Andrea Foppiani / Week 3 assignment

① COMPOSITE WALL

a.) exercise to finalize → $\dot{Q} = ?$

$$\dot{Q} = \frac{T_{\infty_1} - T_{\infty_2}}{R_{TOT}}$$

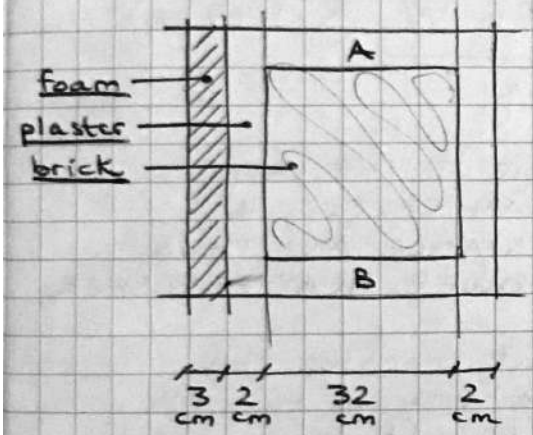
$T_{\infty_1} = 20°C$ (given by the text)

$T_{\infty_2} = 10°C$

$R_{TOT_{wall}} = 6,805 \frac{°C}{W}$ (found during class)

$$\dot{Q} = \frac{20°C - 10°C}{6,805 \frac{°C}{W}} \simeq 1,47\ W \quad (1,4695)$$

b.) same question
different thickness of the bricks: 32 cm

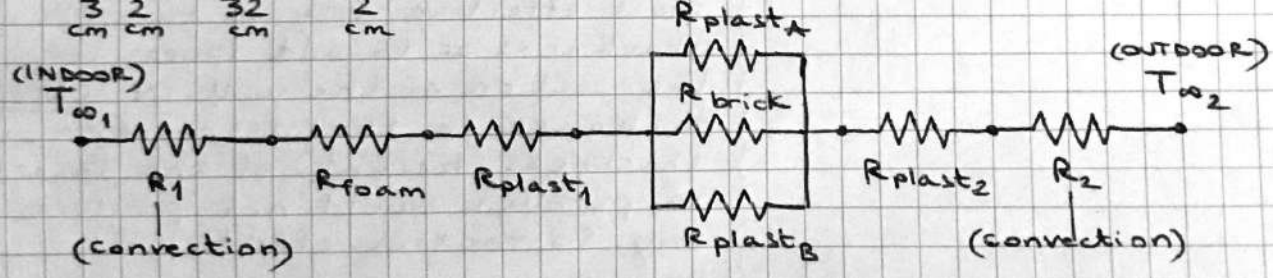


$h_1 = 10 \frac{W}{m^2 \cdot °C}$ $h_2 = 40 \frac{W}{m^2 \cdot °C}$

$K_{foam} = 0,026 \frac{W}{m \cdot °C}$

$K_{plast} = 0,22 \frac{W}{m \cdot °C}$

$K_{brick} = 0,72 \frac{W}{m \cdot °C}$



$$R_1 = \frac{1}{h_1 \cdot A} = \frac{1}{10 \cdot 0,25 \cdot 1} = 0,4\ °C/W$$

$$R_{foam} = \frac{L}{K_{foam} \cdot A} = \frac{0,03}{0,026 \cdot 0,25 \cdot 1} = 4,615\ °C/W$$

$$R_{plast_1} = \frac{L}{K_{plast} \cdot A} = \frac{0,02}{0,22 \cdot 0,25 \cdot 1} = 0,36\ °C/W$$

IN PARALLEL

$$R_{plast_A} = \frac{L}{K_{plast} \cdot A} = \frac{0,32}{0,22 \cdot 0,015 \cdot 1} = 96,97\ °C/W$$

$$R_{brick} = \frac{L}{K_{brick} \cdot A} = \frac{0,32}{0,72 \cdot 0,22 \cdot 1} = 2,02\ °C/W$$

$$R_{plast_B} = R_{plast_A} = 96,97\ °C/W$$

$$\frac{1}{R_{TOT}} = \frac{1}{R_{plast_A}} + \frac{1}{R_{brick}} + \frac{1}{R_{plast_B}}$$

$$\frac{1}{R_{TOT}} = \frac{1}{96,97} + \frac{1}{2,02} + \frac{1}{96,97} = (0,01 + 0,495 + 0,01)\ \frac{W}{°C}$$

$$\frac{1}{R_{TOT}} = 0,515\ \frac{W}{°C}$$

$\rightarrow$ $R_{TOT\ parallel} \cong 1,94\ °C/W$ $(1,9417)$ $\rightarrow$ again very close to R_{brick} because bricks are much more conductive than plaster

$$R_{plast_2} = R_{plast_1} = 0,36\ °C/W$$

$$R_2 = \frac{1}{h_2 \cdot A} = \frac{1}{40 \cdot 0,25 \cdot 1} = 0,1\ °C/W$$

$$\Rightarrow \boxed{R_{TOT\ wall}} = \Sigma R = R_1 + R_{foam} + R_{plast_1} + R_{TOT\ parallel} + R_{plast_2} + R_2 =$$

$$= 7,775\ °C/W$$

$$\dot{Q} = \frac{T_{\infty_1} - T_{\infty_2}}{R_{TOT\ wall}} = \frac{20°C - 10°C}{7,775\ °C/W} \cong \underline{\underline{1,286\ W}}\ (< 1,47\ W)$$

(previous result)

THICKENING ONE OF THE LAYERS PRODUCED AS AN EFFECT, A HIGHER RESISTANCE AND THUS A SLIGHTLY LOWER HEAT TRANSFER

To reduce heat transfer, the most effective way is to add thickness or to add layers to the section of the wall IN SERIES. A change in the disposition or thickness (height) of the layers in parallel would not produce any sustantial effect.

(2) SIMPLIFIED WALL CALCULATION

$$R\_unit = \frac{L}{K}\ \left[m^2 \cdot \frac{°C}{W}\right] \quad (= R \cdot A)$$

(R_unit)	A wood ($m^2 \cdot °C/W$)	B insulation ($m^2 \cdot °C/W$)
1) outside air	0,03	0,03
2) wood bevel	0,14	0,14
3) plywood (13 mm)	0,11	0,11
4) urethane (25 mm) rigid foam	/	$\frac{0,98}{25} \cdot 90$
5) wood studs (90 mm)	0,63	/
6) gypsum board (13 mm)	0,079	0,079
7) inside surface (still air)	0,12	0,12
	1,109	4,007

$\leftarrow$ data coming from table (given)

$\leftarrow$ Total R_unit (or R') in the two cases