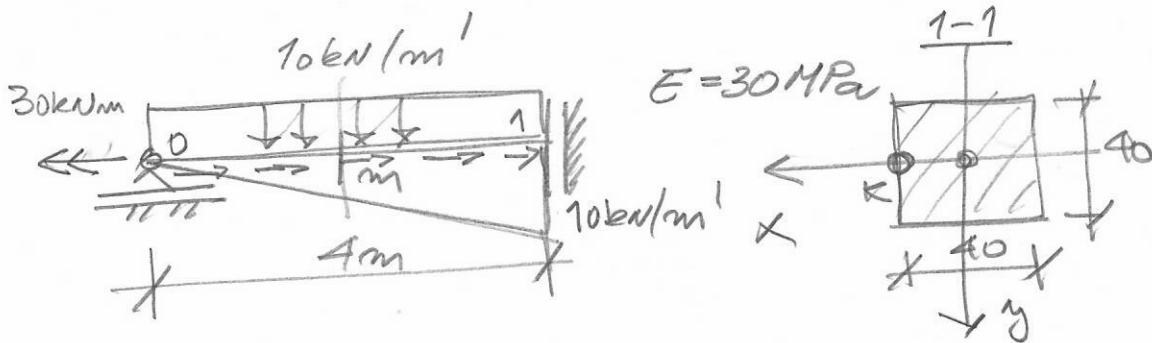


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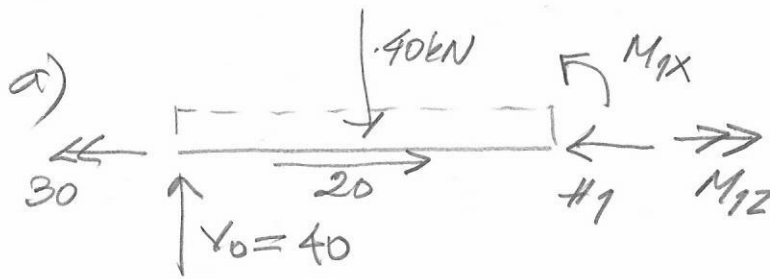
ODORNOST MATERIJALA 1

ZA NOSAČ NA SKICI I ZADATO OPREĆENJE:



- SRADUNATI I NACRTATI DIJAGRAME KOMP. NAPONA U PRESEKU M NA POLOVINI GREDE
- IZVRŠITI ANALIZU STANJA NAPONA U TAČKI K' PRESEKA M I NACRTATI MOROV KRUG NAPONA
- ODREDITI VELIČINU ODLEROVE KRITIČNE SILE I ODLEROV KRITIČNI NAPON ZA GREDE
- INTEGRACIJOM DIF. JEDNAČINA ODREDITI v_m , w_m , φ_{2m}
- MOR MAKSVELOVOM ANALOGIJOM ODREDITI v_m , φ_m , φ_0
- SKICIRATI DEFORMISANU OSU GREDE OD SAVIJANJA

$$\epsilon_2 = \frac{dw}{dz} = \epsilon_2(z) = \frac{N}{EF}$$



$$\begin{aligned} \sum H = 0 & \quad H_1 = 20 \text{ kN} \\ \sum V = 0 & \quad V_0 = 40 \text{ kN} \\ \sum M_x = 0 & \quad M_{1x} = 80 \text{ kNm} \\ \sum M_z = 0 & \quad M_{1z} = 30 \text{ kNm} \end{aligned}$$

$$N_{cm} = \frac{-5 \cdot 2}{2} = -5 \text{ kN}$$

$$T_m = 40 - 2 \cdot 10 = 20 \text{ kN}$$

$$M_{xm} = 40 \cdot 2 - 2 \cdot 10 \cdot 1 = 60 \text{ kNm}$$

$$M_{zm} = 30 \text{ kNm}$$

$$F = 40^2 = 1600 \text{ cm}^2$$

$$J_x = \frac{40^4}{12} = 213333,3 \text{ cm}^4$$

$$\alpha = 0,140 \quad \beta = 0,208 \quad \gamma = 1$$

$$J_t = 0,140 \cdot 40^4 = 358400 \text{ cm}^4$$

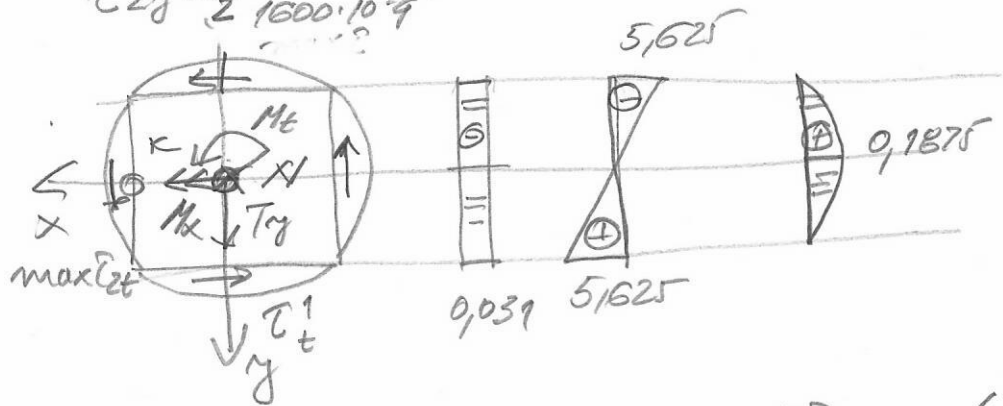
$$W_t = 0,208 \cdot 40^3 = 13312 \text{ cm}^3$$

$$\sigma_z(N) = \frac{-5 \cdot 10^{-3}}{1600 \cdot 10^{-4}} = -0,031 \text{ MPa}$$

$$\sigma_z(M_x) = \frac{60 \cdot 10^{-3} \cdot 0,2}{213333,3 \cdot 10^{-6}} = 5,625 \text{ MPa}$$

$$\max \tau_{zy} = \tau_{zy}^1 = \frac{30 \cdot 10}{320 \cdot 10^3} = 0,9375 \text{ MPa}$$

$$\tau_{zy}^2 = \frac{320 \cdot 10^3}{2 \cdot 1600 \cdot 10^{-4}} = 0,1875 \text{ MPa}$$



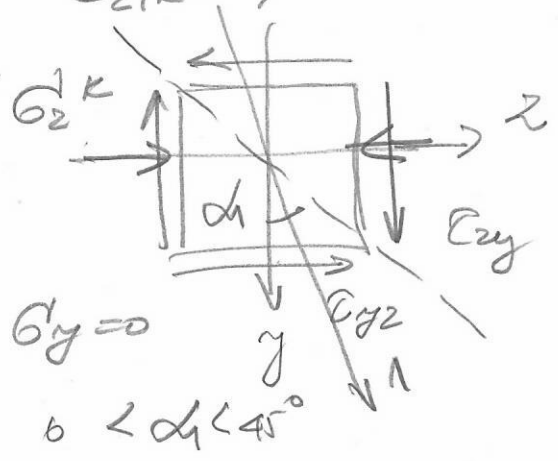
$$b) \quad \tau_{zy,k} = 0,1875 + 2,254 = 2,442 \text{ MPa}$$

$$\tan 2\alpha = \frac{-2(2,442)}{0 - (-0,031)} = \frac{(-)}{(+)} 157,52$$

$$\sigma_{z,k} = -0,031 \text{ MPa}$$

$$\alpha = \frac{1}{2} \arctan 157,52 = 44,61^\circ$$

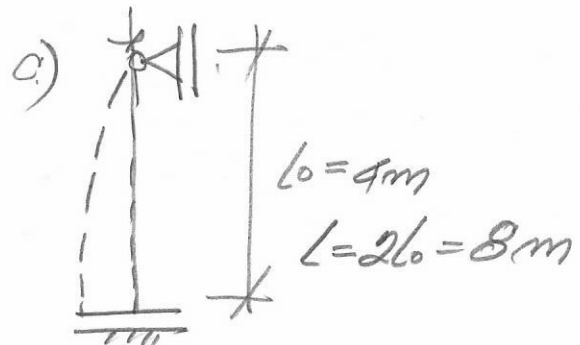
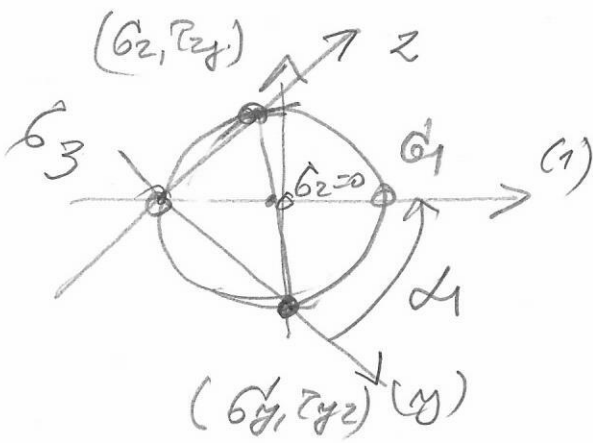
$$\sigma_{max/min} = -\frac{0,031}{2} \pm \sqrt{\left(\frac{0,031}{2}\right)^2 + 2,442^2}$$



$$\sigma_{max/min} = \begin{cases} \sigma_1 = 2,427 \text{ MPa} \\ \sigma_2 = 0 \\ \sigma_3 = 2,458 \text{ MPa} \end{cases}$$

$$\sigma_y = 0$$

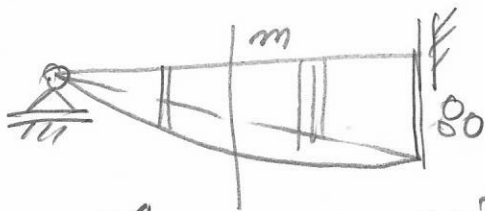
$$0 < \alpha < 45^\circ$$



$$P_{KR}^E = \frac{-2EJ}{l^2} = \frac{-2}{8^2} \cdot 30 = 4,626 \text{ MN}$$

$$G_{KR}^E = \frac{P_{KR}^E}{F} = \frac{4,626}{1600 \cdot 10^{-9}} = 28,915 \text{ MPa}$$

d)



$$f = 10 \cdot \frac{4^2}{8} = 20 \text{ kNm/m}$$

$$M_x(z) = 40z - 10 \cdot \frac{z^2}{2}$$

$$EJ \psi''(z) = -40z + 5z^2$$

$$EJ \psi'(z) = C_1 - 20z^2 + \frac{5}{3}z^3 \quad EJ \psi'(4) = C_1 - 20 \cdot 4^2 + \frac{5}{3} \cdot 4^3 = 0$$

$$EJ \psi(z) = C_2 + 213,3z - \frac{20}{3}z^3 + \frac{5}{12}z^4 \quad C_1 = 213,3$$

$$EJ \psi(z) = 213,3 \cdot z - \frac{20}{3} \cdot z^3 + \frac{5}{12} z^4 \quad EJ \psi(0) = 0 \Rightarrow C_2 = 0$$

$$EJ \psi(z) = 380,00$$

$$\psi_m = \psi(z) = \frac{380 \cdot 10^{-3}}{30} = 12,6 \text{ mm}$$



$$N(z) = -5z$$

$$EF W'(z) = -5z$$

$$EF W(z) = C_1 - \frac{5}{2}z^2$$

$$EF W(4) = C_1 - \frac{5 \cdot 4^2}{2} = 0 \Rightarrow C_1 = 40$$

$$EF W(z) = 40 - \frac{5}{2}z^2$$

$$EJ = 30 \text{ MPa}$$

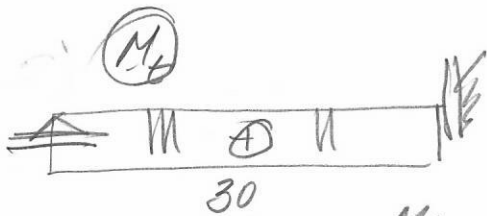
$$\frac{EF}{EJ} = \frac{F}{J} = \frac{1600 \cdot 10^{-9}}{213333,3 \cdot 10^{-8}} = 75 \frac{1}{\text{m}^2}$$

$$EF = 75 \cdot \frac{1}{\text{m}^2} \cdot 30 \cdot \text{MN/m}^2 = 2250 \text{ MN}$$

$$EF W(z) = 40 - \frac{5}{2} \cdot z^2 = 30$$

$$W_m = W(z) = \frac{30 \cdot 10^{-3}}{2250} = 0,013 \cdot 10^{-3} \text{ m}$$

$$W_m = 0,013 \text{ mm}$$



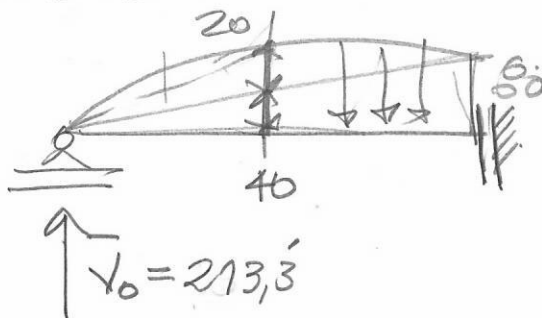
$$M_t = 30$$

$$\frac{d\varphi}{dz} = \theta = \frac{M_t}{GJ_t} \Rightarrow$$

$$GJ_t \varphi_2'(z) = 30$$

$$GJ_t \varphi_2(z) = C_1 + 30z \quad GJ_t \varphi_2(4) = C_1 + 30 \cdot 4 = 0 \quad C_1 = -120$$

$$GJ_t \varphi_2(z) = -120 + 30 \cdot z = -60 \quad \varphi_m = \varphi_2(z) = -\frac{60}{GJ_t}$$



$$\phi_1 = \frac{20 \cdot 4}{2} = 160 \checkmark$$

$$\phi_2 = \frac{2}{3} \cdot 20 \cdot 4 = 53,3$$

$$\bar{V}_0 = 160 + 53,3 = 213,3$$

$$\phi_3 = \frac{60 \cdot 2}{2} = 60 \quad \phi_4 = \frac{2}{3} \cdot 5 \cdot 2 = 6,6$$

$$EJ \bar{V}_m = \bar{M}_m = 213,3 \cdot 2 - 60 \cdot \frac{2}{3} - 6,6 \cdot 1 = 380$$

$$\bar{V}_m = \frac{380 \cdot 10^{-3}}{30} = 12,6 \cdot 10^{-3} \text{ m} = 12,6 \text{ mm}$$

$$EJ \bar{\varphi}_m = \bar{T}_m = 213,3 - 60 - 6,6 = 146,6$$

$$\bar{\varphi}_m = \frac{146,6 \cdot 10^{-3}}{30} = 4,8 \cdot 10^{-3} \text{ rad}$$

$$EJ \bar{V}_0 = \bar{T}_0 = 213,3$$

$$\bar{\varphi}_0 = \frac{213,3 \cdot 10^{-3}}{30} = 7,1 \cdot 10^{-3} \text{ rad}$$

