Thermal Advantages of Masonry Walls

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Background

Masonry walls have the ability to store significant amounts of heat during warm periods or when subjected to direct solar gain. Due to their greater weight, compared to stud wall construction, masonry walls tend to release this heat slowly which reduces the peak energy demand for heating. A similar effect can be observed in climates where energy is primarily used for cooling. The effect of this heat storage is the thermal equivalent of a mechanical flywheel – it evens out building energy requirements.

R-value and U-factors

To understand the heat transmission in masonry, a few terms should first be defined. Most people are familiar with the concept of R-value. This is a measure of the material's resistance to heat flow and as expected the greater the R-value, the less heat flows across a material or assemblage. The U-factor is the reciprocal of the R-value and is a measure of the heat transfer in a material. A lower U-factor means less heat flows across a material or assemblage. Units for the R-value in U.S. customary units are hour-ft^2-ºF per Btu. For example, the heat loss per hour across a wall is a function of the R-value, the area of the wall, and the temperature differential across the wall.

Towards Real World Performance

An inconsistency arises when predicting energy usage using R-values alone as they don't account for the stored or released energy inherent to mass wall construction. Previous attempts have been made to provide a modification factor for the R-value to incorporate this effect. The M-factor was introduced as a result of research conducted in the 1970s that indicated heavy masonry walls had an effectively higher R-value in most climate zones. The M-factor served well for nearly 20 years until new energy codes were developed in the U.S.

Today, nearly all new structures must comply with energy code requirements. Examples include the 2006 International Residential Code [1], the 2006 International Energy Conservation Code [2], and the ASHRAE Standard 90.1 (2004), *Energy Standards for Buildings Except Low-Rise Residential Buildings* [3]. States, counties and cities have typically adopted one of the energy codes listed above and may have additional requirements to the adopted code. The current method of recognizing the effect of thermal mass is reflected in the energy code requirements by specifying minimum R-values for mass walls separately from those listed for wood-framed walls. For example, the 2006 International Residential Code requires minimum R-values for walls as shown below (taken from Table N1102.1).

Table 1. Minimum R-values for mass and wood framed walls (excerpted from Table N1102.1, 2006 International Residential Code).

Zone	Minimum R-value for mass exterior walls (hr·ft^2·°F/Btu)	Minimum R-value for wood frame exterior walls (hr·ft^2·°F/Btu)
1	3	13
2	4	13
3	5	13
4	5	13
5	13	19
6	15	19
7 and 8	19	21

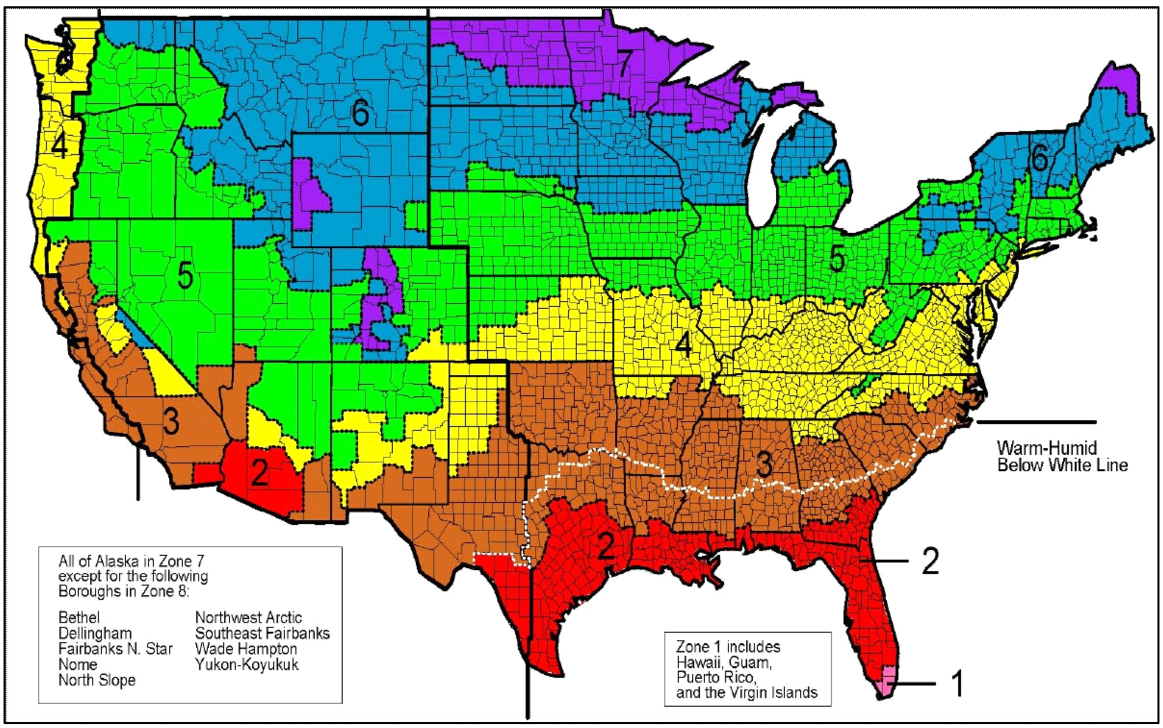

Figure 1. Zone map for ASHRAE and 2006 International Residential Code designations. The heavy line interior to the west coast designates the border between marine(C) and dry (B) climates. The heavy line east of the rocky mountains designates the border between dry (B) and moist (A) climates. (Reference xx)

From the table and the map, it is apparent the effect of thermal mass in masonry walls is most dramatic in temperate to moderate climates. In severe climates, the effect of thermal mass is less apparent.

References:

1. *International Residential Code (IRC)*, International Code Council (ICC) Falls Church, VA, 2006.

2. *International Energy Conservation Code (IECC)*, International Code Council (ICC) Falls Church, VA, 2006.

3. *Energy Standard for Buildings Except Low-Rise Residential Buildings* (ANSI/ASHRAE/IESNA Standard 90.1-2004), American Society of Heating, Refrigerating and Air-Conditioning Engineers 2004, Atlanta, GA.

4. Technical Notes 4 - *Heat Transmission Coefficients of Brick Masonry Walls*, (Reissued Sept. 1997), Brick Industry Association (BIA), Reston, VA.