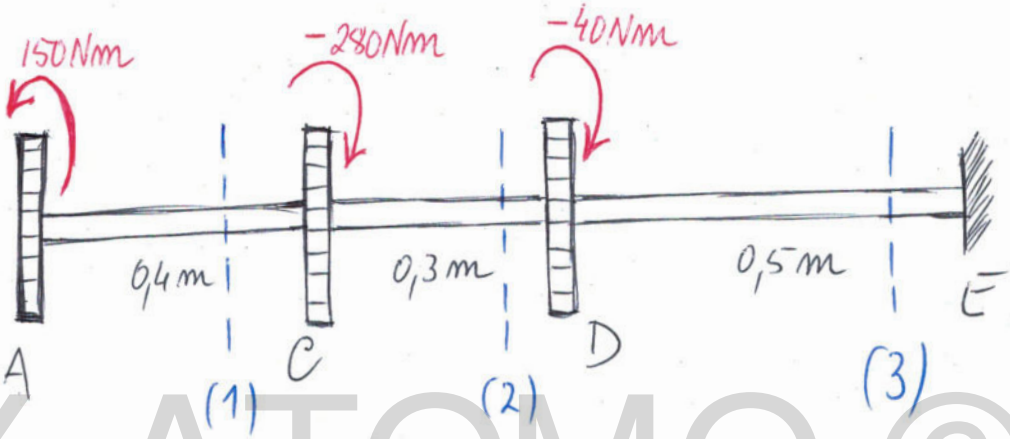
T2 11-12-2020 RM/MM UL

1. $G = 100\ GPa$

$d = 15\ mm$



$T_1 = 150\ Nm$

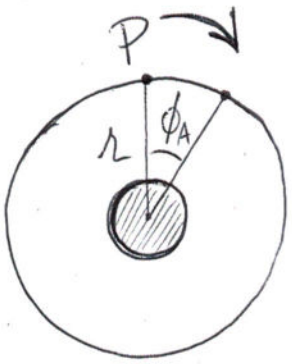
$T_2 = 150 - 280 = -130\ Nm$

$T_3 = 150 - 280 - 40 = -170\ Nm$

$J = \frac{\pi}{2} \times 0{,}0075^4 = 4{,}97 \times 10^{-9}\ m^4$

$$\phi_A = \frac{150 \times 0{,}4 - 130 \times 0{,}3 - 170 \times 0{,}5}{4{,}97 \times 10^{-9} \times 100 \times 10^{9}}$$

$\phi_A = -0{,}129\ rad$



$$s = \phi_A r = -0{,}129 \times 100 \text{ mm}$$

$$s = -12{,}9 \text{ mm}$$

1.2

$$\tau_{máx} = \frac{170 \times 0{,}0075}{4{,}97 \times 10^{-9}} = 256{,}6 \times 10^6 \text{ Pa}$$

$$\simeq 257 \text{ MPa}$$

2.

$$\dot{W} = \Phi = 15 \text{ KW}$$

$$f = 1300 \text{ rpm} = \frac{1300}{60} \simeq 21{,}7 \text{ Hz}$$

$$\tau_{adm} = 56 \text{ MPa}$$

$$\omega_{AB} = 2\pi f = 2\pi \times 21{,}7 = 136{,}1 \text{ rad/s}$$

$$P = T\omega \Rightarrow T_{AB} = \frac{15 \times 10^3}{136{,}1} = 110{,}2 \text{ Nm}$$

(AB)

$$\tau_{max} < \tau_{adm} \iff$$

$$\frac{T_{AB} \, c_{AB}}{\frac{\pi}{2} c_{AB}^4} < \tau_{adm} \iff c_{AB} > \sqrt[3]{\frac{2 T_{AB}}{\pi \tau_{adm}}}$$

$$c_{AB} > \sqrt[3]{\frac{2 \times 110,2}{\pi \times 56 \times 10^6}} = 1,08 \times 10^{-2} m = 1,08 \text{ cm}$$

$$d_{AB} \geq 21,6 \text{ mm}$$

$$\frac{T_{AB}}{r_{AB}} = \frac{T_{CD}}{r_{CD}} \iff T_{CD} = \frac{r_{CD}}{r_{AB}} T_{AB}$$

$$T_{CD} = \frac{125}{75} \times 110,2 = 183,7 \text{ Nm}$$

$$c_{CD} > \sqrt[3]{\frac{2 T_{CD}}{\pi \tau_{adm}}} = \sqrt[3]{\frac{2 \times 183,7}{\pi \times 56 \times 10^6}} = 12,8 \times 10^{-3} m$$

$$= 12,8 \text{ mm}$$

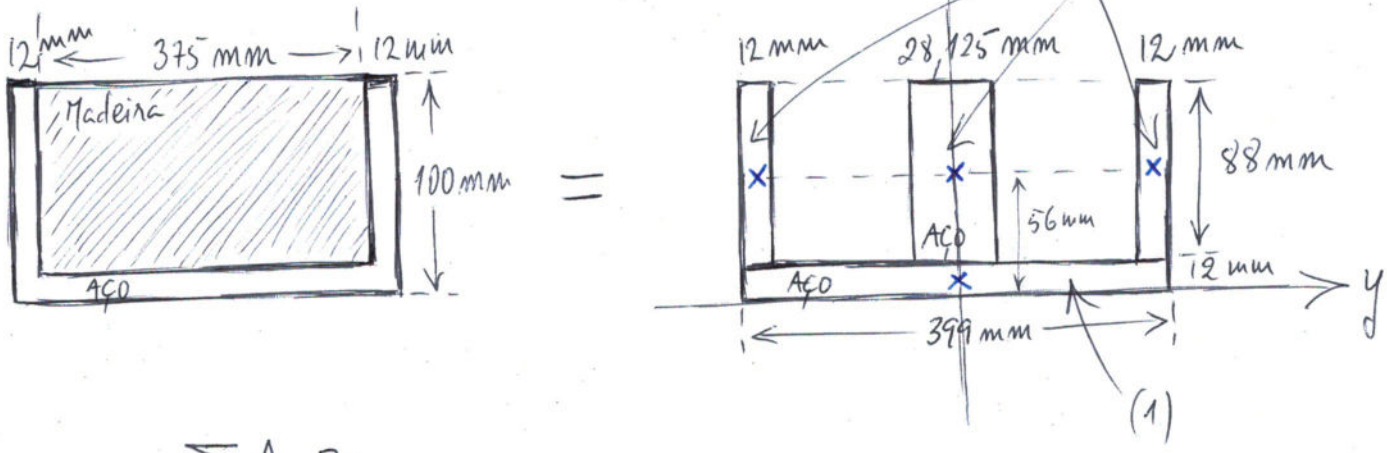
$$d_{CD} \geq 25,6 \text{ mm}$$

3. $M = 1{,}4\ kN\,m$

$E_{aço} = 200\ GPa$

$E_{mad} = 15\ GPa$

$n = \dfrac{E_{mad}}{E_{aço}} = 0{,}075$



$$z_G = \frac{\sum A_i z_i}{\sum A_i} = \frac{399 \times 12 \times 6 + (12 \times 2 + 28{,}125) \times 88 \times (12 + 44)}{399 \times 12 + 52{,}125 \times 88}$$

$= 30{,}464\ mm$

$$I = I_1 + I_2 = \left(I_{G1} + A_1 d_1^2\right) + \left(I_{G2} + A_2 d_2^2\right)$$

$$= \frac{399 \times 12^3}{12} + 399 \times 12 \times (30{,}464 - 6)^2 + \frac{52{,}125 \times 88^3}{12} + 52{,}125 \times 88 \times (56 - 30{,}464)^2$$

$= 8874281{,}6\ mm^4 = 8{,}8742816 \times 10^{-6}\ m^4$

$$\sigma'_{máx,mad.} = n \frac{M C_{mad}}{I} =$$

$$= 0{,}075 \times \frac{1{,}4 \times 10^{3} \times (100 - 30{,}464) \times 10^{-3}}{8{,}8742816 \times 10^{-6}}$$

$$= 822746\ Pa = 823{,}7\ kPa \quad (compressão)$$

$$\sigma'_{máx,Aço} = \frac{M C_{aço}}{I} =$$

$$= \frac{1{,}4 \times 10^{3} \times 30{,}464 \times 10^{-3}}{8{,}8742816 \times 10^{-6}} =$$

$$= 4805978\ Pa = 4\,806\ kPa \ (tração)$$

3.2.

$$\rho = \frac{EI}{M} = \frac{200 \times 10^{9} \times 8{,}8742816 \times 10^{-6}}{1{,}4 \times 10^{3}}$$

$$\rho = 1267{,}8\ m$$

paulo pinto