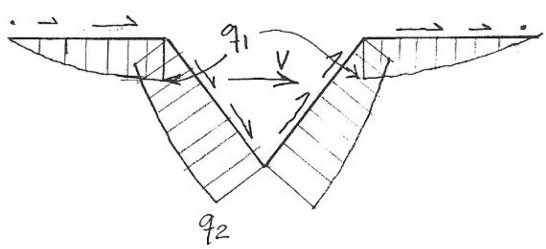
a) Diagrama do fluxo q p/ V horizontal

9



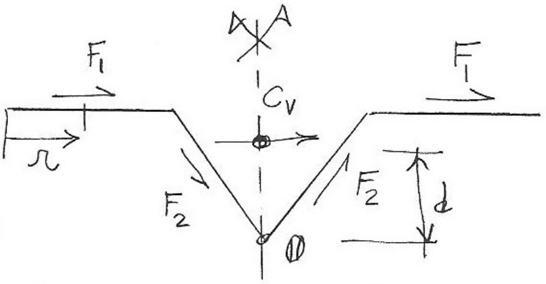
$$\bar{S}_1 = (1{,}5e \times 5b)\, 5{,}5b = 41{,}25\, eb^2$$

$$\bar{S}_2 = \bar{S}_1 + (e \times 5b) \times 1{,}5b = 48{,}75\, eb^2$$

$$q_1 = \frac{V\bar{S}_1}{I_z} = \frac{V\, 41{,}25\, \cancel{e} b^2}{515\, b^3 \cancel{e}} = 0{,}08\, \frac{V}{b}$$

$$q_2 = \frac{V\bar{S}_2}{I_z} = \frac{V\, 48{,}75\, eb^2}{515\, b^3 e} = 0{,}095\, \frac{V}{b}$$

b) Posição do C_V



$$\bar{S}_1(r) = (1{,}5e \times r)\left(8b - \frac{r}{2}\right) = \underbrace{12ber - 0{,}75er^2}_{\substack{0 \\ 41{,}25eb^2}}$$

$$F_1 = \int_0^{5b} q_1(r)\, dr = \int_0^{5b} \frac{V}{I_z}(12ber - 0{,}75er^2)\, dr = \frac{Ve}{I_z}\left[\frac{12br^2}{2} - \frac{0{,}75r^3}{3}\right]_0^{5b}$$

$$= \frac{Ve}{I_z}\left[6b(5b)^2 - 0{,}25 \times (5b)^3\right] = \frac{Veb^3}{I}[118{,}75] = 0{,}2306\, V$$

Equivalência: $\Sigma M_0 = 0 \Rightarrow V \times d = 2F_1 \times 4b \Rightarrow \boxed{d = 1{,}845\, b}$

$$d = 22{,}14 \text{ cm}$$

c) $\tau(M_T)$

$$\tau_{máx} = \frac{M_T}{I_T} e_{máx}$$

$$I_T = \Sigma I_{T_i} = \Sigma \frac{a_i e_i^3}{3} = 2 \times \left(\frac{5b \times (1{,}5e)^3}{3} + \frac{5b \times e^3}{3}\right)$$

$$= \frac{175}{12} be^3 = \frac{175}{\cancel{12}} \times \cancel{12} \times 1^3 = 175 \text{ cm}^4$$

$$\tau_{máx} = \frac{M_T}{\frac{175}{12} be^3} \times 1{,}5e = \frac{\cancel{36}^{\,18}}{\cancel{350}_{\,175}} \frac{M_T}{be^2} = \frac{18}{175}\, \frac{15}{12 \times 1^2} = 0{,}129\, \frac{kN}{cm^2}$$

$$\tau_{máx} = 1{,}29 \text{ MPa}$$

d) $$\theta = \frac{M_T\, \ell}{G\, I_T} = \frac{15 \times 200}{60 \times 10^2 \frac{kN}{cm^2} \times 175} = 2{,}86 \times 10^{-3} \text{ rad} = 0{,}16°$$

$$G = 60 \text{ GPa} = 60 \times 10^3 \text{ MPa} = 6 \times 10^3 \frac{kN}{cm^2}$$