MIH Masonry Institute of Hawaii Inc.

We Build it to Last!

What is the R-value of Masonry? Is there an alternative method in determining the thermal transmittance for masonry and concrete?

With buildings, we refer to heat flow in different ways. The most common reference is the “R value” or resistance to heat flow. The higher the R-value, the better it is at resisting heat loss or heat gain. U-factor or U value is a measure of the flow of heat (thermal transmittance) through a material given a difference in temperature on either side.

R-values are measured by testing laboratories using a *guarded hot box.* Heat flow through the layer of material can be calculated by keeping one side at a constant temperature, say 90 degrees F and measuring how much energy is required to keep the other side of the material at 50 degree F. The result is a steady-state R-value (steady state because the difference in temperature across the material is kept steady). R-value and U-value are the inverse of one another: U = 1/R. Materials that are good at resisting the flow of heat can serve as insulation materials.

Materials have another property that affect their energy performance in certain situations: heat capacity. Heat capacity is a measure of how much heat a material can hold. Heat capacity is found by multiplying the density of the material, by its thickness by its specific heat (the amount of heat a material can hold per unit of mass). Water has a heat capacity of 1 BTU/lb degree F, while most building materials are around .2 to .3 Btu/lb degree F.

When people refer to the “mass effect, they are generally referring to the ability of the high-mass material to achieve better energy performance than would be expected if only the commonly accepted R-value or U-value of that material were considered. In considering a typical building when one side of the wall is warmer than the other side, heat will conduct from the warmer side to the colder side. If both sides are at a constant temperature—say the inside at 75 degrees F and the outside at 32 degrees F-conductivity will carry heat out at a fairly predicted rate. This steady-state heat flow is what most test procedures use for determining R-value.

In Hawaii, the temperature is not constant. In the morning the temperature outside is normally at 70 degrees F or lower and this changes to about 90 degrees F by noon time. Its cooler inside, so heat conducts from the outside surface of the wall inward. As evening falls, it cools down so the outside wall temperature drops. As a result of this modulating heat flow through a high mass material, less heat from outside the building makes its way inside. Under these conditions, the wall has an effective thermal performance that is higher than the steady-state R-value listed in tables. This dynamic process is what some people call the "mass effect".

The Hawaii Energy code recognizes this effect in determining an exception to the R-value. For wood the minimum R-value needed is 10 and for steel 15 and for other building materials an R-value of 11. An exception to the R-value is made for concrete and masonry units. These units need to meet the HC value higher than 7.5 Btu/degrees F.ft. sq. An 8 inch cmu with a density of 105 lb/cubic feet fully grouted has an HC value of 15.1, which far exceeds the 7.5 requirement. (taken from the Hawaii Energy Code table 3G).

As you can see, the R-value is not the only measure to consider when determining the thermal resistance of a wall structure in a building. Heat capacity (HC) is a terminology we will be using more often in determining the thermal effectiveness of a wall system.

Submitted: 8/2/05