

Fact Sheet FS006

Understanding and Achieving R-Values

 ENCON	ISSUED	REVISION	SHEET TITLE
	8.13		Understanding and Achieving R-Values
FS006			

Cover

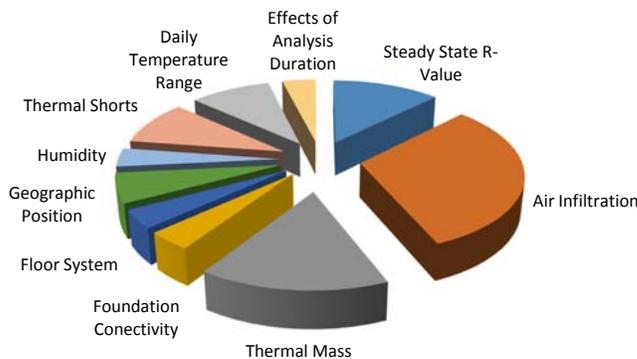
Understanding and Achieving R-Values

R-Value Factors

The R-Value of a project is a measure of thermal resistance of materials, and is used to define the thermal performance of project construction. The overall building envelope is the key to energy efficiency through retaining R-Values and minimizing energy loss. Many factors including daily temperature, geography, wall type, thermal insulation type and thickness, effects of connections through the insulation and spacing, material conductivity, and panel thickness all contribute to R-Value computation and insulation effectiveness.

Since R-Value is a measure of thermal resistance, it is important to understand the ability of insulation to reduce the rate of heat flow. Proper insulation reduces heat loss and hinders convection transfer. Thus, conduction becomes the primary heat transfer mode in a wall panel. Rigid foam typically has a higher R-Value per unit of thickness. Resistance of the insulation to heat transfer depends on the R-Value and the thickness of the insulating layer.

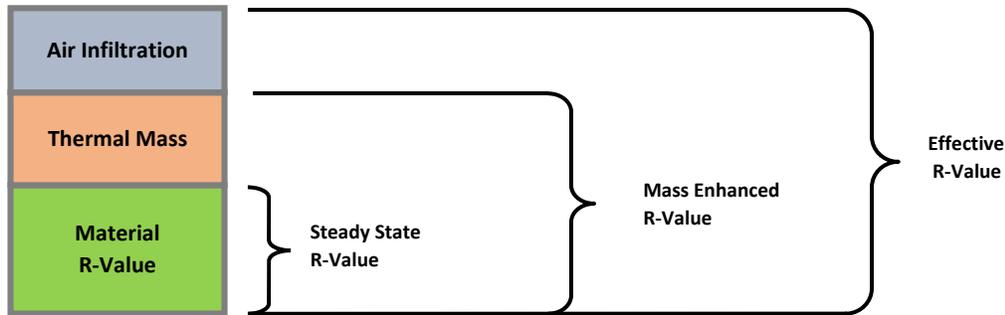
Shown below are all the detailed factors that contribute to a building envelopes R-Value determination. The three primary components are: Steady State R-Value, Air Infiltration, and Thermal Mass.



How to Compute R-Value

R-Value is a ratio of the temperature difference across the insulator, and the heat transfer per unit area through the insulator. To calculate R-Value, the thickness of insulating material used is divided by thermal conductivity. If there are multiple materials that make up the envelope, the total thermal resistance is a function of each of the constituent materials thermal transfer areas, and the total is based on method similar to a weighted average.

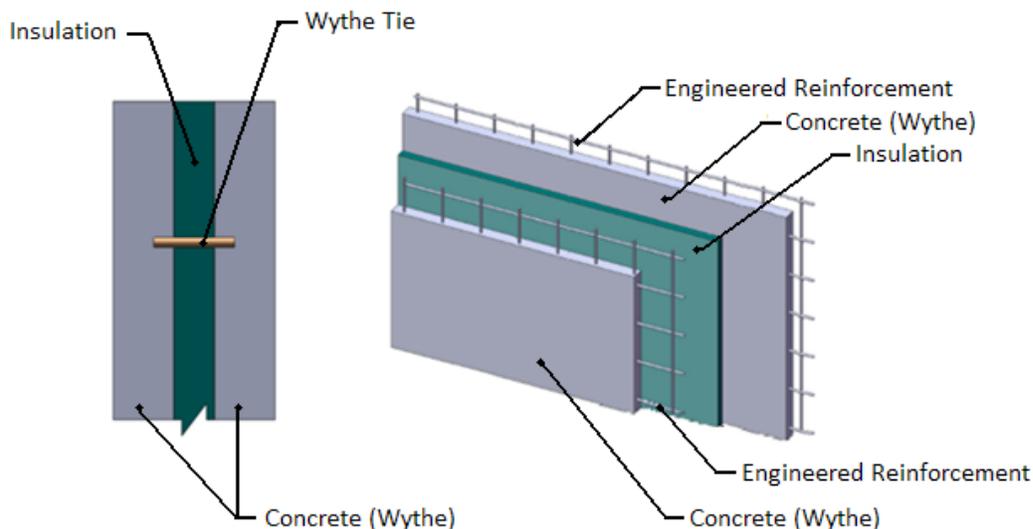
There are three types of R-Values used in the construction industry; Steady State R-Value is based on measured resistances of construction materials comprising a system. Mass effect R-Value is Steady State R-Value and the impact on the construction material's specific heat or Mass Effect. Effective R-Value is a combination of Steady State R-Value, Mass Effect R-Value, and the impact of air infiltration.



Precast wall panel building envelopes have significantly low air infiltration rates within the field of the panel and through caulking joints. R-Value calculations should be based on material R-Values including the influence of thermal bridging. The specified R-Value requirement should be based on Mass Enhanced R-Value.

Insulated Wall Panel Factors

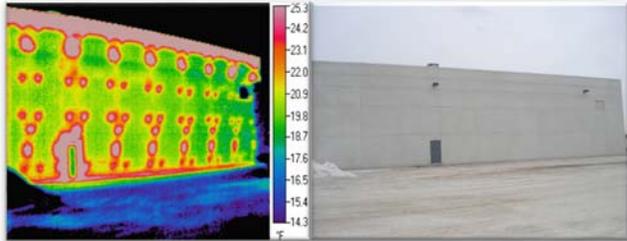
In precast concrete wall panels, R-Value is calculated for a layered system comprised on insulation sandwiched between two layers of concrete, each of which are called a Wythe, and the connector that holds these layers in position. The connector creates a thermal bridge because it crosses the continuous layer of insulation. The connectors, or Wythe Ties, create the largest opportunity to degrade the R-Value by creating thermal bridges. For the best R-Value development within a precast wall panel, non-thermally conductive materials are used for this Wythe tie.



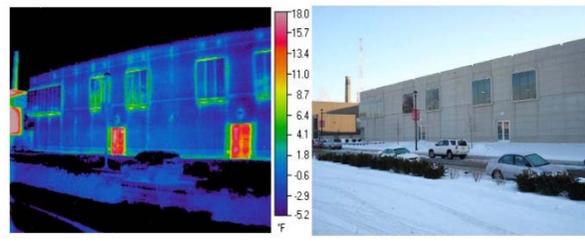
In the past, concrete and metal were used as Wythe ties, however these panels will have a dramatically reduced R-Value if this thermal bridging is not taken into account. The best materials are in the carbon fiber composite family.

Shown below is a thermal image of a panel with concrete ties and one with a nonconductive Wythe tie.

Concrete Wythe Tie Image



Non-Conductive Tie Image

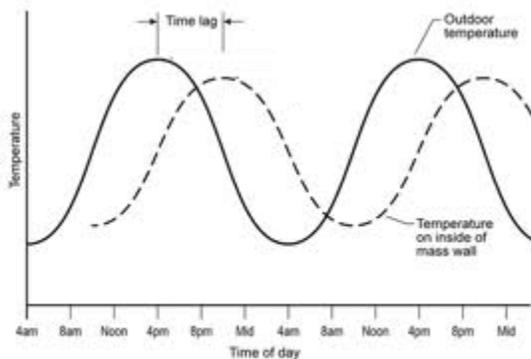


As shown the thermal bridge creates a direct path for the transfer of heat and the panel has a uniform light color with red spots indicating the maximum loss. The panel that is fully blue is completely isolated from the temperature inside the structure. The amount of heat conducted through the connection regions may be as much as 50% reducing the overall R-Value by 40% – 60%.

Continuous Insulation, or CI, is a requirement in current energy codes and standards and the influence of thermal bridging should be taken into consideration when calculating the building envelope R-Value.

Thermal Mass

A key benefit of a precast concrete structure is its thermal mass. Since concrete has a high specific heat, a high product density, and conductivity, a large amount of heat energy can be absorbed and released in the surrounding environment, thus reducing indoor temperature fluctuations. The high thermal mass of the concrete wall panels provides thermal storage and reduces energy requirements through the ability of the concrete to absorb, store and release heat as needed. This natural release to the interior of the structure will dramatically shift the energy demands of HVAC equipment and this shift reduces peak demand as well as the duration of the peak requirement.



Thermal factors

ASHRAE 90.1 recognizes thermal effects of construction type, and clearly recognizes the thermal mass benefits by specifying lower minimum insulation R-Values for precast wall panel construction. High performance precast concrete sandwich wall construction is a way to combine mass and insulation in walls to create a thermal envelope with a high R-Value that slows transmission of heat through the building envelope. Overall energy requirements may be lowered, and thermal performance improved, with the use of precast concrete panels, insulation, and their inherent thermal mass.

EnCon's Precast Insulated Products

EnCon provides insulated precast products in numerous shapes, sizes and architectural finishes. Precast insulated wall panel types include truss, Thermomass® and CarbonCast®. Both of these systems use conventional steel for primary reinforcing, and a non-conductive composite material for secondary reinforcing and load transfer between the Wythes of concrete. When adding R-Value and thermal mass advantages to the proven precast benefits of speed of erection, high quality finish and material consistency, design flexibility and aesthetic options, precast wall panels are an ideal project solution.

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