

#Week 3

1. In this week's assignment you should first finalize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results
2. You should solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigid foam and while replacing the fiberboard with plywood and find the two R-unit values

1.

$$R_{inside} = \frac{1}{h_i A} = \frac{1}{(10 \times 0.25)} = 0.4 \text{ } ^\circ\text{C}/W$$

$$R_{outside} = \frac{1}{h_o A} = \frac{1}{(40 \times 0.25)} = 0.1 \text{ } ^\circ\text{C}/W$$

$$R_{foam} = \frac{L_f}{k_f A} = \frac{0.03}{0.026 \times 0.25} = 4.615 \frac{^\circ\text{C}}{W}$$

$$R_{pc1} = R_{pc2} = \frac{L_{pc1}}{k_p A_{pc1}} = \frac{0.02m}{0.22 \frac{W}{m^\circ\text{C}} \times 0.25} = 0.363 \frac{^\circ\text{C}}{W}$$

$$R_b = \frac{L_b}{k_b A_b} = \frac{0.32m}{0.72 \frac{W}{m^\circ\text{C}} \times 0.22} = 2.02 \frac{^\circ\text{C}}{W}$$

$$R_{total} = R_{conv1} + R_{conv2} + [R_{wall}]$$

$$R_{total} = \frac{1}{h_i A} + \frac{1}{h_o A} + [R_{foam} + 2R_{pc} + R_b]$$

$$R_{total} = 0.4 \frac{^\circ\text{C}}{W} + 0.1 \frac{^\circ\text{C}}{W} + \left[4.615 \frac{^\circ\text{C}}{W} + 2 \left(0.363 \frac{^\circ\text{C}}{W} \right) + 2.02 \frac{^\circ\text{C}}{W} \right]$$

$$R_{total} = 7.861 \text{ } ^\circ\text{C}/W$$

Heat will mostly escape through the brick since the plaster is significantly more resistant than the foam and brick. The foam will create a thermal bridge since it is placed in a parallel direction.

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}} = \frac{40 - (-10)}{7.861} = 6.3605 \text{ W}$$

2. R-values

	A wood	B Insulation
Outside Air	0.03	0.03
Wood Bevel	0.14	0.14
13mm Plywood	0.11	0.11
Urethane Rigid Foam	NA	$0.98 \times (90/25) = 3.528$
Wood Studs	0.63	NA
Gypsum Board	0.79	0.79
Inside Surface	0.12	0.12

$$R'_{with\ wood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.79 + 0.12 = 1.82 \text{ m}^2 \cdot \frac{^{\circ}\text{C}}{\text{W}}$$

$$R'_{with\ insulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.79 + 0.12 = 4.718 \text{ m}^2 \cdot \frac{^{\circ}\text{C}}{\text{W}}$$