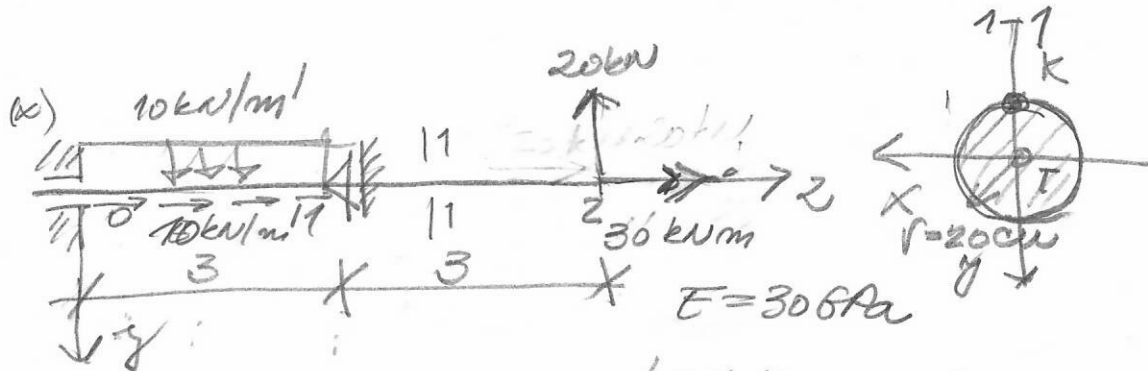


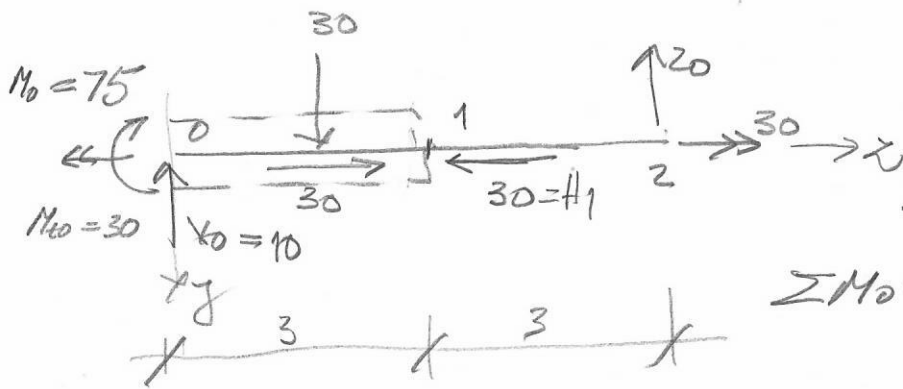
12.02.2021.

OTPORNOST MATERIJALA 1.



ZA NOSAČ I OPTEREĆENJE NA SIKICI TREBA:

- NACRTATI DIJAGRAME KOMPONENTALNIH NAPONA U PRESEKU 1 LEVO
- IZVRŠITI ANALIZU STRUJA NAPONA U ZACKI KU TOG PRESEKA I NACRTATI MOKRU KRUG NAPONA
- INTEGRACIJOM D.J. ODREDITI ψ_1, ψ_2, ψ_0
- MOR-MAKSUELDOVOM ANALOGIJO ODREDITI ψ_1, ψ_2
- SKICIRATI DEFORMISANU OSU NOSAČA



$$\sum H = H_1 - 30 = 0 \quad \underline{H_1 = 30}$$

$$\sum V = V_0 - 30 + 20 = 0 \quad \underline{V_0 = 10}$$

$$\sum M_0 = M_0 + 30 \cdot 15 - 20 \cdot 6 = 0$$

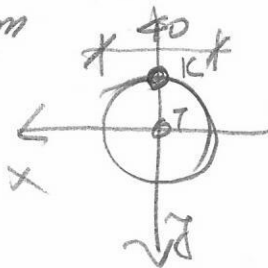
$$\underline{M_0 = 75}$$

$$M_{1L} = 20 \cdot 3 = 60 \text{ kNm}$$

$$T_{1L} = -20 \text{ kN}$$

$$M_{1R} = -30 \text{ kN}$$

$$M_{1t} = 30 \text{ kNm}$$



$$J_0 = J_t = 20^4 \frac{\pi}{2} = 251327,41 \text{ cm}^4$$

$$J_x = J_y = \frac{J_0}{2} = 125663,71 \text{ cm}^4$$

$$F = 20^2 \frac{\pi}{4} = 1256,64 \text{ cm}^2$$

$$\sigma_z(x) = \frac{-30 \times 10}{1256,64 \times 10^{-4}} = -0,239 \text{ MPa}$$

$$\sigma_z(M_x) = \frac{60 \times 10^{-3} (+20 \cdot 10)}{125663,71 \cdot 10^{-8}} = 9,549 \text{ MPa}$$

$$\max \tau_{zy}(\tau_y) = \frac{T_y \tilde{S}_y(0)}{J_x \cdot b(0)}$$

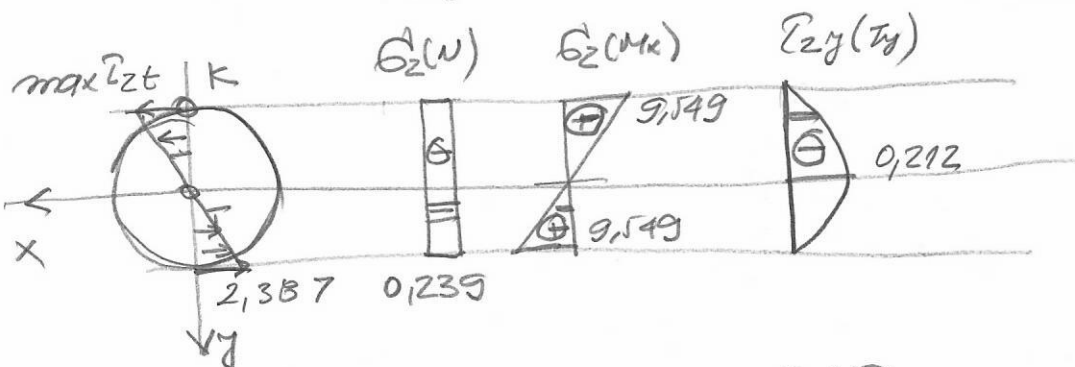
$$= \frac{T_y \cdot \frac{2r^3}{3}}{r \cdot \frac{\pi}{4} \cdot 2r} = \frac{4 T_y}{3 r^2 \pi} = \frac{4}{3} \frac{T_y}{F} = \frac{4}{3} \frac{-20 \cdot 10}{125664 \cdot 10^4}$$

$$\tilde{S}_y(0) = \frac{r^2 \pi}{2} \cdot \frac{2r}{3\pi} \quad b(0) = 2r$$

$$J_x = \frac{r^4 \pi}{4}$$

$$\max \tau_{zy}(\tau_y) \Rightarrow 0,212 \text{ MPa}$$

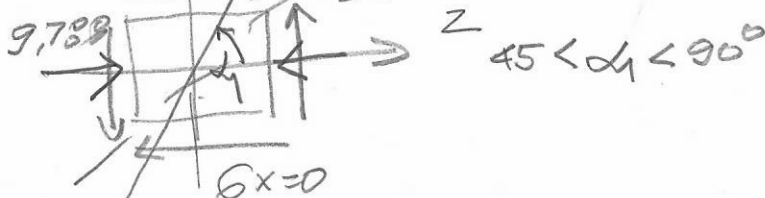
$$\max \tau_{zt} = \frac{M_t \cdot r}{J_t} = \frac{30 \times 10 \times 20 \times 10}{251327,41 \cdot 10^{-8}} = 2,387 \text{ MPa}$$



$$b) \quad \sigma_{zK} = -0,239 - 9,549 = -9,788 \text{ MPa}$$

$$\tau_{zx} = 2,387 \text{ MPa} \quad \sigma_x = 0$$

$$\tau_{xz} = -2,387$$

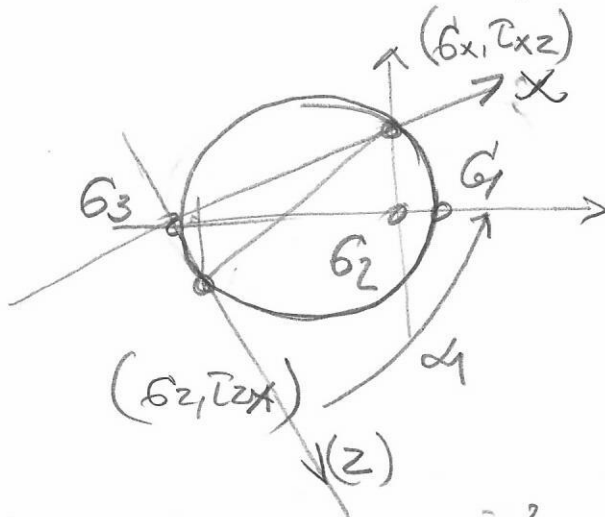


$$\operatorname{tg} 2\alpha = \frac{-2 \cdot \tau_{zx}}{\sigma_z - \sigma_x} = \frac{-2 \cdot (-2,387)}{-9,788} = \frac{(+)}{(-)} 0,488$$

$$2\alpha + \theta = 180^\circ \quad \alpha = 90^\circ - \frac{1}{2}\theta = 90^\circ - \frac{1}{2} \arctan 0,488 = 77,00^\circ$$

$$\sigma_{\max/\min} = \frac{\sigma_z}{2} \pm \sqrt{\left(\frac{\sigma_z}{2}\right)^2 + \tau^2} = \frac{-9,788}{2} \pm \sqrt{\left(\frac{9,788}{2}\right)^2 + 2,387^2}$$

$$= -4,894 \pm 5,445 = \begin{cases} 0,551 = \sigma_1 \\ 0 = \sigma_2 \\ 10,339 = \sigma_3 \end{cases}$$



c)

$$M_x(z) = 75 + 10z - 10 \frac{z^2}{2} \quad 0 \leq z \leq 3 \text{ m}$$

$$EJ_x = 30 \times 10^3 \times 125663,71 \cdot 10^{-8} = 37,70 \text{ MNm}^2$$

$$EJ_x \psi''(z) = -75 - 10z + 5z^2$$

$$EJ_x \psi'(z) = C_1 - 75z - 5z^2 + \frac{5}{3}z^3 \quad EJ_x \psi'(0) = C_1 = 0$$

$$EJ_x \psi'(3) = -75 \cdot 3 - 5 \cdot 3^2 + \frac{5}{3} \cdot 3^3 = -225 \quad \psi_1 = \frac{-225 \times 10}{37,70} = -5,968 \times 10^{-3} \text{ rad}$$

$$EJ_x \psi(z) = C_2 - \frac{75}{2}z^2 - \frac{5}{3}z^3 + \frac{5}{12}z^4 \quad EJ_x \psi(0) = C_2 = 0$$

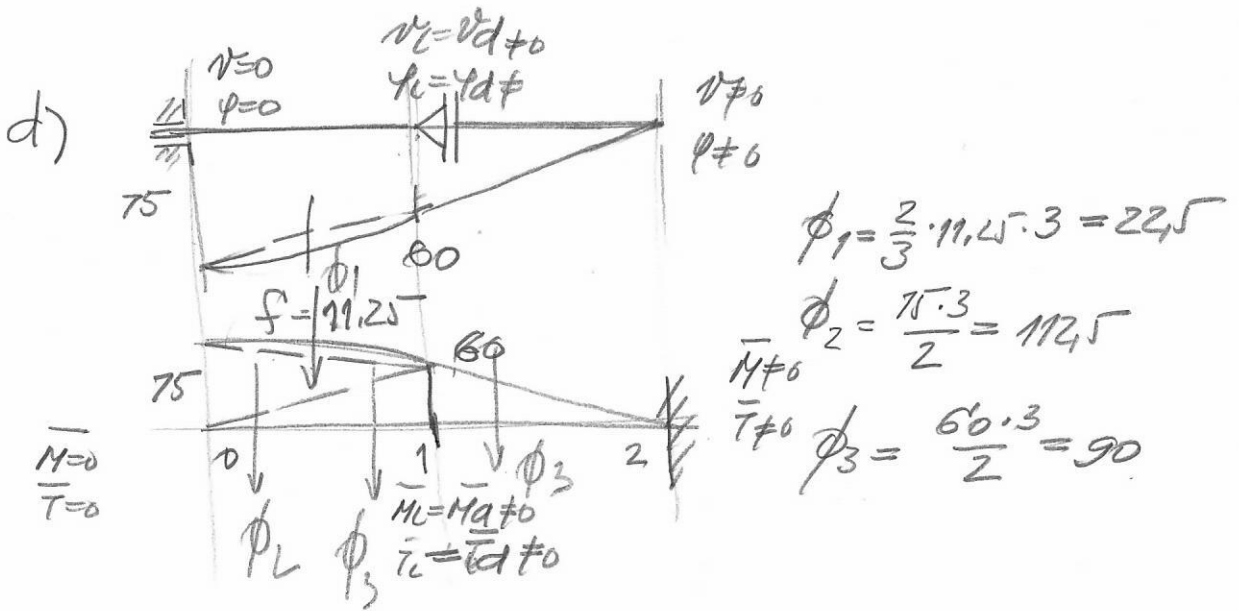
$$EJ_x \psi(3) = -\frac{75}{2} \cdot 3^2 - \frac{5}{3} \cdot 3^3 + \frac{5}{12} \cdot 3^4 = -348,75 \quad \psi_1 = \frac{-348,75 \cdot 10}{37,70} = -9,251 \cdot 10^{-3} \text{ rad}$$

$$EFW(z) = N(z) = -\frac{1}{2}z = -10z$$

$$EFW(z) = C - 5z^2 \quad EFW(3) = C - 5 \cdot 3^2 = 0 \quad C = 45$$

$$EF = 30 \cdot 10^3 \cdot 1256,69 \times 10^{-4} = 3769,92 \text{ MN}$$

$$EFW(0) = 45 \quad w_0 = \frac{45 \times 10^3}{3769,92} = 0,012 \times 10 \text{ m}$$



$$v_1 = \frac{\bar{M}_1}{EJ} = \frac{-(22.5 \times 1.5 + 112.5 \cdot 2 + 90 \cdot 1)}{37.70 \times 10^3} = \frac{-348.75}{37.70} \cdot 10^{-3} = -9.251 \cdot 10^{-3} \text{ m}$$

$$\phi_2 = \frac{\bar{T}_2}{EJ} = -\frac{22.5 + 112.5 + 2 \cdot 90}{37.70 \cdot 10^3} = -8.355 \cdot 10^{-3} \text{ rad}$$

