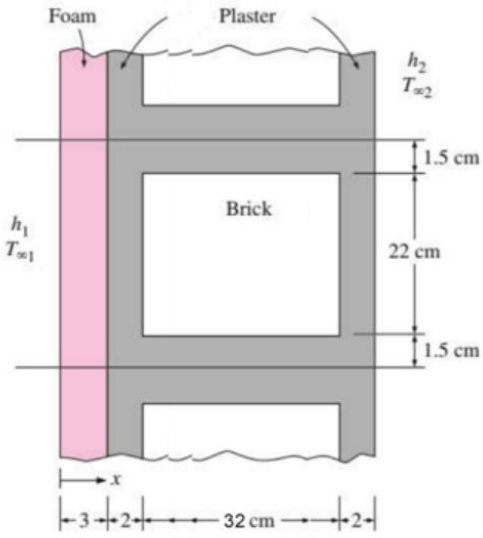
#Week 3 In this week's assignment you should first dfinlize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results.
You should solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigif foam andwhile replacing the fiberboard with plywood and find the two R_unit values.

Question1

• A 3 m high and 5 m 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 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.



$$R_{\mathrm{i}}=\frac{1}{\mathrm{h_i}\times \mathrm{A}}=\frac{1}{10\times 0.25}=0.4℃/W$$

$$R_{\mathrm{f}}=\frac{\mathrm{L_f}}{\mathrm{k_f}\times \mathrm{A}}=\frac{0.03}{0.026\times 0.25}=4.615℃/W$$

$$R_{\mathrm{p1}}=R_{\mathrm{p2}}=\frac{\mathrm{L_{p1}}}{\mathrm{k_p}\times \mathrm{A_{p1}}}=\frac{0.02}{0.22\times 0.25}=0.363℃/W$$

$$R_{\mathrm{o}}=\frac{1}{\mathrm{h_o}\times \mathrm{A}}=\frac{1}{40\times 0.25}=0.1℃/W$$

$$R_{\mathrm{pc1}}=R_{\mathrm{pc2}}=\frac{\mathrm{L_{pc1}}}{\mathrm{k_p}\times \mathrm{A_{pc}}}=\frac{0.32}{0.22\times 0.015}=96.97℃/W$$

$$R_{\mathrm{b}}=\frac{\mathrm{L_b}}{\mathrm{k_b}\times \mathrm{A_b}}=\frac{0.32}{0.72\times 0.22}=2.02℃/W$$

$$\frac{1}{R_{\mathrm{tot}.p}}=\frac{1}{R_b}+\frac{1}{R_{pc1}}+\frac{1}{R_{pc2}}=\frac{1}{2.02}+2\times\frac{1}{96.97}=0.516℃/W$$

$$R_{\mathrm{tot}.p}=\frac{1}{0.516}=1.94℃/W$$

$$R_{total} = R_i + R_f + R_{p1} \times 2 + R_o + R_{tot.p} = 0.4 + 4.615 + 2 \times 0.363 + 0.1 + 1.94 = 7.781℃/W$$

$$\dot{Q} = \frac{T_1 - T_\infty}{R_{total}} = \frac{20+10}{7.781} = 3.856W$$

When the thickness of brick in this composite wall is 16mm: $R_{\text{total}} = 6.81℃/W$

$$\dot{Q} = \frac{T_1 - T_\infty}{R_{total}} = \frac{20+10}{6.81} = 4.405W$$

Conclusion:

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

Question2

Component	R-Value $m^2 \cdot °C/W$	R-Value $ft^2 \cdot h \cdot °F/Btu$
Outside surface (winter)	0.030	0.17
Outside surface (summer)	0.044	0.25
Inside surface, still air	0.12	0.68
Plane air space, vertical, ordinary surfaces (ε_{eff} = 0.82):		
13 mm (½ in)	0.16	0.90
20 mm (¾ in)	0.17	0.94
40 mm (1.5 in)	0.16	0.90
90 mm (3.5 in)	0.16	0.91
Insulation, 25 mm (1 in)		
Glass fiber	0.70	4.00
Mineral fiber batt	0.66	3.73
Urethane rigid foam	0.98	5.56
Stucco, 25 mm (1 in)	0.037	0.21
Face brick, 100 mm (4 in)	0.075	0.43
Common brick, 100 mm (4 in)	0.12	0.79
Steel siding	0.00	0.00
Slag, 13 mm (½ in)	0.067	0.38
Wood, 25 mm (1 in)	0.22	1.25
Wood stud, nominal 2 in × 4 in (3.5 in or 90 mm wide)	0.63	3.58

Component	R-Value $m^2 \cdot °C/W$	R-Value $ft^2 \cdot h \cdot °F/Btu$
Wood stud, nominal 2 in × 6 in (5.5 in or 140 mm wide)	0.98	5.56
Clay tile, 100 mm (4 in)	0.18	1.01
Acoustic tile	0.32	1.79
Asphalt shingle roofing	0.077	0.44
Building paper	0.011	0.06
Concrete block, 100 mm (4 in):		
Lightweight	0.27	1.51
Heavyweight	0.13	0.71
Plaster or gypsum board, 13 mm (½ in)	0.079	0.45
Wood fiberboard, 13 mm (½ in)	0.23	1.31
Plywood, 13 mm (½ in)	0.11	0.62
Concrete, 200 mm (8 in)		
Lightweight	1.17	6.67
Heavyweight	0.12	0.67
Cement mortar, 13 mm (1/2 in)	0.018	0.10
Wood bevel lapped siding, 13 mm × 200 mm (1/2 in × 8 in)	0.14	0.81

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel l.	0.14	0.14
Plywood(13mm)	0.11	0.11
Urethane Rigid Foam	No	0.98*(90/25)=3.528
Wood Stud	0.63	No
Gypsum Board	0.079	0.079
Inside Surface	0.12	0.12

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

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