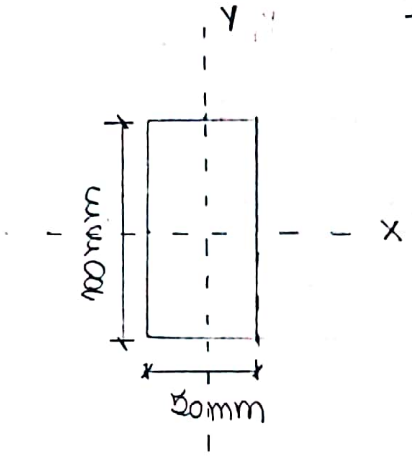
Aluna: Gabriella da C. Cosme — PF - 2020.2

Questão 3

$$P_{cr} = \frac{\pi^2 E I}{(KL)^2}$$

1°) Façamos uma análise de I para a seção transversal:



$I_y \rightarrow$ momento de inércia em torno do eixo y.

$I_x \rightarrow$ momento de inércia em torno do eixo x.

$$I_y = \frac{100(20)^3}{12}$$

$$I_y = 1041666{,}67 \ mm^4$$

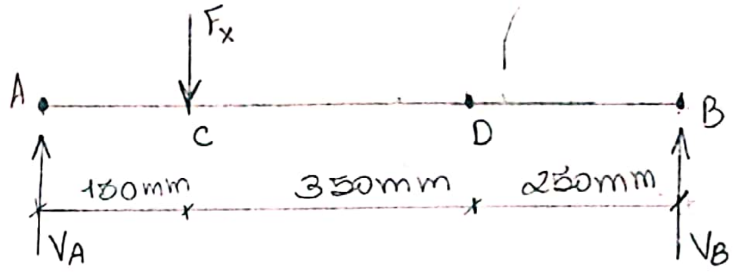
$$I_x = \frac{20(100)^3}{12}$$

$$I_x \approx 4166666{,}67 mm^4$$

- Como Pcr e I são diretamente proporcionais, o menor I gerará a menor Pcr, logo, a flambagem ocorre primeiro quando $I = I_y$.
- $K = 1 \rightarrow$ birrotulada
- $L = 3{,}6m = 3{,}6 \times 10^3 mm$
- $E = 11{,}0 GPa \rightarrow E = 11 \times 10^3 MPa$

$$P_{cr} = \frac{\pi^2 (11\times10^3)(1041666{,}67)}{(1\cdot(3{,}6\times10^3))^2} \rightarrow P_{cr} = 8726{,}02 N \rightarrow P_{cr} = 8{,}73 kN$$

Questão 2



$F_x = ?$

$T_C \rightarrow$ torção em C

$T_D \rightarrow$ torção em D

$T_C + T_D = 0$

$F_x \cdot 75 + 7{,}5(50) = 0$

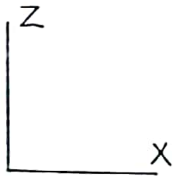
$F_x = 5 KN$

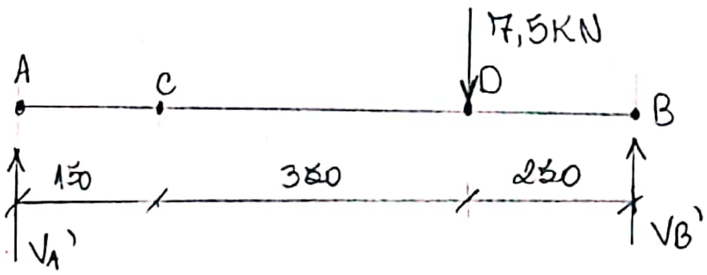
$\sum F = 0 = V_A + F_x + V_B \rightarrow V_A - 5 + V_B = 0 \rightarrow V_A + V_B = 5$

$\sum M_A = 0 = -5 \times 150 + V_B(750) \rightarrow V_B = 1 KN$

$V_A + V_B = 5$

$V_A = 4 KN$





$\sum F = 0$

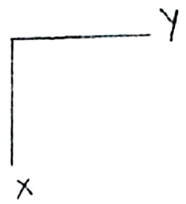
$V_A' + V_B' - 7{,}5 = 0$

$V_A' + V_B' = 7{,}5$

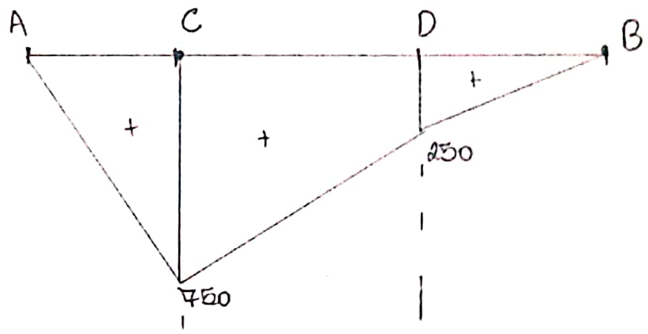
$\sum M_A = 0 = -7{,}5(500) + V_B'(750) \rightarrow V_B' = 5 KN$

$V_A' + V_B' = 7{,}5$

$V_A' = 2{,}5 KN$



momento



$$M_C = 5 \times 150$$

$$M_C = 750 \text{ KNmm}$$

$$M_D = 250 \times 1$$

$$M_D = 250 \text{ KNmm}$$

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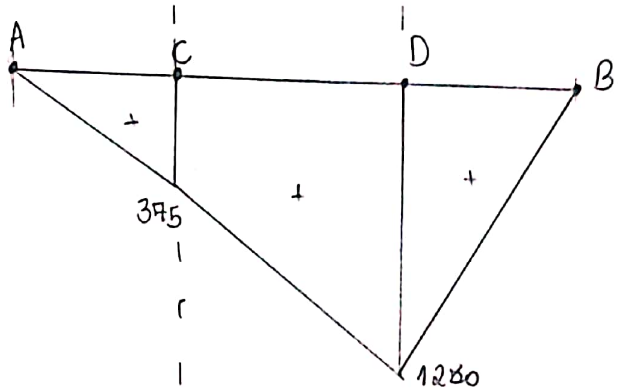
momento



$$M_C = 2{,}5 \times 150$$

$$M_C = 375 \text{ KNmm}$$

$$M_D = 5 \times 250$$

$$M_D = 1250 \text{ KNmm}$$

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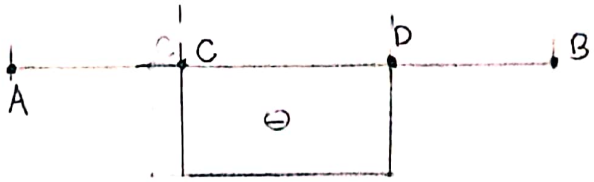
Torção

Torção

$\leftarrow\leftarrow$ (−)

$\rightarrow\rightarrow$ (+)



$$T_C = 5 \times 75$$

$$T_C = -375 \text{ KNmm}$$

$$T_D = 7{,}5 \times 50$$

$$T_D = 375 \text{ KNmm}$$

Somando os momentos em $\ulcorner^{y}_{x}$ e $\llcorner^{z}_{x}$:

$$M_C = \left((750)^2 + (375)^2\right)^{1/2} \rightarrow M_C \approx 450{,}70 \text{ KNmm}$$

$$M_D = \left((250)^2 + (1250)^2\right)^{1/2} \rightarrow M_D \approx 1274{,}75 \text{ KNmm}$$

Como $M_D > M_C$, o ponto mais crítico é D.

Sendo:

$M = 1274{,}75 \text{ KNmm}$

$T = 375 \text{ KNmm}$

$\tau_{adm} = 80 \text{ MPa}$

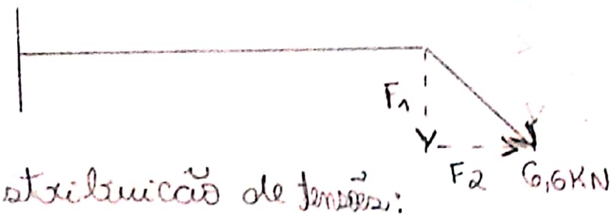
$$c = \left(\frac{2}{\pi \tau_{adm}} \sqrt{M^2 + T^2}\right)^{1/3}$$

$$c = \left(\frac{2}{\pi\, 80} \sqrt{(1274{,}75 \times 10^3)^2 + (375 \times 10^3)^2}\right)^{1/3}$$

$$c = 21{,}95 \rightarrow c = 22 \text{ mm}$$

$$d = 2c \rightarrow d = 44 \text{ mm}$$

Questão 1

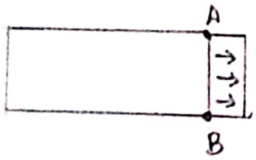


$$\frac{6,6}{F_1} = \frac{5}{3} \quad e \quad \frac{6,6}{F_2} = \frac{5}{4}$$

$$F_1 = 3,96KN \qquad F_2 = 5,28KN$$

Distribuição de tensões:

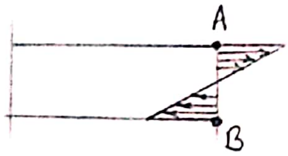
• σ causado por F_2 (tração):



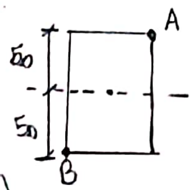
$$\sigma_n = \frac{F}{A} \rightarrow \sigma_{nA} = \sigma_{nB} = \sigma_n = \frac{5,28 \times 10^3}{75 \times 100} \rightarrow \sigma_n = 0,704 MPa$$

$$\sigma_n = 704 KPa$$

• σ causado pelo momento fletor:



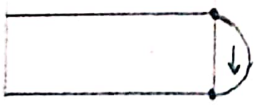
$$\sigma = \frac{M.C}{I}$$



$$C_A = C_B = 50mm$$

$$I = \frac{75 \times 100^3}{12} \Rightarrow I = 6250000 mm^4$$

• τ causado por F_1:



$$\tau_A = \tau_B = 0$$

$$M = F_1 \times 900 \rightarrow 3564 KNmm$$

$$\sigma_A = \frac{3564 \times 10^3 \times 50}{6250000} \rightarrow \sigma_A = +28,51 MPa$$

$$\sigma_B = -\frac{3564 \times 10^3 \times 50}{6250000} \rightarrow \sigma_B = -28,51 MPa$$

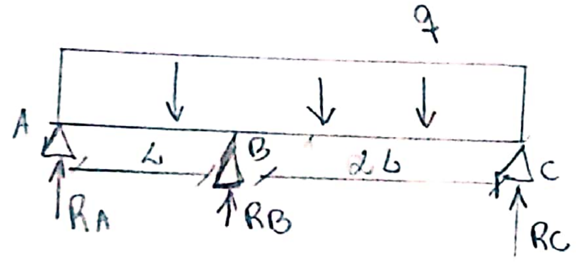
Quando $\tau = 0$, σ_x e σ_y são σ_1 e σ_2, portanto, em B;

$\sigma_1 = 0,704 MPa$

$\sigma_2 = -28,51 MPa$

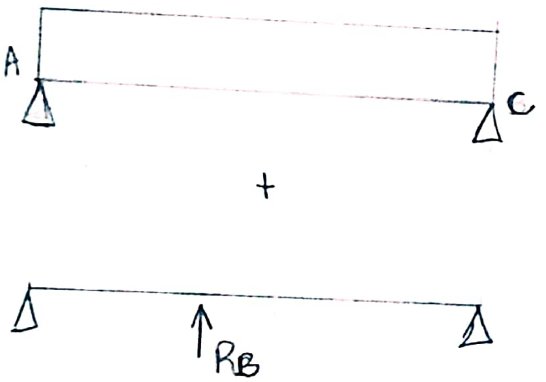
$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2} \rightarrow \tau_{max} = \frac{0,704 + 28,51}{2} \rightarrow \tau_{max} = 14,61 MPa$$

Questão 4

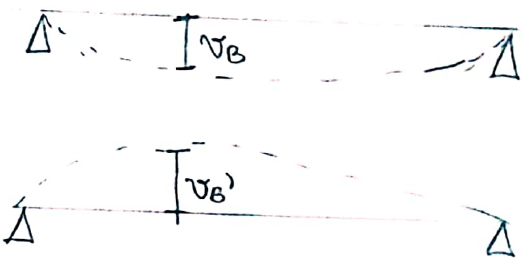


$$\sum F_y = 0 = R_A + R_B + R_C - q3L$$
$$R_A + R_B + R_C = 3qL$$

$$\sum M_A = 0 = R_B . L + R_C 3L - q.3L.\frac{3L}{2}$$
$$R_B + 3R_C = \frac{9qL}{2}$$



Deformadas:



$$v_B + v_B' = 0$$

De acordo com a tabela de inclinações e deslocamentos disponível no Hibbeler:

$$v_B = -\frac{qL}{24EI}((3L)^3 - 2(3L)L^2 + (3L)^3) \rightarrow -\frac{qL}{24EI}(48L^3) \rightarrow -\frac{2qL^4}{EI}$$

$$v_B' = \frac{R_B.(2L).L}{6EI(3L)}((3L)^2 - (2L)^2 - L^2) \rightarrow \frac{R_B 2L^2}{18L EI}(4L^2) \rightarrow \frac{4R_B L^3}{9EI}$$

$$v_B + v_B' = 0$$

$$-\frac{2qL^4}{EI} + \frac{4R_B L^3}{9EI} = 0 \Rightarrow R_B = \frac{9qL}{2}$$

Se $R_B + 3R_C = \frac{9qL}{2}$

$$3R_C = \frac{9qL}{2} - \frac{9qL}{2}$$

$$R_C = 0$$

Se $R_A + R_B + R_C = 3qL$

$$R_A = 3qL - 0 - \frac{9qL}{2}$$

$$R_A = -\frac{3qL}{2}$$