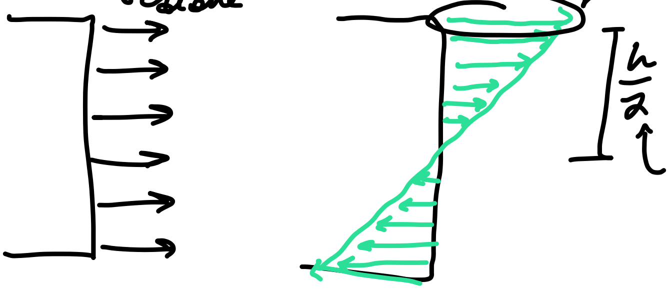
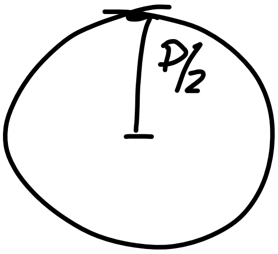
Esercitazione 9

$$\sigma_x = \underbrace{\frac{N}{A}}_{\text{cost. su sezione}} + \frac{M}{J}\, y$$



punto di sforzo peggiore
↳ dove facciamo i calcoli

↳ se rettangolare, $\frac{D}{2}$ se circolare



Rettangolare:

$$J_\square = \frac{bh^3}{12}$$

Circolare:

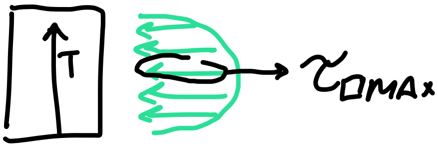
$$J_0 = \frac{\pi D^4}{64}$$

$$\sigma_\square = \frac{M\frac{h}{2}}{\frac{bh^3}{12}} = \frac{6M}{bh^2}$$

$$\sigma_0 = \frac{M\,D/2}{\frac{\pi D^4}{64}} = \frac{32M}{\pi D}$$

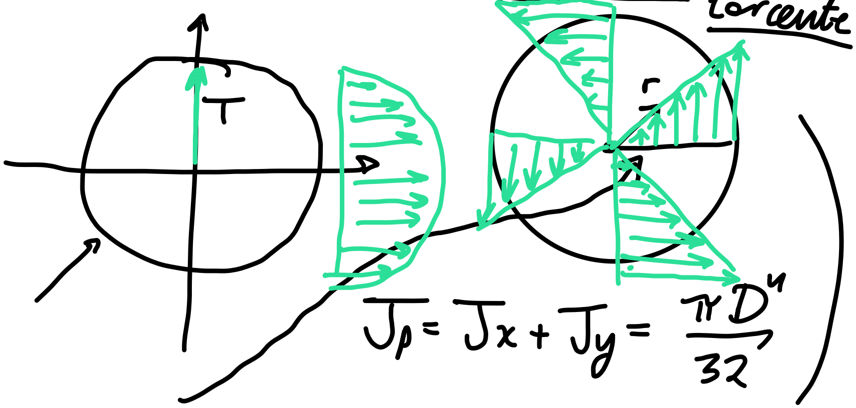
Calcolo di Sforzi di Taglio: lezione era cancellata

$$\tau_\square = \frac{2}{3}\frac{T}{A}$$



$$\tau_{0\,MAX} = \frac{4}{3}\frac{T}{A}$$

Nullo su retta di applicazione, massimo punto ← Sforzo taglio



$$J_p = J_x + J_y = \frac{\pi D^4}{32}$$

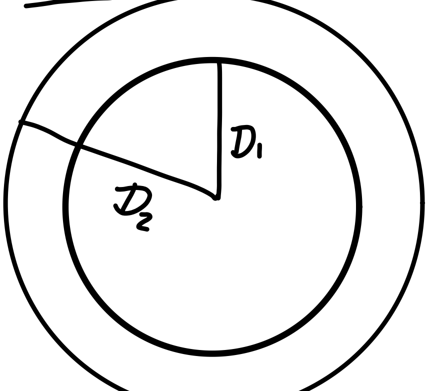
più lontano

Con questa distribuzione
$r = D/2$

$$\tau_{M_t} = \frac{16 \cdot M_t}{\pi D^3}$$

Di solo N e T sono trascurabili rispetto agli sforzi generati da M_t e M_f

Sezione Cava



$$J_2 = \frac{\pi D_2^4}{64}$$

$$J_1 = \frac{\pi D_1^4}{64}$$

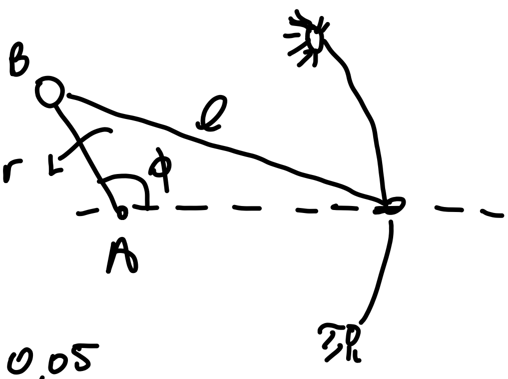
$$\boxed{J} = J_2 - J_1 = \boxed{\frac{\pi}{64}\left(D_2^4 - D_1^4\right)}$$

$$y = \frac{D_2}{2}$$

$$\sigma = \frac{M_f \frac{D_2}{2}}{\frac{\pi}{64}\left(D_2^4 - D_1^4\right)} = \frac{32\, M_f D_2}{\pi \left(D_2^4 - D_1^4\right)}$$

Esercizio 1

Fatica è uno sforzo non costante



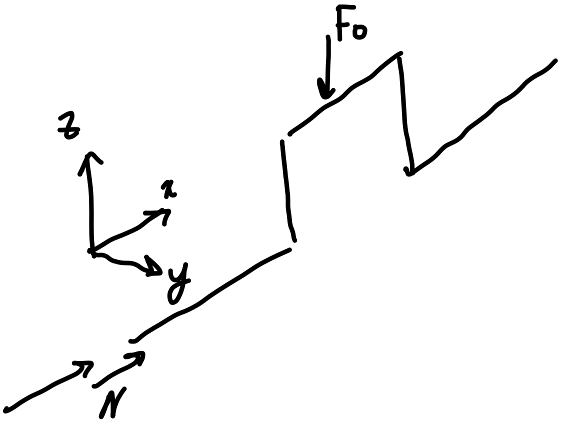
$\frac{r}{l} \simeq 0{,}05$

Stati di Sforzo a:

$\phi = 0$ e $\phi = \frac{\pi}{2}$

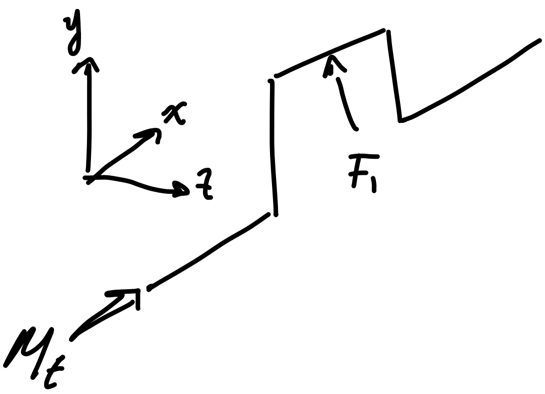
$\underbrace{F_0 = 770N}_{l_{sur}}$ $\quad$ $\underbrace{F_1 = 385}_{l_{sur}}$

Quando $\phi = 0$

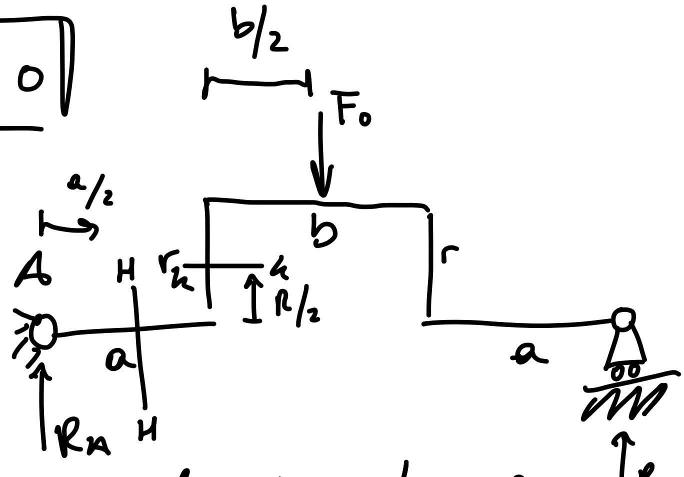


in 2D guardiamo da qui quindi r sembra una linea

$\phi = \frac{\pi}{2}$



$\boxed{\phi = 0}$

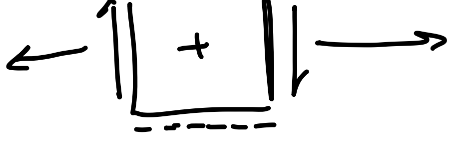


$d_{HH} = 16mm$ $d_{KK} = 20mm$

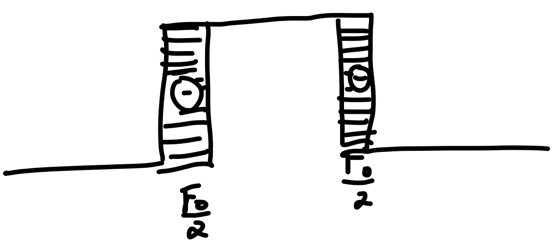
$$\sum M_B = 0 = F_0\left(\frac{b}{2} + a\right) - R_B(2a + b) \Rightarrow R_A = \frac{F_0 \cancel{\left(\frac{b}{2} + a\right)}}{2\cancel{\left(\frac{b}{2} + a\right)}} = \frac{F_0}{2}$$

$$\sum F_y = 0 = \frac{F_0}{2} - F_0 + R_B \Rightarrow R_B = \frac{F_0}{2}$$

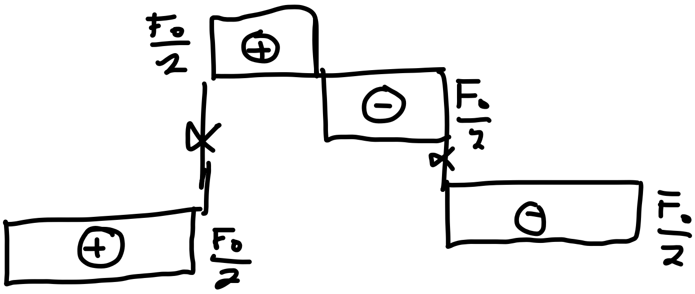
Convenzione:



N

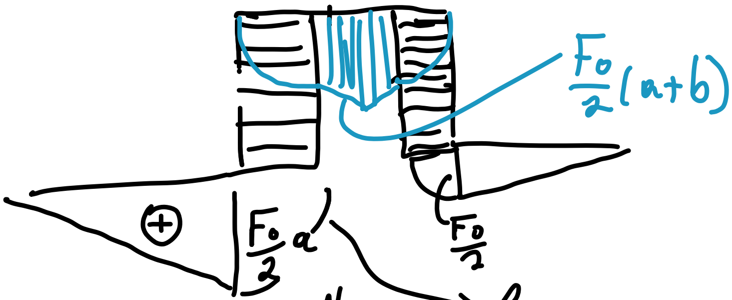


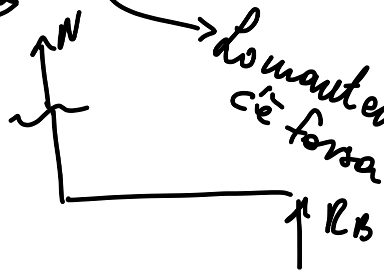
T



$M_t = 0$
↳ siamo sul piano

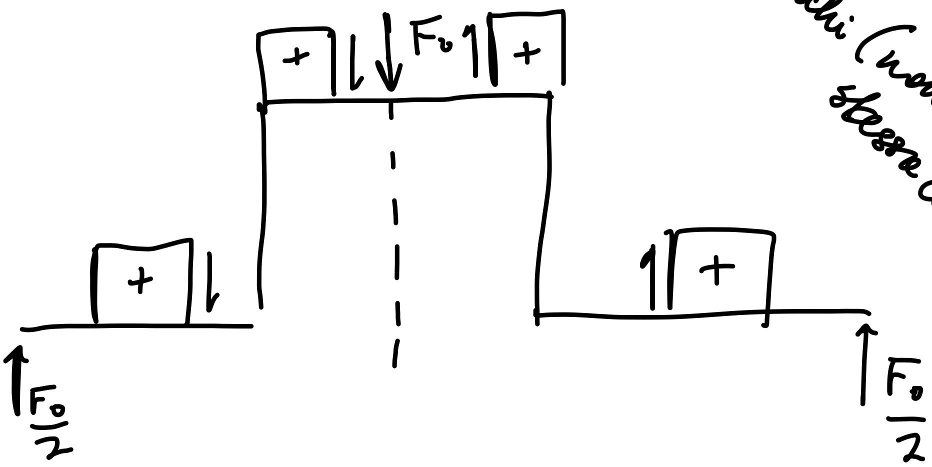
M_b

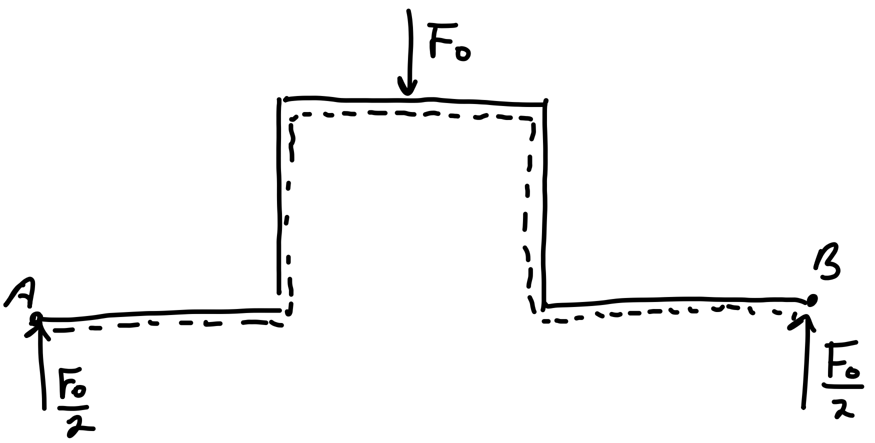


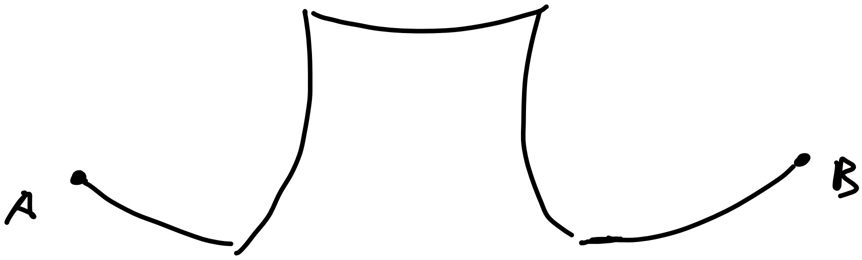


$N = -R_B = \frac{-F_0}{2}$

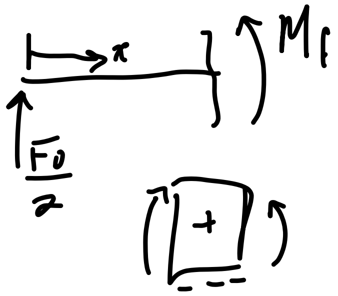
lo manteniamo perchè non c'è forza che lo modifichi (non anche sulle stesse coordinata x



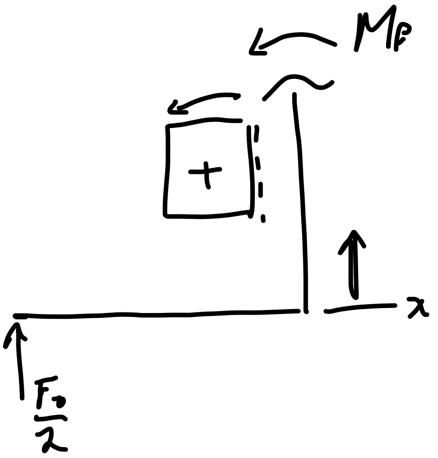




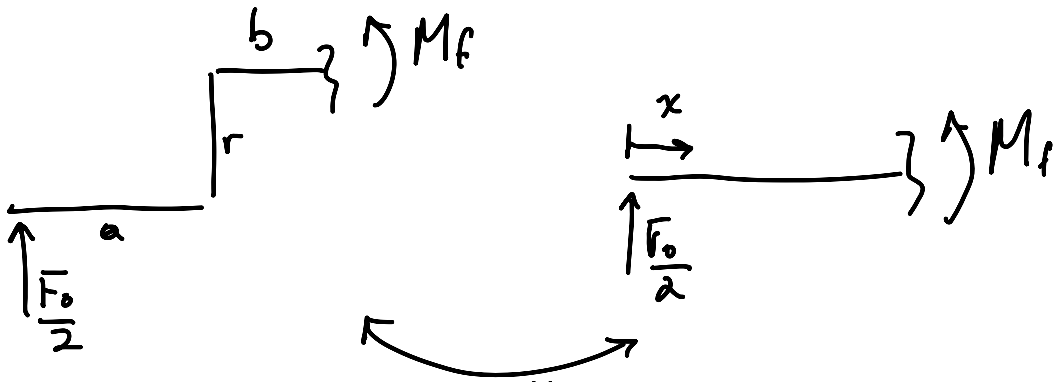
Analisi Momento



$$\sum M = 0 = -\frac{F_0}{2}x + M_f \Rightarrow M_f = \frac{F_0}{2}x$$



$$\sum M = 0 = \frac{-F_0}{2}a + M_f \Rightarrow M_f = \frac{F_0}{2}a$$

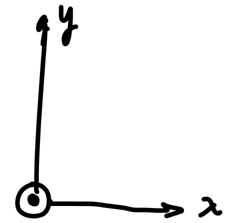


non molta
differenza perchè non c'è nulla che
si scambia il momento

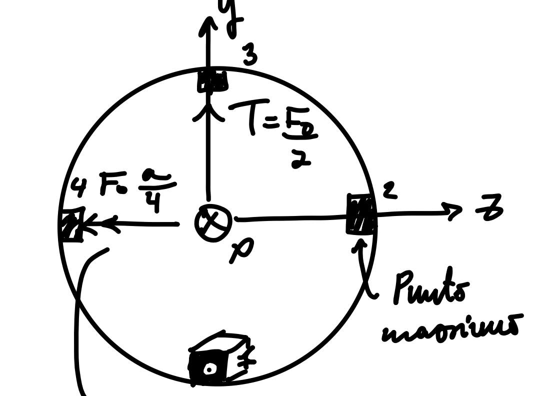
$$\sum M = 0 = M_f - \frac{F_0}{2}(a+x)$$

$$0 \le x \le \frac{b}{2} \Rightarrow M_f = \frac{F_0}{2}(a+x)$$

Stato di sforzo a H-H e K-K



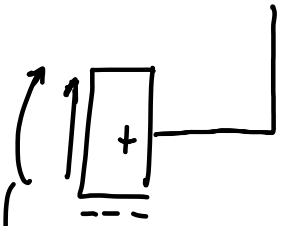
H-H

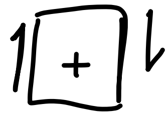


da mano deve andare nella direzione delle fibre tese

$N=0$

$T=\frac{F_0}{2}$





M_z antiorario nel piano quindi opposto ad asse z

Altro metodo per vedere direzione di M

Vogliamo analizzare lo stato di sforzo in 1,2,3 e 4

$d_{HH}=15\,mm$

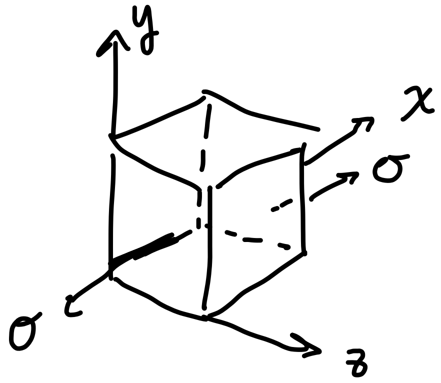
$\boxed{1}$

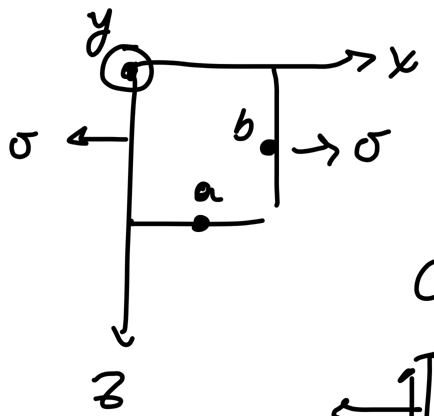
$$\begin{cases} \sigma = \frac{M_f\, y}{J} = \frac{32\, M_f}{\pi d_{HH}^3} = 40{,}66\,MPa \\ \tau = 0 \end{cases}$$

$\boxed{2}$

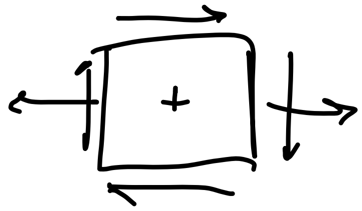
$$\begin{cases} \sigma = 0 \\ \tau = \frac{4}{3}\cdot\frac{T}{A} = 2{,}9\,MPa \end{cases}$$

$\boxed{1}$



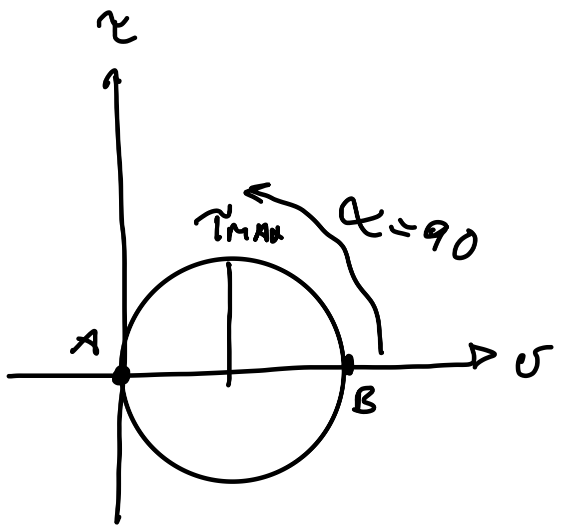


Convenzioni



Coordinate di Mohr

$A(0,0) \quad B(\sigma,0)$



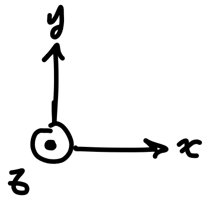
Sappiamo già che x è asse principale e z per $\sigma = 0$

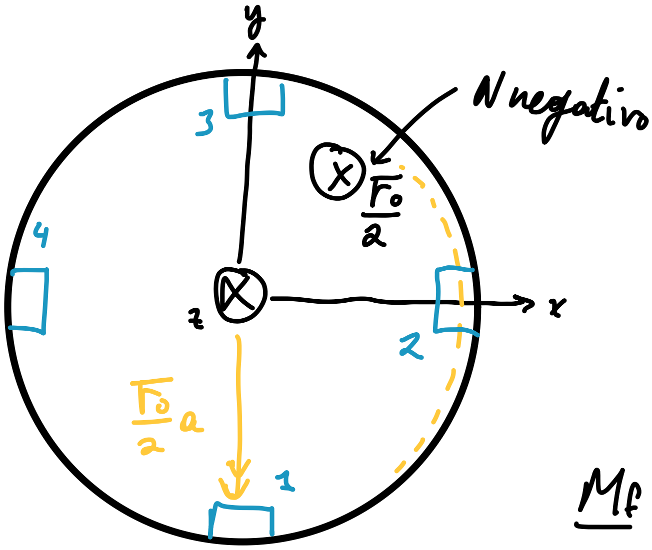
$$\tau_{MAX} = \frac{\sigma_B - \sigma_A}{2} = \frac{\sigma_I - \sigma_{II}}{2} = 20,33\ MPa = R \text{ di circonferenza}$$

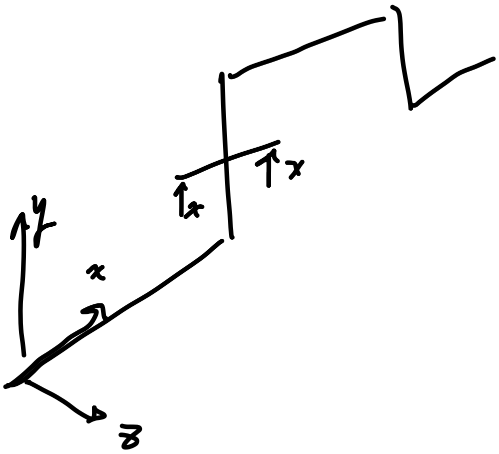
$$C = 20,33\ MPa = \frac{\sigma_B + \sigma_A}{2}$$

Per τ_{MAX} dobbiamo girare di 45 in realtà

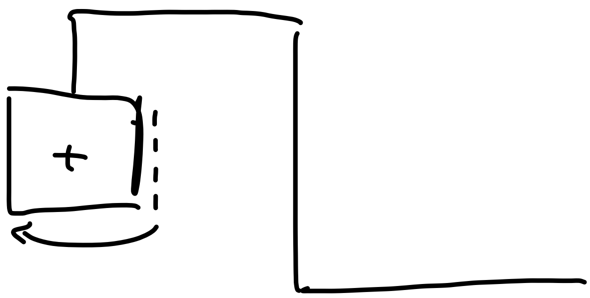
k-k







M_f

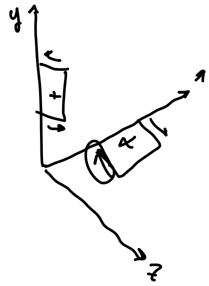


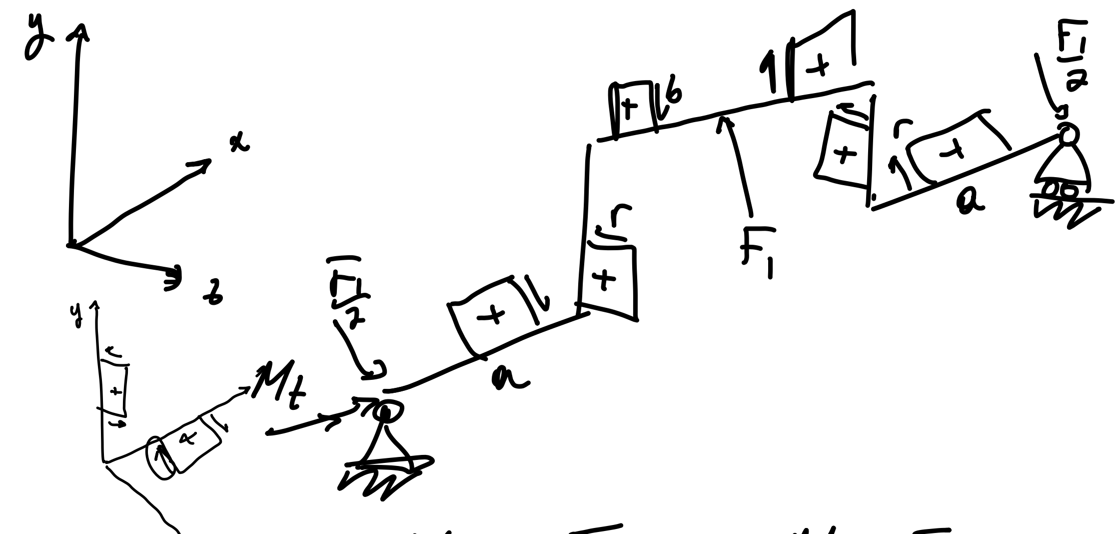
$$\sigma_3 = \sigma_1 = \frac{N}{A} = 1,22\,MPa$$

$$\sigma_2 = \frac{N}{A} + \frac{M_t\, y}{J} = 1,22 + \underbrace{\frac{32 M_f}{\pi d_{kk}^{3}}}_{=34,31\,MPa} = 33,53\,MPa$$

Dopo non guarderemo più N perché sono una parte minuscola.

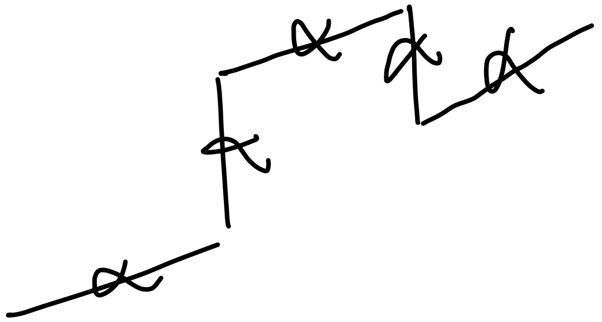
$\boxed{\phi = \frac{\pi}{2}}$ → con Mt invece di N



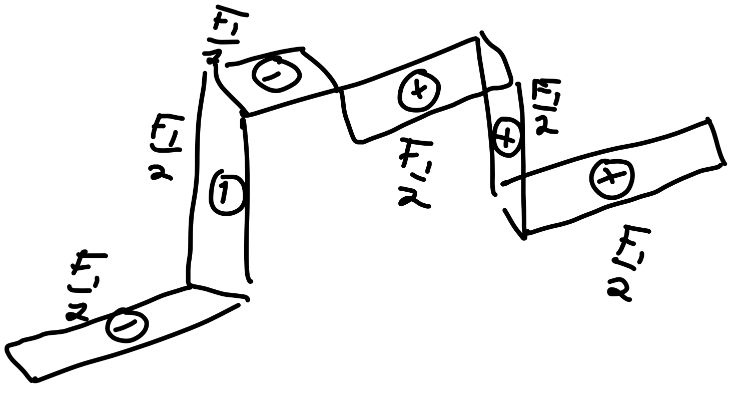


$$\Sigma M_x = 0 = M_t = F \cdot r \Rightarrow M_t = F r$$

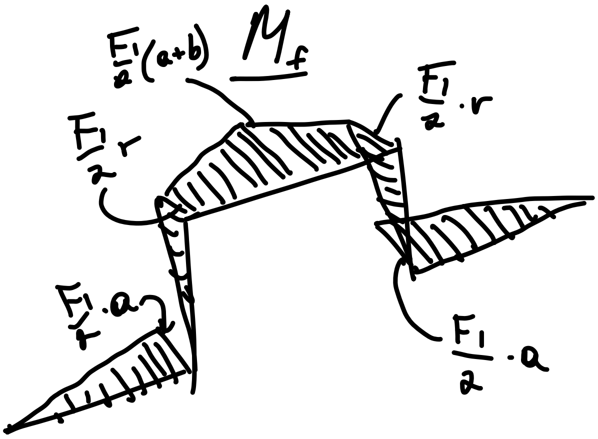
N



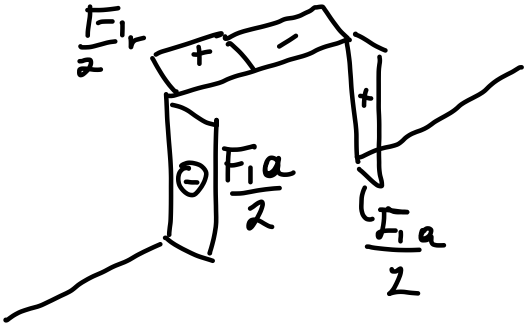
T

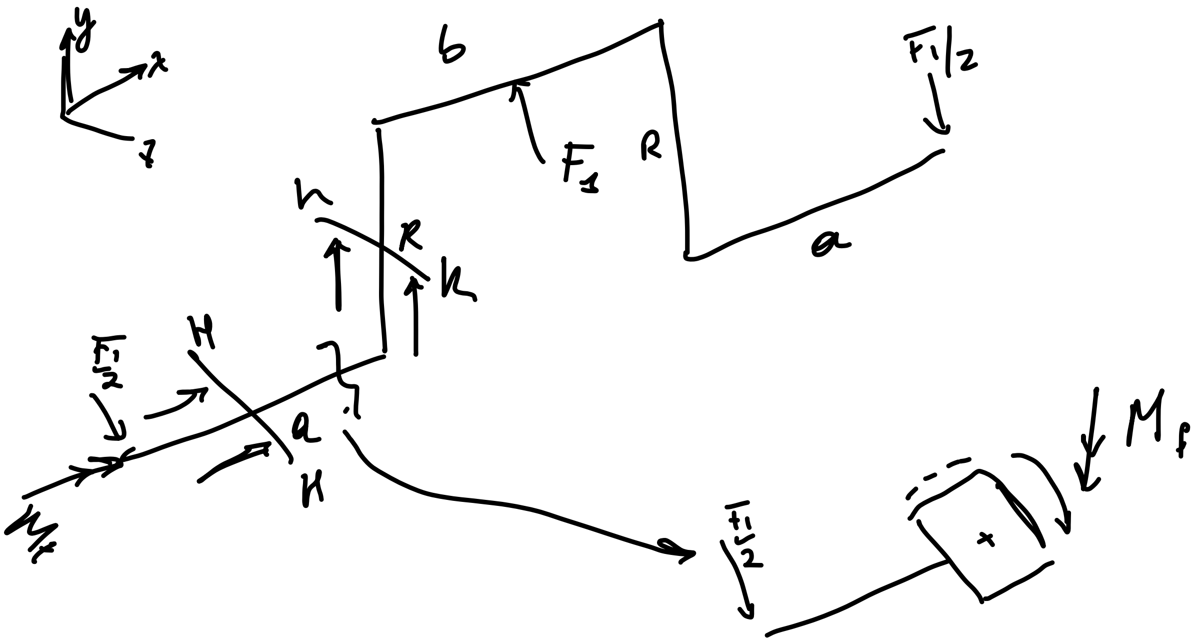


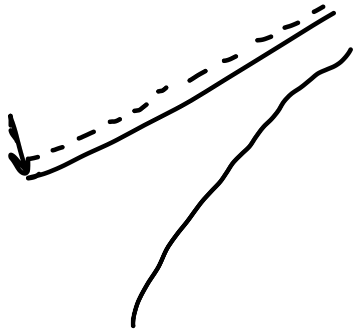
Mf



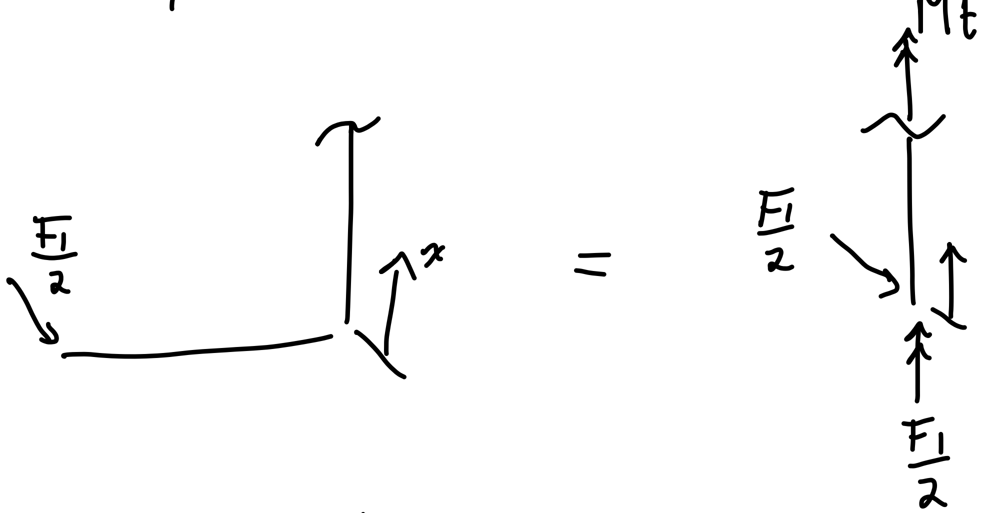
Mt

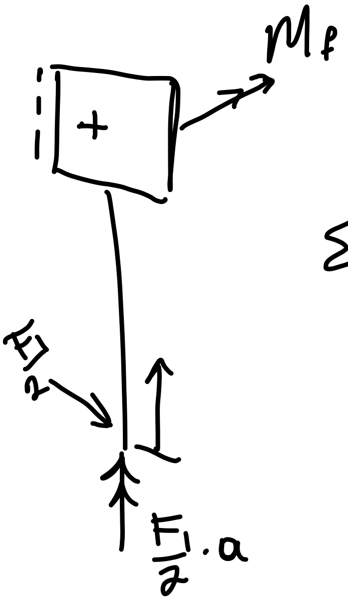






$$\Sigma M = 0 = -M_f + \frac{F_1}{2}x \Rightarrow M_f = \frac{F_1}{2}x$$

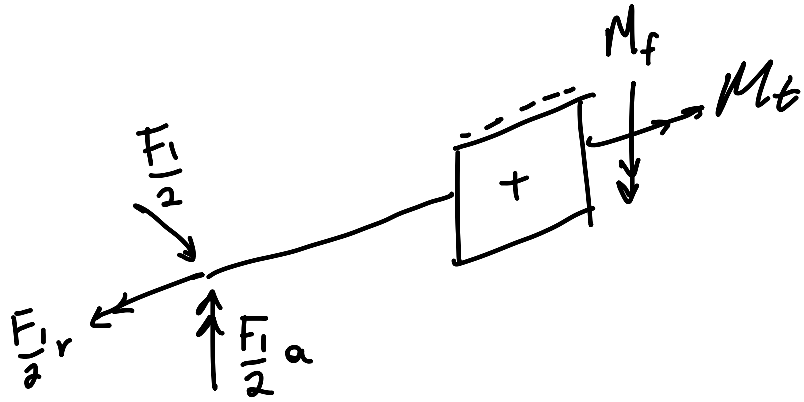




$$\Sigma M_t = 0 = M_t + \frac{F_1 a}{2}$$

$$\Sigma M = 0 = M_f - \frac{F_1}{2}x$$

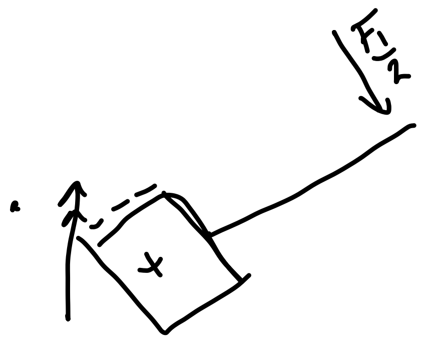
$$\Rightarrow M_f = \frac{F_1}{2}x$$



$$\sum M_y = 0 = -M_f + \frac{F_1}{2} a + \frac{F_1}{2} x$$

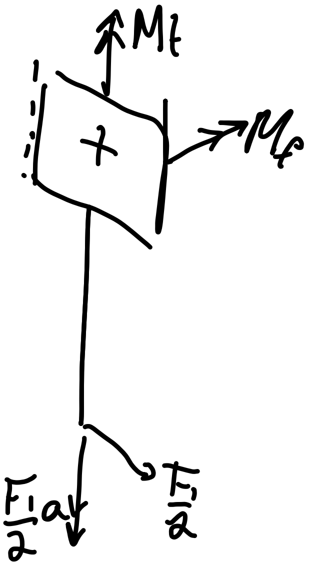
$$M_f = \frac{F_1}{2}(a+x)$$

Dall'altro lato



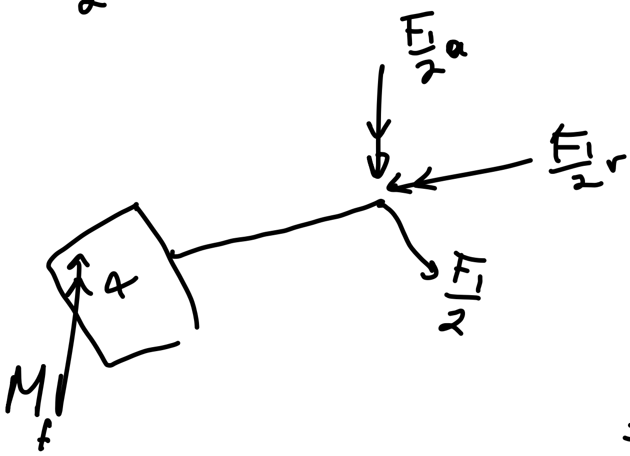
$$\sum M_y = M_f - \frac{F_1}{2} x$$

$$M_f = \frac{F_1}{2} x$$



$$M_t = \frac{F_1}{2} \cdot a$$

$$\sum M_y = 0 = M_f - \frac{F_1}{2} \cdot x \Rightarrow M_f = \frac{F_1}{2} \cdot x$$

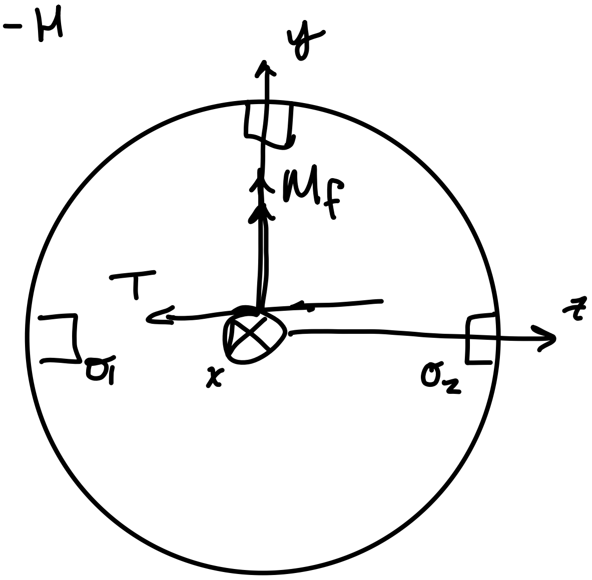


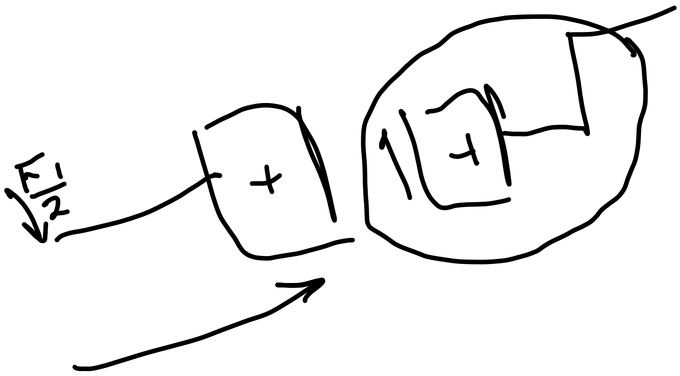
$$M_t = -\frac{F_1}{2} r$$

$$\sum M_f = 0 = M_f - \frac{F_1}{2} a - \frac{F_1}{2} x$$

$$\Rightarrow M_f = \frac{F_1}{2}(a+x)$$

M-M

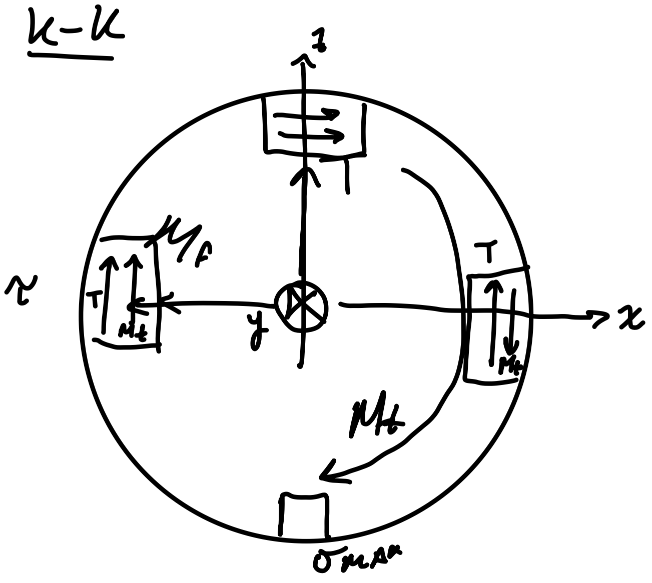


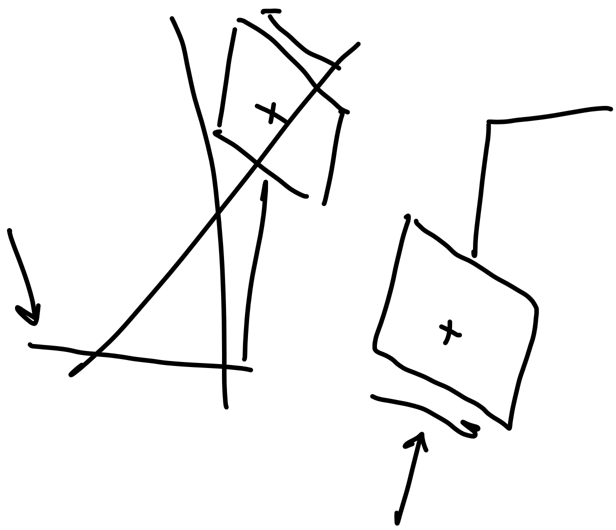


$$\sigma_1 = \frac{32 M_f}{\pi d_{MM}^2}$$

$$\sigma_2 = \frac{32 M_f}{\pi d_{KK}^2}$$

K-K





$$\sigma = \frac{32 M_f}{\pi d_{KK}^3} = 9{,}2\ MPa$$

$$\tau_T = \frac{4}{3} \cdot \frac{T}{A} = 0{,}81\ MPa$$

$$\tau_{M_t} = \frac{16 M_t}{\pi d_{KK}^3} = 8{,}58\ MPa$$

Fare altro esercizio su WeBeep