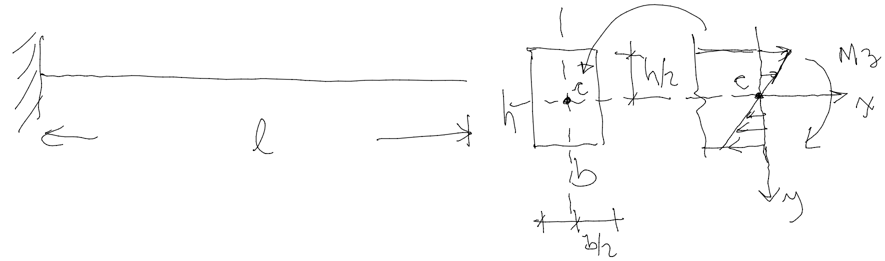
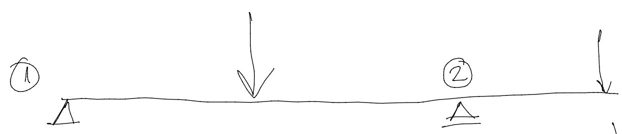
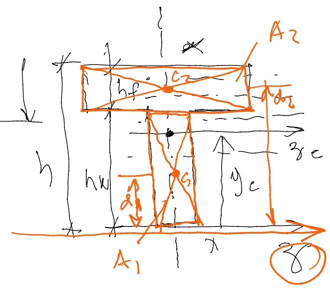
PEF 3207 - Aula 8 de maio 2020

Tuesday, May 5, 2020 7:26 AM

Tensões de cisalhamento na flexão

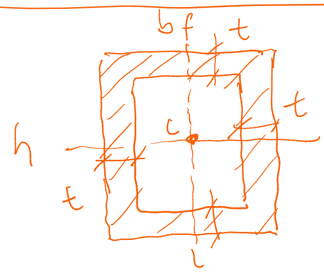


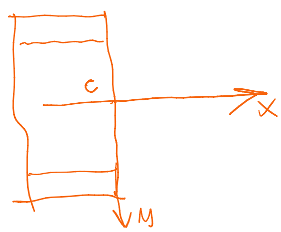


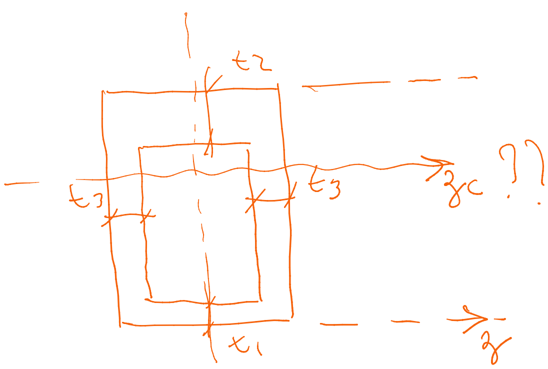


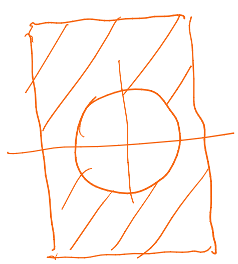
$$y_c = \frac{\sum S_{z_i}}{\sum A_i} = \frac{S_{z_1} + S_{z_2}}{A_1 + A_2}$$

$$S_{z1} = A_1 \cdot d_1 \quad e \quad S_{z2} = A_2 \cdot d_2$$









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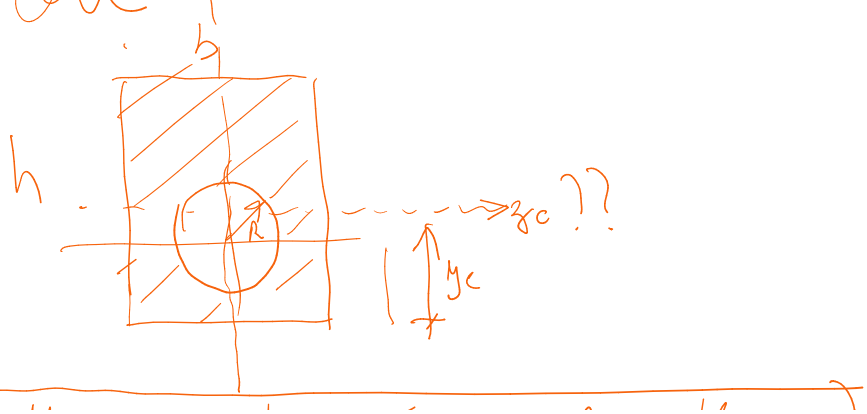
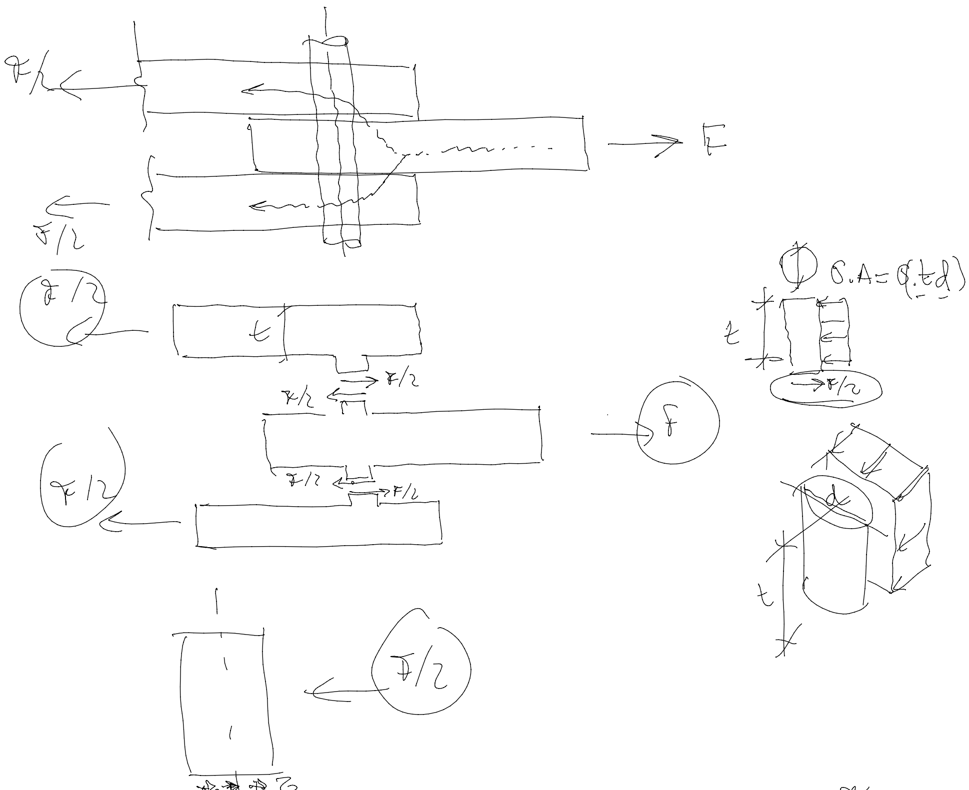
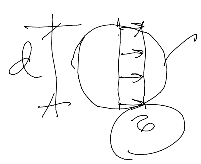


Dúvidas sobre tensão normal da flexão?

Cisalhamento na flexão τ_M

outros cisalhamentos.



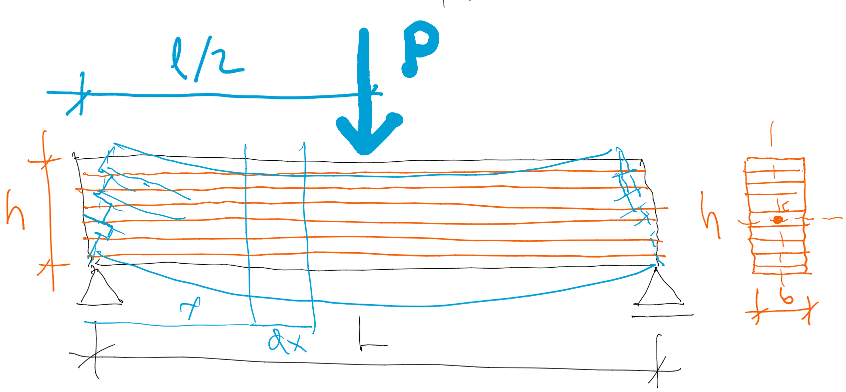


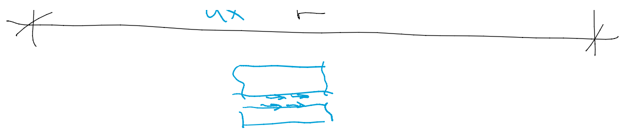
$A_s = \frac{\pi . d^2}{4}$

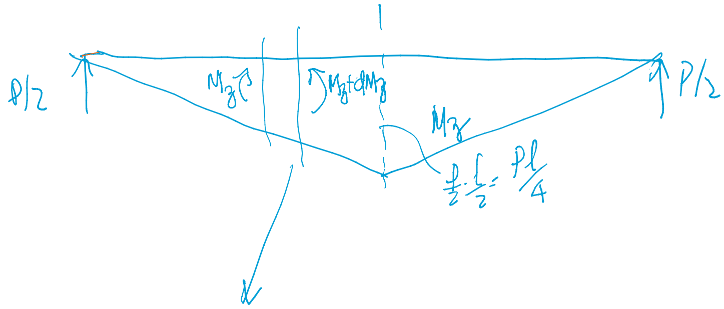
τ : tensão de cisalhamento no corte puro/simples

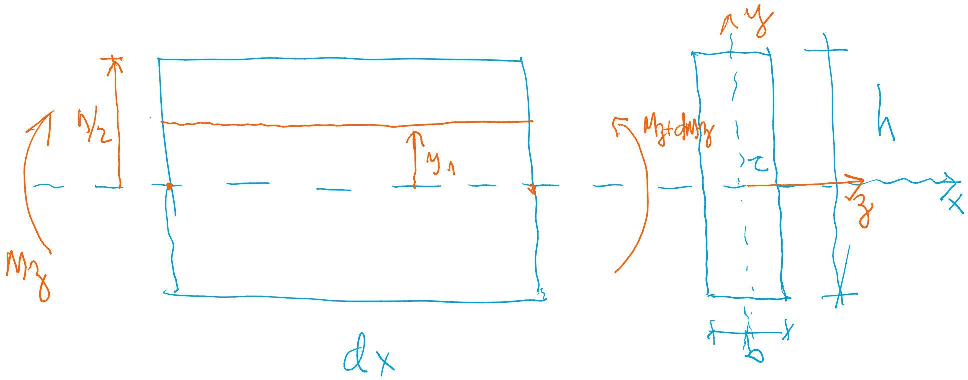
$\tau = \frac{F_s}{2 A_s}$ ou $\tau = \frac{F_{corte}}{A_{corte}}$

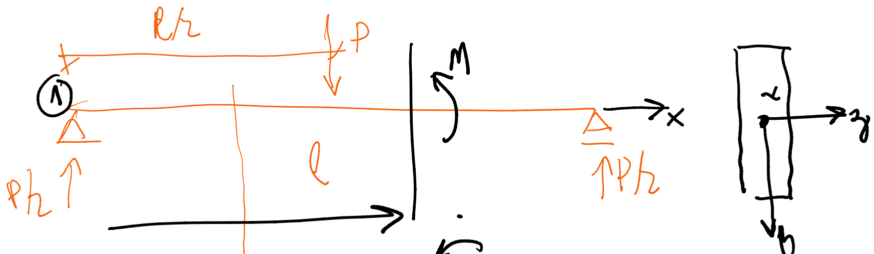
no caso da flexão, temos

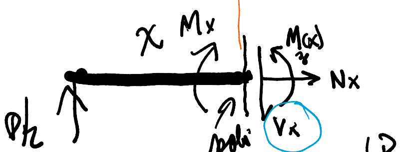








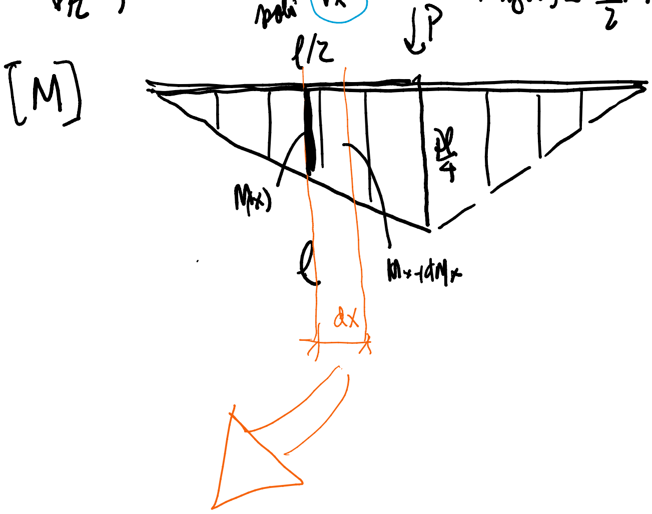




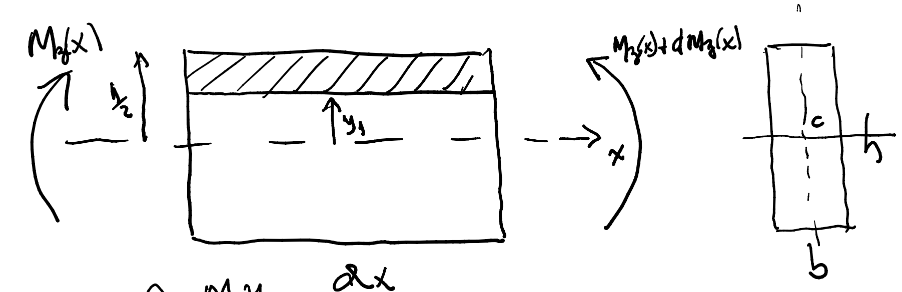
$$M_z(x) - \frac{P}{2}\cdot x = 0$$

$$M_z(x) = \frac{P}{2}\cdot x \quad / \quad x=0 \Rightarrow M_z(0)$$

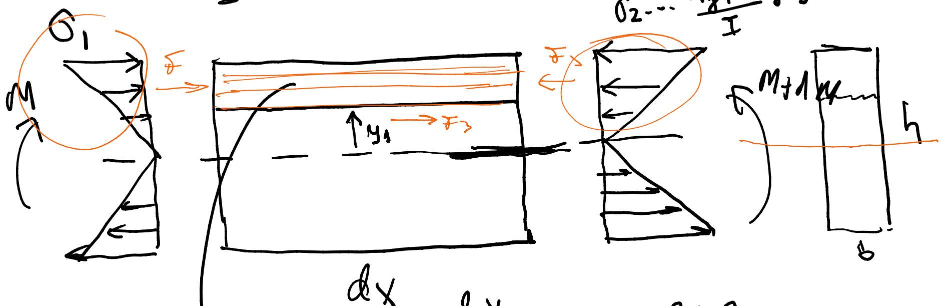
$$x = l/2 \Rightarrow M_z(l/2) = \frac{Pl}{4}$$

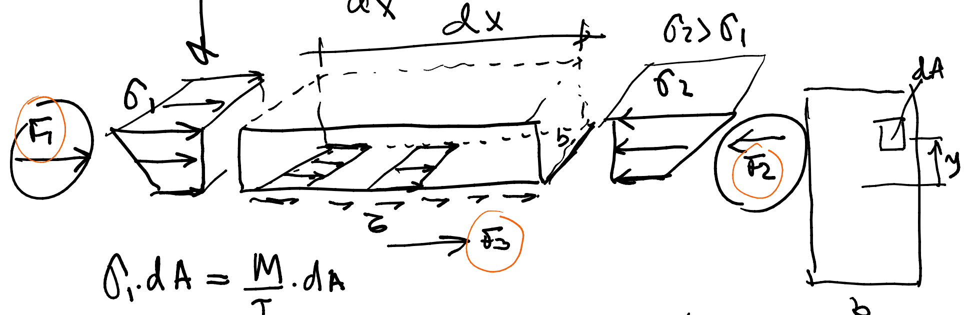


$$\tau_m = \frac{V}{A=bh} = \frac{V}{bh}$$



$\sigma = \frac{M \cdot y}{I}$





$$\sigma_1 \cdot dA = \frac{M}{I} \cdot dA$$

$$F_1 = \int \sigma_1 dA = \int \frac{M_z \cdot y}{I_z} \cdot dA$$

equilíbrio

$$F_1 + F_3 - F_2 = 0$$

$$F_2 = \int \sigma_2 dA = \int \left(\frac{M_z + dM_z}{I}\right) y \, dA$$

$F_3 = F_2 - F_1$ sendo $F_3 = \tau \cdot (b \cdot dx)$

$$\tau b dx = \int \frac{M_z + dM_z}{I} \cdot y \, dA - \int \frac{M_z}{I} \cdot y \, dA$$

$$\tau b dx = \int \frac{dM_z \cdot y \, dA}{I}$$

$$(\tau b) = \frac{dM_z}{dx \, I_z} \cdot \int y \, dA$$

momento estático de área

referência ao centroide da seção C

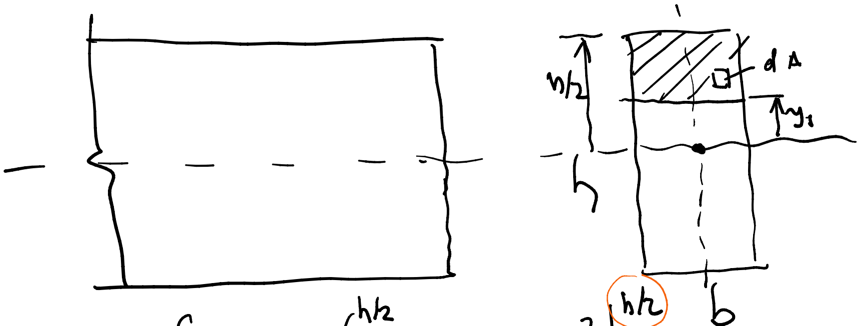
tensão de cisalhamento na flexão é dada por:

$$\tau = \frac{dM_z}{dx} \frac{S_z}{b I_z} \qquad V = \frac{dM}{dx}$$

$$\tau = \frac{V \cdot S_z}{}$$

como S_z varia ao longo da altura?

$$\boxed{\tau = \frac{V \cdot S_z}{b \cdot I_z}}$$ como S_z varia ao longo da altura?



$$S_z = \int y\, dA = \int_{y_1}^{h/2} y \cdot b \cdot dy = \frac{by^2}{2}\Big|_{y_1}^{h/2}$$

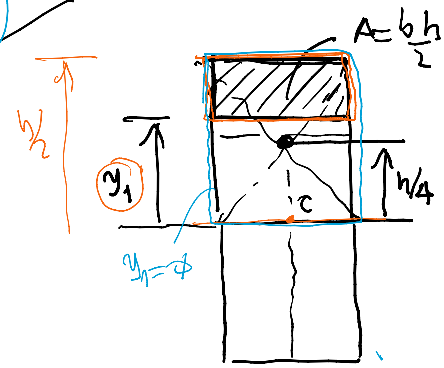
$$\boxed{S_z = \frac{b}{2}\left(\frac{h^2}{4} - y_1^2\right)}$$ → avaliar $S_z(y_1=0)$

$$S_z = \frac{b}{2}\cdot\left(\frac{h^2}{4} - 0\right)$$

$$S_z = \left(\frac{bh}{2}\right)\cdot\frac{h}{4}$$

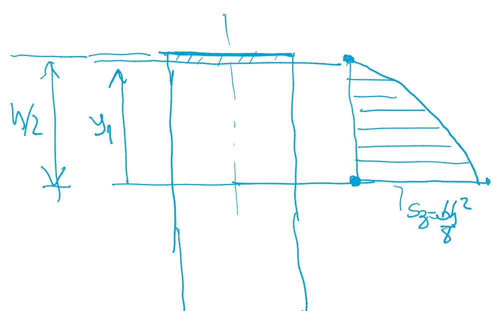
$$\boxed{S_z(y_1=0) = A \cdot h/4}$$

$$S_z(y_1=h/2) = 0$$



$$S_z(y_1=h/2) = \frac{b}{2}\left(\cancel{\frac{h^2}{4}} - \cancel{\left(y_1=\frac{h}{2}\right)^2}\right)$$

$$S_z(y_1=h/2) = 0$$



$$\tau = \frac{V \cdot S_z}{b\, I_z}$$

$$\tau(h/2) = 0$$

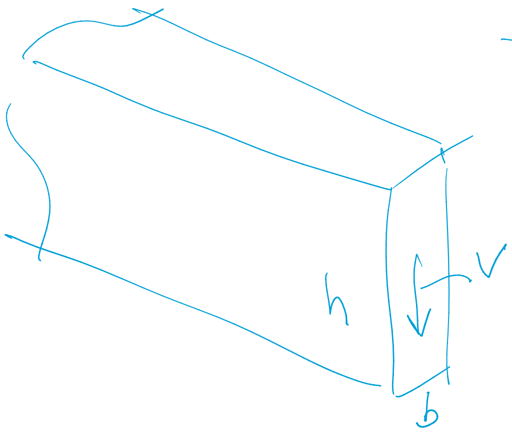
$$\tau(0) = \frac{V}{b I_z}\cdot\frac{bh^2}{8} = \frac{V \cdot bh^2}{b \cdot \frac{bh^3}{12}\cdot 8} = \frac{V}{bh}\cdot\frac{12}{8} = \frac{V}{bh}\cdot\frac{3}{2}$$

$$\tau(y_1=0) = \frac{V}{bh}\cdot\frac{3}{2} = 1{,}5\,\frac{V}{bh}$$ → area da secção transversal

$\tau = \varnothing$

$\tau_m = \dfrac{V}{A}$

Cisalhamento médio



$$\tau = \frac{V \cdot S_z}{b \cdot I_z}$$

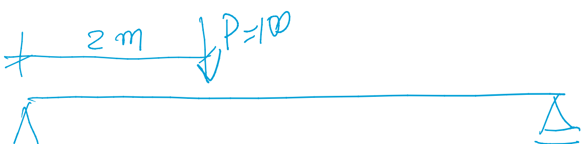
força cortante

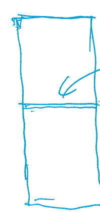
momento estático de área

largura da viga

mo. de inércia

Ex. aplicação.



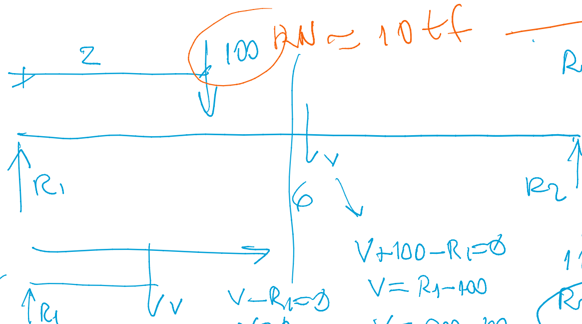


Qual a resistência do adesivo na ligação da viga

a) det. o cisalhamento máximo da viga?

100 kN ≈ 10 tf → ~ 8 veículos

$R_1 + R_2 = 100$



$\dfrac{100 \times 2}{6} = \dfrac{100}{3}$

$\dfrac{100 \times 4}{6}$

$\dfrac{200}{3}$

$V - R_1 = 0$

$V = R_1$

$V + 100 - R_1 = 0$

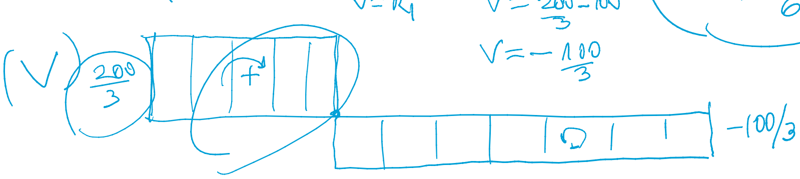
$V = R_1 - 100$

$V = \dfrac{200}{3} - 100$

$V = -\dfrac{100}{3}$

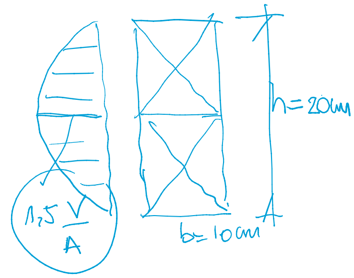
$100 \times 2 - 6R_2 = 0$

$R_2 = \dfrac{100 \times 2}{6}$



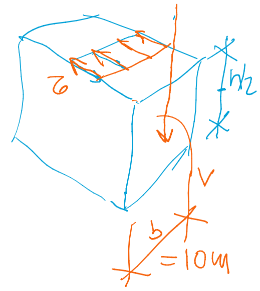
$$\tau = \frac{V \cdot S_z}{b I_z} = \frac{200/3}{6 \cdot I_z} \cdot S_z$$

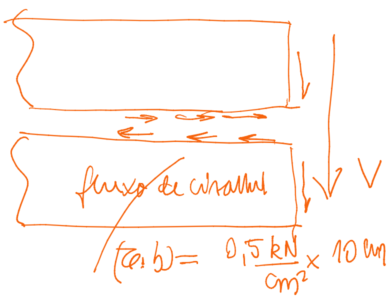
$$\tau_{max} = \frac{V \cdot bh^2/8}{b \cdot \frac{bh^3}{12}} = 1{,}5 \frac{V}{bh}$$



$$\tau_{max} = \left(\frac{200\,kN}{3} \cdot \frac{3}{2} \cdot \frac{1}{10cm \times 20cm}\right)$$

$$\tau_{max} = \frac{100}{200} \frac{kN}{cm^2} = 0{,}5 \frac{kN}{cm^2} = 5\,MPa$$

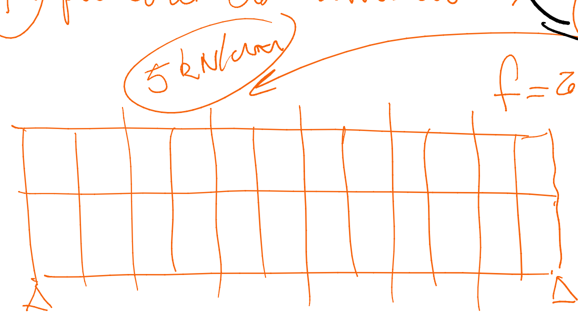




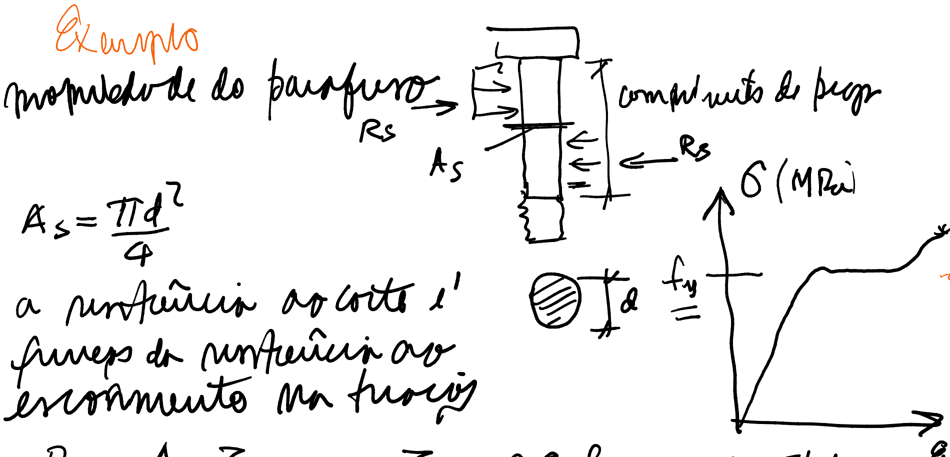
$$\tau(a,b) = 0{,}5 \frac{kN}{cm^2} \times 10\,cm = 5 \frac{kN}{cm}$$

f: fluxo de cisalhamento $\Rightarrow \tau \cdot b = 5 \frac{kN}{cm}$

$f = \tau b = 5 \frac{kN}{cm}$ força por unidade de comprimento



Exemplo



← aço A36 ⇒ $f_y = 250$ MPa

$$A_s = \frac{\pi d^2}{4}$$

a resistência ao corte é função da resistência ao escoamento na tração

$R_s = A_s \cdot \tau_u$ a $\tau_u = 0{,}6\, f_y = 0{,}6\ 25 \frac{kN}{cm^2}$

$R_s = \left(\frac{\pi d^2}{4}\right) 0.6 \times 25 \frac{kN}{cm^2}$ com $d = 1{,}25$ cm

$R_s = 1{,}23\, \cancel{cm^2} \times 0{,}6 \times 25 \frac{kN}{\cancel{cm^2}} = 1{,}23 \times 15\,kN = 18{,}45\,kN$

33,20

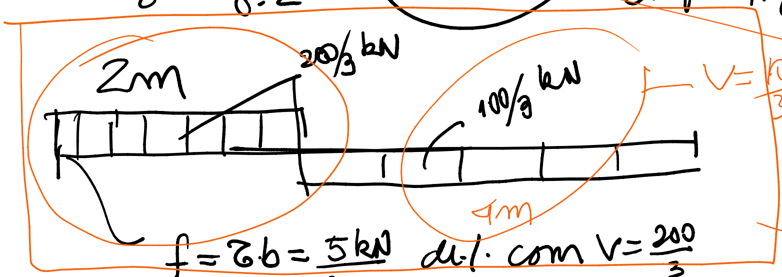
$R_d = \frac{R_s}{\gamma} = \frac{18{,}45}{\gamma = 2} = 9{,}225\,kN$ ← resistência com coef. de segurança 2

aumentou a resistência do material do parafuso.

$f_y = 450$ MPa

$f_u = 45$ kN

$R_d = \frac{R_s}{\gamma} = \frac{18,45}{\gamma=2} = 9,225 \text{ kN}$ conf. da figura 2



$f = \tau b = \frac{5 \text{ kN}}{cm}$ de l. com $V = \frac{200}{3}$

16,6

$f_y = 45 \frac{kN}{cm^2}$

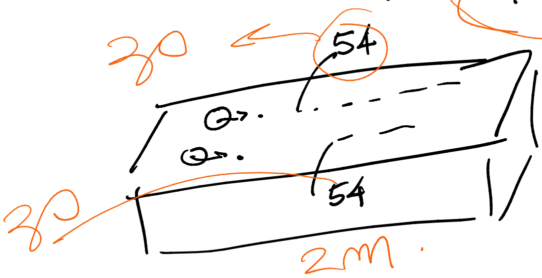
diagrama de força cortante.

$2,0 m = 200 \text{ cm} \Rightarrow F_s = \frac{5 kN}{cm} \times 200 cm = 1000 kN$

$f = \tau b = \frac{V \cdot S_z}{I_z}$

portanto, com $R_d = 9.225 kN \Rightarrow$

$n.\text{parafusos} = \frac{F_s}{R_d} = \frac{1000 kN}{9,225 kN} \cong 108,4$ Parafusos em pares de corte



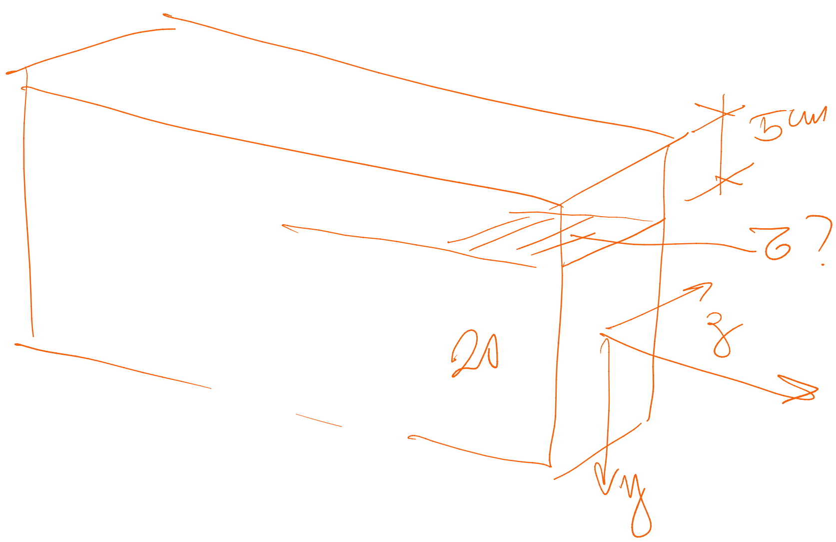
$\frac{200}{54} =$

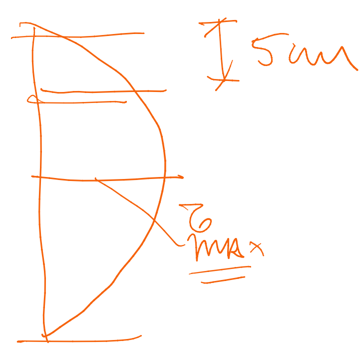
$\frac{200}{30} = 6$

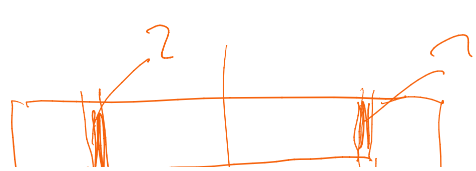
60 pinos

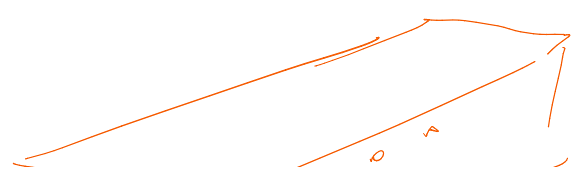
1 pino a cada 6,6 cm

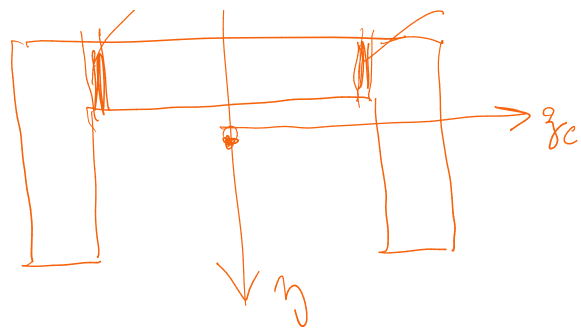
para a tração deve-se aumentar a resistência do parafuso $\rightarrow$ 450 MPa











z_c
y