

Q1.

Finalize the composite wall question by finding the heat transfer rate, and then solve the same question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32cm and comment on the results?

ANS:

Wall :

Height = 3m

Width = 5m

Brick :

Length = 32cm

Width = 22cm

$K = 0.72 \text{ W/m}^\circ\text{C}$

Plaster:

Bricks separated by 3cm thick plaster

$K = 0.22 \text{ W/m}^\circ\text{C}$

Foam :

$K = 0.026 \text{ W/m}^\circ\text{C}$

Outside:

$h_1 = 10$

$T_{\text{out}} = -10^\circ\text{C}$

Inside:

$h_2 = 25$

$T_{\text{in}} = 20^\circ\text{C}$

$$R_{1\text{conv}} = \frac{1}{h_1 * A} = \frac{1}{10 * 0.25} = 0.4 \frac{^\circ\text{C}}{\text{W}}$$

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

$$R_{\text{plaster1}} = R_{\text{plaster2}} = \frac{L_{p1}}{K_{p1} * A} = \frac{0.32}{0.22 * 0.015} = 96.97 \frac{^\circ\text{C}}{\text{W}}$$

$$R_{\text{brick}} = \frac{L_b}{K_b * A} = \frac{0.32}{0.72 * 0.022} = 2.02 \frac{^\circ\text{C}}{\text{W}}$$

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_{p1}} + \frac{1}{R_b} + \frac{1}{R_{p2}} = \frac{1}{96.97} + \frac{1}{2.02} + \frac{1}{96.97} = 0.516 \frac{\text{W}}{^\circ\text{C}}$$

$$R_{\text{total parallel}} = \frac{1}{0.516} = 1.94 \frac{^{\circ}\text{C}}{\text{W}}$$

$$R_{\text{plaster in}} = R_{\text{plaster out}} = \frac{Lp}{Kp * A} = \frac{0.02}{0.022 * 0.25} = 0.363 \frac{^{\circ}\text{C}}{\text{W}}$$

$$R_{2\text{conv}} = \frac{1}{h2 * A} = \frac{1}{25 * 0.25} = 0.16 \frac{^{\circ}\text{C}}{\text{W}}$$

$$R_{\text{wall total}} = R_{1\text{conv}} + R_{\text{foam}} + R_{\text{plaster out}} + R_{\text{total parallel}} + R_{\text{plaster in}} + R_{2\text{conv}}$$

$$R_{\text{wall total}} = 0.4 \frac{^{\circ}\text{C}}{\text{W}} + 4.615 \frac{^{\circ}\text{C}}{\text{W}} + 0.363 \frac{^{\circ}\text{C}}{\text{W}} + 1.94 \frac{^{\circ}\text{C}}{\text{W}} + 0.363 \frac{^{\circ}\text{C}}{\text{W}} + 0.16 \frac{^{\circ}\text{C}}{\text{W}}$$

$$= 7.841 \frac{^{\circ}\text{C}}{\text{W}}$$

$$Q = \frac{\Delta T}{R_{\text{total}}} = \frac{30}{7.841} = 3.826 \text{ W}$$

The rate of heat transfer of composite wall with 32mm thick brick is 3.826 W

Whereas the rate of heat transfer for composite wall of 16mm thick brick is 4.41 W

Therefore by increasing the thickness of brick does not have impact on the resistance or on the overall heat transfer.

Q2.

Solve again the simplified wall calculation procedure replacing the glass fibre one with urethane rigid foam and while replacing the fibreboard with plywood and find the two R_unit values?

ANS:

Wooden wall with wooden studs:

Dimensions : 38mm , 90 mm

Center to center distance = 400mm

Insulation:

Thickness: 90mm

Filled with urethane rigid foam insulation

Inside finish :

13mm thick gypsum

Outside finish :
 13mm polywood
 13mm 200mm wood bevel lapped siding

R_{unit} values

	Wood	Insulation
Outsidde air	0.03	0.03
Wood bevel (13mm * 200mm)	0.14	0.14
Polywood (13mm)	0.11	0.11
Urethane rigid foam (90mm)	No	$\frac{0.98 * 90}{25} = 3.528$
Wood studs (90mm)	0.63	No
Gypsum board (13mm)	0.079	0.079
Inside surface	0.12	0.12

$$R_{\text{with wood}} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 \text{ m}^2 \frac{^{\circ}\text{C}}{\text{W}}$$

$$R_{\text{with insulation}} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 \text{ m}^2 \frac{^{\circ}\text{C}}{\text{W}}$$