

## RESIDENTIAL APPENDIX RA3 – 2008 (Former RAGM RB)

### Appendix RA3 – 2008 – Interior Mass Capacity

#### RA3.1 Scope and Purpose

Interior Mass Capacity (IMC) is a measure of the total thermal mass in a low-rise residential building. IMC is used to determine if a building qualifies as a high mass building. Credit for thermal mass in the *Proposed Design* may only be considered when the *Proposed Design* qualifies as a high mass building. A high mass building is one with thermal mass equivalent to having 30 percent of the conditioned slab floor exposed and 15 percent of the conditioned non-slab floor exposed two inch thick concrete.

#### RA3.2 Calculating Interior Mass Capacity (IMC)

The IMC for the building is calculated using Equation RA3-1. The IMC for the building is the sum of the area of each mass material multiplied times its Unit Interior Mass Capacity (UIMC). Table RA3-1, Table RA3-2, and Table RA3-3 give UIMC values for a number of common thermal mass materials. This method allows for multiple mass types common in low-rise residential construction.

Equation RA3B-1

$$IMC = \sum_{i=1}^n A_i \times UIMC_i$$

where

IMC = Interior thermal mass of the building

$A_i$  = Surface area of the  $i^{\text{th}}$  material

$UIMC_i$  = Unit Interior Mass Capacity (UIMC) of the  $i^{\text{th}}$  material selected from Table RA3-1, Table RA3-2, and Table RA3-3

$N$  = Number of thermal mass materials in the *Proposed Design*

#### RA3B.3 IMC Threshold for a High Mass Building

In order to qualify as a high mass building, the *Proposed Design* must have an IMC greater than or equal to that determined from Equation RA5-D2. The IMC threshold is based on 30% percent of the conditioned slab area (CSA) being exposed (UIMC=4.6); 70% percent of the CSA being covered (UIMC=1.8); and 15% percent of the conditioned non-slab floor area as exposed two inch thick concrete (UIMC=2.5).

Equation RA3B-2

$$\begin{aligned} IMC_{\text{Threshold}} &= 0.3 \times 4.6 \times CSA + 0.7 \times 1.8 \times CSA + 0.15 \times 2.5 \times (CFA - CSA) \\ &= 2.640 \times CSA + 0.375 \times (CFA - CSA) \end{aligned}$$

where:

CSA = Conditioned Slab floor Area

CFA = Total Conditioned Floor Area

Table RA3B-1 – Interior Mass UIMC Values: Interior Mass<sup>11</sup> - Surfaces Exposed on One Side<sup>13</sup>

Material	Surface Condition	Mass Thickness (inches)	Unit Interior Mass Capacity
Concrete Slab-on-Grade and Raised Concrete Floors	Exposed <sup>1</sup>	2.00	3.6
		3.50	4.6
		6.00	5.1
	Covered <sup>2</sup>	2.00	1.6
		3.50	1.8
		6.00	1.9
Lightweight Concrete <sup>9</sup>	Exposed	0.75	1.0
		1.00	1.4
		1.50	2.0
		2.00	2.5
	Covered	0.75	0.9
		1.00	1.0
		1.50	1.2
Solid Wood <sup>9</sup>	Exposed	2.00	1.4
		1.50	1.2
		3.00	1.6
		1.00	1.4
Tile <sup>3,9</sup>	Exposed	0.50	0.8
		1.00	1.7
		1.50	2.4
		2.00	3.0
Masonry <sup>4,9</sup>	Exposed	1.00	2.0
		2.00	2.7
		4.00	4.2
Adobe <sup>9</sup>	Exposed	4.00	3.8
		6.00	3.9
		8.00	3.9
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.1
	1.00" Gypsum	na	0.5
	0.88" Stucco	na	1.1
Masonry Infill <sup>7</sup>	0.50" Gypsum	3.50	1.3

Table RA3B-2 – Interior Mass UIMC Values: Interior Mass<sup>11</sup> - Surfaces Exposed on Two Sides<sup>5, 13</sup>

Material	Surface Condition	Mass Thickness (inches)	Unit Interior Mass Capacity
Partial Grout Masonry <sup>4</sup>	Exposed <sup>1</sup>	4.00	6.9
		6.00	7.4
		8.00	7.4
Solid Grout Masonry <sup>4,6</sup>	Exposed	4.00	8.3
		6.00	9.2
		8.00	9.6
Adobe	Exposed	4.00	7.6
		12.00	7.8
		16.00	7.6
Solid Wood/ Logs	Exposed	3.00	3.3
		4.00	3.3
		6.00	3.3
		8.00	3.3
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.2
	1.00" Gypsum	na	0.9
	0.88" Stucco	na	2.1
Masonry Infill <sup>7</sup>	0.50" Gypsum	3.50	2.6

Table RA3B-3 – Exterior Wall Mass UIMC Values<sup>13</sup>

Material	Surface Condition	Mass Thickness (inches)	Wall U-value	Unit Interior Mass Capacity
Solid Wood/ Logs	Exposed <sup>1</sup>	3.00	0.22	0.7
		4.00	0.17	0.9
Wood Cavity Wall <sup>12</sup>	Exposed	6.00	0.12	1.1
		8.00	0.093	1.2
		10.00	0.075	1.3
		12.00	0.063	1.3
		3.00 <sup>12</sup>	0.11	1.1
Adobe	Exposed		0.065	1.3
			0.045	1.4
		8.00	0.35	2.1
Masonry Veneer <sup>4</sup>	Framed Wall	16.00	0.21	2.8
		24.00	0.15	3.1
		4.00	0.10	na
Adobe Veneer	Framed Wall		0.08	na
			0.06	na
		4.00	0.10	na
Partial Grout Masonry <sup>4</sup>	Exposed <sup>1</sup>		0.08	na
			0.06	na
		4.00	0.68	0.9
		6.00	0.58	1.0
		8.00	0.54	1.3
			0.44	1.5
			0.49	1.5
	Furred <sup>10</sup>		0.38	1.7
		4.00	0.40	0.5
			0.30	0.5
			0.20	0.5
			0.10	0.5
			0.08	0.5
		6.00	0.40	0.9
	0.30	0.6		
	0.20	0.5		
	0.10	0.5		
	0.08	0.5		
	8.00	0.30	0.8	
	0.20	0.5		
	0.10	0.5		
	0.08	0.5		

**Table RA3-3: Exterior Wall Mass UIMC Values (continued)**<sup>13</sup>

Material	Surface Condition	Mass Thickness (inches)	Wall U-value	Unit Interior Mass Capacity
Solid Grout Masonry <sup>4,6</sup>	Exposed	4.00	0.79	1.0
		6.00	0.68	1.5
		8.00	0.62	1.8
	Furred <sup>10</sup>	4.00	0.40	0.5
			0.30	0.5
			0.20	0.5
		6.00	0.40	0.5
			0.30	0.5
			0.20	0.5
		8.00	0.40	0.5
			0.30	0.5
			0.20	0.5
			0.10	0.5
			0.08	0.5
			0.40	0.8
			0.30	0.6
0.20	0.5			
	0.10	0.5		
	0.08	0.5		

**RA3.B4 Table Notes**

- "Exposed" means that the mass is directly exposed to room air or covered with a conductive material such as ceramic tile.
- "Covered" includes carpet, cabinets, closets or walls.
- The indicated thickness includes both the tile and the mortar bed, when applicable.
- Masonry includes brick, stone, concrete masonry units, hollow clay tile and other masonry.
- The unit interior mass capacity for surfaces exposed on two sides is based on the area of one side only.
- "Solid Grout Masonry" means that all the cells of the masonry units are filled with grout.
- The indicated thickness for masonry infill is for the masonry material itself.
- Use the Exterior Mass value for calculating Exterior Wall Mass.
- Mass located inside exterior walls or ceilings may be considered interior mass (exposed one side) when it is insulated on the exterior with at least R-11 insulation, or a total resistance of R-9 including framing effects.
- "Furred" means that 0.50-inch gypsum board is placed on the inside of the mass wall separated from the mass with insulation or an air space.
- When mass types are layered, e.g. tile over slab-on-grade or lightweight concrete floor, only the mass type with the greatest interior mass capacity may be accounted for, based on the total thickness of both layers.
- This wall consists of 3 inches of wood on each side of a cavity. The cavity may be insulated as indicated by the U-value column.
- Values based on properties of materials listed in 1993 ASHRAE Handbook of Fundamentals.