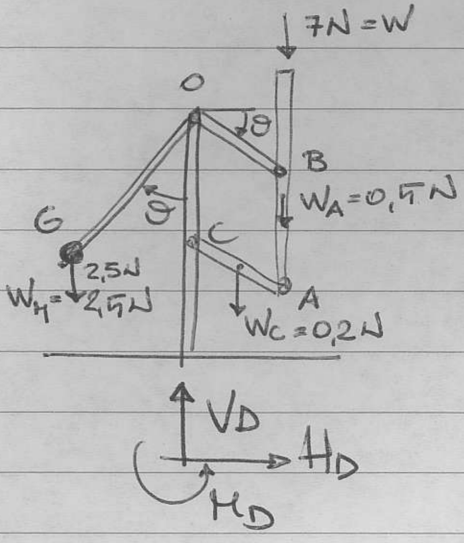
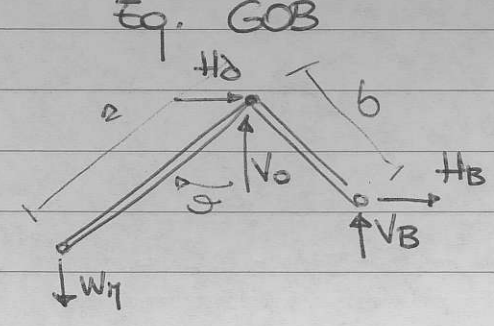
ESERCIZIO 1 – Compito TCM energetici 29/06/2009

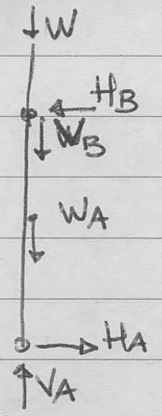


Eq. GOB



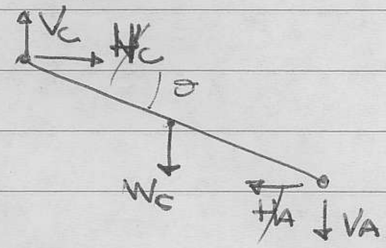
$$\begin{cases} H_B + H_O = 0 \\ V_O + V_B - W_M = 0 \\ W_M \cdot a \cdot \operatorname{sen}\vartheta + V_B \cdot b \cdot \cos\vartheta + \cancel{H_B} \cdot b \cdot \operatorname{sen}\vartheta = \end{cases}$$

Eq AB



$$\begin{cases} -H_B + H_A = 0 & \Rightarrow H_B = 0 \\ -W - V_B - W_A + V_A = 0 & \rightarrow V_B = V_A - W - W_A \\ H_A \cdot \overline{AB} = 0 & \Rightarrow H_A = 0 \end{cases}$$

Eq AC



$V_C - W_C - V_A = 0$

$-\cancel{H_A} + H_C = 0 \Rightarrow H_C = 0$

$V_C \cdot \cancel{\frac{b}{2}} \cdot \cancel{\cos\vartheta} + V_A \cdot \cancel{\frac{b}{2}} \cdot \cancel{\cos\vartheta} = 0 \Rightarrow \underline{V_C = -V_A}$

→ Di conseguenza

$V_C = \frac{W_C}{2} = 0{,}1\,N$

$V_A = -0{,}1\,N$

$V_B = -0{,}1 - 7 - 0{,}5 = -7{,}6\,N$

$V_O = W_M - V_B = 2{,}5 + 7{,}6 = 10{,}1\,N$

Posizione di equilibrio:

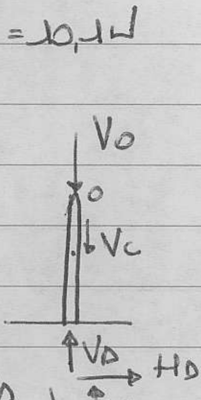
$W_M \cdot a \cdot \operatorname{sen}\vartheta + V_B \cdot b \cdot \cos\vartheta = 0$

$\downarrow \operatorname{tg}\vartheta = -\frac{V_B \cdot b}{W_M \cdot a} = \frac{7{,}6 \cdot \cancel{40}}{2{,}5 \cdot \cancel{80}_2} = 1.$

$\rightarrow \underline{\vartheta \simeq 57^\circ}$

$\underline{H_D = 0}$; $\underline{M_D = 0}$

REAZIONI TELAIO



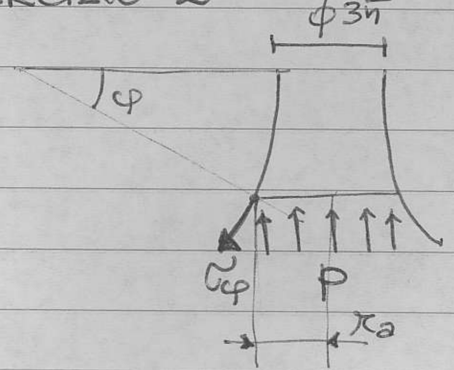
$V_D - V_O - V_C = 0$

$V_D = V_O + V_C = 10{,}1 + 0{,}1 =$

$\underline{\underline{10{,}2\,N = V_D}}$

ESERCIZIO 2

A)



$$\varphi = 20^\circ$$

$$R_\varphi = 90\ mm$$

$$r_a = R_\varphi (1-\cos\varphi) + \frac{35}{2}\ mm =$$

$$= 22{,}9\ mm$$

$$R_\theta = \frac{r_a}{\cos\varphi} = 24{,}4\ mm$$

Equilibrio assiale

$$p \cdot \cancel{\pi} r_a^{\cancel{2}} - \sigma_\varphi \cdot t \cdot 2\cancel{\pi}\cancel{r_a} \cos\varphi = 0 \Rightarrow \sigma_\varphi = \frac{p \cdot r_a}{2t\cos\varphi} = \frac{30 \cdot 22{,}9}{2 \cdot 3 \cdot \cos\varphi} = 12$$

Eq. di Laplace

$$\frac{\sigma_\theta}{R_\theta} + \frac{\sigma_\varphi}{R_\varphi} = \frac{p}{t} \Rightarrow \sigma_\theta = R_\theta \cdot \left(\frac{p}{t} - \frac{\sigma_\varphi}{R_\varphi}\right) =$$

$$= 24{,}4 \cdot \left(\frac{30}{3} - \frac{122}{-90}\right) = 277\ kPa$$

PUNTO B) $\Rightarrow$ Con Laplace

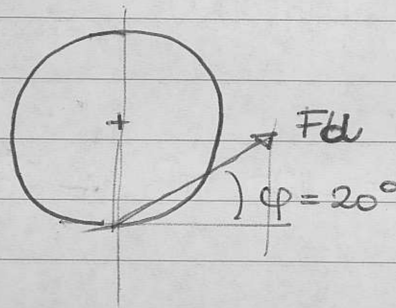
$$\sigma_{\varphi_B} = \sigma_{\theta_B} = \frac{-pR}{2t} = -\frac{30 \cdot 15}{2 \cdot 4} = -56\ kPa$$

ESERCIZIO 3

$$W = 10\,kW = 10000\,W = M_m \cdot \underset{\uparrow rad/s}{\omega_m} = M_m \cdot \frac{240 \cdot 2\pi}{60}$$

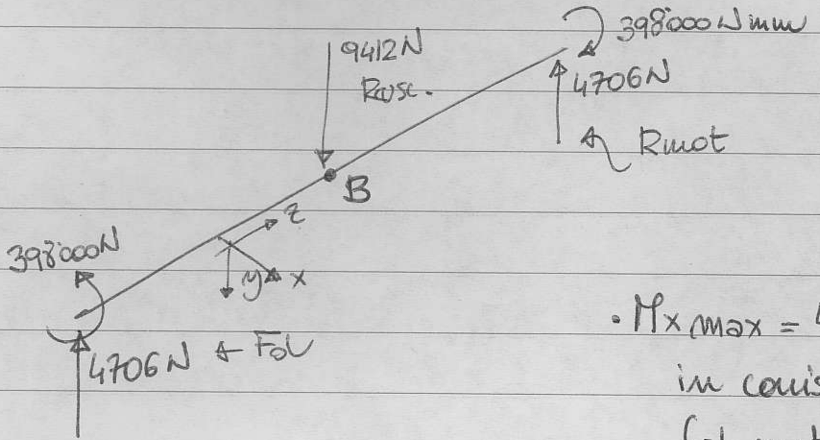
$$M_m = \frac{10000 \cdot 60}{240 \cdot 2\pi} = \underline{398\ Nm}$$ ⇐ momento torcente

Ruota dentata:



$$F_d = \frac{M_m}{R \cdot \cos\varphi} = \frac{398}{0{,}09 \cdot \cos\varphi} = \underline{4706\ N}$$

Considero quindi l'albero sul piano ~~della~~ diretto come la forza scambiata tra i denti passante × l'asse dell'albero



→ Considero solo gli effetti dei momenti M_x e M_z

- $M_{x\,max} = 4706 \cdot 100 = 4{,}706 \cdot 10^5$ Nmm in corrisp. del cuscinetto di supporto (al centro, in B)-
- $M_{z\,max} = 398'000$ Nmm su tutto l'albero

$$\tau_{M_x} = \frac{M_x \cdot D_{ext}}{2 \cdot J_{x\,albero}} = \frac{M_x \cdot D_{ext}}{2 \cdot \left(\frac{\pi \cdot (D^4 - d^4)}{64}\right)}$$

$$\tau_{max} = \frac{M_z}{J_0} \cdot r = \frac{M_z \cdot D_{ext}}{2 \cdot \left(\frac{\pi(D_{ext}^4 - d^4)}{32}\right)} = \frac{M_z \cdot D_{ext}}{4 \cdot \left(\frac{\pi(D_{ext}^4 - d^4)}{64}\right)}$$

Determino l'espressione della tensione equivalente con il criterio di TRESCA:

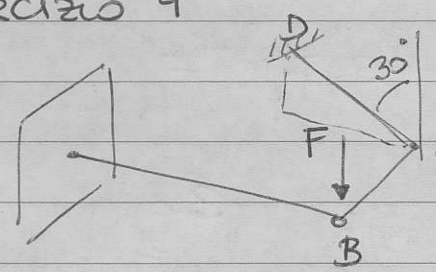
$$\sigma_{eq} = \sqrt{\sigma_{max}^2 + 4\,\tau_{zo}^2} = \sqrt{\left(\frac{D_{ext}}{2\left(\frac{\pi(D_{ext}^4 - d^4)}{64}\right)}\right)^2 \cdot \left(M_x^2 + M_z^2\right)} =$$

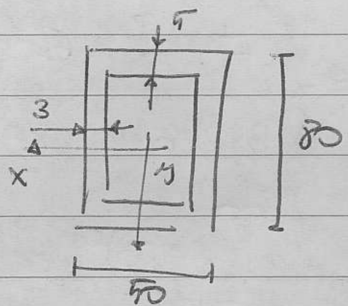
$$= \frac{D_{ext}}{2\left(\frac{\pi(D_{ext}^4 - d^4)}{64}\right)} \cdot \sqrt{\left(4{,}706 \cdot 10^5\right)^2 + \left(3{,}98 \cdot 10^5\right)^2} =$$

$$= 6{,}16 \cdot 10^5 \cdot \frac{32 \cdot D_{ext}}{\pi(D_{ext}^4 - d^4)} = 120\ MPa \le \sigma_{amm}$$

$\to$ $\underline{d = 43{,}7\ mm}$

ESERCIZIO 4





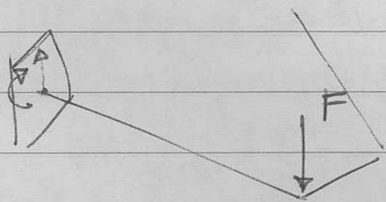
$$J_x = \frac{50 \cdot 80^3}{12} - \frac{44 \cdot 70^3}{12} = 8{,}76 \cdot 10^5 \ mm^4$$

$$J_y = \frac{80 \cdot 50^3}{12} - \frac{70 \cdot 44^3}{12} = 3{,}36 \cdot 10^5 \ mm^4$$

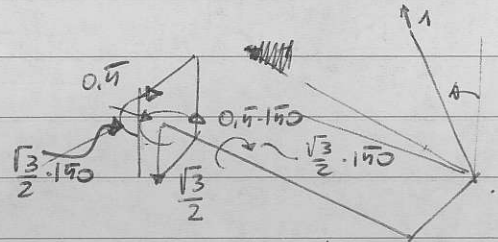
$$J_{eq} = \frac{4}{2} \cdot \frac{(47 \cdot 75)^2}{\left(\frac{47}{5} + \frac{75}{3}\right)} = 7{,}22 \cdot 10^5 \ mm^4$$

$$A_{CAVO} = \frac{\pi \cdot d^2}{4} = \frac{\pi \cdot 5^2}{4} = 19{,}6 \ mm^2$$

Sist. principale

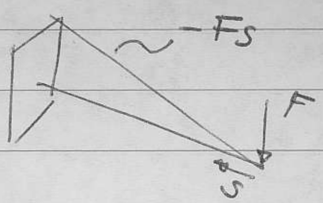


Sist. ausiliario:

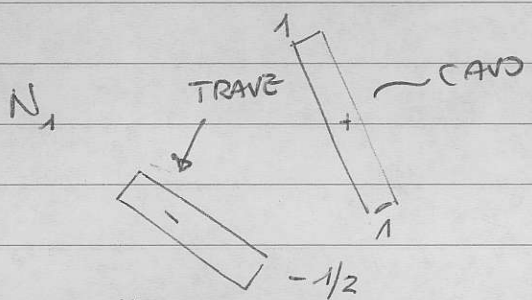


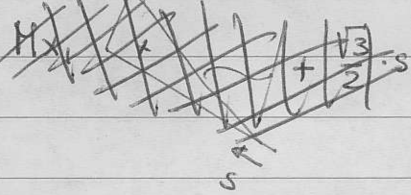
$$J_{1p} + X_1 J_{11} = \Delta$$

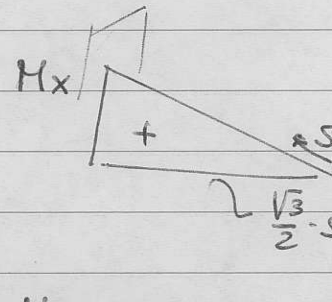
dopo ~~la~~ la forza è tutto scarico

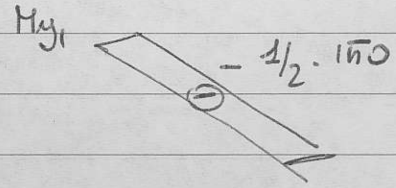


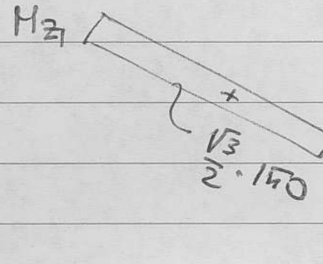
M_{x_p}











$$\delta_{1p} = \int_0^{600} -\frac{F \cdot \frac{\sqrt{3}}{2} \cdot s^2}{EJ_x} ds = -\frac{F \cdot \frac{\sqrt{3}}{2} \cdot 600^3}{3 \cdot 206 \cdot 10^3 \cdot 8{,}76 \cdot 10^5} = -3{,}45 \cdot 10^{-4} F$$

$$\delta_{11} = \int_0^{600} \frac{\left(\frac{\sqrt{3}}{2} \cdot s\right)^2}{EJ_x} ds + \int_0^{600} \frac{\left(-\frac{1}{2} \cdot 150\right)^2}{EJ_y} ds + \int_0^{600} \frac{\left(\frac{\sqrt{3}}{2} \cdot 150\right)^2}{GJ_{eq}} ds + \int_0^{300} \frac{1}{EA_c} ds =$$

trascuro il contr. di forza normale sulla trave

$$= 2{,}99 \cdot 10^{-4} + 4{,}88 \cdot 10^{-5} + 1{,}77 \cdot 10^{-4} + 7{,}42 \cdot 10^{-5} =$$

$$= 5{,}99 \cdot 10^{-4} \frac{mm}{N} = \delta_{11}$$

Ho $\delta_{1p} + X_1 \delta_{11} = \Delta$ $\Rightarrow$ trovo δ_{1p} con $\Delta = 2$ mm e $X_1 = 10$ kN

$$\delta_{1p} = \Delta - X_1 \delta_{11} \Rightarrow 2 - \cancel{10}^4 \cdot 5{,}99 \cdot \cancel{10}^{-4} = -3{,}45 \cdot 10^{-4} \cdot F$$

$$\Rightarrow F = \frac{3{,}99}{3{,}45} \cdot 10^4 \, N = \underline{1{,}15 \cdot 10^4 \, N}$$