WEEK 3_ GANHUI 10712558

- In this week's assignment you should first dfinlize 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.

Question1:

A 3 m high and 5 m wide wall consists of long 16 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 rigid 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, and the convection heat transfer coefficients on the inner and the outer sides are h1=10 W/m2 · °C and h2 =40 W/m2 · °C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

ANSWER:

the thickness of the brick is 16 cm

$$\dot{Q} = \frac{T_1 - T_2}{R_{total}} = \frac{20℃ + 10℃}{6.81} = 4.405℃/\mathrm{W}$$

the thickness of the brick is 32 cm

$$\mathrm{R_{inside}} = \frac{1}{\mathrm{H_{inside}} \cdot A} = \frac{1}{10 \cdot 0.25} = 0.4℃/W$$

$$\mathrm{R_{foam}} = \frac{L_{foam}}{\mathrm{K}_{foam} \cdot A} = \frac{0.03}{0.026 \cdot 0.25} = 4.615℃/W$$

$$\mathrm{R_{Plaster_1}} = \mathrm{R_{Plaster_2}} = \frac{\mathrm{L_{P_1}}}{\mathrm{K_{P_1}} \cdot A_{\mathrm{P_1}}} = \frac{0.16}{0.22 \cdot 0.25} = 0.364℃/\mathrm{W}$$

$$\mathrm{R_{P_{c1}}} = \mathrm{R_{P_{c1}}} = \frac{\mathrm{L_{P_{c1}}}}{\mathrm{K_{P_{c1}}} \cdot A_{\mathrm{P_{c1}}}} = \frac{0.16}{0.22 \cdot 0.015} = 48.48℃/\mathrm{W}$$

$$\mathrm{R_{brick}} = \frac{\mathrm{L_{brick}}}{\mathrm{K}_{brick} \cdot A} = \frac{0.32}{0.72 \cdot 0.22} = 2.02℃/W$$

$$\frac{1}{\mathrm{R_{total_{plaster}}}} = \frac{1}{\mathrm{R_{P_{c1}}}} + \frac{1}{\mathrm{R_{brick}}} + \frac{1}{\mathrm{R_{P_{c1}}}}$$

$$\frac{1}{\mathrm{R_{total_{plaster}}}} = 0.5362$$

$$\mathrm{R_{total_{plaster}}} = 1.865℃/W$$

$$\mathrm{R}_{outside} = \frac{1}{\mathrm{H_{outside}} \cdot A} = \frac{1}{40 \cdot 0.25} = 0.1℃/W$$

$$\mathrm{R}_{total} = \mathrm{R_{inside}} + \mathrm{R_{foam}} + \mathrm{R_{Plaster_1}} + \mathrm{R_{total_{plaster}}} + \mathrm{R_{Plaster_2}} + \mathrm{R}_{outside}$$

$$= 0.4 + 4.615 + 0.364 + 1.865 + 0.364 + 0.1 = 7.708℃/\mathrm{W}$$

$$\dot{Q} = \frac{T_1 - T_2}{R_{total}} = \frac{20℃ + 10℃}{7.708} = 3.892℃/\mathrm{W}$$

- You should solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigif foam and while replacing the fiberboard with plywood and find the two R_unit values

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.

Also, determine the rate of heat loss through the walls of a house whose perimeter is 50 m and wall height is 2.5 m in Las Vegas, Nevada, whose winter design temperature is -2 C. Take the indoor design temperature to be 22 C and assume 20 percent of the wall area is occupied by glazing.

ANSWER:

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel lapped siding	0.14	0.14
13mm fiber board	0.23	0.23
Plywood, 13mm	0.11	0.11
Glass fiber ins.	NO	0.7*90/25=2.52
Urethane rigif foam	NO	0.98*90/25=3.53
Wood studs	0.63	No
Gypsum board 13mm	0.079	0.079
Inside surface	0.12	0.12

$R_{withwood}$=0.03+0.14+0.11+No+0.63+0.079+0.12=1.109 ㎡ • ℃/W

$R_{withins}$=0.03+0.14+0.11+3.528+No+0.079+0.12=4.007 ㎡ • ℃/W