WEEK_3

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Question 1:

A 3-m high and 5-m wide wall consist of long 32cm 22cm cross section horizontal bricks (k=0.72 W/m $^{o}$C) separated by 3cm thick plaster layers (k=0.22 W/m $^{o}$C)

There are also 2 cm thick plaster layers on each side of the brick and a 3cm thick rigid foam (k=0.026 W/m $^{o}$C) on the inner side of the wall. The indoor and the outdoor temperatures are 20 $^{o}$C and -10 $^{o}$C and the convection heat transfer coefficients on the inner and the outer sides are $h_1$=10 W/ m$^2$ $^{o}$C and $h_2$= 40 W/m$^2$ $^{o}$C, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

Answer:

$R_{total}=R_{conv1}+R_{foam}+R_{plaster1}+R_{total}$ (plaster.up;brick;plaster.down)$+R_{plaster2}+R_{conv2}$
$R_{total}$=1/(10*0.25)+0.03/(0.026*0.25)+0.02/(0.22*0.25)+0.97+0.02/(0.22*0.25)+1/(40*0.25)
$R_{total}$=0.4+4.61+0.36+0.97+0.36+0.1= 6.8 (C/W)

*2) Finding the rate of heat transfer through the wall:*

Q=($Tin_1$-$Tin_{inf}$)/6.8
Q=(20-(-10))/6.8=30/6.8= **4.4117 (W)**

**2. Solving the same exercise with the thickness of the brick = 32(cm) with comments on the results:**

1) *Finding the total resistance of the 3 parallel layers:*

$R_{plaster.up}$ = $R_{plaster.down}$ =$L_{plaster}$/($k_{plaster}$*$A_{plaster}$)=0.32/(0.22*0.015)=96.96;1/96.96=0.01 C/W
$R_{brick}$ = $L_{brick}$/($k_{brick}$*$A_{brick}$) =0.32/(0.72*0.22)=2.02 C/W;
1/2.02=0.49 C/W
$R_{total}$ (3 layers in parallel) =0.01*2+0.49=0.51;
1/0.51=1.96 C/W

2) *Finding the total resistance of the wall:*

$R_{total}$ =$R_{conv1}$+$R_{foam}$+$R_{plaster1}$+$R_{total}$(3 layers in parallel)+$R_{plaster2}$+$R_{conv2}$
$R_{total}$=0.4+4.61+0.36+1.96+0.36+0.1=7.79 C/W

3) *Finding the rate of heat transfer through the wall:*

Q= ($Tin_1$-$Tin_{inf}$)/7.79
Q= (20-(-10)/7.79=30/7.79= **3.851 W**

Comparing :
**Q** (16 cm brick)= 4.411 W

**Q** (32 cm brick)= 3.851 W

The thickness of the brick inside a composite wall cannot increase the resistance of the whole wall when be doubled. Thermal resistance of the brick has approximately doubled by doubling the thickness of the brick Also, the heat transfer rate Q dot for the new brisk thickness of 32 cm has decreased as well from 4.4031 W to 3.8550 W. However, the decrease is not enough compared to the cost that was probably paid.

Question 3:

Solving the simplified wall calculations procedure with a replacement of the *glass fiber one* > *urethane rigid foam*; *fiberboard* > *plywood*, and finding the two R_unit values :

| | Wood A | Insulation B |
|---|---|---|
| Outside air | 0.03 | 0.03 |
| Wood bevel (13*200mm) | 0.14 | 0.14 |
| Plywood (13mm) | 0.11 | 0.11 |
| Urethane rigid foam (90mm) | - | 3.528 |
| Wood studs (90mm) | 0.63 | - |
| Gypsum (13mm) | 0.079 | 0.079 |
| Inside air | 0.12 | 0.12 |

$R_{wood}$ (section A)= 0.03+0.14+0.11+0.63+0.079+0.12= 1.109 (m2.$^{o}$C )/W

$R_{insulation}$(section B)= 0.03+0.14+0.11+3.528+0.079+0.12= 4.007 (m2.$^{o}$C )/W