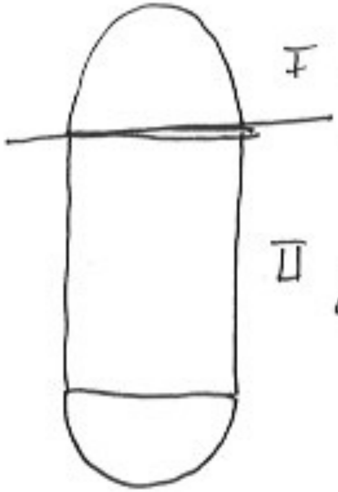
(1)

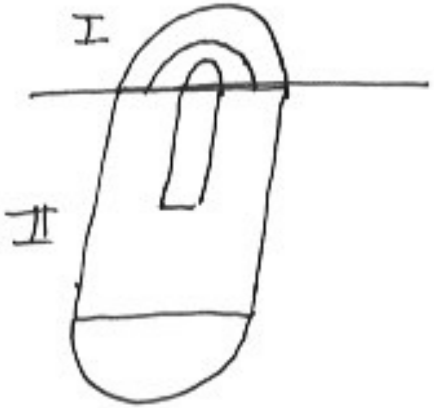


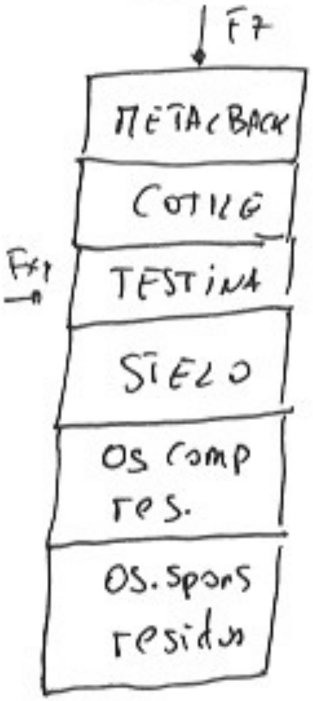
I $\frac{1}{E_t} = \frac{f_{oc}}{E_{oc}^{t}} + \frac{f_{os}}{E_{os}}$

II $E_{xy} = f_{oc} E_{oc}^{xy} + f_{os} E_{os}$

I

II





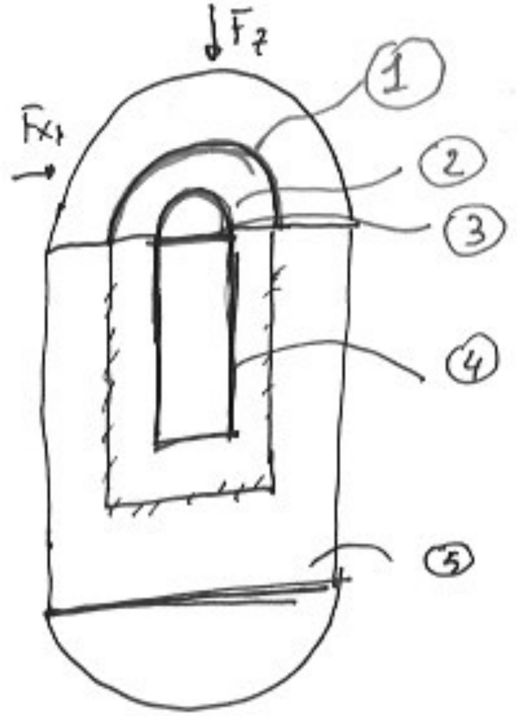
r est MB → r int MB
r est COT → r int COT
r test
r s stelo, h stelo

$$\frac{1}{E_t} = \frac{f_{MB}}{E_{MB}} + \frac{f_{COT}}{E_{COT}} + \frac{f_{TEST}}{E_{TEST}} + \frac{f_{STELO}}{E_{ST}} + \frac{f_{OC.T}}{E_{OC.TS}} + \frac{f_{OS.T.SP}}{E_{OS.T}}$$

$$E_{xy} = f_{MB} E_{MB} + f_{COT} E_{COT} + f_{TEST} \cdot E_{TEST} + f_{STELO} E_{ST} + f_{OC.T} E_{OC.T} + f_{OST} E_{OST}.$$

$$f_{MB} + f_{COT} + f_{TEST} + f_{STELO} + f_{OC.T} + f_{OST} = 1$$

ISOSTRESS



$$\sigma_z = \sigma_{xy}$$

1 $$\frac{F_z^1}{A_z} = \frac{F_{xy}^1}{A_{xy}} \qquad \frac{R_z}{2\pi R_{COT}^2} = \frac{R_{xy}}{\frac{2}{3}\pi \frac{R_{COT}^3}{h_{COT}}}$$

2 $$\frac{F_z^2}{A_z} = \frac{F_{xy}^2}{A_{xy}} \qquad \frac{R_z}{2\pi R_{TEST}^2} = \frac{R_{xy}}{\frac{2}{3}\pi \frac{R_{TEST}^3}{h_{TEST}}}$$

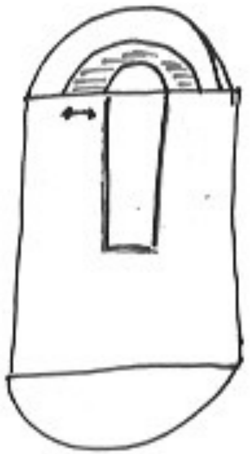
4 $$\frac{F_z^4}{A_z} = \frac{F_{xy}^4}{A_{xy}} \qquad \frac{R_z}{\pi R_{STEO}^2} = \frac{R_{xy}}{2\pi R_{St} \cdot h_{St}}$$

1 $$\Rightarrow \frac{R_{xy}}{R_z} = \frac{2}{3} \cancel{\pi} \frac{R_{COT}^3}{h_{COT}} \cdot \frac{1}{\cancel{2\pi} R_{COT}^2} = \frac{R_{COT}}{3 h_{COT}}$$

2 $$\Rightarrow \frac{R_{xy}}{R_z} = \frac{R_{TEST}}{3 h_{TEST}}$$

$$\boxed{R_{MB} = R_{CA}}$$

4 $$\frac{R_{xy}}{R_z} = \frac{2 R_{STEO}}{h_{St}}$$



$R_{MB} = R_{CA}$

2017/745 CE tassousura cotile $10\mu m$/anno → sp. minimo del sistema $\underline{1\ cm}$.

$$\delta_{COT} = 10,2\ mm$$

$$R_{MB\,INT} = \underline{R_{TEST}} + \underline{\delta}_{COT}$$

R_{TEST}
h_{STELO}
R_{STELO}

$$\begin{cases} \dfrac{1}{E_z} & \text{reuss} \\ E_{xy} & \text{voigt} \\ \sum f_i = 1 \\ \dfrac{F_z^4}{A_z} = \dfrac{F_{xy}^4}{A_{xy}} \end{cases}$$

1 g.d.L

$$V_{TOT} = \frac{2\pi}{3} R_{MB}^3 + \pi \underline{R}_F^2 \cdot \underline{h}_{fem} + \frac{2}{3}\pi \underline{R}_{ep}^3$$

$h_{fem} = 50\ cm$

$R_{fem} = 2\ cm$

$R_{ep} = 2.1/2.2\ cm$

$$V_{TOT} = \frac{2}{3}\pi R_{AC}^3 + \pi R_{F}^2 h_{fem} + \frac{2}{3}\pi R_{ep}^3$$

$$f_{\pi B} = \frac{V_{\pi B}}{V_{TOT}} = \frac{\frac{2}{3}\pi \underline{R^3_{AC}} - \frac{2}{3}\pi \left(R_{TEST} + \underline{\delta_{COT}}\right)^3}{V_{TOT}}$$

$$f_{COT} = \frac{V_{COT}}{V_{TOT}} = \frac{\frac{2}{3}\pi \cdot \left(R_{TEST} + \delta_{COT}\right)^3 - \frac{2}{3}\pi R^3_{TEST}}{V_{TOT}}$$

$$f_{TEST} = \frac{V_{TEST}}{V_{TOT}} = \frac{\frac{2}{3}\pi R^3_{TEST}}{V_{TOT}}$$

$$f_{STELO} = \frac{\pi r^2_{st} \cdot h_{st}}{V_{TOT}}$$

$$f_{OC.RES} = \pi \frac{r^2_{fem} \cdot h_{fem} - \pi r^2_{st} h_{ST}}{V_{TOT}}$$

$$f_{OS.RES} = \frac{2}{3} \frac{\pi R^3_{ep+\varepsilon}}{V_{TOT}}$$

$$\frac{R_{AX}}{R_Z} = \frac{2 R_{STEL}}{2 h_{ST}} \Rightarrow h_{STELO} = \frac{2 R_{STEL}}{2} \cdot \frac{R_Z}{R_{XY}}$$

$$\frac{F_z}{A_z} = \frac{F_{xy}}{A_{xy}} \qquad \frac{R_z}{\pi R^2_{stelo}} = \frac{R_{xy}}{2\pi R_{st} \cdot h_{stelo}}$$

$$R_{stelo} = \left(\frac{R_z}{R_{xy}}\right) \cdot 2h_{stelo}$$

METODO PUNTUALE

R_z R_{xy} → su ogni superficie

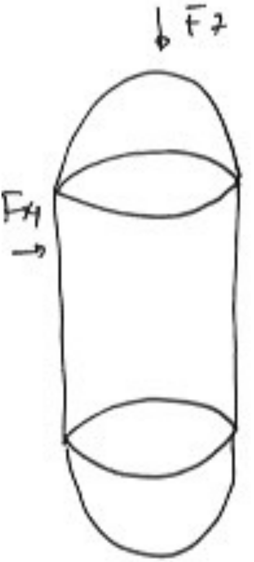
$E_{osso\,sano} = E_{osso+protesi}$ omogeinizzazione

$$\begin{cases} \varepsilon_{z\,osso\,sano} = \varepsilon_{z\,osso+protesi} \\ \varepsilon_{xy\,osso\,sano} = \varepsilon_{xy\,osso+protesi} \end{cases}$$

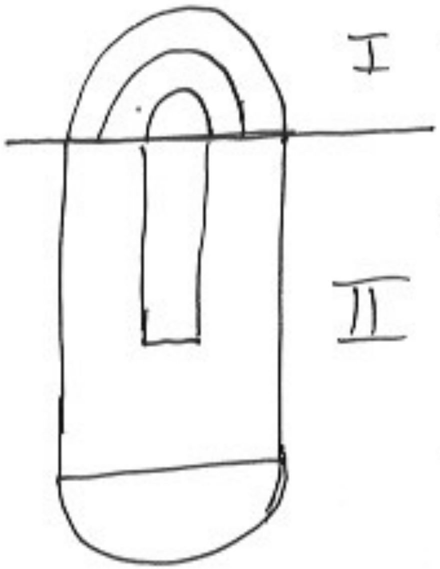
Regione di elasticità dell'osso

$E_{osso+protesi} = \sum E_i$ di tutti gli elementi

6



$$\begin{cases} \varepsilon_z = \dfrac{F_z}{2\pi R^2_{ep1}} \cdot \dfrac{1}{E_{pf1}} + \dfrac{F_z}{\pi R^2 f_{em}} \cdot \dfrac{1}{E^z_{oc}} + \dfrac{F_z}{2\pi R^2_{ep2}} \cdot \dfrac{1}{E_{pf2}} \\ \varepsilon_{xy} = \dfrac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep1}}{h_{ep1}}} \cdot \dfrac{1}{E_{p1}} + \dfrac{F_{\cancel{z}y}}{2\pi R f_{em} \cdot h f_{em}} \cdot \dfrac{1}{E^{xy}_{oc}} + \dfrac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep2}}{h_{ep2}}} \cdot \dfrac{1}{E_{pf2}} \end{cases}$$

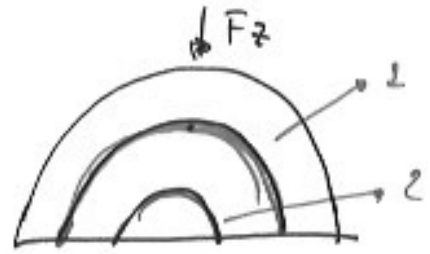


I – puntuale parziale

– puntuale completo

II

$$\begin{cases} \varepsilon_z = \dfrac{F_z}{2\pi R^2_{ep1}} \cdot \dfrac{1}{E_{oss.p}} \\ \varepsilon_{xy} = \dfrac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep1}}{h_{ep1}}} \cdot \dfrac{1}{E_{oss.p}} \end{cases}$$



7

$$\varepsilon_z = \frac{F_z}{2\pi R^2_{\Pi B}} \cdot \frac{1}{E_{\Pi B}} + \frac{F_z}{2\pi R^2_{COT}} \cdot \frac{1}{E_{COT}} + \frac{F_z}{2\pi R^2_{TEST}} \cdot \frac{1}{E_{TEST}}$$

$$\varepsilon_{xy} = \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{\Pi B}}{h_{\Pi B}}} \cdot \frac{1}{E_{\Pi B}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{COT}}{h_{COT}}} \cdot \frac{1}{E_{COT}} + \frac{F_z}{\frac{2}{3}\pi \frac{R^3_{TEST}}{h_{TEST}}} \cdot \frac{1}{E_{TEST}}$$

$r_{est\,\Pi B}$

$r_{int\,\Pi B} = r_{cot\,ex}$

$r_{test} = r_{in\,cont}$

$$\boxed{1 \Rightarrow \frac{F_z}{2\pi R^2_{COT}} = \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{COT}}{h_{COT}}}}$$

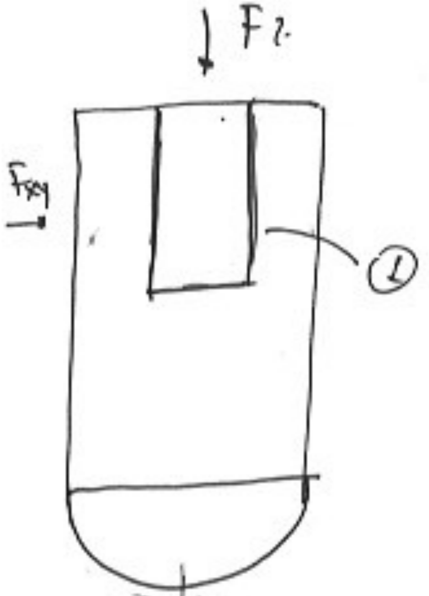
2 $$\frac{F_z}{2\pi R^2_{TEST}} = \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{TEST}}{h_{TEST}}}$$

$R_{\Pi B} = R_{C.A}$

$\delta_{COT} = 10.2$ mm

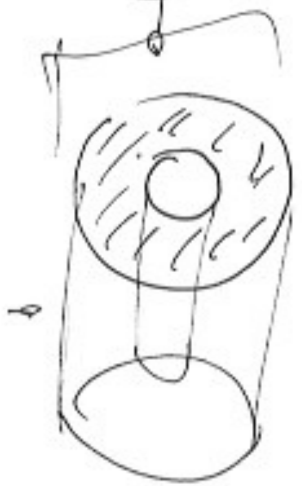
$\delta_{COT} = Sp.mm + 2 \cdot tasso \cdot t = 10\text{ mm} + 0.2\text{ mm} = 10.2$

(8)



$$\varepsilon_z = \frac{F_z}{\pi R^2_{st}} \cdot \frac{1}{\dot{\varepsilon}_{ST}} + \frac{F_z}{\pi(R^2_{fem} - R^2_{st})} \cdot \frac{1}{\dot{\varepsilon}^{z}_{com}} + \frac{F_z}{2\pi R^2_{ep_2}} \cdot \frac{1}{\dot{\varepsilon}_{Pf_2}}$$

$$\varepsilon_{xy} = \frac{F_{\cancel{x}y}}{2\pi R_{fem} \cdot h_{fem}} \cdot \frac{1}{\dot{\varepsilon}^{xy}_{oc}} + \frac{F_{xy}}{2\pi R_{st} h_{st}} \cdot \frac{1}{\dot{\varepsilon}_{ST}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep_2}}{h_{ep_2}}} \cdot \frac{1}{\dot{\varepsilon}_{pl_2}}$$

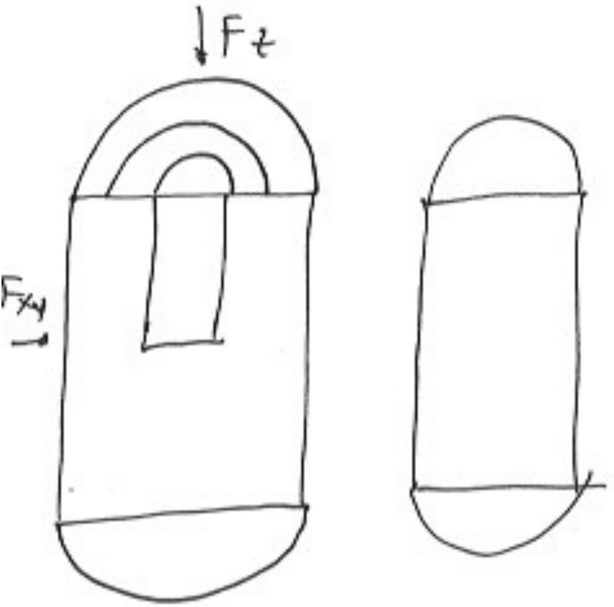


1 $$\frac{F_z}{\pi R^2_{st}} = \frac{F_{xy}}{2\pi R_{st} \cdot h_{st}}$$

$$\boxed{\varepsilon = \varepsilon_0 (1-\rho)^{\alpha} A^{\beta} \dot{\varepsilon}^{\delta}}$$

$$\varepsilon_z^{Sano} = \frac{F_z}{\pi R^2_{fem}} \cdot \frac{1}{\dot{\varepsilon}^{z}_{oc}} + \frac{F_z}{2\pi R^2_{ep}} \cdot \frac{1}{\dot{\varepsilon}_{os\,sp}}$$

$$\varepsilon_{xy}^{Sano} = \frac{F_{xy}}{2\pi R_{fen} \cdot h_{fen}} \cdot \frac{1}{\dot{\varepsilon}^{xy}_{oc}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep_2}}{h_{ep_1}}} \cdot \frac{1}{\dot{\varepsilon}_{epf_1}}$$



$$\varepsilon_z^{Sens} = \frac{F_z}{2\pi R^2_{ep1}} \cdot \frac{1}{E_{pl1}} + \frac{F_z}{\pi R^2_{fam}} \cdot \frac{1}{\bar{E}^z_{o.c.}} + \frac{F_z}{2\pi R^2_{epl_2}} \cdot \frac{1}{E_{pl_2}}$$

$$\varepsilon_{xy}^{Sens} = \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{ep1}}{h_{ep1}}} \cdot \frac{1}{E_{pl1}} + \frac{F_{xy}}{2\pi R_{fam} \cdot h_{fam}} \cdot \frac{1}{E^{xy}_{o.c}} + \frac{F_{xy}}{2\pi R^2_{epl_2}} \cdot \frac{1}{E_{pl_2}}$$

---

(1) $$\varepsilon_z = \frac{F_z}{2\pi R^2_{\Pi B}} \cdot \frac{1}{E_{\Pi B}} + \frac{F_z}{2\pi R^2_{COT}} \cdot \frac{1}{E_{COT}} + \frac{F_z}{2\pi R^2_{TEST}} \cdot \frac{1}{E_{TEST}} + \frac{F_z}{\pi R^2_{ST}} \cdot \frac{1}{E_{ST}} +$$

$$+ \frac{F_z}{\pi (R^2_{fam} - R^2_{ST})} \cdot \frac{1}{\bar{E}^z_{o.R.}} + \frac{F_z}{2\pi R^2_{epl_2}} \cdot \frac{1}{E_{pl_2}}$$

(2) $$\varepsilon_{xy} = \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{\Pi B}}{h_{\Pi B}}} \cdot \frac{1}{E_{\Pi B}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{COT}}{h_{COT}}} \cdot \frac{1}{E_{COT}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{TEST}}{h_{TEST}}} \cdot \frac{1}{E_{TEST}} + \frac{F_{xy}}{2\pi R_{fam} h_{fam}} \cdot \frac{1}{\bar{E}^{xy}_{OR}} +$$

$$+ \frac{F_{xy}}{2\pi R_{st} h_{st}} \cdot \frac{1}{E_{ST}} + \frac{F_{xy}}{\frac{2}{3}\pi \frac{R^3_{epl_2}}{h_{epl_2}}} \cdot \frac{1}{E_{pl_2}}$$

1
2 R_{est} MB *
3 R_{int} MB
4 R_{est} COT
R_{int} COT
R_{TEST} *
h_{STERO} –
R_{STERO} –

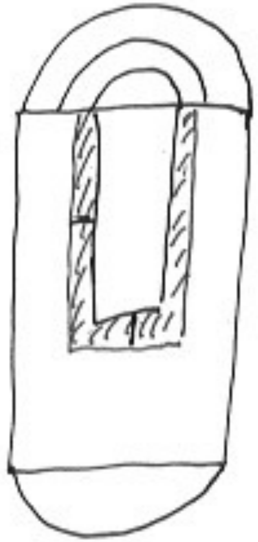
Ipotesi somplificative.

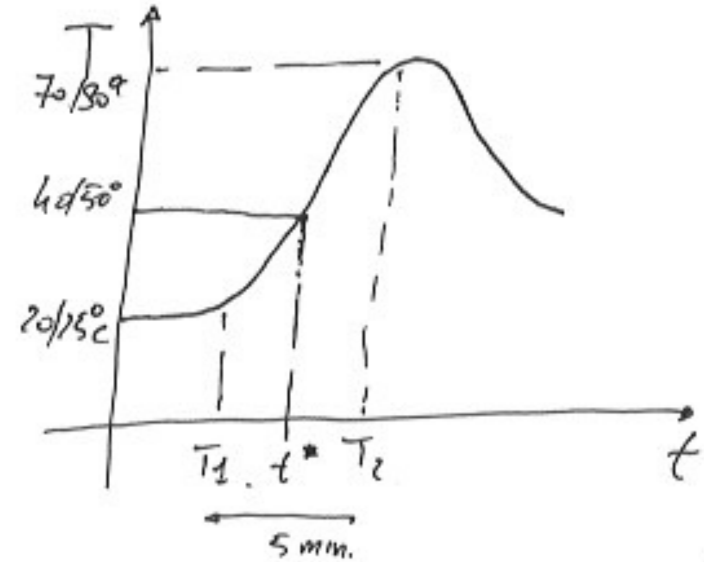
$R_{MB} = R_{CA}$

$\delta_{COT} = 10.2$ mm.

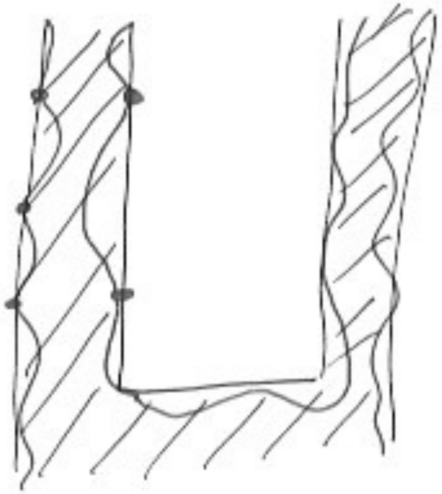
$R_{INT\,CA} = R_{TEST}$

$R_{EST\,COT} = R_{int}$ MB





$\delta_{xy}^{cem} = \delta_{z}^{cem} = X_0$ 4%. $\underline{X_f = 1.04\, X_0}$



$$\frac{\partial T}{\partial t} = D \frac{\partial^2 T}{\partial x^2}$$

$$\underline{D} = \frac{K}{\rho c_p} = \frac{\text{conducibilità termica}}{\text{densità} \cdot \text{calore specifico}} =$$

Conducibilità termica $= \frac{W}{m \cdot {}^\circ K}$

densità $= \frac{Kg}{m^3}$ calore specifico $= \frac{J}{Kg \cdot {}^\circ K}$

Dst
Dosso
Dcemento

17

$$\frac{\partial T}{\partial t} = D\frac{\partial^2 T}{\partial x^2} \qquad T(t, x)$$

$$\begin{cases} \dfrac{\partial T}{\partial t} = A \\ D\dfrac{\partial^2 T}{\partial x^2} = A \end{cases} \rightarrow \int_{T(0,\hat{x})}^{T(t,\hat{x})} \partial T = \int_0^t A\,\delta t \qquad T(t,\hat{x}) - T(0,\hat{x}) = A\,t$$

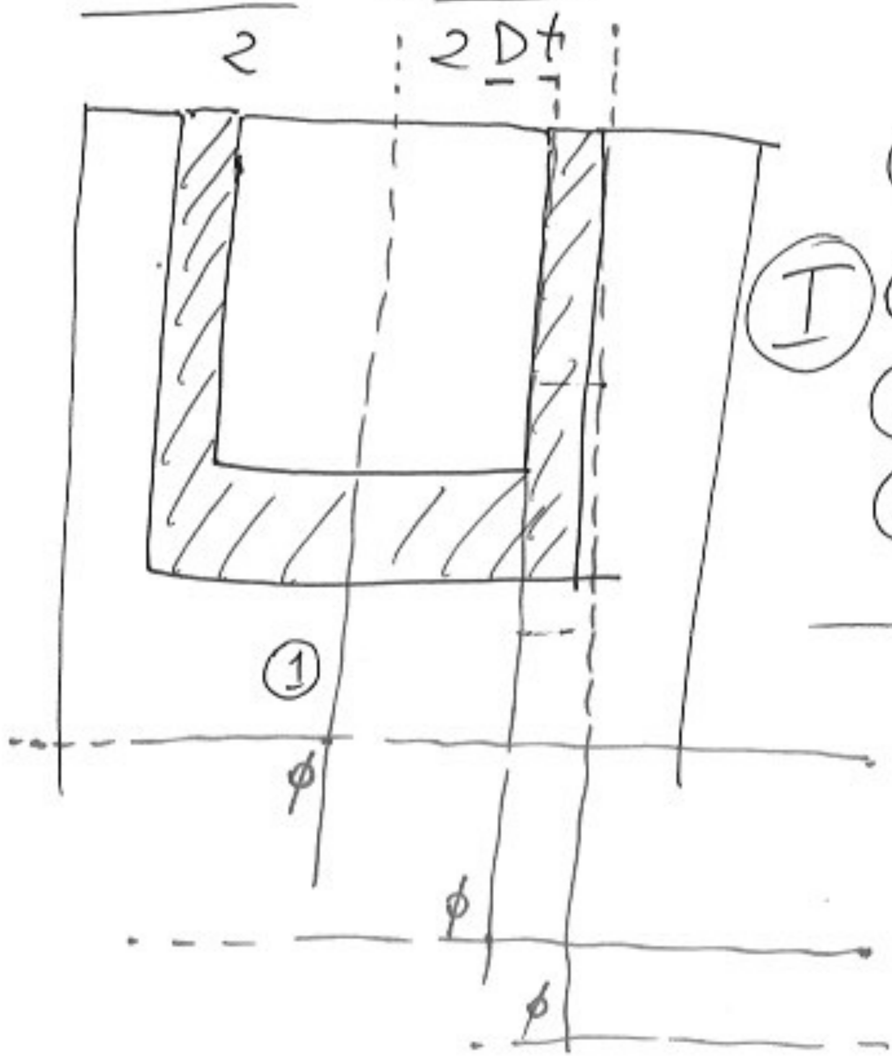
$$A = \frac{T(t,\hat{x}) - T(0,\hat{x})}{t}$$

$$\frac{\partial^2 T}{\partial x^2} = \frac{A}{D} = \frac{1}{D}\,\frac{T(t,\hat{x}) - T(0,\hat{x})}{t} = \beta \qquad \beta = \frac{A}{D}$$

$$\frac{\partial^2 T}{\partial x^2} = \beta \qquad \int_{T(t,0)}^{T(t,\hat{x})} \partial^2 T = \int_0^{\hat{x}} \beta\,\partial x^2 \qquad \underline{\frac{T^2(t,\hat{x})}{2} - \frac{T^2(t,0)}{2} = \frac{\beta x^2}{2} + \gamma x + c}$$

$$\frac{T^2(t,\hat{x})}{2} - \frac{T^2(t,0)}{2} = \frac{x^2}{2D} \cdot \left(\frac{T(t,\hat{x}) - T(0,\hat{x})}{t}\right) + \gamma x + c.$$

$$\frac{T^2(t,\hat{x})}{2} - \frac{x^2}{2Dt} T(t,\hat{x}) - \frac{T^2(t,0)}{2} + \frac{x^2}{2Dt} T(0,\hat{x}) = \gamma x + c.$$



I

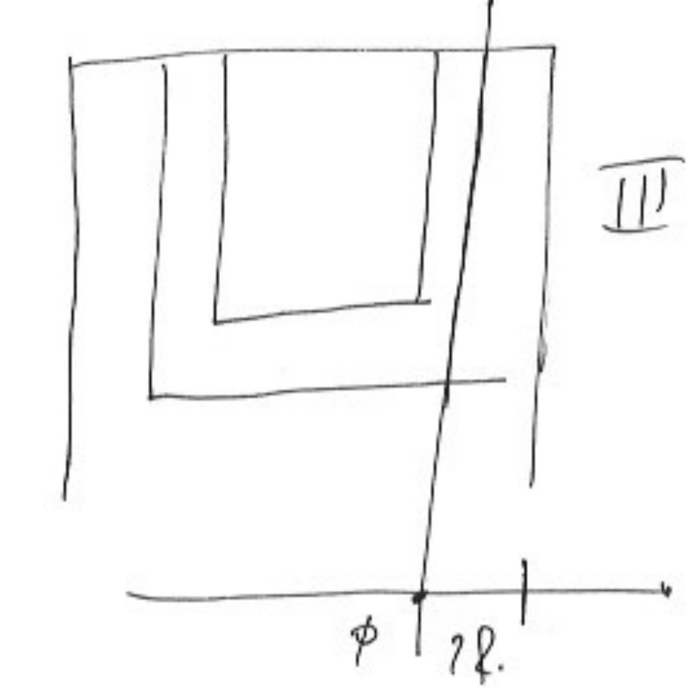
1. $T(0,0) = 20/25\,°C$
2. $T(0,2st) = 70/80\,°C$
3. $T(\infty,0) = 37\,°C$
4. $T(\infty,2st) = 37\,°C$

D_{stelo}

II

1. $T(0,0) = 70/80\,°C$
2. $T(0,\delta) = 37\,°C$
3. $T(\infty,0) = 37\,°C$
4. $T(\infty,\delta) = 37\,°C$

$D_{cem.}$



$T(0,0) = 70/80°C$

$T(0,2l^*) = 37°C$

$T(\infty,0) = 37°C$

$T(\infty,2l^*) = 37°C$

$2l^* = (2l - 2st - \delta_{cem})$

D_{osso}

$\boxed{X_f} \simeq \underline{1-1.1\ mm}$