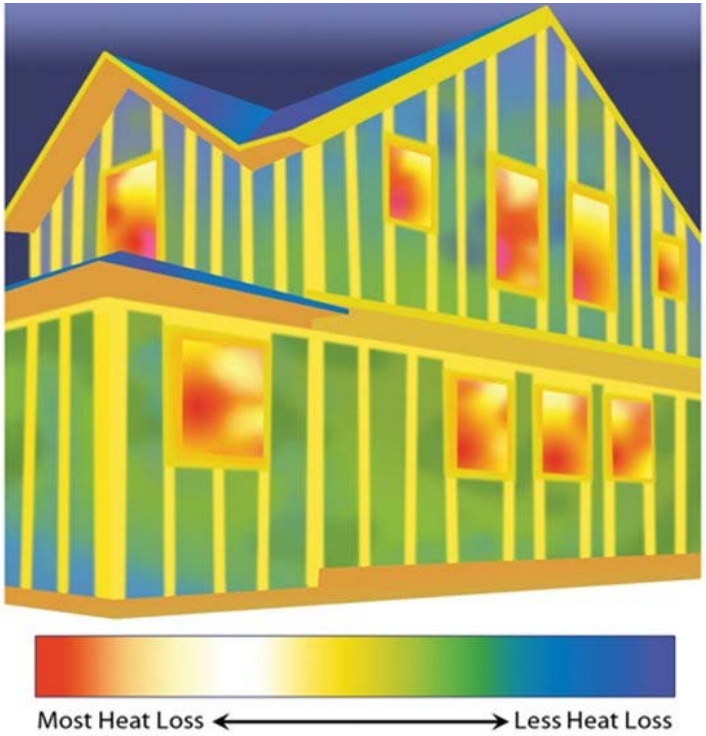


Photo courtesy of Autodesk Sustainability Workshop

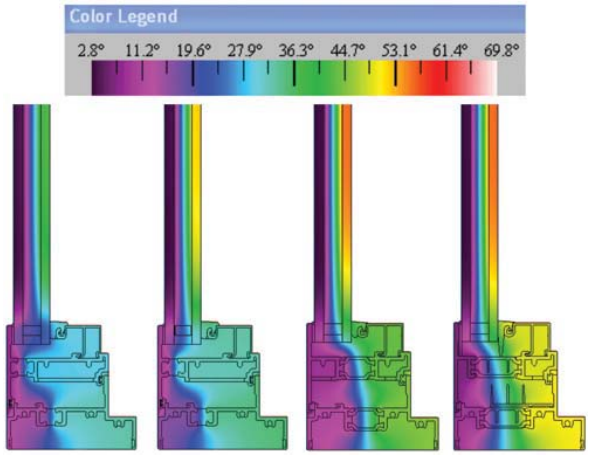


Photo courtesy of Manko Window Systems, Inc.

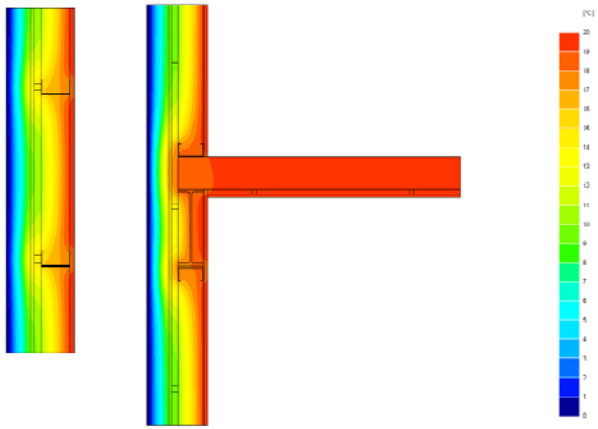


Photo courtesy of www.steelconstruction.info/Thermal_performance

Thermal Technology – Easier access

Photo courtesy of
George Showman – Flickr

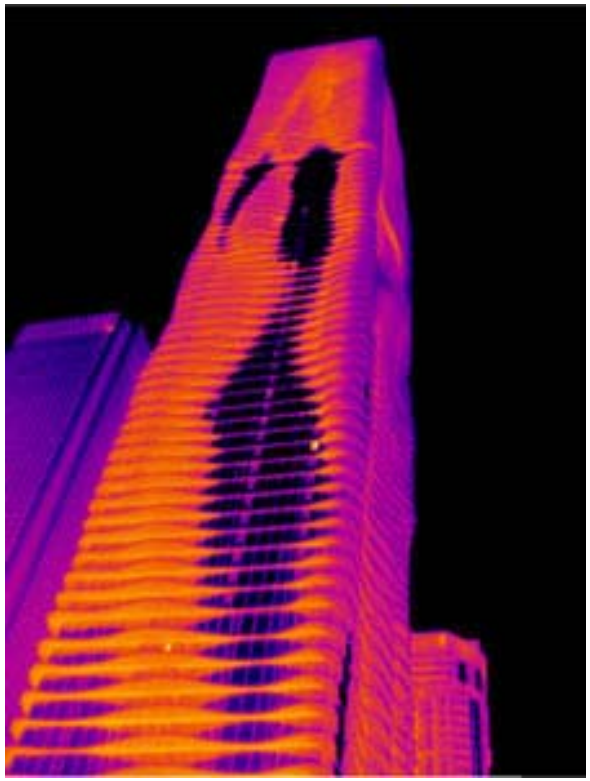
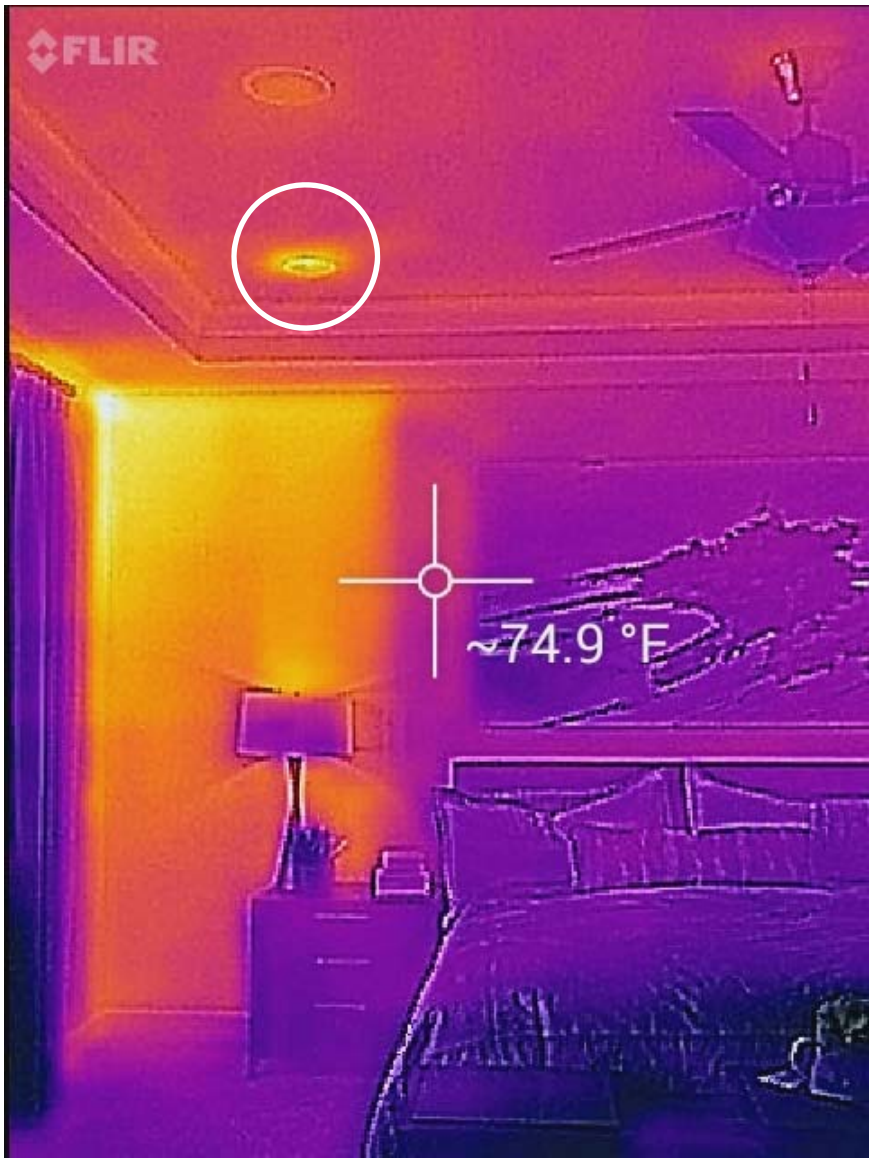


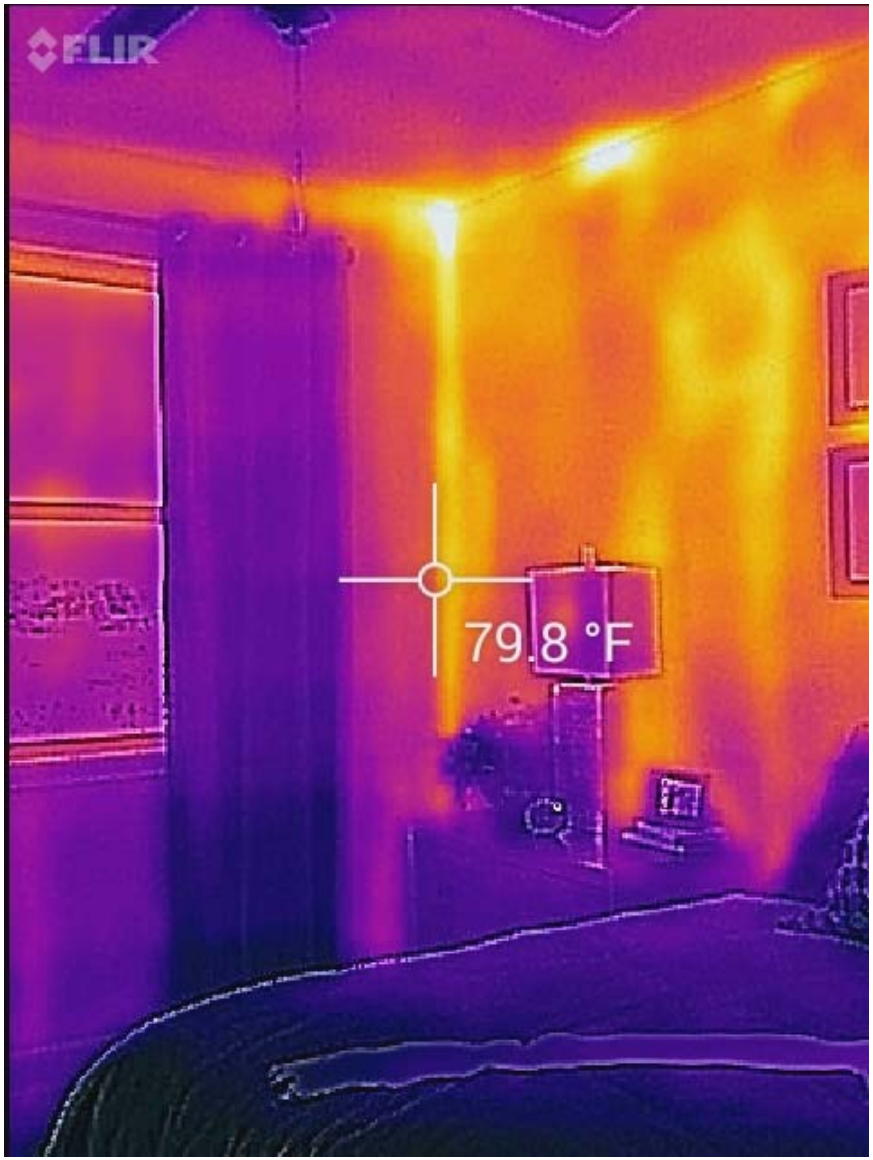
Photo courtesy of
Dave Robley, Thermographer – Fluke Corp
And Michael Stuart, L3 TI/IRT – Fluke Corp
Via Building Science Corporation

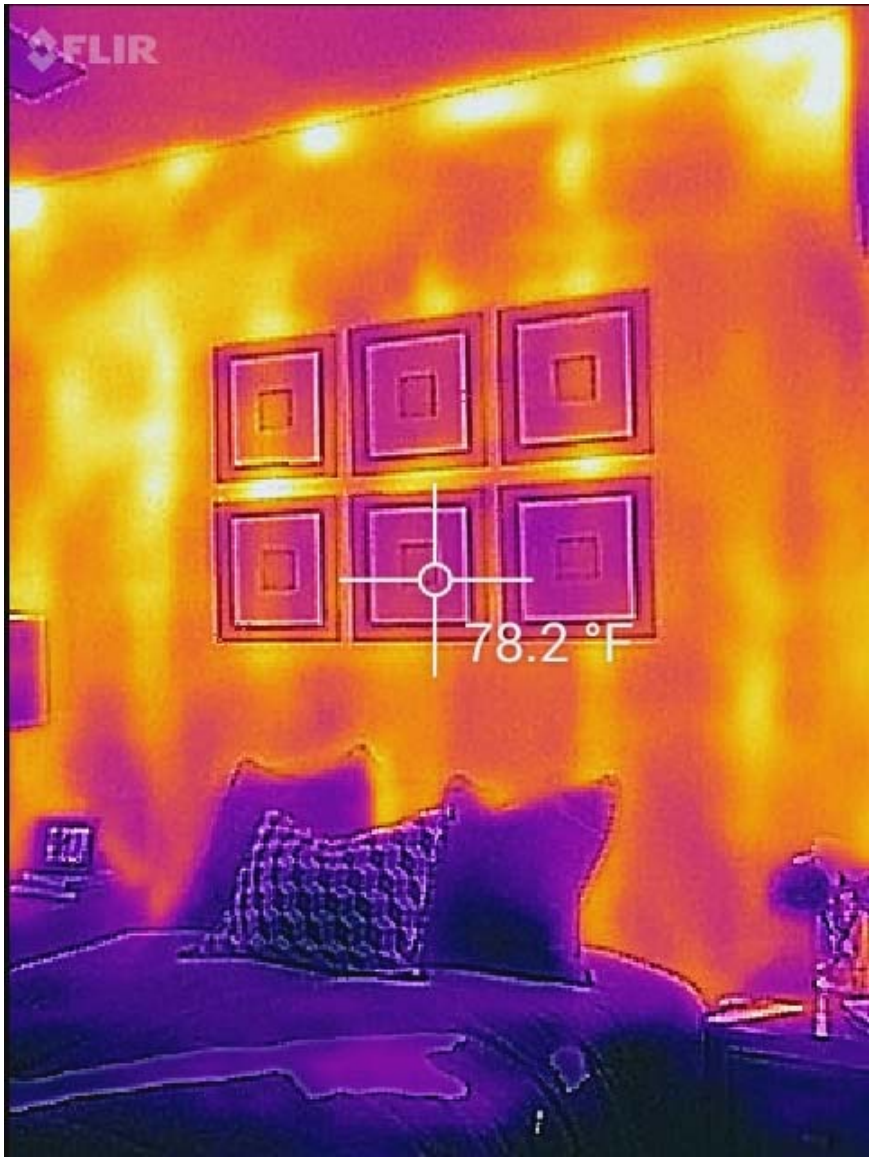
Photo courtesy of Amazon.com

Thermal Technology – In the field

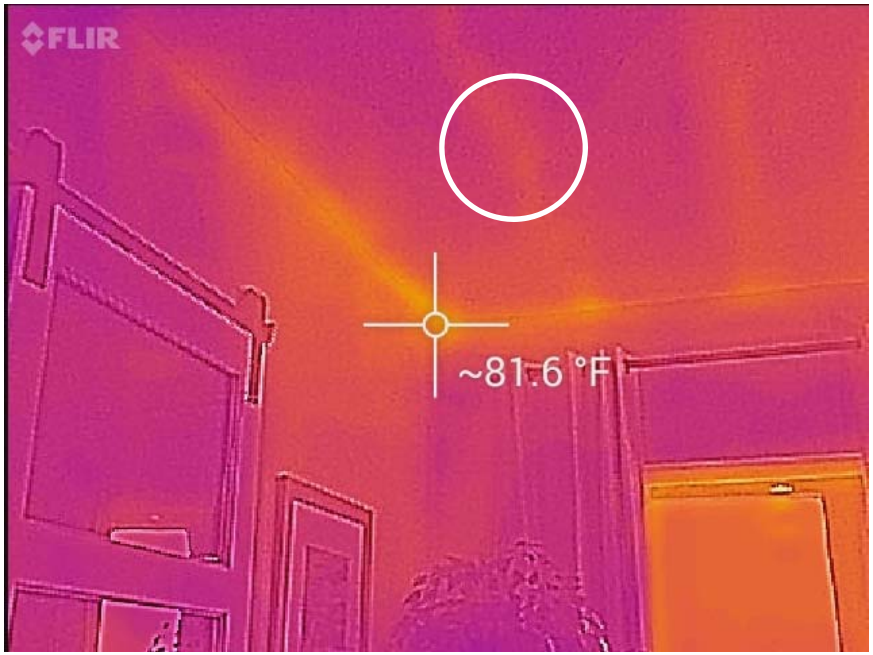


Thermal Technology – In the field





Thermal Technology – In the field



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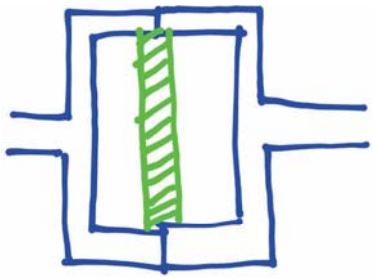
Current Thermal Testing



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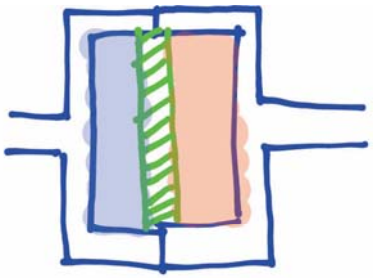

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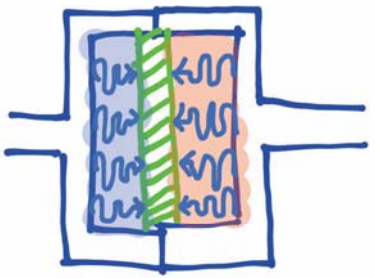

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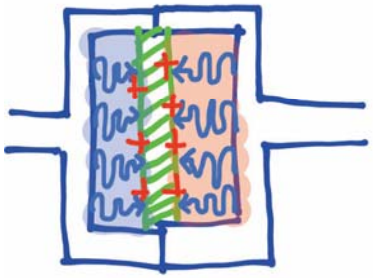

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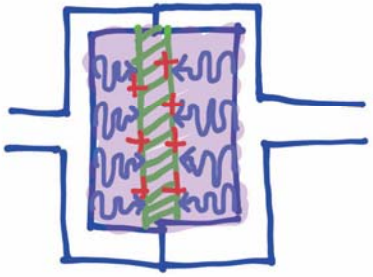

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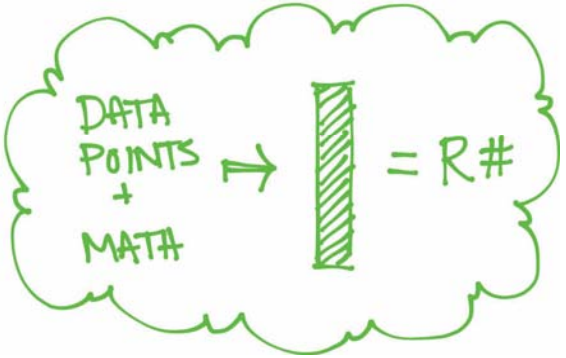
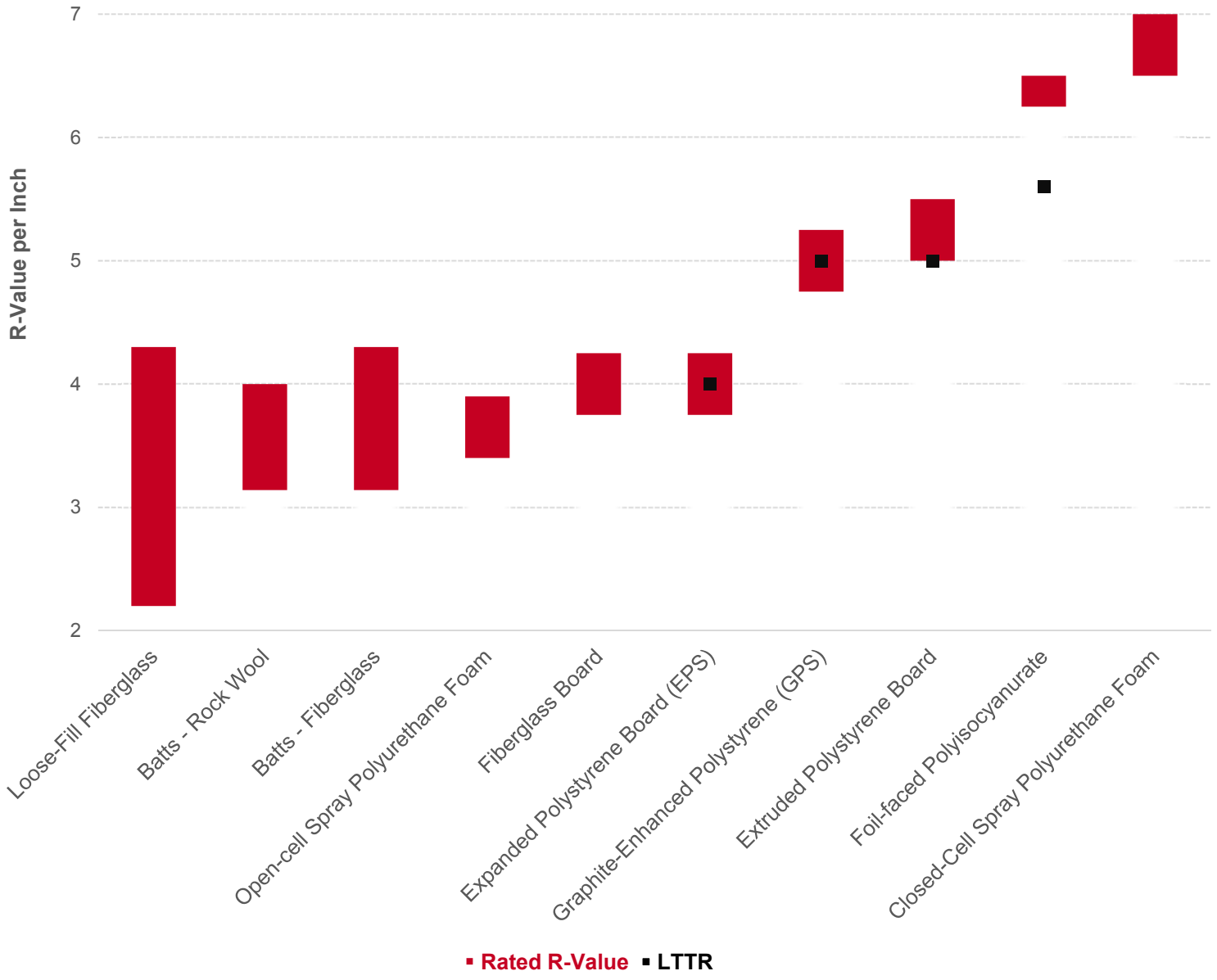
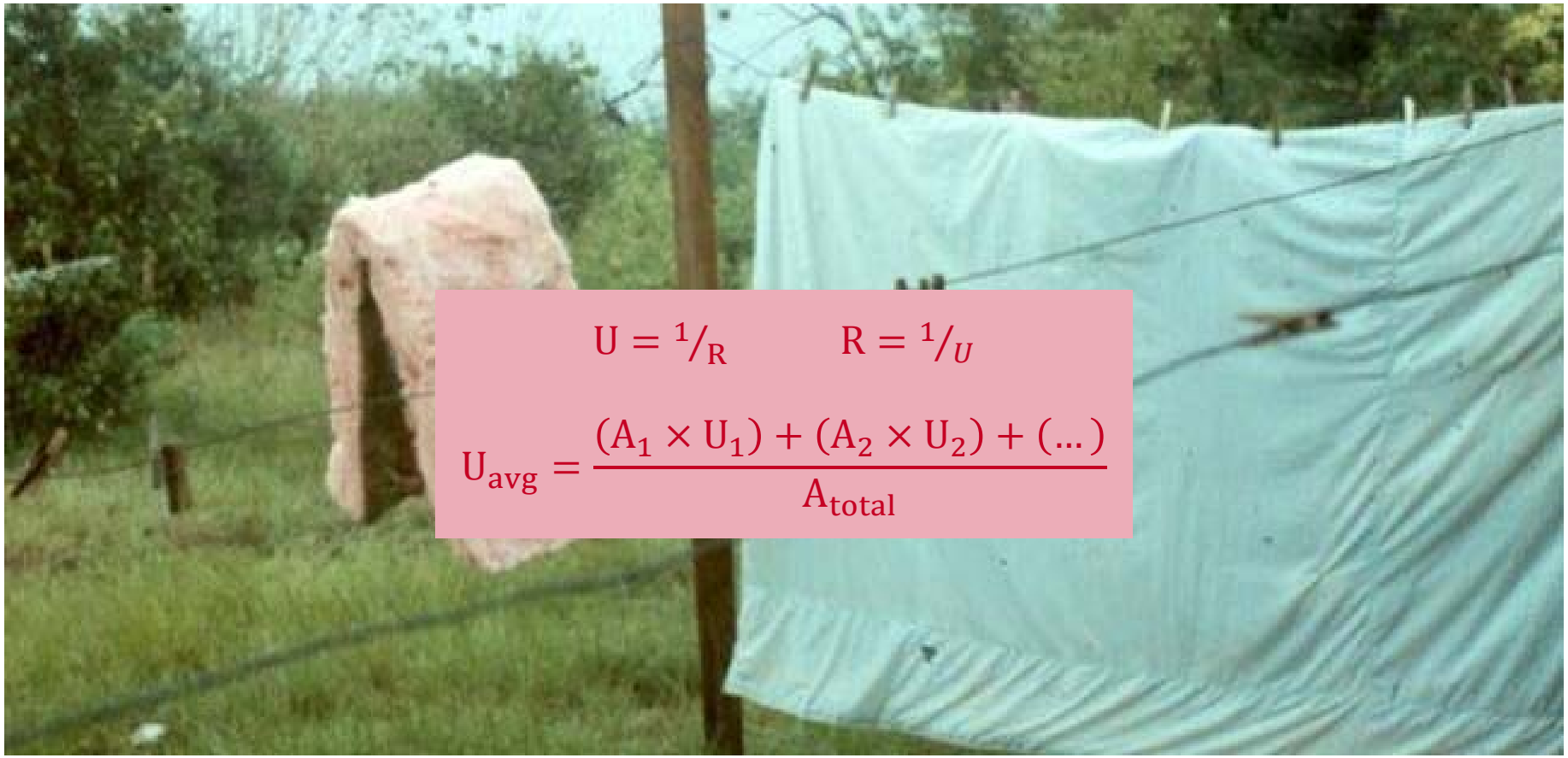


6

Representative R-Values



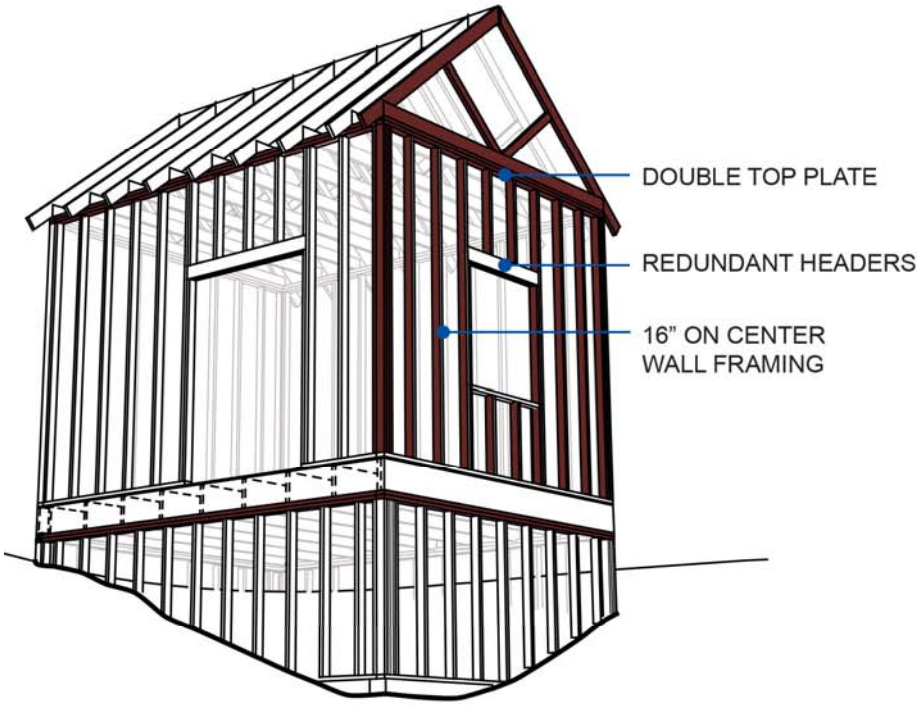
Effective R-value – it's the assembly



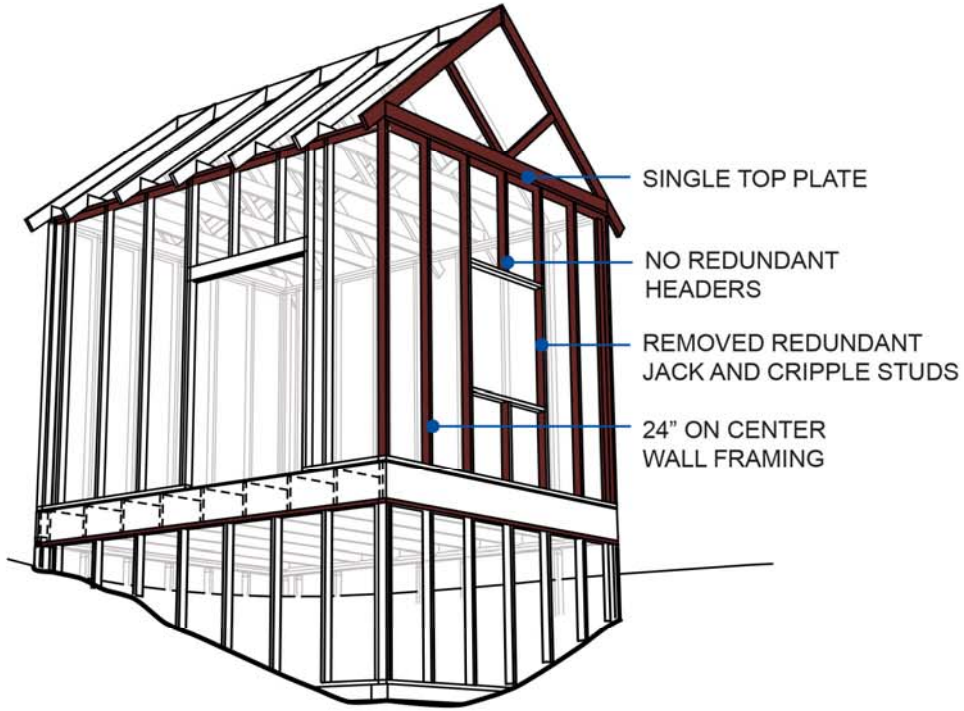
$$U = {}^{1}/_{R} \qquad R = {}^{1}/_{U}$$

$$U_{avg} = \frac{(A_1 \times U_1) + (A_2 \times U_2) + (\dots)}{A_{total}}$$

Framing and Thermal Bridging



Standard Framing
25% Uninsulated Wall Area

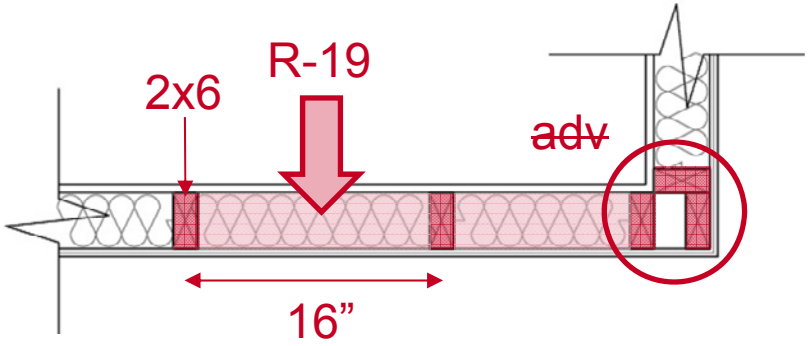


Advanced Framing
16% Uninsulated Wall Area

Impact of Cavity Insulation

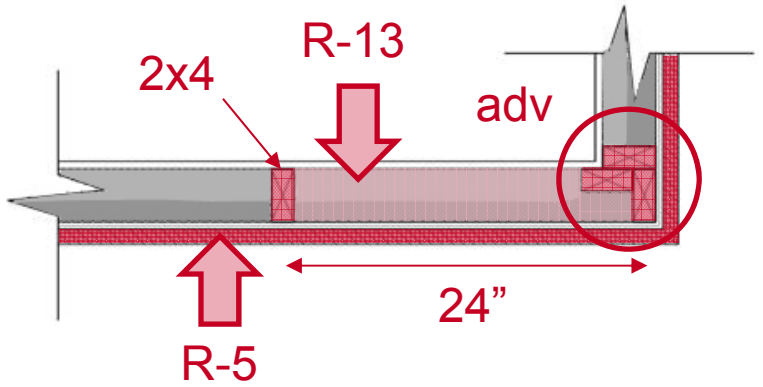
Impact of Continuous Insulation Blanket

Assembly R-value - The impact of CI



First Example
- 2x6 Wood Framing
- R-19 cavity insulation
- No continuous insulation

Second Example
- No advanced-framing techniques
- 16” o.c. framing spacing



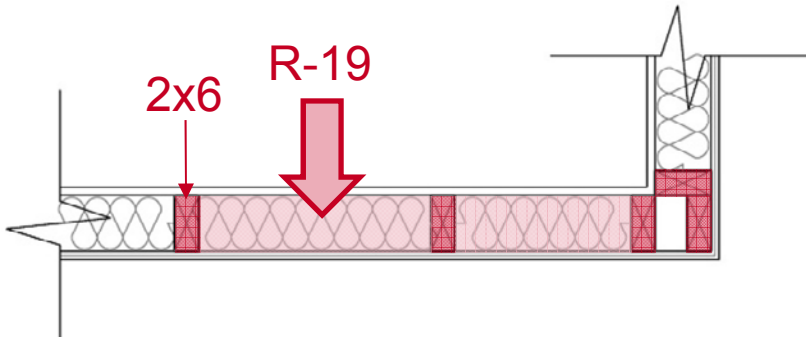
First Example
- 2x4 Wood Framing
- R-13 cavity insulation
- R-5 Continuous Insulation

- **Second Example**
- Advanced-framing techniques
- 24” o.c. framing spacing

Assembly R-value - The impact of CI

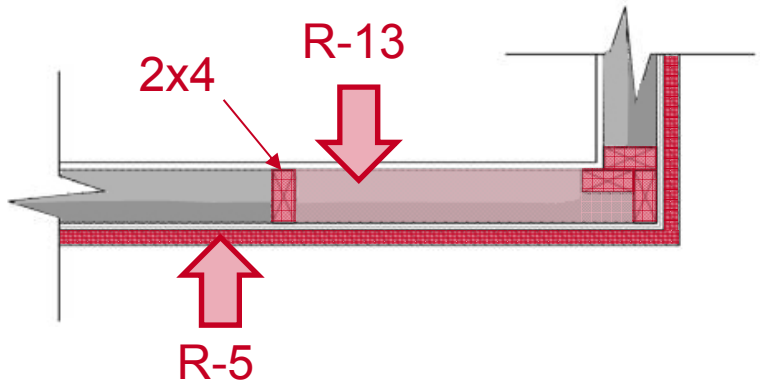
$$U_{avg} = \frac{(75\% \times 0.05) + (25\% \times 0.13) + (\dots)}{100\%} = 0.085$$

$$R = 1/U = 1/0.085 = R\text{-}11.77$$



$$U_{avg} = \frac{(75\% \times 0.06) + (25\% \times 0.12) + (\dots)}{100\%} = 0.071$$

$$R = 1/U = 1/0.071 = R\text{-}14.07$$



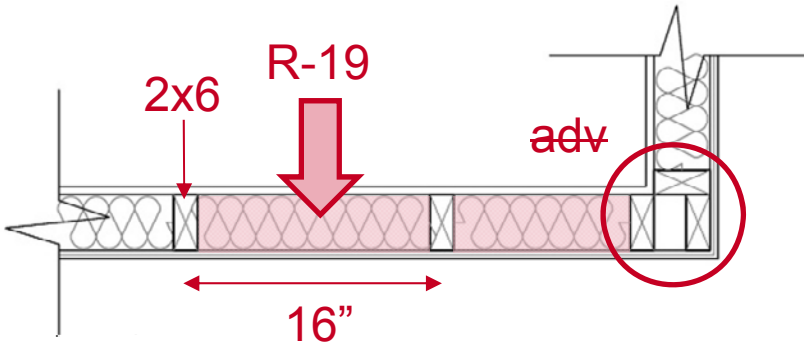
Assembly R-value - Impact of Advanced Framing

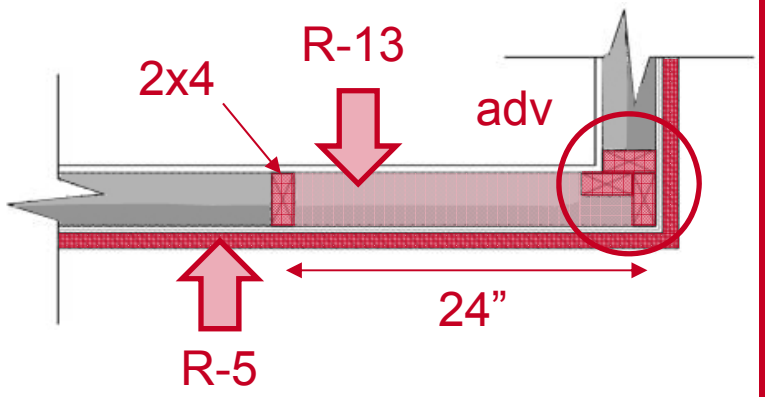
$$U_{avg} = \frac{(75\% \times 0.05) + (25\% \times 0.18)}{100\%} = 0.085$$

$$R = {}^{1}/_{U} = {}^{1}/_{0.085} = \mathbf{R\ 11.77}$$

$$U_{avg} = \frac{(84\% \times 0.06) + (16\% \times 0.12) + (\ldots)}{100\%} = 0.065$$

$$R = {}^{1}/_{U} = {}^{1}/_{0.065} = \mathbf{R\ 15.27}$$





Future of R-value – full assembly testing

Rotatable Guarded Hot Box Testing

- Measure heat flux across a full assembly with a **temperature** and **pressure** difference in horizontal or vertical orientation

Metering Guard Chamber

Climate Chamber

Wall Test Frame

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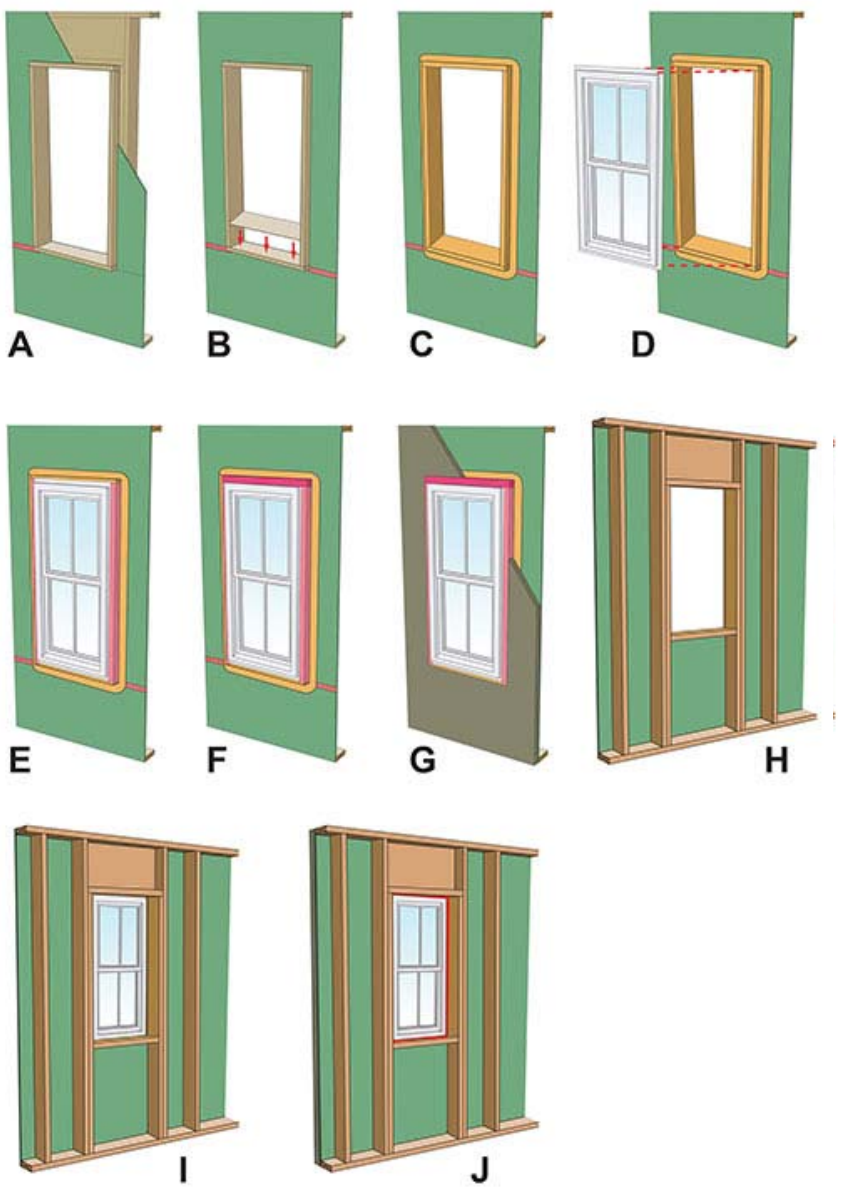
Common Installation Techniques – with Continuous



Images courtesy of Building Science Corporation

“Innie” Window

- Weather Resistant Barrier is UNDER the continuous insulation
- Window is installed flush with WRB layer, and sheathing board, where applicable
- Continuous insulation thickness is only limited by the cladding fastening required
- If stucco is used, the continuous insulation may comply as one layer of required WRB
- Creating a **structural box** to secure the window or to fasten the siding trim later, is a more common method of pursuing an “innie” window

Common Installation Techniques – “Innie”

Images courtesy Green Building Advisor

Common Installation Techniques – “Outie”

Images courtesy of Building Science Corporation

“Outie” Window

Keep in mind:

- The gray layer can be any board continuous insulation, so long as a compliant weather resistant barrier is added on top of the continuous insulation (or it complies with tape on it’s own).

- Continuous insulation thickness is limited to 1-1/2”, otherwise the window must be structurally tied into the framing with an added boxed frame (see next slide)

Common Installation Techniques – “Outie”

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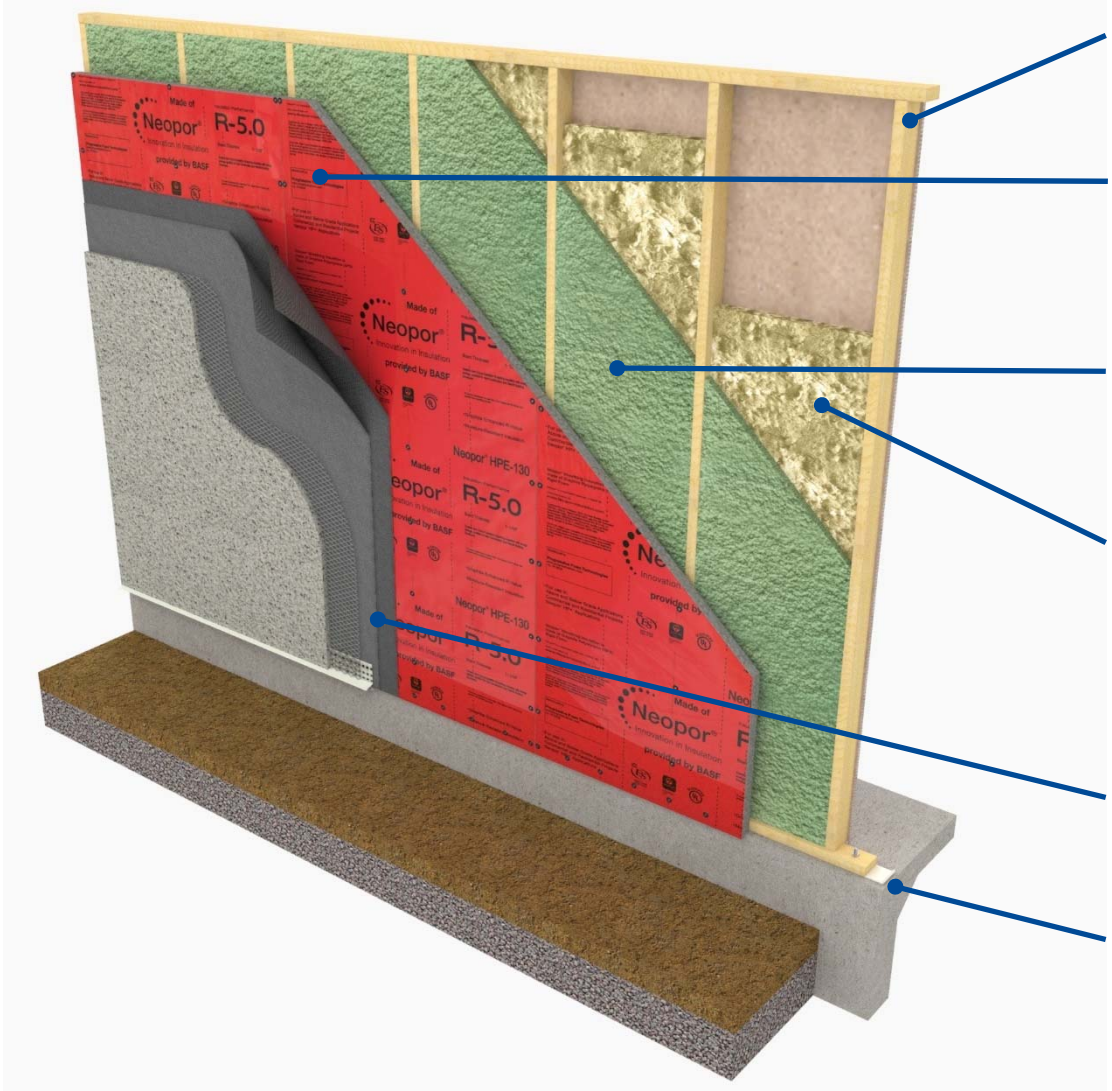
High Performance Wall Systems

Thermal Metric Study conducted by RDH Building Science Inc.



Advanced Framing
Saves wood and cost

GPS – R5
Vapor permeable continuous insulation

ccSPF – R10
Lateral strength, air/vapor barrier

Optional Fill Insulation
Up to R8 in a 2x4

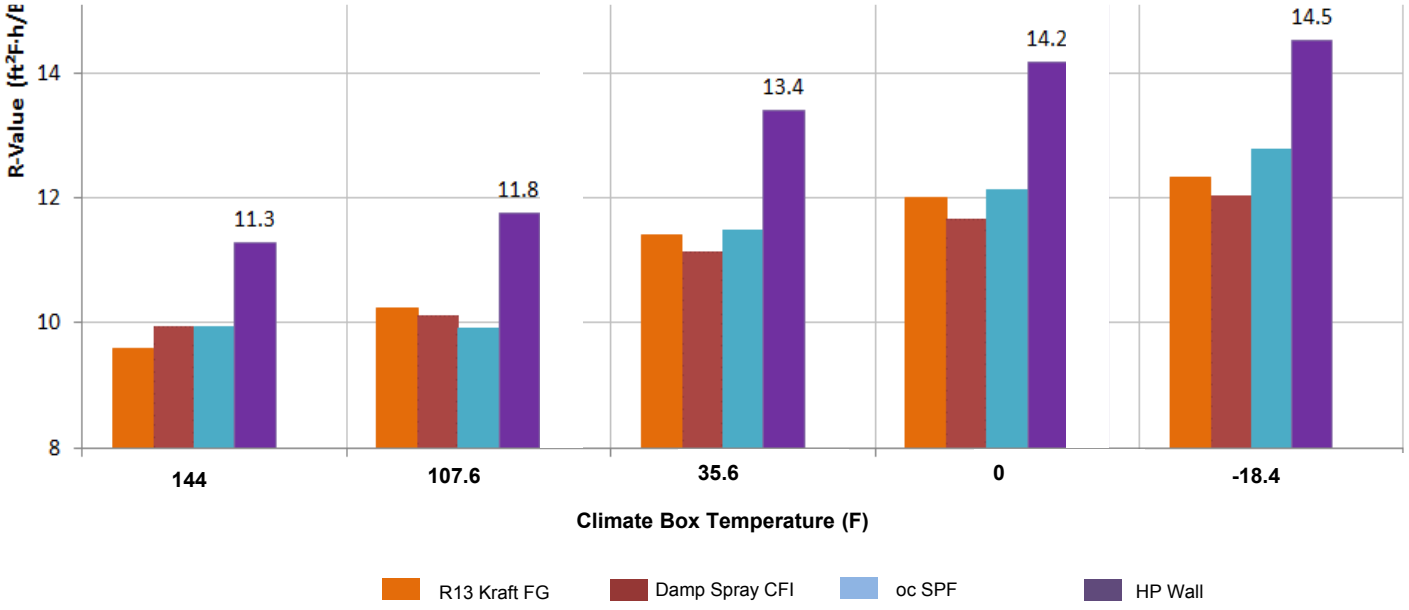
Weather Resistant Barrier
Bulk moisture drainage

Sealants
Additional air sealing

Proven higher effective R-value

Thermal Metric Study conducted by RDH Building Science Inc.

- Quantifies loss in R-value from air leakage across full wall assemblies (with windows) under wind pressure at real world temps
- 2x4 HP assemblies **thermally outperform** walls with full cavity insulation, **even vs. 2x6** construction by as much as 25%
- Air tight construction gives HP a **95% less risk of condensation**, 98% reduction in energy used to condition air from air leaks



Long-Term ETICS* Study

Frauenhofer Institute for Building Physics report released in 2017 on long-term study of ETICS projects in Germany.

- 40 year study
- 12 different buildings
- 4 cities in Germany

- No physical defects over the life of the monitoring.

- Most significant item to mention was some surface discoloration shown in buildings that hadn't been refurbished in any way over 29 years.


Fraunhofer
IBP

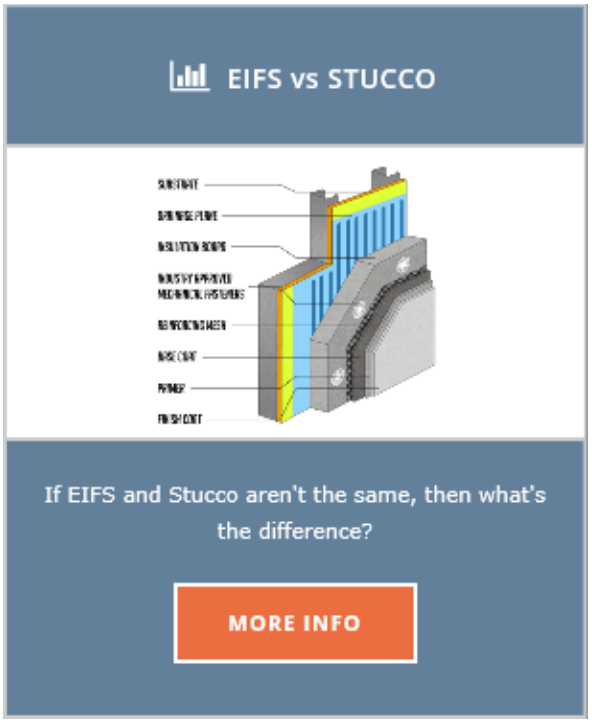
IBP REPORT 539

ASSESSING THE LONG-TERM PERFORMANCE OF APPLIED EXTERNAL THERMAL INSULATION COMPOSITE SYSTEMS (ETICS)

North American Resources

EIMA EIFS INDUSTRY MEMBERS ASSOCIATION

www.EIMA.com

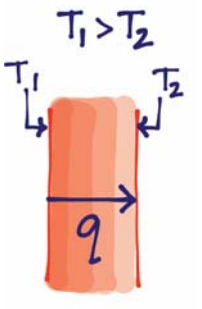


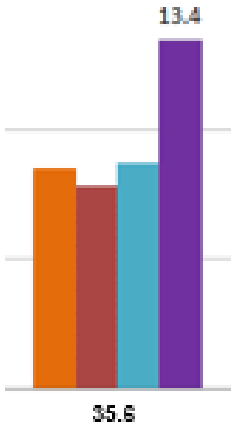
•The global warming impact and carbon footprint of EIFS is 3 times smaller than stucco and 5 times smaller than brick.
•To move 25,000 square feet of material, EIFS requires 16 times less tractor trucks than brick and 6 times less than stucco.
•Low/no volatile organic compounds.
•Recycled content and recyclable packaging.
•EIFS is 84% more energy efficient than the next best performing cladding, outpacing brick and stucco among others.
•EIFS provides a continuous layer of insulation that reduces air leakage that currently plagues many buildings.
•2 inches of EIFS offers the equivalent energy efficiency performance as that of 8 inches of fiberglass insulation in a wall cavity.

**figures according to a proprietary study done by the National Institute of Standards and Technology*

Summary

- Scientific principles support the use of continuous insulation
- Reducing thermal bridging has measurable value, and is becoming more visual!
- There are established practices for installing continuous insulation – don't be afraid
- Third-party building science experts have validated the performance benefits of advanced wall systems





Conclusion

This concludes the American Institute of Architects Continuing Education Systems program

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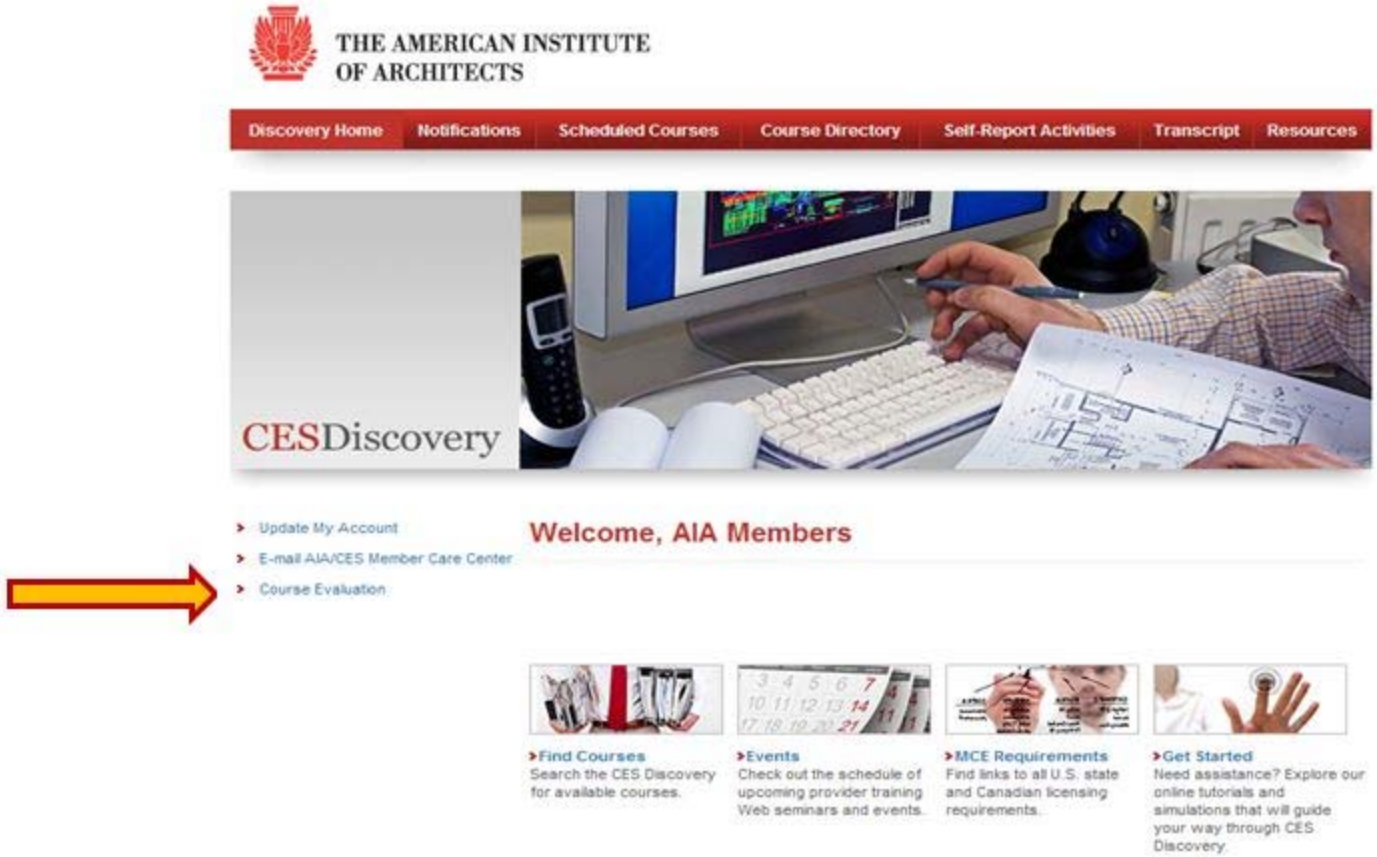
Course Evaluations

In order to maintain high-quality learning experiences, please access the evaluation for this course by logging into CES Discovery and clicking on the Course Evaluation link on the left side of the page.



QUESTIONS?

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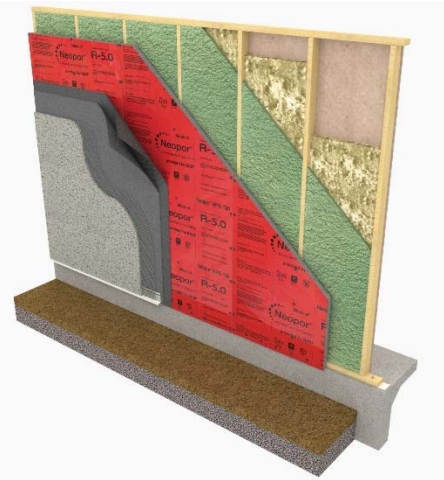
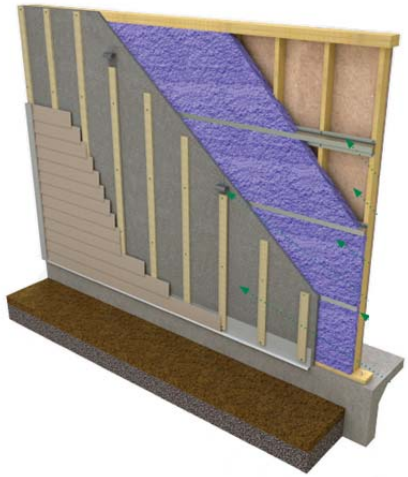


E Series

X Series

FR Series



XR Series

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