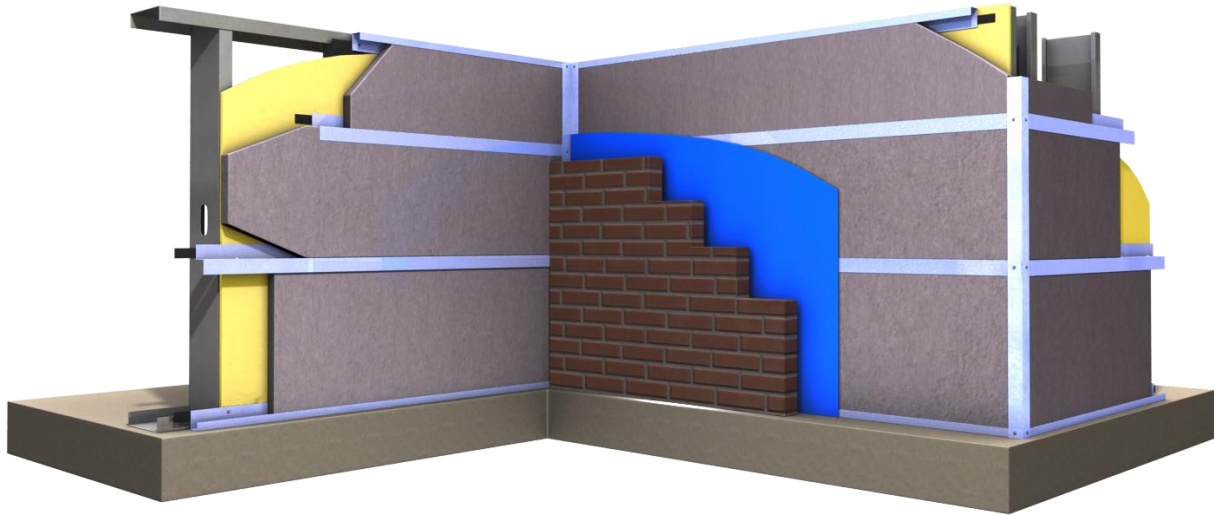


# Continuous Insulation: The Importance of Thermal Science in Modern Construction



## Introduction to Continuous Insulation

The thermal design of a building is an essential aspect of its construction, not only for meeting mandated insulation standards but also for designing a sustainable and reliable structure. To accomplish both, continuous insulation is a necessity. The purpose of this paper is to provide a concise explanation of continuous insulation for those who are unfamiliar with the concept, as well as provide a refresher on the technicalities to experienced builders.

## Importance of Continuous Insulation

The American Society of Heating, Refrigeration, and Air-Conditioning (ASHRAE) defines continuous insulation (CI) as: “Insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings.” The standard is for both residential and commercial buildings, and it would seem a straightforward directive to simply cover all gaps with sufficient insulation. Indeed, this is a requirement most builders would consider common sense, however, the thermal engineering of a building can quickly become very complicated. ASHRAE 90.1 is a list that covers the specifics on continuous insulation, from the number of floors in the building to the materials used and more. Effective insulation is more than a requirement however, as there are numerous inherent benefits of a tightly-sealed building envelope. Foremost, consistent insulation reduces heat loss caused by thermal bridging, thus increasing the energy efficiency of the building. Spaces stay warmer in the winter and cooler in the summer. This is especially important in areas of the country with more dynamic climates. Proper installation of CI can also protect against intruding water and the erosion of support structures, extending the building's lifetime. By reducing temperature differentials, especially within stud cavities, and limiting exposure to harmful elements, CI prolongs the durability of steel parts. This means that CI improves a building's design by both

increasing the longevity of the structure as well as making it more energy-efficient. Together these result in money savings, particularly in the long term. Moreover, porous insulation and mold present serious health risks which can be drastically mitigated by CI. It can not only serve as a selling point to catch the attention of energy or money-conscious buyers but also imperative for contractors looking to avoid potential liability down the road.



	Climate Zone	Above Grade Walls: Mass, Steel, Wood Min. Eff. R-value	Roofs: Sloped, Flat Min. Eff. R-value
8	7	16.4, 15.6, 19.6	47.6, 35.7
7	6	12.8, 15.6, 19.6	47.6, 31.3
6	5 & 4C	12.8, 15.6, 15.6	47.6, 25.6
5	4 A/B	9.6, 15.6, 15.6	37.0, 25.6
4	3	9.1, 15.6, 15.6	37.0, 20.8
3	2	7.0, 13.0, 15.6	37.0, 20.8
2	1	7.0, 13.0, 15.6	37.0, 20.8
1			

*Based on Maximum Effective Assembly U-value Tables.*

*Residential Building R-values similar or in some cases slightly higher.*

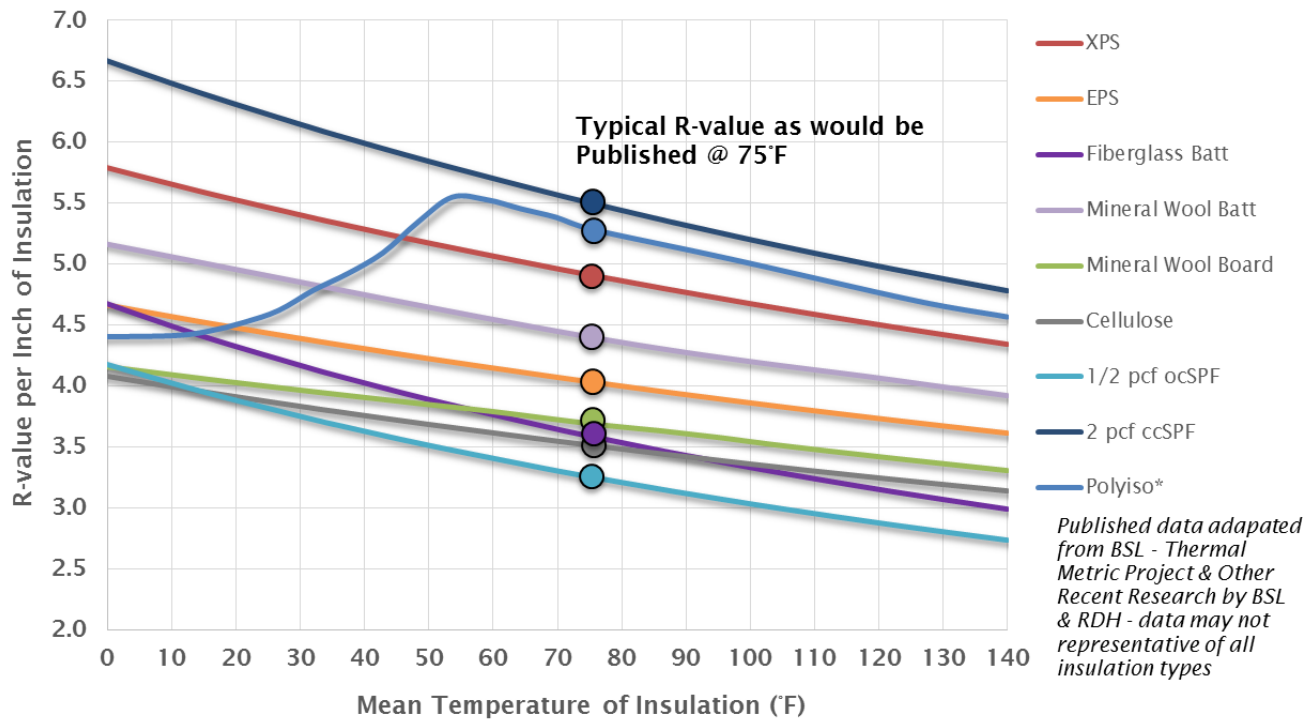
*Source: IECC 2012*

The standards of the degree which a building must be insulated is largely determined by the climate the construction takes place in. The milder the climate, the less insulation coverage is considered necessary. The R-Values listed are the required minimum, and as such it is advisable to exceed these ratings, whether that be to further increase energy efficiency or to ward against increased regulation.

### **Achieving Continuous Insulation**

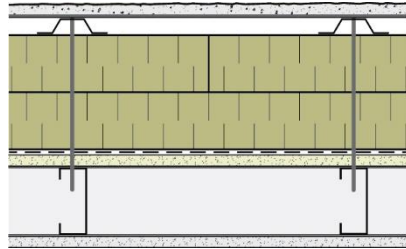
The purpose of continuous insulation is to prevent thermal energy from entering or escaping a building. The most significant obstacle to insulation is thermal bridges, also known as cold or heat bridges. These are objects or surfaces between insulating materials with a higher thermal conductivity than adjacent surfaces. These bridges create a path of least resistance for heat transfers, reducing the overall thermal resistance of the building. Ideally, thermal bridges will be identified and eliminated in the original construction of the building to maintain CI. However, often this is not the case, and retroactive measures must be taken to remove these thermal bridges. Of course, finding thermal bridges is the first step to eliminating them, and there are a few ways to do this. Objects that are known to cause thermal bridging such as studs made of steel and wood should be visually inspected. Hidden or unknown objects can be found using advanced thermal imaging equipment so long as the builder has the budget for it. This can be expensive which is why it is important to consider CI when designing and constructing a building.

**Long-Term R-value per Inch for Various Insulation Samples vs. Mean Temperature**



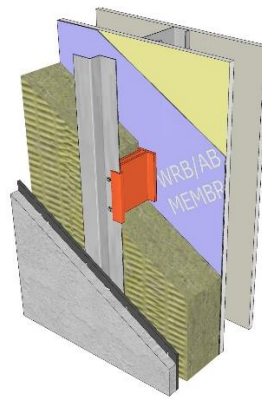
Once thermal bridges have been identified, builders can apply one or a combination of measures to eliminate them. Specialized fasteners, washers, and anchoring systems made of non-conductive materials, instead of stainless or galvanized steel, can be used to fasten insulation and reduce thermal conductivity. These components attach to rigid insulation to tighten the air barrier reducing leaks in the building's envelope. Water-resistive barriers, or WRBs, are installed between the studs and the siding to prevent moisture damage. One such example is flashing, a material that is installed onto specific objects like chimneys, vents, and windows that are susceptible to water penetration. Adhesives like tapes, sealants, coatings, and polyurethane foam come in varying forms of flexible matter, which can be deployed with precision into at-risk spaces. These materials can form both water and air resistant seals in tighter spaces where fibrous insulation isn't feasible. Board stock materials are usually a form of hardened plastic foam that attaches outside a building's framing, adding an extra layer and filling any gaps left by the insulation materials installed between the studs. In many cases, one of these measures will not be sufficient to meet energy codes, thus it is best to utilize various measures to optimize a building's insulation based on the conditions present.

Not all attachment solutions are equivalent, though. Some pieces are more expensive, more difficult to install, or less efficient insulators of thermal energy. Any of these factors can make a system less useful for contractors as it makes implementing CI more of an ordeal.



*Source: RDH CE Presentation*

One of the more thermally resistant attachments is using long fasteners through insulation. This attachment system utilizes cantilevered screws that connect girts or strapping on the exterior of rigid insulation directly into the structure. The combination of the continuous exterior strapping/girts, long fasteners, and rigid insulation create a truss system to support lightweight cladding systems. The thermal performance of this system depends on the back-up wall, type of fastener and fastener spacing. Fasteners are typically every 12" vertically and 16" horizontally, resulting in a thermal efficiency of 75-95%. Another useful attachment is low-conductivity fiberglass clips attached to the shear block of the structure by long screws. The performance of a fiberglass clip is largely dependent on the spacing of the clip and the type of fasteners used, ranging from 70% with tightly spaced heavier claddings to just over 90% with well-distributed lighter claddings. These clips generally have thermal resistivity rating close to R-9.1 and are most useful when Z-girts or hat-channels are used as the vertical or horizontal rail elements entirely on the exterior of the insulation. The fiberglass clips are can be pre-clipped to the metal girts and then screwed to the wall as one element, speeding up installation time.



*Source: RDH CE Presentation*

In addition to the various attachment systems presented here, there exist many opportunities for engineered approaches and adaptations of existing systems. One such system is The Steel Network's (TSN) ThermaFast® Continuous Rigid Insulation Framing. This framing has numerous depths ranging from 1-4", to meet a building's varying insulation needs. On the ThermaFast track components, there is a continuous strip of 1" thermal tape, reducing the thermal conductivity of the connection, thus minimizing its function as a thermal bridge. Slots on the girts also reduce the thermal conductivity of this system. Different installations provide a different value for insulation—a table of R-values is available on TSN's website. One setup, with the 2" Z-Track, 43mil studs, and R-19 Batt Insulation maintains a thermal resistivity of R-19.89.

A final benefit to using an engineered system such as ThermaFast is the capability for the system to carry a higher load. Some systems which perform well as insulators are not structurally ideal. For example, cantilevered screws extending through the insulation will be more difficult to install as specified and will have less capability to safely support the weight of the cladding. ThermaFast overcomes this challenge as a pre-engineered system capable of supporting the weight of various cladding options. Section properties published for each component of ThermaFast enable an engineer to specify the system with confidence.

<b>Attachment Type</b>	<b>Exterior Rigid Foam Insulation Thickness</b>	<b>Thermal Efficiency</b>	<b>Cladding Type</b>
Long Fasteners	2"	75-95%	Light (e.g., vinyl)
Fiberglass/Galvanized Clips	2"	60-90%	Medium (e.g., stucco)
Fiberglass Clips	2"	70-95%	Medium (e.g., stucco)
ThermaFast System	2"	30-50%	All (inc. brick and stone)

It is vital to note that none of these systems or attachments will serve as a substitute or “quick-fix” for a structure with sub-par insulating material. All of these products are designed specifically to minimize the loss of energy at thermal bridges and are useless without adequate insulating material in place.

## References

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