

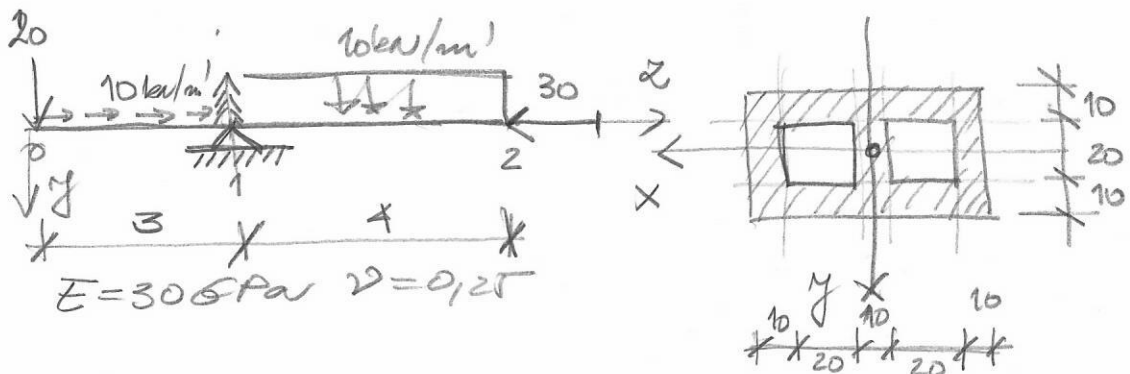
UNIVERZITET U BANOVAJALUCI

ARHITEKTONSKO - GRAĐEVINSKO - GEODEZSKI FAKULTET
KATEDRA ZA MEHANIKU I TEORIJU KONSTRUKCIJA
STUDIJSKI PROGRAM GRAĐEVINARSTVO

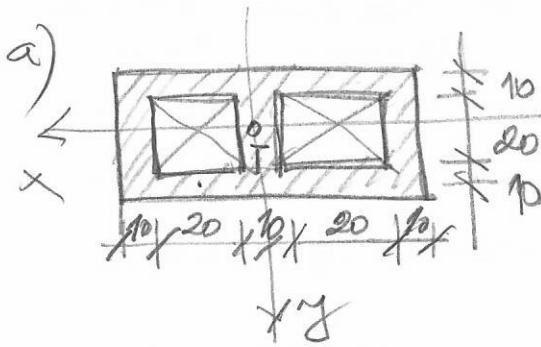
02.07.2021.

OTPORNOST MATERIJALA 1.

ZA NOSAČ I OPTEREĐENJE NA SKICI TREBA:



- SRADNATI I NACRTATI DIJAGRAME KOMPONENTALNIH NAPONA U PRESEKU 1 DEOSNO
- IZVRŠITI ANALIZU STANJA NAPONA U TEŽIŠTU I NACRTATI MODOV KRUG NAPONA
- INTERAKCIJOM DIF. JEDNAČINA ODREDITI w_0 , v_2 I φ_2
- MOR-MAKSVELOVOM ANALOGIJOM ODREDITI v_{1d} , v_2 , φ_2 I SKICIRATI DEFORMANU U OSU NOSAČA



$$F = 70 \times 40 - 2 \times 20^2 = 2000 \text{ cm}^2$$

$$J_x = \frac{1}{12} (70 \times 40^3 - 2 \cdot 20^4)$$

$$J_x = 346\,666,6 \text{ cm}^4$$

$$N_{yd} = -30 \text{ kN} \quad T_{yd} = 40 \text{ kN} \quad M_x = -80 \text{ kNm}$$

$$\sigma_z(N) = \frac{-30 \times 10^{-3}}{2000 \times 10^{-4}} = -0,15 \text{ MPa}$$

$$\sigma_z(M_x) = \frac{-80 \times 10^{-3} \times 20 \cdot 10^{-2}}{346\,666,6 \cdot 10^{-8}} = -4,615 \text{ MPa}$$

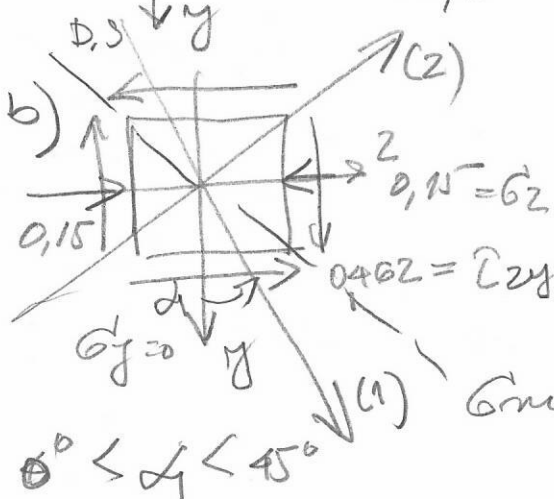
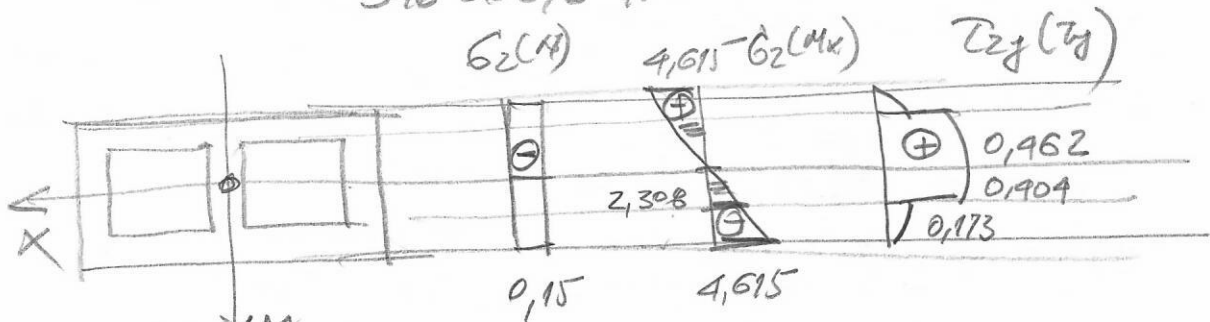
$$\tilde{S}_x(10) = 70 \times 10 \times 15 = 10500 \text{ cm}^3$$

$$\tilde{S}_x(7) = 10500 + 3 \cdot 10^2 \times 5 = 12000 \text{ cm}^3$$

$$\tau_{zy}(10+E) = \frac{40 \times 10^{-3} \times 10500 \times 10^{-6}}{346\,666,6 \times 10^{-8} \times 70 \times 10^{-2}} = 0,173 \text{ MPa}$$

$$\tau_{zy}(10+E) = \frac{40 \times 10^{-3} \times 10500 \times 10^{-6}}{346\,666,6 \cdot 10^{-8} \times 30 \times 10^{-2}} = 0,409 \text{ MPa}$$

$$\tau_{zy}(7) = \frac{40 \times 10^{-3} \times 12000 \times 10^{-6}}{346\,666,6 \cdot 10^{-8} \times 30 \times 10^{-2}} = 0,462 \text{ MPa}$$



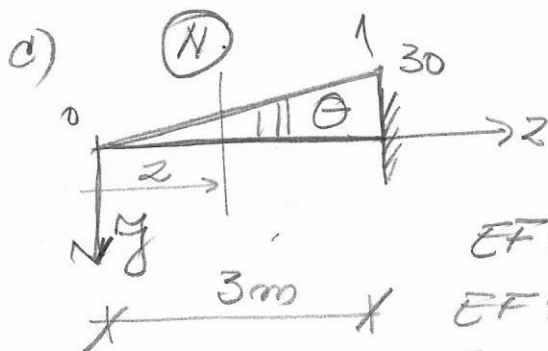
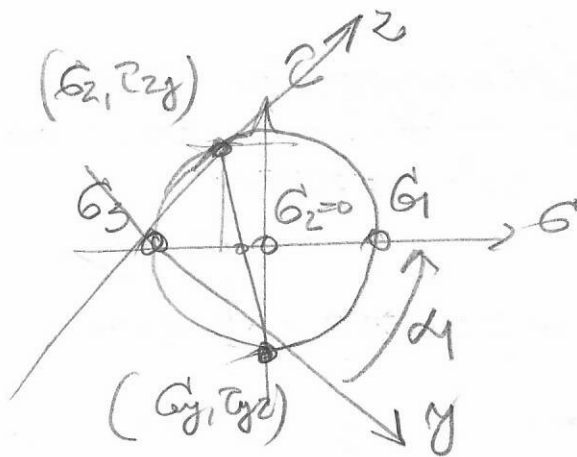
$$\tan 2\alpha_1 = \frac{-2 \cdot (-0,462)}{0 - (-0,15)} = \frac{(+)}{(+)} 6,16$$

$$2\alpha_1 = \arctan 6,16$$

$$\alpha_1 = 40,39^\circ$$

$$\sigma_{\max/\min} = \frac{0,15}{2} \pm \sqrt{\left(\frac{0,15}{2}\right)^2 + 0,462^2}$$

$$= \begin{cases} 0,543 = \sigma_1 \\ 0 = \sigma_2 \\ -0,359 = \sigma_3 \end{cases}$$



$$N(z) = -10z$$

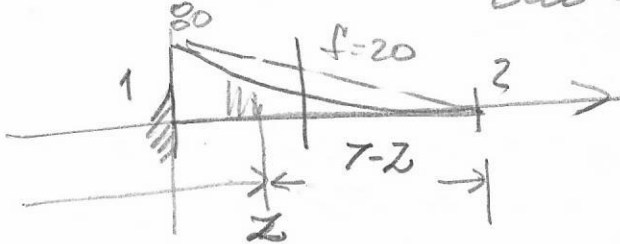
$$EF = 30 \cdot 10^3 \cdot 20000 \text{ N/D} = 60000 \text{ MN}$$

$$EF W'(z) = N(z) = -10z$$

$$EF W(z) = C_1 - 5z^2 \quad EF W(3) = 0$$

$$EF W(3) = C_1 - 5 \cdot 3^2 = 0 \quad C_1 = 45$$

$$W_0 = W(0) = \frac{45 \times 10^3}{60000} = 7,5 \cdot 10^{-6} \text{ m} = 7,5 \cdot 10^{-3} \text{ mm}$$



$$M_x(z) = -10 \cdot \frac{(7-z)^2}{2} = -5(49 - 14z + z^2) = -245 + 70z - 5z^2$$

$$M_x(3) = -245 + 70 \cdot 3 - 5 \cdot 3^2 = -80 \quad \checkmark$$

$$M_x(7) = -245 + 70 \cdot 7 - 5 \cdot 7^2 = 0 \quad \checkmark$$

$$EJ = 30 \cdot 10^3 \cdot 346666,6 \cdot 10^{-8} = 104 \text{ MN m}^2$$

$$EJ W'' = 245 - 70z + 5z^2$$

$$EJ W'(z) = C_1 + 245z - 35z^2 + \frac{5}{3}z^3 \quad EJ W'(3) = 0$$

$$EJ W'(3) = C_1 + 245 \cdot 3 - 35 \cdot 3^2 + \frac{5}{3} \cdot 3^3 = 0 \quad C_1 = -465$$

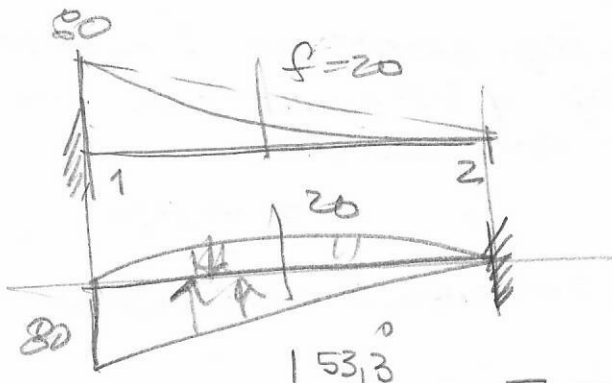
$$EJ W(z) = C_2 - 465z + 245 \cdot \frac{z^2}{2} - \frac{35}{3}z^3 + \frac{5}{12}z^4 \quad EJ W(3) = 0$$

$$EJ W(3) = C_2 - 465 \cdot 3 + 245 \cdot \frac{3^2}{2} - \frac{35}{3} \cdot 3^3 + \frac{5}{12} \cdot 3^4 = 0 \quad C_2 = 573,75$$

$$EJ W(z) = 573,75 - 465z + 122,5z^2 - \frac{35}{3}z^3 + \frac{5}{12}z^4$$

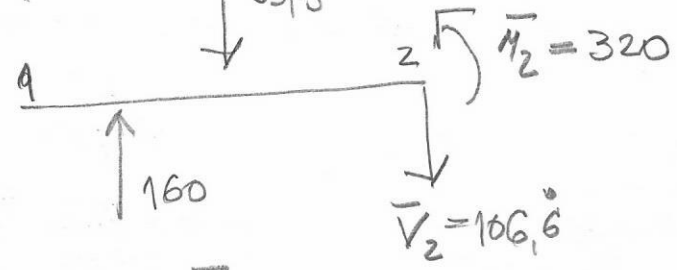
$$\varphi_2 = \varphi(7) = \frac{-465 + 245 \cdot 7 - 35 \cdot 7^2 + \frac{5}{3} \cdot 7^3}{104 \cdot 10^3} = 1,026 \cdot 10^{-3} \text{ rad}$$

$$w_2 = w(7) = \frac{573,75 - 465 \cdot 7 + 122,5 \cdot 7^2 - \frac{35}{3} \cdot 7^3 + \frac{5}{12} \cdot 7^4}{104 \cdot 10^3} = 3,077 \cdot 10^{-3} \text{ m}$$



$$\phi_1 = \frac{2}{3} \cdot 20 \cdot q = 53,3^\circ$$

$$\phi_2 = \frac{1}{2} \cdot 80 \cdot q = 160$$



$$v_{1d} = \frac{\bar{M}_{1d}}{EJ} = 0$$

$$v_2 = \frac{\bar{M}_2}{EJ} = \frac{320 \cdot 10^{-3}}{109} = 3,077 \cdot 10^{-3} \text{ m}$$

$$\phi_2 = \frac{\bar{V}_2}{EJ} = \frac{106,6 \cdot 10^{-3}}{109} = 1,026 \cdot 10^{-3} \text{ rad.}$$

