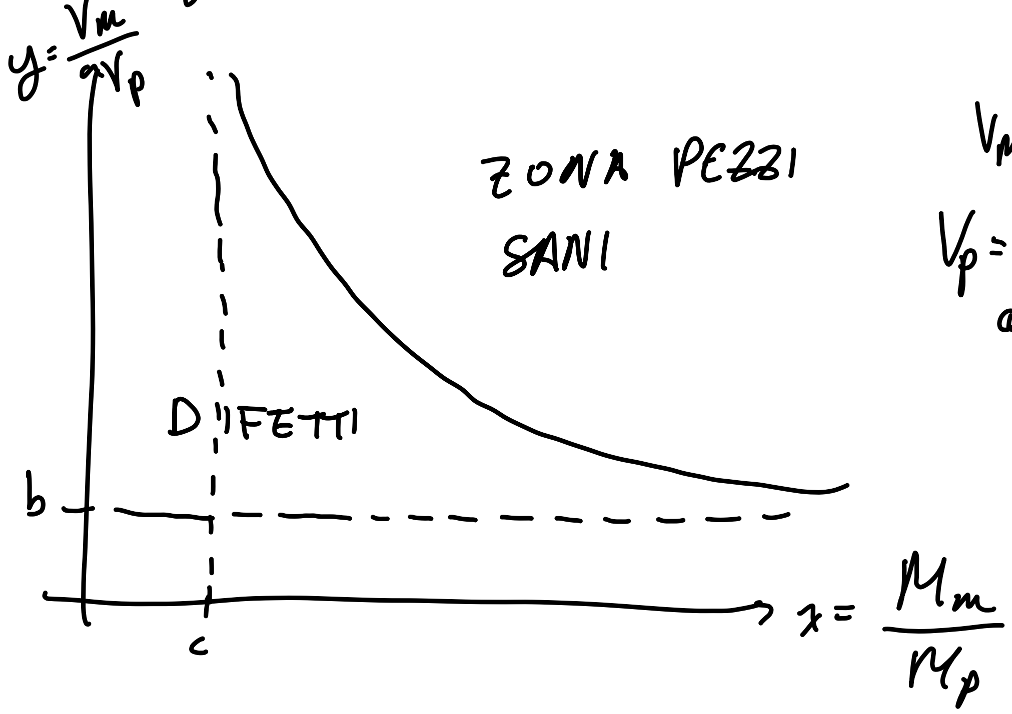
# Esercitazione 3 - Dimensionamento Sistema di Alimentazione

Diagramma di Caine




$V_M$ = Volume Materozza

$V_p$ = volume di pezzo alimentato
↓
o parte di pezzo

$M_m$ = modulo termico materozza

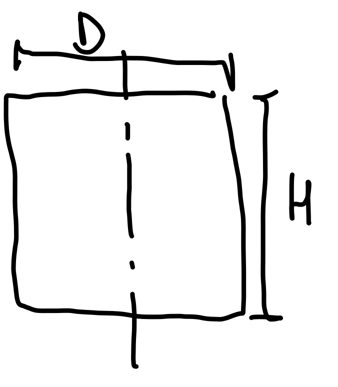
$M_p$ = modulo termico pezzo

$$y = \frac{a}{x-c} + b$$

b - coefficiente di ritiro volumetrico

c → minima velocità relativa di raffreddamento

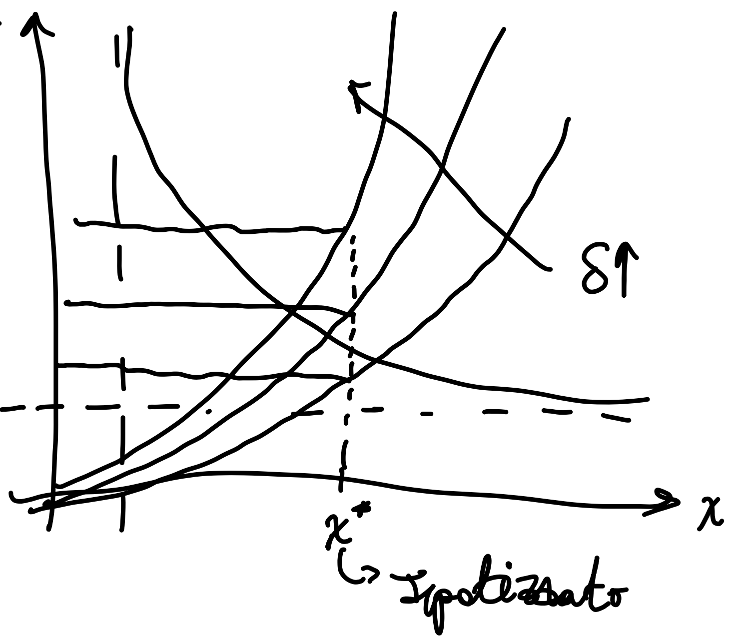
Materozze Cilindriche:




$\delta = \frac{H}{D}$ Rapporto di Forma

$$y = \frac{\pi}{4} \frac{M_p^3}{V_p} \cdot \frac{(4\delta +)^3}{\delta^2} x^3$$

Fissato $\delta$ $\qquad$ $y = k x^3$




Modello di Chvorinov:

$$t_{TS} = C_m M^n$$

$t_{TS} \to$ tempo solidificazione totale

$M \to$ modulo termico

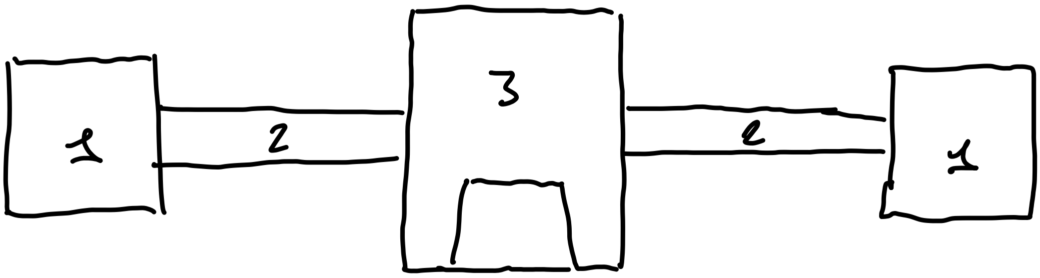
$C_m \to$ costante sperimentale $\left[\frac{min}{cm^2}\right]$

$n \to$ esponente sperimentale (di solito $n=2$)

Esercizio 1

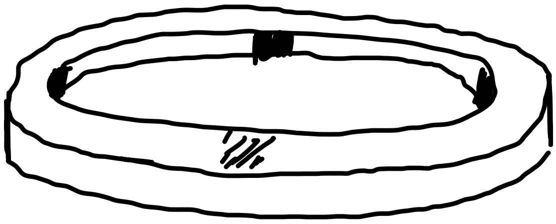
↳ Numero, posizione e dimensione di materozze

$C_m = 3$ min



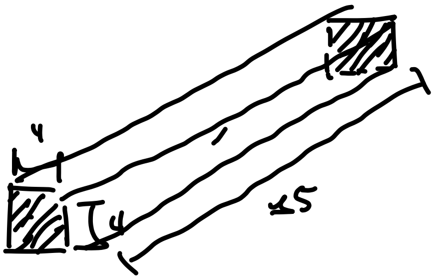

$$M_1 = \frac{V_1}{A_1}$$

$\approx 1{,}278\ cm$



$$V_1 = \pi \cdot 5 \cdot (25^2 - 10^2) = 3534{,}29\ cm^3$$

$$A_1 = 5 \cdot \pi \cdot 50 + 5\pi \cdot 40 + 2 \cdot (\pi(25^2 - 20^2)) - 4 \cdot 4 \cdot 4$$
$$= 2763{,}43\ cm^2$$



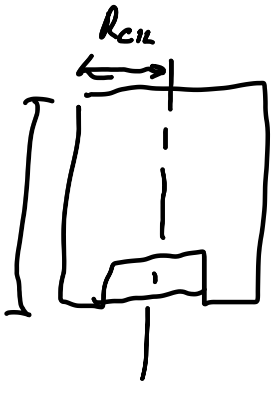

$$M_2 = \frac{V_2}{A_2}$$

$$V_2 = 4 \cdot 4 \cdot 15 = 240\ cm^3$$

$$A_2 = 4 \cdot (15 \cdot 4) = 240\ cm^2$$

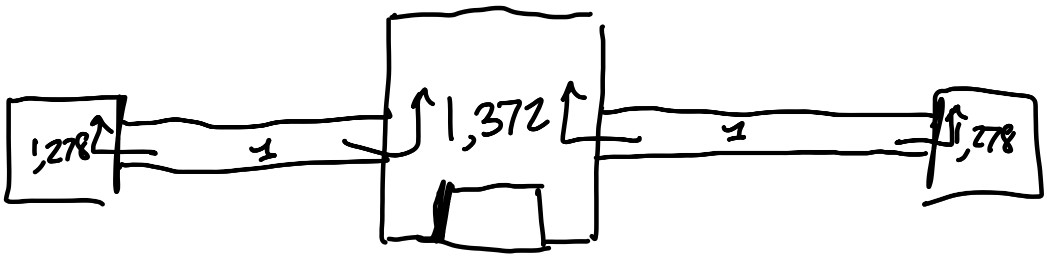
$M_2 = 1\ cm$

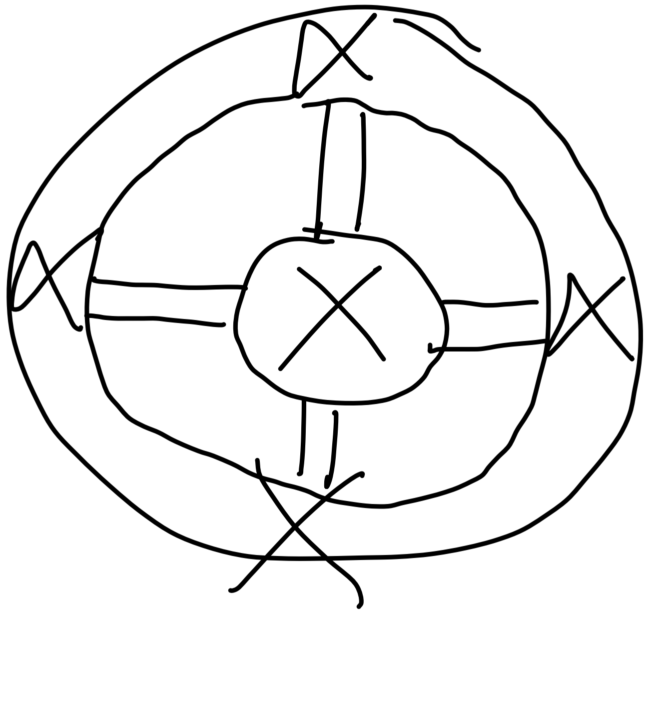
$$M_3 = \frac{V_3}{A_3}$$



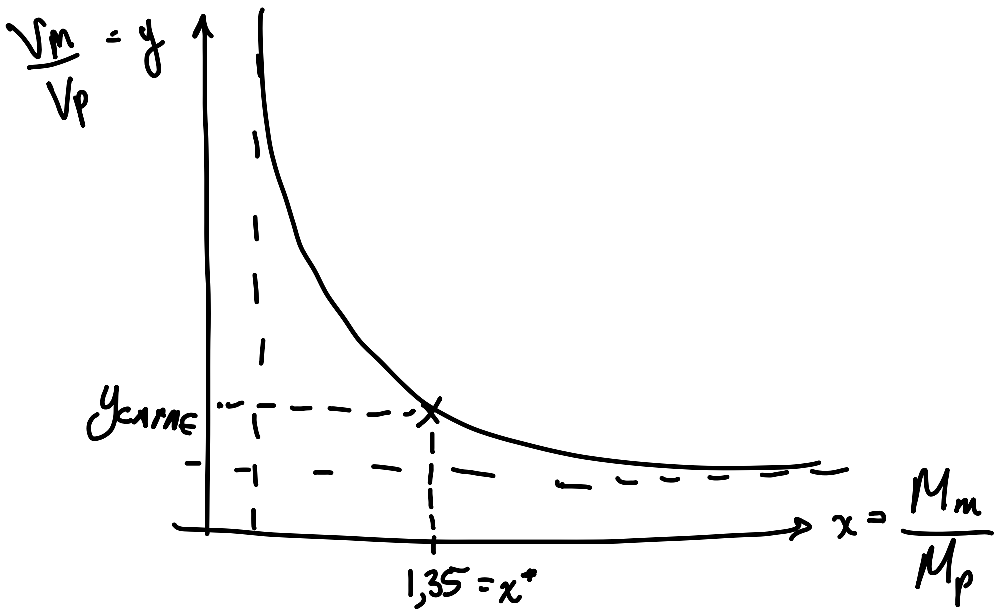
$$\frac{V_3}{A_3} = \frac{\pi R_{CIL}^2 H_{CIL} - \frac{1}{3}\pi H_{CONO}\left(R_{CONO}^2 + r_{CONO}^2 - R_{CONO}\, r_{CONO}\right)}{\pi\left(R_{CIL}^2 - R_{CONO}^2\right) + \pi\left(R_{CIL} - r_{CONO}^2\right) + 2\pi R_{CIL} H_{CIL} + \pi\left(R_{CONO} - r_{CONO}\right)\sqrt{\left(R_{CONO} - r_{CONO}\right)^2 + H_{CONO}^2} - 4 H_{razza}^2}$$

$$M_3 = 1{,}372$$



$$\left.\begin{aligned} \frac{M_1}{M_2} &= 1{,}278 \\ \frac{M_3}{M_2} &= 1{,}372 \end{aligned}\right\} \quad 1{,}3 < \frac{M_x}{M_y} < 1{,}4$$




$$y = \frac{a}{x-c} + b = \frac{0,1}{x-1} + 0,03$$

$$x^* = 1,35$$

$$y_{CAINE}\,(x = 1,35) = \frac{0,1}{1,35-1} + 0,03 = 0,32$$

Dobbiamo verificare $y^* > y_{CAINE}$

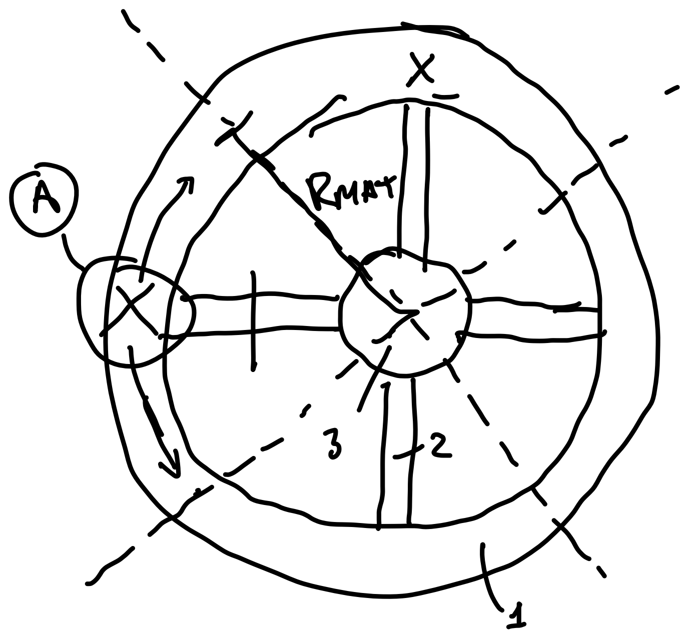
↳ da $\delta$ con $x^*$

↳ da $x^*$

$$y = \frac{\pi}{4} \frac{M_i^3}{V_p} \frac{(4\delta+1)^3}{\delta^2} x^3$$

$M_1$ = modulo tecnico della zona a contatto con materozza

$V_p$ - Volume di partenza




$$V_{p,MA} = \frac{1}{4} V_1 + \frac{1}{2} V_2 = 100325\ mm^3$$

$$M_1 = 1,28\ cm = 12,79\ mm$$

$$y = \frac{\pi}{4} \frac{M_1^3}{V_{p,MA}} \frac{(4\delta+1)^3}{\delta^2} (x^*)^3$$

Dobbiamo fare per i 3 $\delta$:

- $\delta = 0,5$
- $\delta = 1$
- $\delta = 1,5$

$\rightarrow$

$y^* = 0,43$

$y^* = 0,50$

$y^* = 0,61$

$y^* > \underbrace{y_{CAINE}}_{0,32}$ $\rightarrow$ verificato in tutti e 3 i casi

$$V_{MA} = y^* \cdot V_{p,MA}$$

$$V_M = \frac{\pi}{4} D^2 H = \frac{\pi}{4} D^3 \delta$$

$$D = \sqrt[3]{\frac{4}{\pi} \frac{V_m}{\delta}} \leftarrow$$ È fatto per ogni valore di $\delta$

$V_m(\delta = 0,5) = 436\ cm^3$

$D(\delta = 0,5) = 10,4\ cm$ slide 38

$H(\delta = 0,5) = 5,2\ cm$

Dimensionamento Materozza centrale

$$V_{p,MB} = V_3 + 4 \cdot \frac{1}{2} V_2$$
$$= 114140\ cm^3$$

$$y^* = \frac{\pi}{4} \frac{M_3^3}{V_{p,MB}} \cdot \frac{(4\delta+1)^3}{\delta^2} (x^*)^3$$

$\delta = 0,5$ $\quad y^*(0,5) = 0,47 \Rightarrow V_M = y^* \cdot V_{p,MB}$ $\quad D = \sqrt[3]{\frac{4}{\pi} \frac{V_m}{\delta}}$

$\quad 1$ $\quad y^*(1) = 0,55$ $\quad H = \delta \cdot D$

$\quad 1,5$ $\quad y^*(1,5) = \underbrace{0,67}_{>0,32}$

Numero e prendiamo raggio di influenza da libro

Abbiamo $T = 5cm$ e $W = 5cm \Rightarrow$ barra

| $D_A$ | $\delta$ | $D_{ALIM}$ |
|---|---|---|
| 10,4 | 0,5 | 12,5 |
| 8,6 | 1 | 13,4 |

$$D_{ALIM} = \frac{2\pi R_{MAT} - 4 D_A}{8}$$

8,1 | 1,5 | 13,6

Distanza tra materozze è tra 1 T e 4 T, no effetti bordo

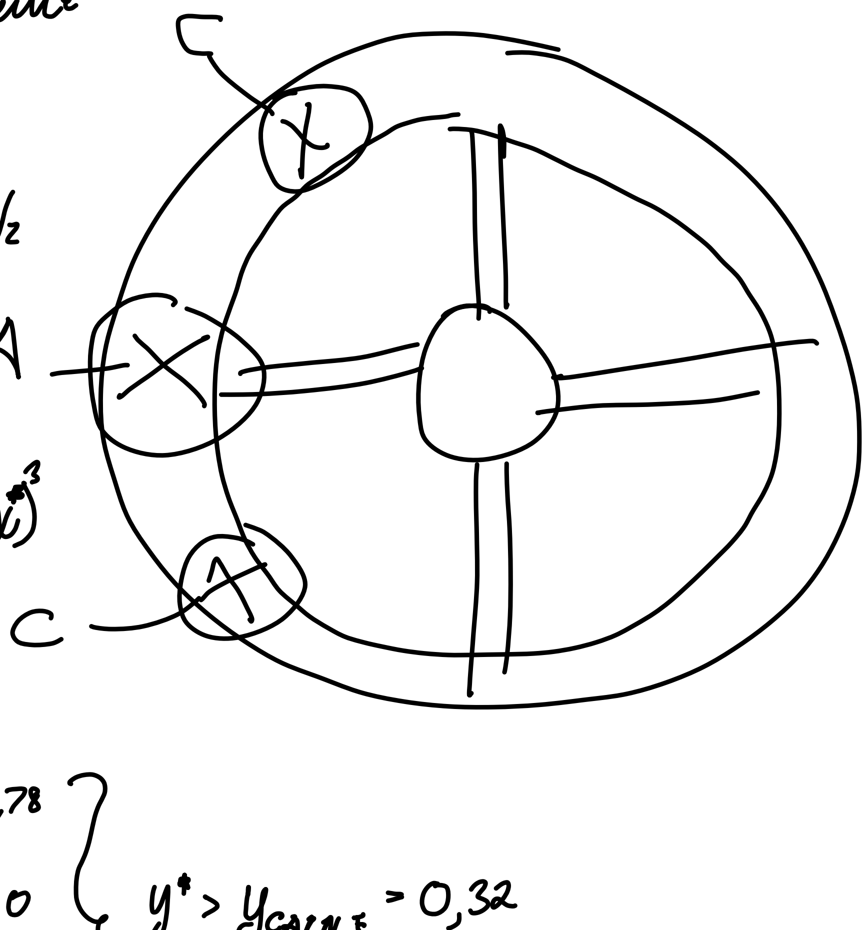
$$D_{MAX} = 2 \cdot T = 10$$

$D_{MAX} < D_{ALIM}$ $\forall S$, non va bene

$\Rightarrow$ servono altre materozze in altri punti

Dovranno esser dimensionate diversamente perchè non avranno lo scambio con le rosse

Ridimensionamento




$$V_{p,MA} = \frac{1}{8} V_1 + \frac{1}{2} V_2$$

$$= 561862{,}5\ mm^3$$

$$y^* = \frac{\pi}{4} \frac{M_1^3}{V_{p,MA}} \frac{(4S+1)^3}{S^2} (\chi^*)^3$$

$$S \rightarrow \left.\begin{array}{l} y^*(S=0{,}5) = 0{,}78 \\ y^*(S=1) = 0{,}90 \\ y^*(S=1{,}5) = 1{,}01 \end{array}\right\} y^* > y_{CAIN} = 0{,}32$$

$$\Rightarrow V_{MA} = y^* \, V_{p,MA}$$

$$V_m = \frac{\pi}{4} D^3 \delta \Rightarrow D = \sqrt[3]{\frac{4}{\pi} \frac{V_m}{\delta}}$$

$$H = \delta D$$

$$V_{p,me} = \frac{1}{8} V_1 = 441862,5 \text{ mm}^3$$

$$y^* = \frac{\pi}{4} \frac{M_1^3}{V_{p,Mc}} \frac{(4\delta+1)^3}{\delta^2} x^{*3}$$

$$y^*(\delta = 0,5) = 0,99$$

$$y^*(\delta = 1) = 1,14$$

$$y^*(\delta = 1,5) = 1,34 \qquad \text{ok}$$

$$y > y_{CANNE}$$

CORONA

$$D_{ALIM} = \frac{2\pi R_{mat} - 4 D_{MA} - 4 D_{ne}}{16}$$

$T = 5\,\text{cm} \quad W = 5\,\text{cm}$

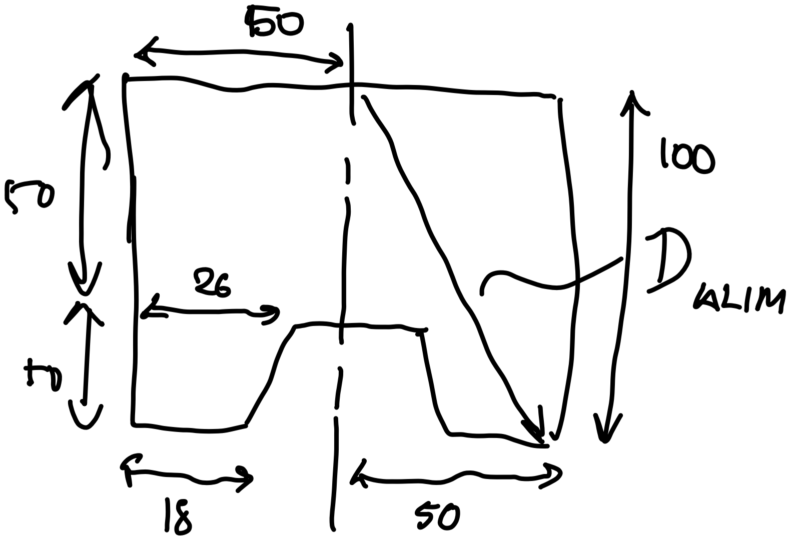
$D_{MAX} = 2 \cdot T = 10\,\text{cm}$

BARRE

$T = 4\,\text{cm} \quad W = 4\,\text{cm} \Rightarrow$ BARRE pg 49

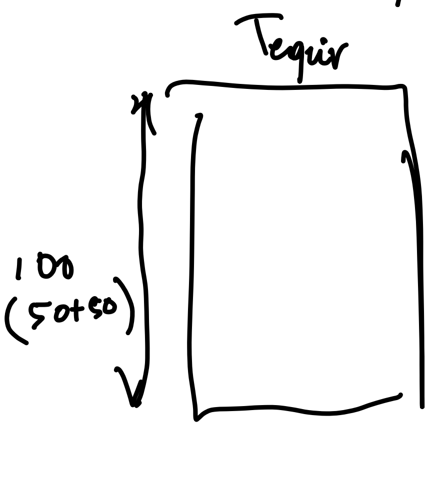
$D_{ALIM} = \frac{L_{vasca}}{2} = 7,5\,cm$

$D_{MAX} = 2 \cdot T = 8\,cm \qquad D_{ALIM} < D_{MAX} \Rightarrow OK$




$A_{mozza} = 50 \cdot 50 + \frac{50\,(26+18)}{2}$

$A_{equiv} = (50+50)\,T_{equiv} = A_{mozza}$




$T_{equiv} = \frac{A_{mozzo}}{100} = 3,6\,cm$

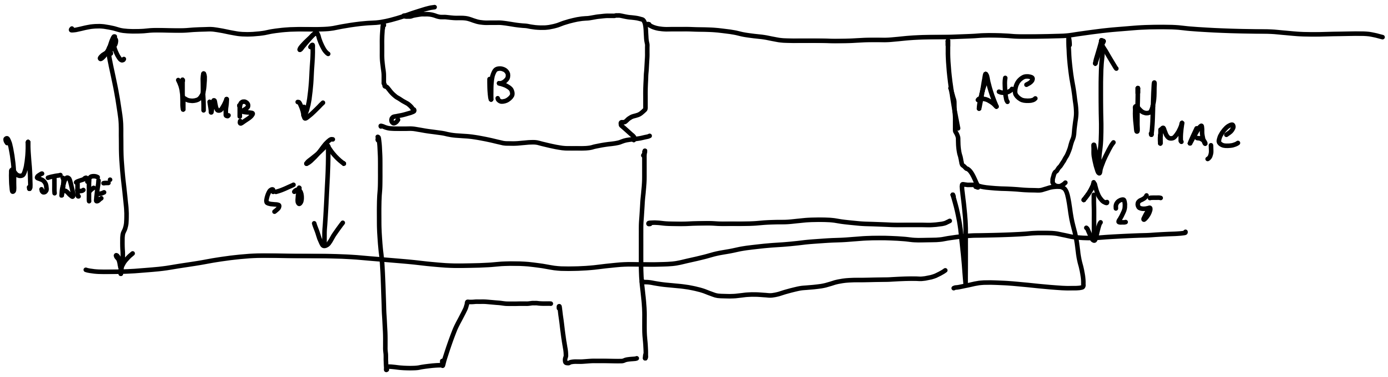
$D_{MAX} = 4,5\,T = 16,2\,cm$

$D_{alim} = \sqrt{10^2 + 5^2} = 11,2\,cm$

Distanza più lontana

$D_{ALIM} < D_{MAX} \Rightarrow OK$

ALTEZZA STAFFE




$H_{STAFFE} = 50 + H_{MB}$

$H_{STAFFE,A,C} = H_{M,AC} + 2,5$

$H_{STAFFE,B} = H_{M,B} + 5$

| Materozza | S | $D_m$ | $H_m$ | $H_{STAFFE}$ |
|---|---|---|---|---|
| A | 1 | 8,6 | 8,6 | 11,1 |
| B | 0,5 | 11,1 | 5,6 | 10,6 |
| C | 1 | 8,6 | 8,6 | 11,1 |

$H_{STAFFE,min} = 11,1$ cm

Alternativa

| Materozza | S | $D_m$ | $H_m$ |
|---|---|---|---|
| A | 1,5 | 12,3 | 14,6 |
| B | 1 | 9,3 | 14,3 |

| | | | |
|---|---|---|---|
| c | 1,5 | 12,1 | 14,6 |

$H_{STAFFE,MAX} = 14,6$ cm

## Tempo di Solidificazione

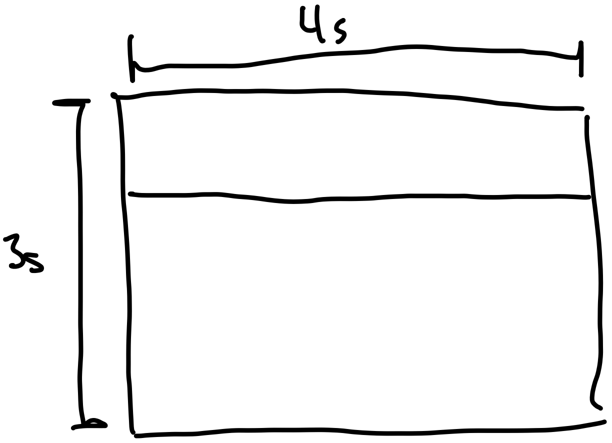
$$t_{TS} = C_m \left(\frac{V_0}{A_0}\right)^2 = 4,51 \text{ min}$$

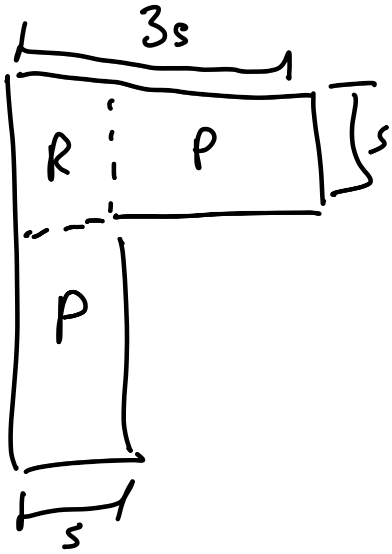
$$V_0 = V_1 + V_2 + V_3$$

$$A_0 = A_1 + A_2 + A_3$$

$$C_m = 3$$

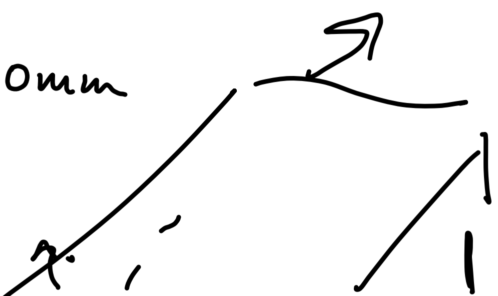
## Esercizio 2



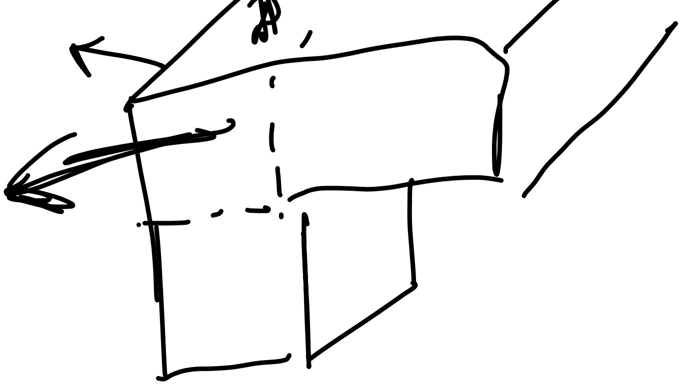




$a = 0,1$ $\quad b = 0,03$ $\quad c = 1$

$$x^* = \frac{M_m}{M_p} = 1,3 \qquad \delta = 1 \qquad s = 200\text{mm}$$



## Zona R



$V_R = 4s \cdot s^2 = 3{,}2 \times 10^2 \, mm^3$

$A_R = 2s^2 + 2 \cdot s \cdot 4s = 10$

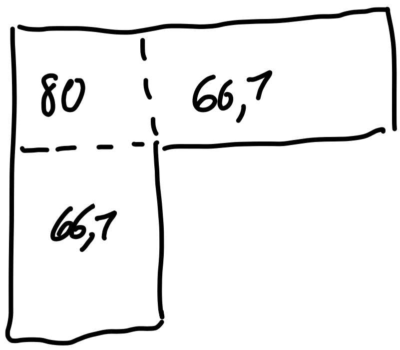
$M = 80$

## Zona P

$V_p = s \cdot 2s \cdot 4s = 8s^3 = 6{,}4 \cdot 10^7 \, mm^3$

$A_p = s \cdot 4s + 2s \cdot s \cdot 2 + 2 \cdot 2s \cdot 4s$
$= 96 \times 10^5 \, mm^3$

$M_p = \dfrac{V_p}{A_p} = 66{,}7 \, mm$



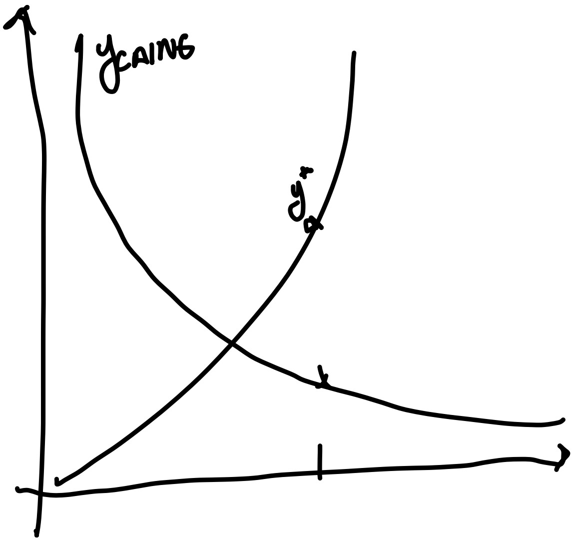

$\dfrac{M_R}{M_p} = \dfrac{80}{66{,}7} \cong 1{,}2$

$\underbrace{1{,}1 < OK < 1{,}4}_{\text{Verificato}}$

$y^* = \dfrac{\pi}{4} \dfrac{M_R^3}{V_{pezzo}} \dfrac{(48+1)^3}{\delta^2} (x^*)^3$

$V_{pezzo} = 2 \cdot V_p + V_R$

$\Rightarrow y^* = 0{,}69$ $\qquad y_{CAINE} = \dfrac{a}{x^* - c} + b = 0{,}36$




$y^* > y_{CAINE} \Rightarrow OK$

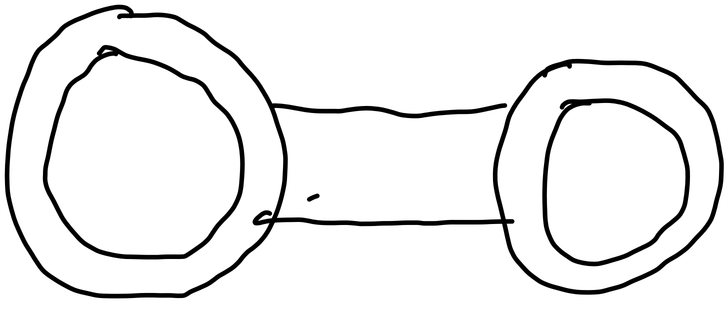
Verificato

$$V_m = V_p \cdot y^* = 1{,}1 \cdot 10^8 \text{ mm}^3$$

$$D_m = \sqrt[3]{\frac{4}{\pi}\frac{V_m}{\delta}} = 520 \text{mm}$$

$\delta = 1 \Rightarrow H = D = 520$

Esercizio 3/6



$a = 0{,}1 \quad b = 0{,}03 \quad c = 1$

$x^* = 1{,}3 \quad \delta = 1$

$A = 50 \quad B = 35$
$C = 24 \quad D = 15$
$E = 20 \quad F = 10$
$G = 20 \quad I = 70$

## Fusto

$$P_{erimetro,f} = 2F + 2G = 60\ mm$$

$$Sezione_{,f} = F \times G = 200\ mm^2$$

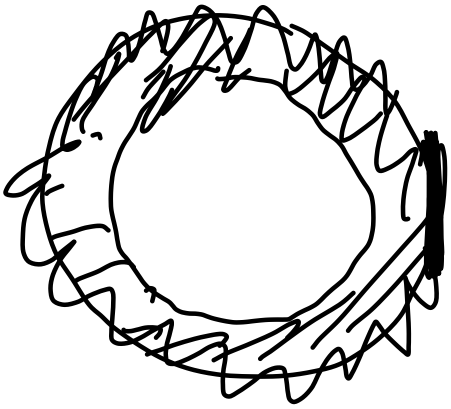
$$V_{FUSTO} = Sezione_{,f} \left(I - \frac{A}{2} - \frac{C}{2}\right) = 6600\ mm^2$$

$$A_{FUSTO} = \left(I - \frac{A}{2} - \frac{C}{2}\right) * Perimetro_{,f} = 1980\ mm^2$$

$$M_f = \frac{V_{FUSTO}}{A_{FUSTO}} = 3{,}33\ mm$$

## Testa

$$A_t = \pi E (A+B) + \frac{\pi}{2} (A^2 - B^2) - F \cdot G = 7143\ mm^2$$



$$V_T = \frac{\pi}{4} E (A^2 - B^2) = 20028\ mm^3$$

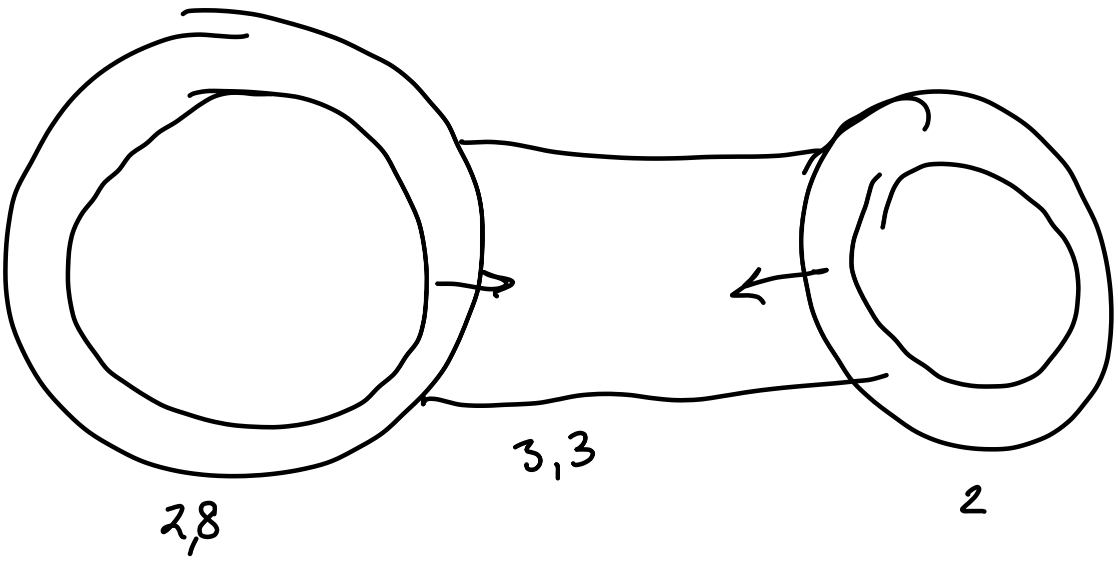
$$M_T = \frac{V_t}{A_t} = 2{,}8\ mm$$

## Piede

$$A_p = \pi E (C+D) + \frac{\pi}{2} (C^2 - D^2) - F \cdot G = 2802\ mm^2$$

$$V_p = \frac{\pi}{4} E \left( C^2 - D^2 \right) = 5513 \, mm^3$$

$$M_p = \frac{V_p}{A_p} = 2{,}0 \, mm$$




$$\frac{M_{FUSTO}}{M_{TESTA}} = \frac{3{,}3}{2{,}8} = 1{,}17$$

NO OK

$$\frac{M_{FUSTO}}{M_{PIEDE}} = \frac{3{,}3}{2{,}0} = 1{,}65 > 1{,}4$$

Disegno cambiare la forma per non creare problemi

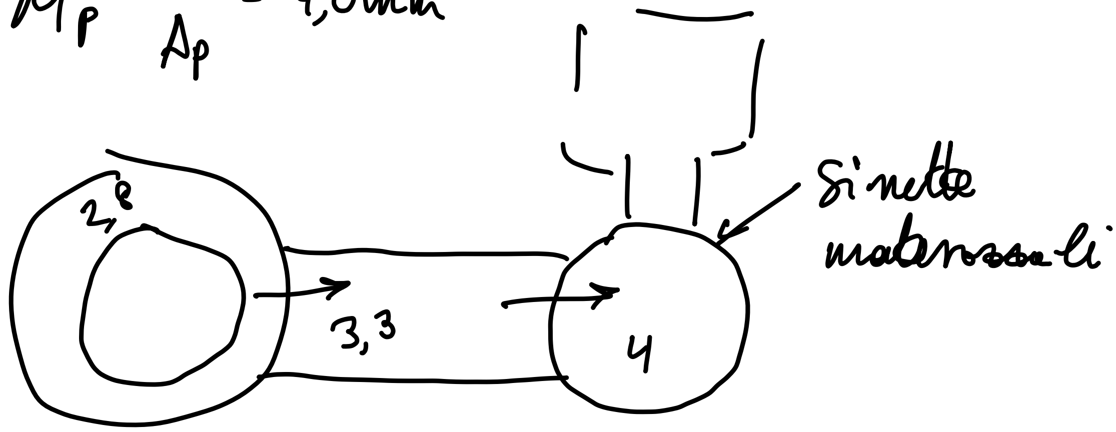
↳ Togliamo foro nel piede per rientrare nelle condizioni.

Le nuove dimensioni saranno:

$$A_p = \pi EC + \frac{\pi}{2}C^2 - FG = 2213\ mm^2$$

$$V_p = \frac{\pi}{4} EC^2 = 9048\ mm^3$$

$$M_p = \frac{V_p}{A_p} = 4{,}0\ mm$$




Basato sulla direzione del flusso del calore, si confronta i moduli termici tale che i successivi (in ordine di flusso) siano tra 1,1 e 1,4 di quello prima.

In questo caso si fanno i confronti fusto testa e piede fusto perché $\longrightarrow \longrightarrow$

Prima era testa fusto e piede fusto perché $\longrightarrow \longleftarrow$

$$\frac{M_p}{M_f} = \frac{4}{3{,}3} = 1{,}21$$

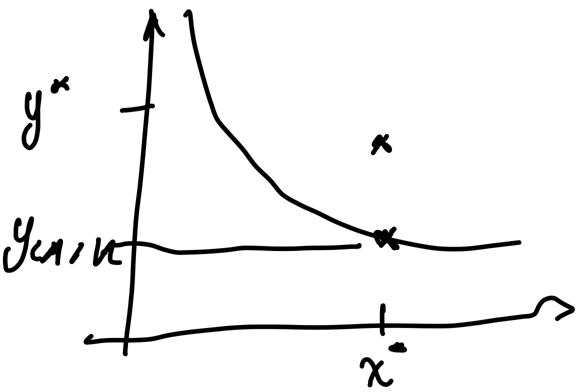
$$y(x^*) = \frac{\pi}{4}\frac{M_p^3}{(V_{piede} + V_{FUSTO} + V_{TESTA})} \cdot \frac{(41+1)^3}{\delta^2} \cdot x^{*3}$$

$x^* = 1{,}3$

$y^* = 0,41$

$y^* > y_{CAINE}$ OK

$y_{CAINE} = \frac{a}{x^* + c} + b = 0,36$




$V_M = (V_{TESTA} + V_{FUSTO} + V_{PIEDE})\, y^*$

$\Rightarrow V_M = 14746\ mm^3$

$D_M = \sqrt[3]{\frac{4}{\pi}\frac{V_M}{\delta}} = 26,6\,mm$

$H = \delta D_M = 26,6\ mm$

Qual è il diametro massimo per ridurre lavoro

Cr punto 3

Vogliamo D più grande possibile con

$$M_{PIEDE} = \frac{\frac{\pi}{4}E(C^2-D^2)}{\pi E(C+D)+\frac{\pi}{2}(C^2-D^2)-FG} \leq 1,1\, M_{FUSTO}$$

$$\frac{\pi}{4}EC^2 - \frac{\pi}{4}ED^2 = \pi EC\,1,1\,M_f + \pi ED \cdot 1,1\,M_f + 1,1\,M_f \frac{\pi}{2}C^2 - 1,1\,M_f\frac{\pi}{2}D^2 - FG\,1,1\,M_f$$

$$0 = \left(\frac{\pi}{4} E - 1{,}1\, M_f \frac{\pi}{2}\right) D^2 + \pi \epsilon\, 1{,}1\, M_f D + \frac{\pi}{4} \epsilon C^2 + \pi \epsilon C\, 1{,}1 M_f +$$

$$+ 1{,}1 M_f \frac{\pi}{2} C^2 - FG \cdot 1{,}1 M_f$$

$$0 = aD^2 + bD + c$$

$$\hookrightarrow D = 3{,}5 \, mm$$