Calculation of the rate of heat transfer for L(brick) = 16 cm

$$\begin{cases} R_{TOTAL} = 6{,}81\ °C/W \ ; \quad T_{\infty 1} = 20\ °C \ ; \quad T_{\infty 2} = -10 \\ \dot{Q} = \dfrac{T_{\infty 1} - T_{\infty 2}}{R_{TOTAL}} = \dfrac{20+10}{6{,}81} \end{cases} \Rightarrow \boxed{\dot{Q} = 4{,}4\ W}$$

Calculation of the total resistance and the rate of heat transfer for L(brick) = 32 cm

$(A = 0{,}25\,m \times 1\,m)$

$$\underset{(inside)}{R_i} = \frac{1}{h_i \times A} = \frac{1}{10 \times 0{,}25} = 0{,}4\ °C/W$$

$$\underset{(foam)}{R_f} = \frac{L_f}{k_f \times A} = \frac{0{,}03}{0{,}026 \times 0{,}25} = 4{,}615\ °C/W$$

$$\underset{(plaster)}{R_{P1}} = R_{P2} = \frac{L_P}{k_P \times A} = \frac{0{,}02}{0{,}22 \times 0{,}25} = 0{,}363\ °C/W$$

$$\underset{(outside)}{R_o} = \frac{1}{h_o \times A} = \frac{1}{40 \times 0{,}25} = 0{,}1\ °C/W$$

$$1/\underset{parallel}{R_{TOT}} = 1/\underset{(brick)}{R_b} + 2 \times 1/\underset{(plaster)}{R_P}$$

$$= \frac{k_b \times A_b}{L_b} + 2 \times \left(\frac{k_P \times A_P}{L_P}\right)$$

$$= \left(\frac{0{,}72 \times 0{,}22}{0{,}32}\right) + 2 \times \left(\frac{0{,}22 \times 1{,}5 \times 10^{-2}}{0{,}32}\right)$$

$$= \left[0{,}495 \left(= \frac{1}{2{,}02}\right)\right] + 2 \times \left[0{,}01 = \left(\frac{1}{100}\right)\right] = 1/0{,}515$$

$$\boxed{\underset{parallel}{R_{TOT}} = 1{,}94\ °C/W}$$

$$\Rightarrow R_{TOTAL} = R_i + R_f + 2 \times R_{P1} + R_{parallel} + R_o$$

$$= 0{,}4 + 4{,}615 + (2 \times 363) + 1{,}94 + 0{,}1$$

$$\boxed{R_{TOTAL} = 7{,}78\ °C/W} \Rightarrow \boxed{\dot{Q} = 3{,}856\ W}$$

- The resistance of the parallel plasters is neglicted compared to the resistance of the brick => the heat tansfer happens mainly through the brick.
- The resistance of the brick has increased by increasing its thickness (the double) and so has decreased the heat transfer by 0,544 W.

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The R_unit values

The simplified wall calculation procedure replacing the glass fiber one with urethane rigid foam and while replacing the fiberboard with plywood :

Case 1 :

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm wood fiberboard	0.23
38-mm 90-mm wood studs	0.63
90 mm urethane rigid foam	(90/25)*0.98 = 3.528
13-mm gypsum wallboard	0.079
Inside	0.12

R_unit (1) = ∑R_units = 4,757 $m^2.°C /W$

Case 2 :

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm Polywood	0.11
38-mm 90-mm wood studs	0.63
90 mm glass fiber insulation	(90/25)*0.7 = 2.52
13-mm gypsum wallboard	0.079
Inside	0.12

R_unit (2) = ∑R_units = 3,629 $m^2.°C /W$