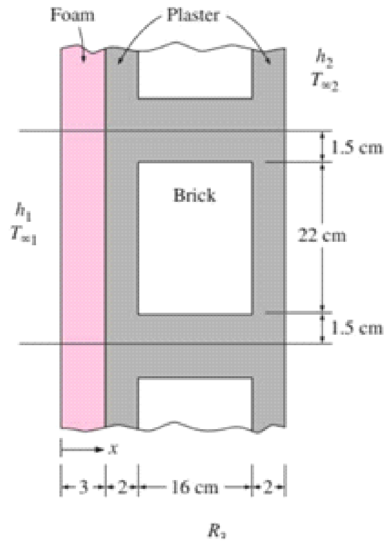
week3_MelissaMartinoli

martedì 22 ottobre 2019 11:44

01a.Finalizing the composite wall question by finding the heat transfer rate.

A 3 m high and 5 m wide wall consists of long 16 cm 22 cm cross section horizontal bricks (k = 0,72 w/m°C) separated by a 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 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:
$h_1 = 10\ W/m^2°C$
$h_2 = 25\ W/m^2°C$



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

During the lesson we stop calculating the R of the total wall.

$R_{total} = R_f + R_i + R_o + R_{p1} + R_{p2} + R_{tot.parallel}$ = 4,615 + 0,4 + 0,1 + 0,363 + 0,363 + 0,97 =

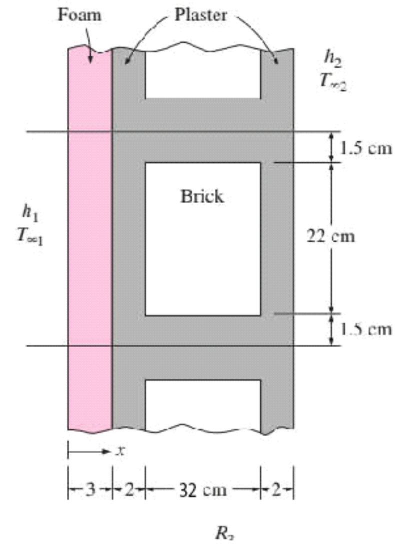
$R_{total} = 6{,}811\ \frac{°C}{W}$

The following part is the conclusion of the exercise.

$$\dot{Q} = \frac{T_S - T_\infty}{Rtotal} = \frac{20 - (-10)}{6{,}811} = 4{,}405\ W$$

01b.Solve the same excercise, with the thickness of the brick increased to 32 cm and comment 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:
h_1 = 10 W/m^2°C
h_2 = 25 W/m^2°C



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

$A_1 = 1 \text{ x } 0{,}015 = 0{,}015 \text{ m}^2$ $\qquad$ $A_2 = 1 \text{ x } 0{,}22 = 0{,}22 \text{ m}^2$

$$R_{tot.parallel} = \frac{1}{\frac{1}{R_{pc1}} + \frac{1}{R_{brick}} + \frac{1}{R_{pc2}}} = \frac{1}{\frac{1}{\frac{L}{k \text{ x } A_1}} + \frac{1}{\frac{L}{k \text{ x } A_2}} + \frac{1}{\frac{L}{k \text{ x } A_1}}}$$

$$R_{pc1} = R_{pc2} = \frac{L}{k \text{ x } A_1} = \frac{0{,}32}{0{,}22 \text{ x } 0{,}015} = 96{,}969 \ \frac{°C}{W}$$

$$R_b = \frac{L}{k \text{ x } A_1} = \frac{0{,}32}{0{,}72 \text{ x } 0{,}22} = 2{,}02 \ \frac{°C}{W}$$

$$R_{tot.parallel} = \frac{1}{\frac{1}{96{,}969} + \frac{1}{2{,}02} + \frac{1}{96{,}969}} = 1{,}942 \ \frac{°C}{W}$$

$$R_f = \frac{L_{foam}}{k_f \text{ x } A_f} = \frac{0{,}03}{0{,}026 \text{ x } 0{,}25} = 4{,}615 \ \frac{°C}{W}$$

$$R_i = \frac{1}{h_1 \text{ x } A} = \frac{1}{10 \text{ x } 0{,}25} = 0{,}4 \ \frac{°C}{W}$$

$$R_o = \frac{1}{h_2 \text{ x } A} = \frac{1}{40 \text{ x } 0{,}25} = 0{,}1 \ \frac{°C}{W}$$

$$R_{p1} = R_{p2} = \frac{L_p}{k_p \text{ x } A_p} = \frac{0{,}02}{0{,}22 \text{ x } 0{,}25} = 0{,}363 \ \frac{°C}{W}$$

$R_{total} = R_f + R_i + R_o + R_{p1} + R_{p2} + R_{tot.parallel} = 4{,}615 + 0{,}4 + 0{,}1 + 0{,}363 + 0{,}363 + 1{,}942 =$

$$R_{total} = 7{,}783 \ \frac{°C}{W}$$

$$\dot{Q} = \frac{T_1 - T_\infty}{R_{total}} = \frac{20 - (-10)}{7{,}783} = 3{,}855 \text{ W}$$

From the exercise we did during the class, where the thickness of the brick was 16 cm, we knew that:

$R_{total} = 6{,}811 \frac{°C}{W}$ $\dot{Q} = 4{,}405$ W

If we compare the results, we can see that there isn't a big discrepancy and that the wall's thermal resistance has not increased considerably. Consequently also the rate of heat transfer through the wall has not substantially decreased.

02.Solve the same exercise, replacing the glass fiber with urethane rigid foam and replacing the fiberboard with plywood, find the two R_{unit} values.

Determine the overall unit thermal resistance (the r-value) and the overall heat transfer coefficient (the u-factor) of a wood frame wall that is built around 38 mm 90 mm wood studs with a center-to-center distance of 400 mm.
The 90 mm-wide cavity between the studs is filled with urethane rigid foam, the inside is finished with 13 mm gypsum wallboard and the outside with 13 mm plywood and 13 mm 200 mm wood bevel lapped siding.
The insulated cavity constitutes 75 percent of the heat transmission area while the studs, plates, and sills constitute 21 percent.
The headers constitute 4 percent of the area, and they can be treated as studs.
Find the two R_{unit} values.
At the end, determine the rate of heat loss through the walls of a house whose perimeter is 50 m and wall height is 2,5 m in Las Vegas, Nevada, whose winter design temperature is - 2 ° C. Take the indoor design temperature to be 22 °C and assume 20 % of the wall area is occupied by glazing.

	Wood	Insulation
Outside air	0,03	0,03
Wood bevel (13x200mm)	0,14	0,14
Plywood (13mm)	0,11	0,11
Urethane rigid foam (90mm)	no	(0,98x90)/25 = 3,528
Wood studs (90mm)	0,63	no
Gypsum board (13mm)	0,079	0,079
Inside surface	0,12	0,12

$R_{withwood} = 0{,}03\ m^2\frac{°C}{W} + 0{,}14\ m^2\frac{°C}{W} + 0{,}11\ m^2\frac{°C}{W} + 0{,}63\ m^2\frac{°C}{W} + 0{,}079\ m^2\frac{°C}{W} + 0{,}12\ m^2\frac{°C}{W} =$

$R_{withwood} = 1{,}109\ m2 \frac{°C}{W}$

$R_{withinsulation} = 0{,}03\ m^2\frac{°C}{W} + 0{,}14\ m^2\frac{°C}{W} + 0{,}11\ m^2\frac{°C}{W} + 3{,}528\ m^2\frac{°C}{W} + 0{,}079\ m^2\frac{°C}{W} + 0{,}12m^2\frac{°C}{W} =$

$R_{withinsulation} = 4{,}007\ m^2\frac{°C}{W}$