submission week **3**

Eleonora Maggi	926069

1 Finish the question on the composite wall (example C) finding the heat transfer rate.

calculated resistance:

$R_{total} = 6.81\ °C/W$

indoor and outdoor temperatures:

$T_1 = 20°C$
$T_2 = -10°C$

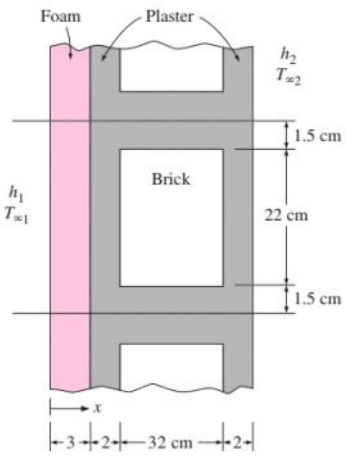
heat transfer rate:

$$\dot{Q} = \frac{T_1 - T_2}{R_{tot}} = \frac{20-(-10)}{6.81} = 4.40\ W$$

2 Consider a 3 m high and 5 m wide wall consists of long 16 cm 32 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 h_1=10 W/m2 · °C and h_2 =40 W/m2 · °C, respectively.

Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

Comment on the result.



$$R_i = \frac{1}{h_1 * A} = \frac{1}{(10 * 0.25)} = 0.4\ °C/W$$

$$R_f = \frac{L_f}{K_f * A} = \frac{0.03}{(0.026 * 0.25)} = 4.615\ °C/W$$

$$R_{P_1} = R_{P_2} = \frac{L_{p_1}}{k_p * A_{p_1}} = \frac{0.02}{(0.22 * 0.25)} = 0.363\ °C/W$$

$$R_{p_{c_1}} = R_{p_{c_2}} = \frac{L_{p_{c_1}}}{k_p \times A_{p_{c_1}}} = \frac{0.32}{(0.22 * 0.015)} = 96.97\ °C/W$$

$$R_b = \frac{L_b}{k_b \times A_b} = \frac{0.32}{(0.72 * 0.22)} = 2.02\ °C/W$$

$$\frac{1}{R_{tot_{parallel}}} = \frac{1}{R_b} + \frac{1}{R_{p_{c_1}}} + \frac{1}{R_{p_{c_2}}} = \frac{1}{2.02} + 2 * \left(\frac{1}{96.97}\right) = 0.51$$

$$\rightarrow R_{tot_{parallel}} = \frac{1}{0.516} = 1.938\ °C/W$$

$$R_o = \frac{1}{h_2 * A} = \frac{1}{(40 * 0.25)} = 0.1\ °C/W$$

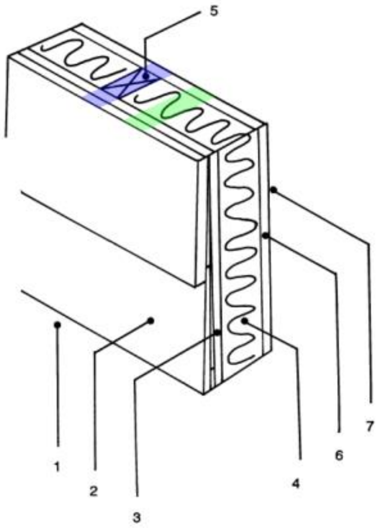
$$R_{total} = R_i + R_f + 2 * R_{P_1} + R_{tot_{parallel}} + R_o = 0.4 + 4.651 + 2 * 0.336 + 1.938 + 0.1$$

$$R_{total} = 7.76\ °C/W$$

$$\dot{Q} = \frac{T_1 - T_2}{R_{tot}} = \frac{20-(-10)}{7.76} = 3.86\ W$$

→ Comparing the heat transfer rate in the two cases we can see that changing the thickness of the brick the wall is not much more performing because the material is placed in parallel and not in series. Working on the thickness of the foam could make the wall more performing.

3 Determine the overall unit thermal resistance (the *R*-value) of a wood frame wall composed like that:



layer	material	section A	section B
1	outside surface	0.03	0.03
2	wood bevel lapped siding (13mm*200mm)	0.14	0.14
3	Playwood (13mm)	0.11	0.11
4	urethane rigid foam (90mm)	-	0.98*90/25 = 3.528
5	wood stud (90mm)	0.63	-
6	gypsum wallboard (13mm)	0.079	0.079
7	inside surface	0.12	0.12

section A: section with wood
section B: section with insulation

$$R'_{withIns} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109\ m^2.°C/W$$

$$R'_{withWood} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007\ m^2.°C/W$$