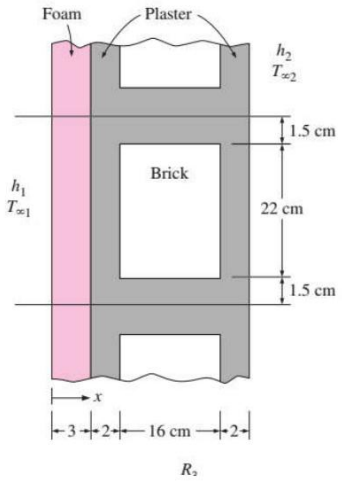
#Week 3 In this week's assignment you should first dfinlize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results

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

(1): Heat loss through a composite wall

• 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 are20°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 =25 W/ ㎡ ·°C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.



$A_1 = (0.015 + 0.22 + 0.015) * 1 = 0.25\,m^2$

$$R_{conv,1} = \frac{1}{h_1 \times A_1} = \frac{1}{10 \times 0.25} = 0.4℃/W$$

$$R_{foam} = \frac{L}{h_f \times A_1} = \frac{0.03}{0.026 \times 0.25} = 4.615℃/W$$

$A_{palster} = 0.015 \times 1 = 0.015\,m^2$

$$R_{plaster} = \frac{L_{plaster}}{k_{plaster} \times A_{plaster}} = \frac{0.32}{0.22 \times 0.015} = 96.97℃/W$$

$A_{brick} = 0.22 \times 1 = 0.22\,m^2$

$$R_{brick} = \frac{L_{brick}}{k_{brick} \times A_{plaster}} = \frac{0.32}{0.72 \times 0.22 \times 1} = 2.02℃/W$$

$$R_{parallel} = \frac{1}{2 \times \frac{1}{R_{plaster}} + \frac{1}{R_{brick}}} = \frac{1}{2 \times \frac{1}{96.97} + \frac{1}{2.02}} = 1.94℃/W$$

$$R_{plaster,\,R} = R_{plaster,\,R} = \frac{L_{plaster,\,R}}{k_{plaster} \times A_{plaster,\,R}} = \frac{0.02}{0.022 \times 0.25 \times 1} = 0.363℃/W$$

$$R_{conv,2} = \frac{1}{h_2 \times A_1} = \frac{1}{40 \times 0.25 \times 1} = 0.1℃/W$$

$R_{total} = R_{conv,1} + R_{foam} + R_{total} + 2R_{plaster,\,R} + R_{conv,2}$

$= 0.4 + 4.615 + 。363 + 1.94 + 2 \times 0.363 + 0.1$

$= 7.781℃/W$

So the heat transfer rate is: $\dot{Q} = \frac{\Delta T}{R_{totall}} = \frac{30}{7.781} = 3.86W$

The R_{totall} while the thickness of brick in this composite wall is 16mm, R_{totall} =6.81W

$$\dot{Q} = \frac{\Delta T}{R_{totall}} = \frac{30}{6.81} = 4.41W$$

Conclusion：

Increasing the thickness of the brick within the composite wall does not significantly increase the thermal resistance of the wall.

Question 2：

Determine the overall unit thermal resistance(the R-value) and the overall heat transfer coefficient(the U-factor) of a wall frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400mm. The 90-mm wide cavity between the studs is filled with urethane rigif foam. The inside is filled with 13-mm gypsum wallboard and outside with 13-mm plywood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75% heat transmission area while the studs, plates, and sills constitutes 21%. The headers constitutes 4% of the area, and they can be treated as studs.

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel(13mm-200mm)	0.14	0.14
Plywood(13mm)	0.11	0.11
Urethane rigif foam insulation(90mm)	\	0.98*90/25=3.528
Wood studs(90mm)	0.63	\
Gypsum board(13mm)	0.079	0.079
Inside surface	0.12	0.12