Week3

Tasks:

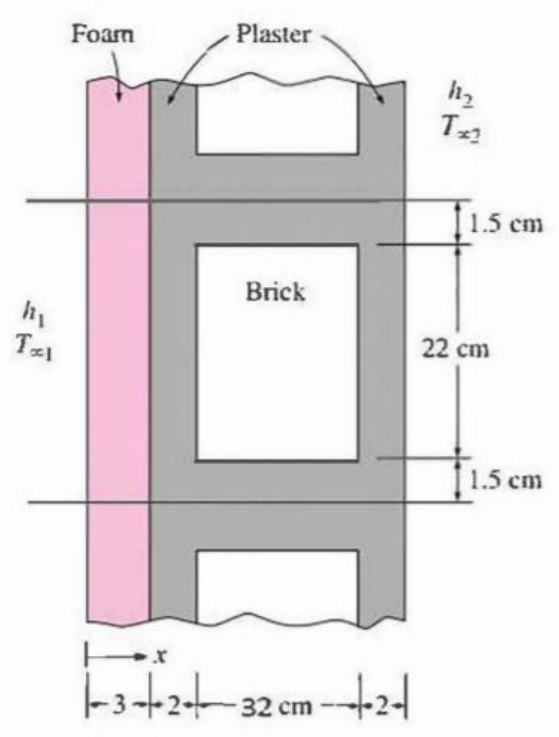
dfinlize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results

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

1. Calculation

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

There are also 2cm thick plaster on each side of the brick and a 3cm thick rigid foam(k=2.026w/m℃) on the inner side of the wall. The indoor and the outdoor temperature are 20℃ and -10℃, and the convection heat transfer coefficients on the inner and the outer sides are h1=10w/㎡℃ and h2=40w/㎡℃, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.



Answer:

$A_u = (0.015 + 0.22 + 0.015) * 1 = 0.25$ ㎡

$$R_f = \frac{LP_1}{K_f * A_u} = \frac{0.03}{0.026 * 0.25} \approx 4.62\,℃/w$$

$$R_{p1} = \frac{LP_1}{K_P * A_u} = \frac{0.02}{0.22 * 0.25} \approx 0.36\,℃/w$$

$$R_{p2} = \frac{LP_2}{K_p * A_2} = \frac{0.32}{0.22 * 0.015} \approx 96.97\,℃/w$$

$$R_b = \frac{LP_2}{K_p A_3} = \frac{0.32}{0.72 * 0.22} \approx 2.02\,℃/w$$

$$\frac{1}{R_{pt}} = \frac{1}{R_f} + 2 * \frac{1}{R_{P2}} = \frac{1}{2.02} + 2 * \frac{1}{96.97} \approx 0.52w/℃$$

$$R_{pt} = \frac{1}{0.52} \approx 1.92℃/w$$

$$R_{conv1} = \frac{1}{h_1 * Au} = \frac{1}{10 * 0.25} = 0.4℃/w$$

$$R_{conv2} = \frac{1}{h_2 * Au} = \frac{1}{40 * 0.25} = 0.1℃/w$$

$$R_t = R_{conv1} + R_f + R_{pt} + R_{p1} * 2 + R_{conv2} = 0.4 + 4.62 + 1.92 + 0.36 * 2 + 0.1$$

$$= 7.76℃/w$$

$$\dot{Q}_1 = \frac{T_1 - T_\infty}{R_t} = \frac{20 - (-10)}{7.76} \approx 3.87w$$

$$\because R_{t16mm} = 6.81w$$

$$\therefore \dot{Q}_2 = \frac{T_1 - T_\infty}{R_{t16mm}} = \frac{20 - (-10)}{6.81} \approx 4.41w$$

Conclusion:

Increasing the thickness of the brick in the composite wall only has little effect on improving the thermal resistance of the wall.

2. Answer:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel l.	0.14	0.14
Plywood(13mm)	0.11	0.11
Urethane Rigid Foam	/	0.98*(90/25)=3.528
Wood Stud	0.63	/
Gypsum Board	0.079	0.079
Inside Surface	0.12	0.12

$$R'_{with.wood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 m^2 * ℃/W$$

$$R'_{with.insulation} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 m^2 * ℃/W$$