Thermal Mass and R-Value: Making Sense of a Confusing Issue

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Understanding Heat Transfer

Heat flows by three mechanisms: **conduction, convection, and radiation**.

Conduction is the transfer of heat through a solid object. When one part of an object is heated, the molecules within it begin to move faster and more vigorously, when these molecules hit other molecules within the object they cause heat to be transferred through the entire object. The handle on a cast iron skillet gets hot as heat is transferred from the bottom by means of conduction.

Convection is the transfer of heat by the movement of a fluid (water, air, etc.) Hold your hand above the stove and you feel the heat as the hot air rises by means of Conduction. Inside of a wall air removes heat from a hot exterior wall, then circulates to the colder interior wall where it loses the heat. Forced-air heating systems work by moving hot air from one place to another.

Radiation is a direct transfer of heat from one object to another, without heating the air in between, the same process in which the Earth receives heat from the Sun or a wood stove supplies heat to its surroundings.

If there are various layers in the wall, total heat capacity is found by adding up the heat capacities for each layer (drywall, solid concrete, masonry block, and stucco, for example). In the following section, we will examine how the heat capacity of materials can affect the energy performance of buildings.

Thermal Mass

Thermal Mass is a property that enables building materials to absorb, store, and later release significant amounts of heat. Buildings constructed of concrete have a unique energy saving advantage because of their inherent thermal mass. These materials absorb energy slowly and hold it for much longer periods of time than do less massive materials. This delays and reduces heat transfer through a thermal mass building component, leading to three important results. First, there are fewer spikes in the heating and cooling requirements, since mass slows the response time and moderates indoor temperature fluctuations. Second a massive building uses less energy than a similar low mass building due to the reduced heat transfer through the massive elements. Third, thermal mass can shift energy demand to off peak time periods when utility rates are lower.

How does insulation work?
Insulation is any material that slows the rate of heat flow from a warm area to a cooler one. The more the rate is slowed, the better the insulative qualities of the material. Its ability to resist heat flow is measured as an R or RSI (metric) value, the higher the R - value, the more the material will resist the flow of heat. In order to be effective, insulation materials must be able to reduce the transfer of heat by the three ways we just discussed, conduction, convection and radiation

Conventional insulation materials like fiberglass, cellulose, rock wool and Styrofoam, no matter how thick, have almost no ability to block radiant heat energy which can account for as much as 93 percent of summer heat gain.

These products are only designed to slow down (resist) conduction heat energy only. Insulation once saturated with heat will simply allow remaining heat to pass through.

Remember... R-value means "resistance", if a product resists, it does not stop radiant heat transfer. R-value material only deals with conductive heat transfer. Other factors to consider when choosing insulation are the materials fire, mold, insect, vermin and moisture resistant properties, as well as its cost and ease of application.

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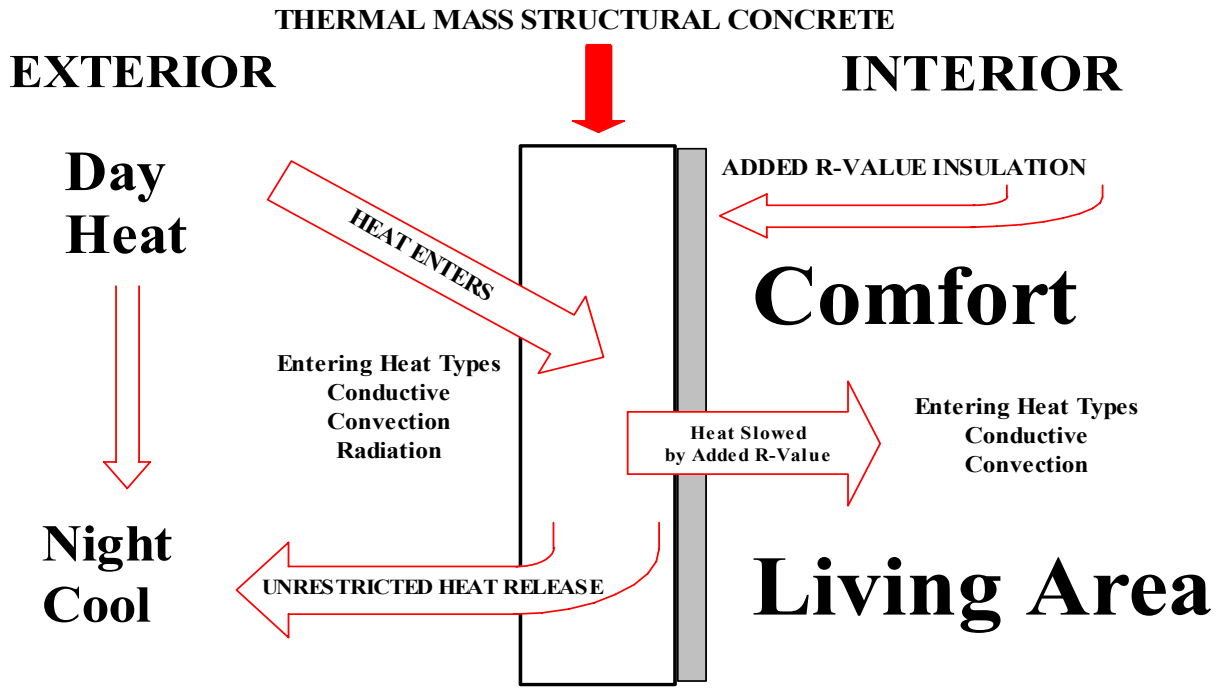

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Structural Concrete Thermal Mass Wall