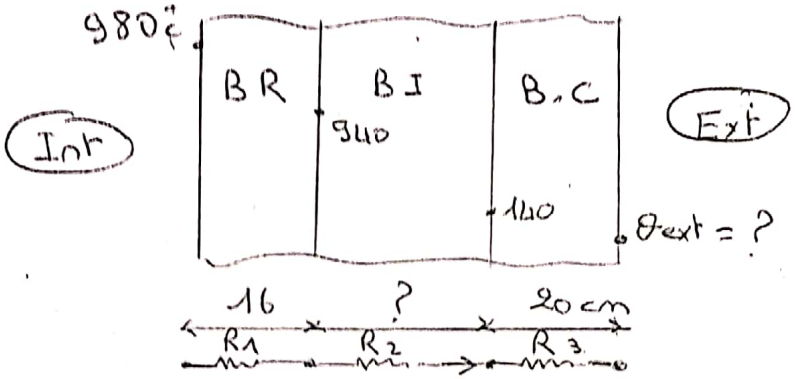
Univ - Souk - Ahras.
Departement Genie Civil - Master 1 - Structures et Materiaux.
Module : Thermique de Batiments.
Chargée du Module : N. BOUACHA

Corrigé de la serie de TD n° 1.

Exercice 1 :



Brique Refractaire : $\lambda_1 = 1,62$.
" Isolante : $\lambda_2 = 0,23$.
" Construction : $\lambda_3 = 1,39$.

1. Calcul de l'epaisseur de la couche B I.

En considerant la propriété de conservation de flux, nous avons.

$$\phi_{entrant} = \phi_{interieu} = \phi_{sortant}.$$

$$\Rightarrow \phi = \frac{\Delta T}{R} = \frac{980 - 940}{R_1} = \frac{940 - 140}{R_2} = \frac{140 - \theta_{ext}}{R_3}$$

Avec : R_i : Resistance thermique d'une couche i

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$R_i = \frac{e_i}{\lambda_i . S_i}$ → e_i : Epaisseur [m].
λ_i : Conductivité [W/m²°C]
S_i : Surface d'échange [m²]

$R_1 = \frac{0,16}{1,62 . 1} = 0,0987$ °C/W

$R_2 = \frac{e_2}{0,23 . 1} = ?$

$R_3 = \frac{0,2}{1,39 . 1} = 0,1438$ °C/W

$\phi = \frac{980 - 940}{0,0987} = 405,26$ W.

$\phi = \frac{940 - 140}{R_2} = 405,26 \Rightarrow R_2 = \frac{940 - 140}{\phi} = 1,974.$

$R_2 = \frac{e_2}{\lambda_2 . S} = \frac{e_2}{0,23 . 1} = 1,974. \Rightarrow e_2 = 1,974 . 0,23.$

$\Rightarrow e_2 = 0,45 m = 45 cm.$

. calcul de la température θ_{ext}.
Avec la même formule.

$\phi = \frac{140 - \theta_{ext}}{R_3} \Rightarrow \theta_{ext} = 140 - \phi . R_3.$

$\theta_{ext} = 140 - 405,26 . 0,1438 = 58,26$ °C.

Exercice 2.

couche 1 $e_1 = 20cm$ $\lambda_1 = 1,05$

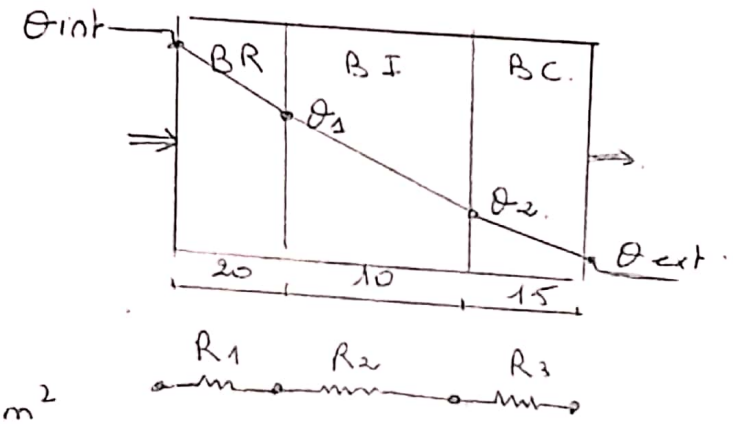
" 2 $e_2 = 10cm$ $\lambda_2 = 0,22$.

" 3 $e_3 = 15cm$ $\lambda_3 = 0,595$.

$\theta_{int} = 871\,°C$, $\theta_{ext} = 52\,°C$.

1- Calcul du flux.

$$\phi = \frac{\Delta T}{R} = \frac{\theta_{int} - \theta_{ext}}{R_{eq}} \text{ tel que } R_{eq} = \sum R_i = R_1 + R_2 + R_3$$



$S = 1m^2$

$$R_1 = \frac{e_1}{\lambda_1 . S} = \frac{0,20}{1,05 . 1} = 0,1904$$

$$R_2 = \frac{e_2}{\lambda_2 . S} = \frac{0,10}{0,22 . 1} = 0,4545$$

$$R_3 = \frac{e_3}{\lambda_3 . S} = \frac{0,15}{0,595 . 1} = 0,252$$

$R_{eq} = \sum R_i = 0,897$

$$\phi = \frac{\theta_{int} - \theta_{ext}}{R_{eq}} = \frac{871 - 52}{0,897} = 913,04\,W.$$

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. calcul des températures aux interfaces.

$$\phi = \frac{\theta_{int} - \theta_{ext}}{R_{eq}\ (1)} = \frac{\theta_{int} - \theta_1}{R_1\ (2)} = \frac{\theta_1 - \theta_2}{R_2\ (3)} = \frac{\theta_2 - \theta_{ext}}{R_3\ (4)}$$

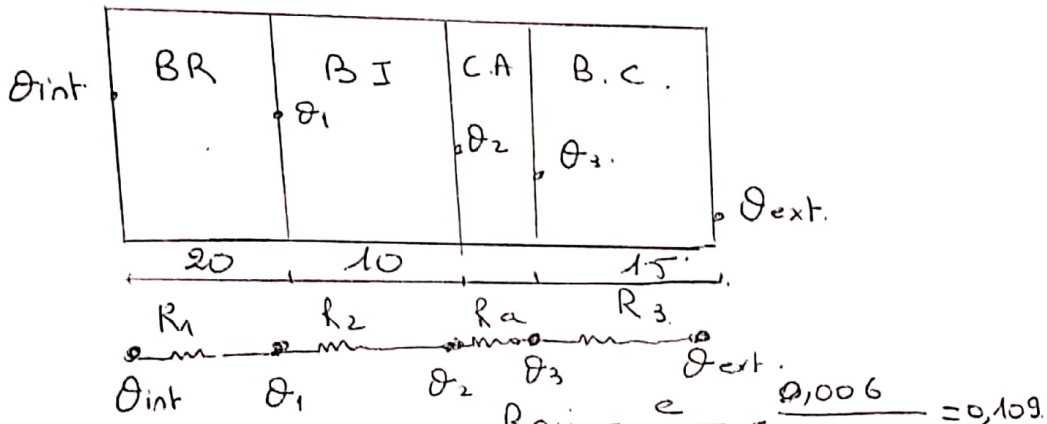
$= 913,04$.

De (2) $\rightarrow \phi = \frac{\theta_{int} - \theta_1}{R_1} \Rightarrow \theta_1 = \theta_{int} - \phi . R_1$

$\theta_1 = 871 - 913,04 . 0,1904 = 697,15$ °C.

(3) $\rightarrow \phi = \frac{\theta_1 - \theta_2}{R_2} \Rightarrow \theta_2 = \theta_1 - \phi . R_2$.

$\theta_2 = 697,15 - 913,04 . 0,4545 = 282,17$ °C.



$$R_{ai} = \frac{e}{\lambda . S} = \frac{0,006}{0,055 . 1} = 0,109$$

$R_{TOT} = R_{eq} + R_{ai}$;

$= 0,897 + 0,109 = 1,006$

$$\Rightarrow \Phi = \frac{\theta_{int} - \theta_{ext}}{R_{TOT}} = \frac{871 - 52}{0,905} = 814\ W.$$

le % Reduction $\frac{\phi_2 - \phi_1}{\theta_2} . 100 = \frac{913,04 - 814}{913,04} . 100 = 10,87\% \simeq 11\%$. /2

Exercice 3:

Chambre froide:

Largeur 4m, Hauteur 3,5m.

$\theta_{int} = -12$ °C , $\theta_{ext} = +12$ °C.

Mur composé de 80cm de Maçonnerie.
2cm de Liège.

porte (1,5 x 2) : 4cm de bois.
2,2cm de Liège Granulé.

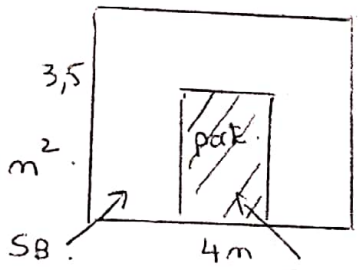
On demande de calculer le flux total traversant le mur.

- Détermination des surfaces.

$S_{MT} = 4 \times 3,5 = 14\ m^2$.

$S_{MB} = 14 - S_p = 14 - 3 = 11\ m^2$.

$S_{porte} = 1,5 \times 2 = 3\ m^2$.



$\phi_{TOTAL} = \phi_{MB} + \phi_{porte}$.

ϕ = → $\phi_{mur\ Brut}$.
→ ϕ_{porte}

1- ϕ_{MUR} :-

$\phi_M = -\theta_{int} + \theta_{ext}$, $R_{eq_M} = R_{Maco} + R_{Liege}$.

R_{eq_M}

$R_{Maco.} = \frac{0,8}{2,25 \times 11} = 0,032$.

$R_{Liege} = \frac{0,02}{0,039 \times 11} = 0,0466$

$R_{eq_1} = 0,0786$ °C/W

$\phi = \frac{+12 - (-12)}{0,0786} = 305,34$

- ϕ_{porte} :

$$\phi_{porte} = \frac{\theta_{ext} - \theta_{int}}{Req_{porte}} \quad , Req_{porte} = R_{bois} + R_{LG}.$$

$$R_{bois} = \frac{0,04}{0,107 \times 3} = 0,1246$$

$$R_{LG} = \frac{0,022}{904 \times 3} = 0,1629$$

$$\Big\} \; Req_2 = 0,2875 \; °C/W$$

$$\Rightarrow \phi_{porte} = \frac{+12 - (-12)}{0,2875} = 83,47 W.$$

$$\Rightarrow \phi_{TOTAL} = \phi_{MB} + \phi_p = 305,34 + 83,47 = 388,81 W.$$

Exercice 5 :

Soit 3 Cylindres concentriques.

$R_1 = 10 cm$, $R_2 = 13 cm$, $R_3 = 17 cm$, $e = 12 cm$

$T_{int} = 200 °C$, $T_{ext} = 20 °C$.

$\lambda_1 = 60 W/m°C$, $\lambda_2 = 40 W/m°C$, $\lambda_3 = 0,08 W/m°C$

$L = 60 m$

$$\phi = \frac{\theta_{int} - \theta_{ext}}{Req.}$$

$Req = R_1 + R_2 + R_3$