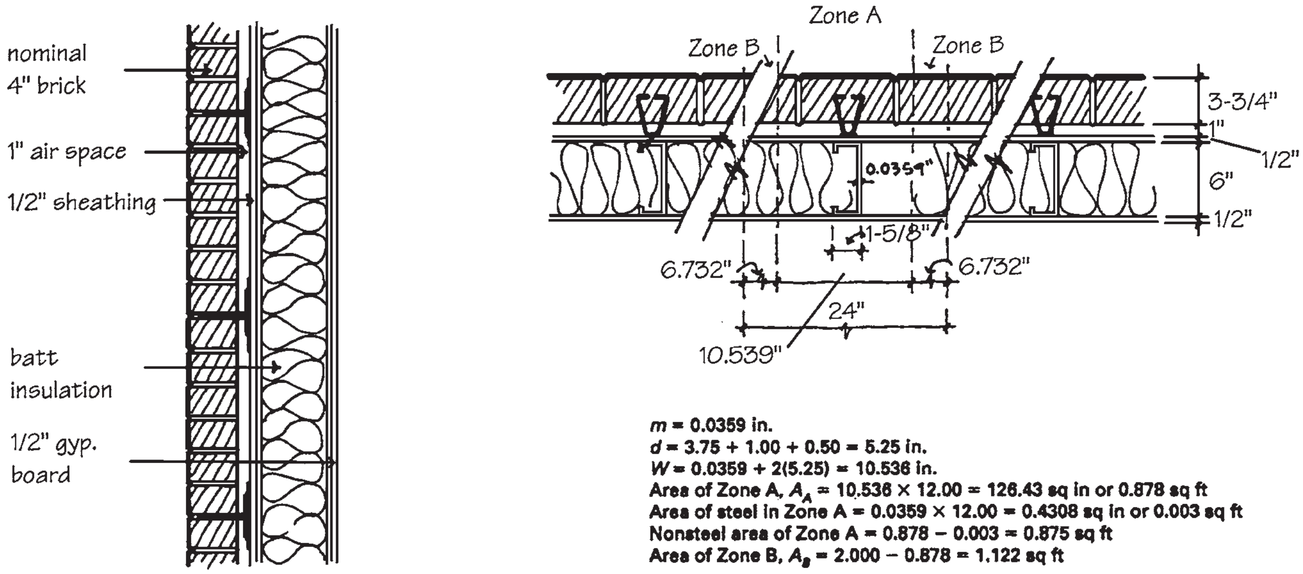

$m = 0.0359$ in.
$d = 3.75 + 1.00 + 0.50 = 5.25$ in.
$W = 0.0359 + 2(5.25) = 10.536$ in.
Area of Zone A, $A_A = 10.536 \times 12.00 = 126.43$ sq in or 0.878 sq ft
Area of steel in Zone A = $0.0359 \times 12.00 = 0.4308$ sq in or 0.003 sq ft
Nonsteel area of Zone A = $0.878 - 0.003 = 0.875$ sq ft
Area of Zone B, $A_B = 2.000 - 0.878 = 1.122$ sq ft

					Zone A			Zone B		
Section	C (Btu /(hr • °F • sq ft))	K ((Btu • in.) /(hr • °F • sq ft))	x (in.)	C_x (Btu /(hr • °F • sq ft))	A (sq ft)	$C_x \cdot A$ (Btu /(hr • °F))	$\frac{1}{C_x \cdot A} = \frac{R}{A}$ ((hr • °F) /Btu)	A (sq ft)	$C_x \cdot A$ (Btu /(hr • °F))	$\frac{1}{C_x \cdot A} = \frac{R}{A}$ ((hr • °F) /Btu)
Outside air surface	6.000			6.000	0.878	5.268	0.19	1.122	6.732	0.15
4-in. nominal face brick		9.000	3.75	2.400	0.878	2.107	0.47	1.122	2.693	0.37
1-in. airspace	1.030			1.030	0.878	0.904	1.11	1.122	1.156	0.87
½-in. exterior gypsum sheathing	2.250			2.250	0.878	1.975	0.51	1.122	2.525	0.40
6-in. batt insulation	0.053			0.053	0.875	0.046		1.122	0.059	16.95
Steel		314.000	6.00	52.333	0.003	0.157				
					Subtotal	0.203	4.93			
½-in. gypsum wallboard	2.250			2.250	0.878	1.976	0.51	1.122	2.525	0.40
Inside air surface	1.470			1.470	0.878	1.291	0.77	1.122	1.649	0.61
					$R_A/A_A = 8.49$ $1/(R_A/A_A) = 0.118$			$R_B/A_B = 19.75$ $1/(R_B/A_B) = 0.051$		

$U_{avg} = [1/(R_A/A_A) + 1/(R_B/A_B)]/(A_A + A_B) = (0.118 + 0.051)/(0.878 + 1.122) = 0.085$ Btu/(hr • °F • sq ft)

$U_B = [1/(R_B/A_B)]/A_B = 0.051/1.122 = 0.045$ Btu/(hr • °F • sq ft) $\quad \frac{U_{avg} - U_B}{U_B} \times 100\% = \frac{0.085 - 0.045}{0.045} \times 100\% = 88.89\%$

Figure 8-24 Thermal calculations for brick veneer/metal stud wall. (*From BIA* Technical Note 7 Rev.)

test conditions) assume a constant temperature differential between outdoor and indoor air, and do not take into account the diurnal cycles of solar radiation and air temperature. As the sun rises and sets each day, the outdoor/indoor temperature differential continually fluctuates. *The static conditions on which R and U values are based do not actually exist in the*

Metal Stud Walls			
Stud Size (in.x in.) (16-18 gauge C-Channel or Lighter)	Center-to-Center Spacing of Studs (in.)	Cavity Insulation R-Value	Effective Framing/Cavity R-Value
2 x 4	16	11	5.5
2 x 4	16	13	6.0
2 x 4	16	15	6.4
2 x 4	24	11	6.6
2 x 4	24	13	7.2
2 x 4	24	15	7.8
2 x 6	16	19	7.1
2 x 6	16	21	7.4
2 x 6	24	19	8.6
2 x 6	24	21	9.0
2 x 8	16	25	7.8
2 x 8	24	25	9.6

Figure 8-25 Effective R values for metal stud walls used as backing for masonry veneers. (*From* ASHRAE Standard 90.1, *Energy Efficient Design of New Buildings Except New Low-Rise Residential Buildings.*)

real world. Building materials with heavy mass can react to temperature fluctuations, producing a dynamic thermal response which differs substantially from heat flow calculations based solely on U values. Research indicates that the actual measured rate of heat transfer for masonry walls is 20 to 70% less than steady-state calculation methods predict.

8.5.1 Thermal Inertia

Heat transfer through solid materials is not instantaneous. The time delay involving absorption of the heat is called *thermal lag*. Although most building materials absorb at least some heat, higher density and greater mass cause slower absorption and longer retention. The speed with which a wall will heat up or cool down is described as *thermal inertia,* and is dependent on wall thickness, density, specific heat, and conductivity. It is this phenomenon, in fact, which also contributes to masonry fire safety by delaying heat transfer through the walls of burning buildings.

The thermal storage properties of masonry have been used for centuries. Large, massive central fireplaces were used during the day for heating and cooking. At night, the heat stored in the fireplace shell provided radiant warmth until dawn. In the desert Southwest of the United States, thick adobe masonry walls were used, not so much for strength as for thermal stability. Buildings remained cool during the hot summer days, and heat stored in the walls was later radiated outward to the cooler night air. Until recently, however,