Week assignment 3

Task 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. L_{foam}

Question 1:

Determine resistances and the rate of heat transfer through the wall.

Solution:

1. $R_i = \frac{1}{h1 \text{ x } A1} = \frac{1}{10 \frac{W}{m2 \cdot °C} \text{ x } 0.25m \text{ x } 1m} = 0{,}4 \frac{°C}{W}$
2. $R_f = \frac{Lf}{kf \text{ x } A1} = \frac{0.03m}{0.026 \frac{W}{m \cdot °C} \text{x } 0.25m \text{ x } 1m} = 4{,}61 \frac{°C}{W}$
3. $R_{plaster.up} = R_{plaster.down} = \frac{Lp1}{kp \text{ x } Ap} = \frac{0.32m}{0.22 \frac{W}{m \cdot °C} \text{x } 0.015m \text{ x } 1m} = 96.97 \frac{°C}{W}$

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

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

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

   $R_{total.parallel} = \frac{1}{0.52 \frac{W}{°C}} = 1.93 \frac{°C}{W}$
4. $R_{plaster.left} = R_{plaster.right} = \frac{Lp2}{kp \text{ x } A1} = \frac{0.02m}{0.22 \frac{W}{m \cdot °C} \text{x } 0.25m \text{ x } 1m} = 0.36 \frac{°C}{W}$

5. $R_o = \frac{1}{h2 \times A1} = \frac{1}{40 \frac{W}{m2 \cdot °C} \times 0.25m \times 1m} = 0.1 \frac{°C}{W}$

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

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

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

By comparing situation of 16cm brick and 32cm brick we can notice that brick thickness duplication does not make big changes so thermal resistance in the wall is not notably increased also heat transfer rate in wall is not notably decreased.

The proof for that we can find within this calculation:

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

   $R_{wall.16} = 6.81 \frac{°C}{W}$

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

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

Task 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 foad 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 percet of the heat transimission 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 Rigif 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	/

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

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