Assignment 3

Question 1

3 meter high and 5 meter wide wall consists of long 32cm x 22cm cross section horizontal brick (k=0.72 W/m · °C) separated by 3cm thick plastic layers (k=0.22 W/m · °C). Thickness of plaster layers on the each side of brick are 2cm and 3cm-thick rigid foam (k=0.026 W/m · °C) standing by the wall. Indoor temperature is 20°C and outdoor temperature is -10°C. Amount of convention heat transfer on the inner and the outer sides are h_1= 10 W/m^2 · °C and h_2= 40 W/m^2 · °C . Determine resistances and the rate of heat transfer through the wall.

$$R_i = \frac{1}{h1 \text{ x } A1} = \frac{1}{10 \frac{W}{m2 \cdot °C} \text{ x } 0.25m \text{ x } 1m} = 0{,}4 \frac{°C}{W}$$

$$R_f = \frac{Lf}{kf \text{ x } A1} = \frac{0.03m}{0.026 \frac{W}{m \cdot °C} \text{x } 0.25m \text{ x } 1m} = 4{,}61 \frac{°C}{W}$$

$$R_{plaster\ up} = R_{plaster.down} = \frac{Lp1}{kp \text{ x } Ap} = \frac{0.32m}{0.22 \frac{W}{m \cdot °C} \text{ x } 0.015m \text{ x } 1m} = 96.97 \frac{°C}{W}$$

$$Rb = \frac{Lb}{kb \text{ x } Ab} = \frac{0.32m}{0.72 \frac{W}{m \cdot °C} \text{x } 0.22m \text{ x } 1m} = 2.02 \frac{°C}{W}$$

$$\frac{1}{Rtotal\ paralel} = 2 \text{ x } \frac{1}{Rplaster\ up/down} + \frac{1}{Rb} = 2 \text{ x } \frac{1}{96.97 \frac{°C}{W}} + \frac{1}{2.02 \frac{°C}{W}}$$

$$\frac{1}{Rtotal\ paralel} = 0.52 \frac{W}{°C}$$

$$R_{total.parallel} = \frac{1}{0.52 \frac{W}{°C}} = 1.93 \frac{°C}{W}$$

$$R_{plaster\ l} = R_{plaster.r} = \frac{Lp2}{kp \text{ x } A1} = \frac{0.02m}{0.22 \frac{W}{m \cdot °C} \text{x } 0.25m \text{ x } 1m} = 0.36 \frac{°C}{W}$$

$$R_o = \frac{1}{h2 \text{ x } A1} = \frac{1}{40 \frac{W}{m2 \cdot °C} \text{ x } 0.25m \text{ x } 1m} = 0.1 \frac{°C}{W}$$

$$R_{wall} = R_i + R_f + R_{total\ parallel} + R_{plaster\ left} + R_{plaster\ right} + R_o$$

$$R_{wall} = 0.4+4.61+1.93+0.36+0.36+0.1 = 7.76 \frac{°C}{W}$$

$$\dot{Q} = \frac{T1 - T\infty}{Rwall} = \frac{20°C - (-10°C)}{7.76 \ °C/W} = 3.866 \text{ W}$$

$R_{wall.32cm}$ = 0.4+4.61+1.93+0.36+0.36+0.1 = 7.76 $\frac{^\circ C}{W}$

$R_{wall.16}$ = 6.81 $\frac{^\circ C}{W}$

$\dot{Q}_{32cm} = \frac{T1-T\infty}{Rwall} = \frac{20°C-(-10°C)}{7.76\ °C/W}$ = 3.866 W

$\dot{Q}_{16cm}$ = 4.41 W

We can conclude that the brick thickness does not have an effect in thermal resistance since the heat transfer does not decrease significantly in the wall. It is noticeable that the foam is the main insulator in the wall and that the brick function is mostly structural.

Question 2

A wood frame wall that is bulid around 38-mm 90-mm wood studs with a center-to- center distance of 400 mm. The 90-mm wide cavity between the studs is filled with urethane rigid foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13-mm polywood and 13 mm 200mm wood bevel lapped siding. The insulted cavity constitutes 75 % of the heat transmission area while the studs, plates and sills constitute 21 percent. The headers constitute 4 percent of the area and they can be treated as studs.

Find the two R_{unit} values.

	Wood	Insulation
Outside air	0.03	0.03
Wood Bevel	0.14	0.14
Urethane Rigid Foam	/	(0.98/25)x90 = 3.53
Polywood	0.11	0.11
Gypsum Board	0.079	0.079
Inside surface	0.12	0.12
Wood Studs	0.63	/

R'_{wood} = 0.03 + 0.14+ 0.11 + 0.079 + 0.12 + 0.63 = 1.11 $\frac{\mathrm{m2 \cdot °C}}{W}$

$R'_{insulation}$ = 0.03 + 0.14 + 3.53 + 0.11 + 0.079 + 0.12 = 4.01 $\frac{\mathrm{m2 \cdot °C}}{W}$