WEEK_3 Againi

In this week's assignment you should first finalize 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.
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.

1.COMPOSITE WALL

Thickness of the brick 16 cm

$R_{conv1}=0,4\ \frac{C}{W}$

$R_{f}=4.61\ \frac{C}{W}$

$R_{p}=0,36\ \frac{C}{W}$

$R_{p1}=48.48\ \frac{C}{W}$

$R_{b}=1.01\ \frac{C}{W}$

$R_{conv2}=0,1\ \frac{C}{W}$

$Rtotal=R_{conv1}+R_{f}+R_{p}+\frac{1}{Rp1}+\frac{1}{Rp}+\frac{1}{Rp2}+R_{p}+R_{conv2}$

$Rtotal=0.4+4.61+0.36+\frac{1}{48.48}+\frac{1}{1.01}+\frac{1}{48.48}+0.36+0.1$

$Rtotal=\mathbf{6.86}\frac{C}{W}$

$Q=\frac{T1\ -T2}{Rtotal}$

$Q=\frac{20C-(-10C)}{6.86\frac{C}{W}}$ **Q=4.37 W**

2.COMPOSITE WALL

Thickness of the brick 32 cm

$R_{conv1}=0,4\ \frac{C}{W}$

$R_{f}=4.61\ \frac{C}{W}$

$R_{p}=0,36\ \frac{C}{W}$

$R_{p1}=96.96\ \frac{C}{W}$

$R_{b}=2.02\ \frac{C}{W}$

$R_{conv2}=0{,}1\ \frac{C}{W}$

$Rtotal=R_{conv1}+R_f+R_p+\frac{1}{Rp1}+\frac{1}{Rb}+\frac{1}{Rp2}+R_p+R_{conv2}$

$Rtotal=0.4+4.61+0.36+\frac{1}{96.96}+\frac{1}{2.02}+\frac{1}{96.96}+0.36+0.1$

$Rtotal=\mathbf{6.34}\frac{\boldsymbol{C}}{\boldsymbol{W}}$

$Q=\frac{T1\ -T2}{Rtotal}$

$Q=\frac{20C-(-10C)}{6.34\frac{C}{W}}$ **Q=4.73 W**

With double thickness of the brick, decrease the total resistance of the wall but not significantly
The resistance of the brick and the plaster in the section rise to the double, however, as it is inversely proportional to the total resistance, the amount decreases comparing with the initial exercise. We can conclude that brick main function is structural one. The foam is the most important isolator.

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

3. SIMPLIFIED WALL CALCULATION

	WOOD	INSULATION
Outside Air winter	0.030 $\frac{m2\ C}{W}$	0.030 $\frac{m2\ C}{W}$
Wood bevel	0.14 $\frac{m2\ C}{W}$	0.14 $\frac{m2\ C}{W}$
Playwood 13mm	0.011 $\frac{m2\ C}{W}$	0.011 $\frac{m2\ C}{W}$
Urethane rigid foam 90mm	--	3.52 $\frac{m2\ C}{W}$
Wood stud	0.63 $\frac{m2\ C}{W}$	--
Gypsum board	0.079 $\frac{m2\ C}{W}$	0.079 $\frac{m2\ C}{W}$
Inside air	0.12 $\frac{m2\ C}{W}$	0.12 $\frac{m2\ C}{W}$
R value	**1.01** $\frac{\boldsymbol{m2\ C}}{\boldsymbol{W}}$	**3.9** $\frac{\boldsymbol{m2\ C}}{\boldsymbol{W}}$

R wood= 0.03 + 0.14 + 0.011 +0.63 + 0.079 + 0.12 = 1.01 $\frac{\text{m2 C}}{\text{W}}$

R insulation= 0.03 + 0.14 + 0.011 + 3.52 + 0.079 + 0.12 = 3.9 $\frac{\text{m2 C}}{\text{W}}$