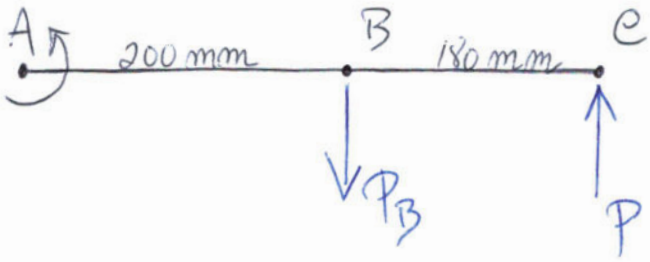
06-11-2020 RM UL T1

1. $E = 200\ GPa$

$P = 4\ kN$

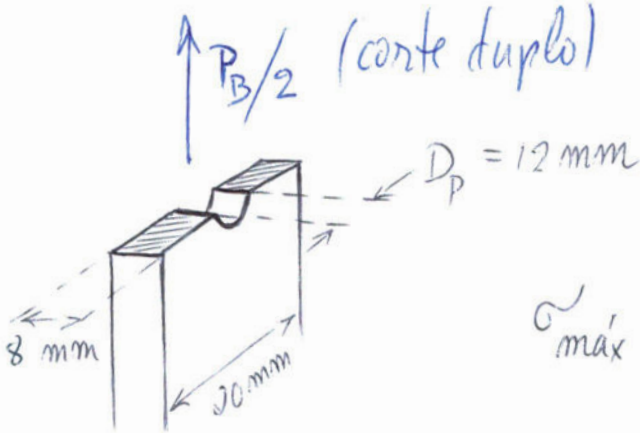
$\tau_L = 200\ MPa$ (para os pinos) $D_p = 12\ mm$

1.1



$\sum M_A = 0 \iff 380P - 200P_B = 0$

$\iff P_B = \frac{380 \times 4}{200} = 7,6\ kN$



$\sigma_{máx} = \frac{P_B/2}{A_{mín}} = \frac{7,6/2 \times 10^3}{8 \times (20-12)}$

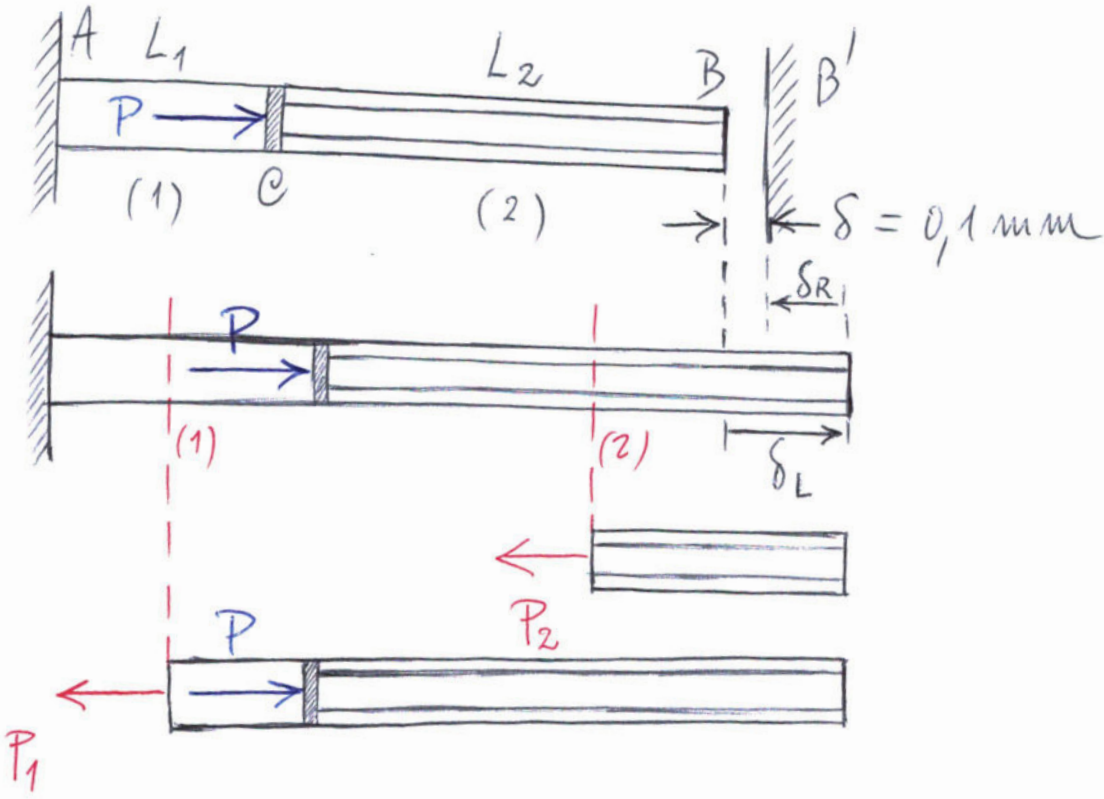
$= 59,4\ MPa$

1.2

$\delta_{BD} = \frac{P_B/2\ L}{AE} = \frac{3,8 \times 200}{200 \times 8 \times 20} = 23,75 \times 10^{-3}\ mm =$

$= 23,75\ \mu m$

2.



$P_2 = 0$

$P_1 = P = 20\,kN$

$L_1 = 400$ mm

$L_2 = 800$ mm

$P = 20\,kN$

$E_1 = 200\,GPa$

$D_1 = 10$ mm

$E_2 = 75\,GPa$

$D_{2e} = 10$ mm

$D_{2i} = 5$ mm

2.1

$$\delta_L = \frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 L_2} = \frac{P_1 L_1}{A_1 E_1}$$

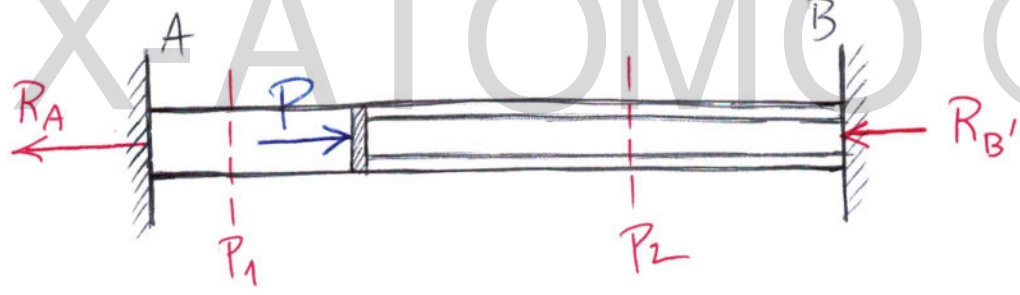
$$\delta_R = \frac{-R L_1}{A_1 E_1} + \frac{-R L_2}{A_2 E_2} = -R\left(\frac{L_1}{A_1 E_1} + \frac{L_2}{A_2 E_2}\right)$$

$$\delta_R + \delta_L = \delta \iff$$

$$-R\left(\frac{L_1}{A_1E_1}+\frac{L_2}{A_2E_2}\right)+\frac{P_1L_1}{A_1E_1}=\delta$$

$$R=R_{B'}=-\frac{\delta-\frac{P_1L_1}{A_1E_1}}{\frac{L_1}{A_1E_1}+\frac{L_2}{A_2E_2}}$$

$$R_{B'}=-\frac{0,1-\frac{20\times400}{\pi\times5^2\times200}}{\frac{400}{\pi\times5^2\times200}+\frac{800}{\pi(5^2-2,5^2)\times75}}=1,98\ kN$$



$$-R_A+P-R_{B'}=0 \iff$$

$$R_A=-R_{B'}+P=-1,98+20=18,02\ kN$$

2.2

$P_1=R_A=18,02kN$ (Tração)

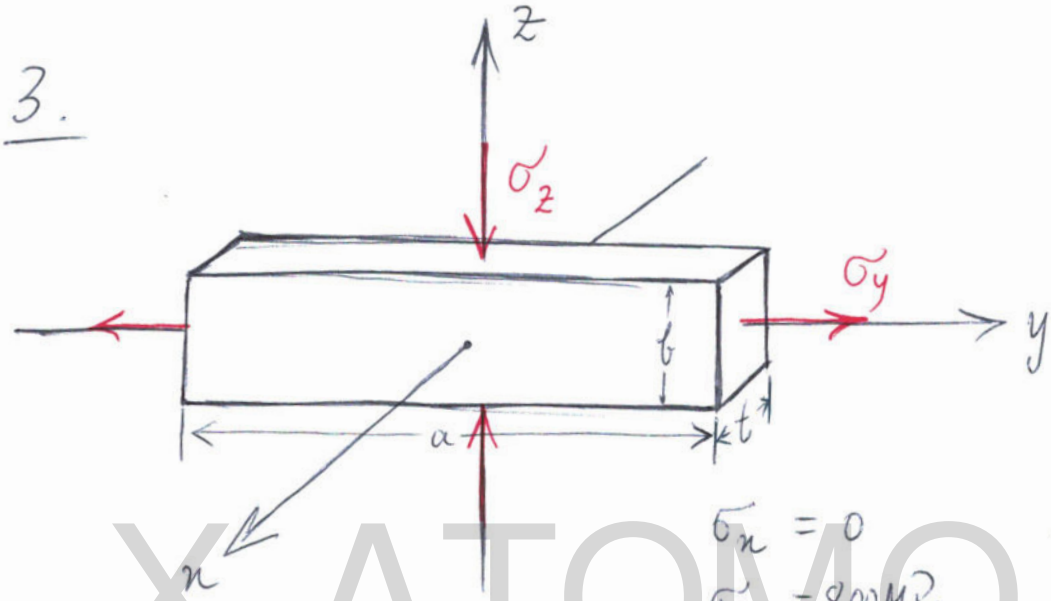
$P_2=R'_B=-1,98\ kN$ (Compressão)

$$\therefore\quad \sigma_1=\frac{P_1}{A_1}=\frac{18,02\times10^3}{\pi\times0,005^2}=229\ MPa$$

$$\sigma_2 = \frac{P_2}{A_2} = \frac{-1{,}98 \times 10^3}{\pi \times (0{,}005^2 - 0{,}0025^2)} = -33{,}6\ MPa$$

$$|\sigma_1| > |\sigma_2|$$

3.



$\sigma_x = 0$
$\sigma_y = 800\ MPa$
$\sigma_z = -500\ MPa$

$a_0 = 300\ mm$
$b_0 = 50\ mm$
$t_0 = 20\ mm$
$E = 110\ GPa$
$\nu = 0{,}34$

3.1 $l = l_0 + \Delta l = l_0 + \varepsilon l_0 = l_0(1 + \varepsilon)$.

$$\therefore \quad \varepsilon_x = \varepsilon_t = \frac{\sigma_x - \nu(\sigma_y + \sigma_z)}{E} = -\frac{0{,}34 \times (800 - 500)}{110 \times 10^3}$$

$$\varepsilon_t = -9{,}273 \times 10^{-4}$$

$$\therefore \quad t = (1 - 9{,}273 \times 10^{-4}) \times 20 = 19{,}981\ mm$$

$$t = t_0(1 + \varepsilon_t)$$

$$\varepsilon_y = \varepsilon_a = \frac{\sigma_y - \nu(\sigma_z + \sigma_x)}{E} = \frac{800 - 0{,}34 \times (-500)}{110 \times 10^3}$$

$$\varepsilon_a = 8{,}8182 \times 10^{-3}$$

$$\therefore a = a_0(1 + \varepsilon_a) = 300\left(1 + 8{,}8182 \times 10^{-3}\right) = 302{,}645 \text{ mm}$$

$$\varepsilon_z = \varepsilon_b = \frac{\sigma_z - \nu(\sigma_x + \sigma_y)}{E} = \frac{-500 - 0{,}34 \times 800}{110 \times 10^3}$$

$$\varepsilon_b = -7{,}0182 \times 10^{-3}$$

$$\therefore b = b_0(1 + \varepsilon_b) = 50\left(1 - 7{,}018 \times 10^{-3}\right) = 49{,}649 \text{ mm}$$

3.2 $\Delta V = V - V_0 = abt - a_0 b_0 t_0 =$

$= 302{,}645 \times 49{,}649 \times 19{,}981 - 300 \times 50 \times 20$

$= 235 \text{ mm}^3$

ou $\Delta V = \ell V_0 \cong \frac{1 - 2\nu}{E}(\sigma_x + \sigma_y + \sigma_z) \cdot a_0 b_0 t_0$

$= \frac{1 - 2 \times 0{,}34}{110 \times 10^3}(800 - 500) \times 300 \times 50 \times 20 = 262 \text{ mm}^3$