Week 3
Yasmine Emad Farouk Ibrahim

Question 1:

A 3m high and 5m wide wall consists of long 32 cm 22 cm cross section horizontal bricks (k = 0.72 W/m. C) separated by 3 cm thick plaster layers (k = 0.22 W/m.C).

There are also 2 cm thick plaster layers on each side of the brick and a 3 cm thick grid foam (k = 0.026 W/m.C) on the inner side of the wall. The indoor and the outdoor temperatures are 20 C and -10 C, the convection heat transfer coefficients on the inner and the outer sides are $h_1 = 10\ W/m^2 . C$ and $h_2 = 40\ W/m^2 . C$, respectively. Assuming one dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

Answer:

$R_1 = \frac{1}{h1\ X\ A1-dimen} = \frac{1}{10*(0.015+0.22+0.015)*1} = 0.4\ C/W$

$R_{foam} = \frac{L(foam)}{K(foam)\ X\ A1-dimen} = \frac{0.03}{0.026*(0.015+0.22+0.015)*1} = 4.615\ C/W$

$R_{brick} = \frac{L(brick)}{K(brick)\ X\ A1-dimen} = \frac{0.32}{0.72*0.22*1} = 2.02\ C/W$

$R_{brick} = \frac{L(brick)}{K(brick)\ X\ A1-dimen} = \frac{0.32}{0.72*0.22*1} = 2.02\ C/W$

$1/R_{total-parallel} = \frac{1}{R(plaster1)} + \frac{1}{R(brick)} + \frac{1}{R(Plaster2)} = \frac{1}{9.97} + \frac{1}{2.02} + \frac{1}{96.97} = 0.516\ C/W$

$R_2 = \frac{1}{h2*A1} + \frac{1}{40*(0.015+0.22+0.015)} = 0.1\ C/W$

$$R_{Plaster3} = R_{Plaster4} = \frac{L(P)}{K(P)*A(P)} = \frac{0.02}{0.02*(0.015+0.22+0.015)*1} = 0.363\ C/W$$

$$R_{wall,total} = R_{1.conv} + R_{foam} + R_{plaster1} + R_{parallel} + R_{plaster2} + R_{2.conv}$$

$$= 0.4 + 4.615 + 0.363 + 1.94 + 0.363 + 0.1 = 7.781\ C/W$$

$$Q. = \frac{T1 - T\infty}{R(wall\ total)} = \frac{20C-(-10)C}{7.781\ C/W} = 3.86\ W$$

R_{wall} is calculated then

$$R_{wall\ total(thickness\ of\ the\ brick\ 16mm)} = 6.81\ C/W$$

$$Q. = \frac{T1 - T\infty}{R(wall\ total)} = \frac{20C-(-10)C}{6.81\ C/W} = 4.41\ W$$

Conclusion: Both walls difference is that increasing the thickness of the brick thickness inside the wall doesn't increase the thermal resistance and therefore the rate of heat transfer doesn't increase, The foam changes the heat transfer rate and increases the thermal resistance.

Question 2:

Determine the overall unit thermal resistance (the *R*-value) and the overall heat transfer coefficient (the *U*-factor) of a wood frame wall that is built 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

glass fiber insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm wood fiberboard and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent 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.

Answer:

	Wood	Insulation
Outside Air	0.03	0.03
Wood bevel	0.14	0.14
Polywood	0.11	0.11
Urethane rigif foam ins.	No	3.528
Wood studs	0.63	No
Gypsum board	0.079	0.079
Inside surface	0.12	0.12

Urethane rigif foam ins.---> $0.98 * \frac{90}{25} = 3.528$

$R'_{\text{with wood}} = (0.12+0.079+0.63+0.11+0.14+0.03)\ m^2 \frac{C}{W} = 1.11 \frac{m2\ C}{W}$

$R'_{\text{with insulation}} = (0.12+0.079+3.528+0.11+0.14+0.03)\ m^2 \frac{C}{W} = 4.007 \frac{m2\ C}{W}$