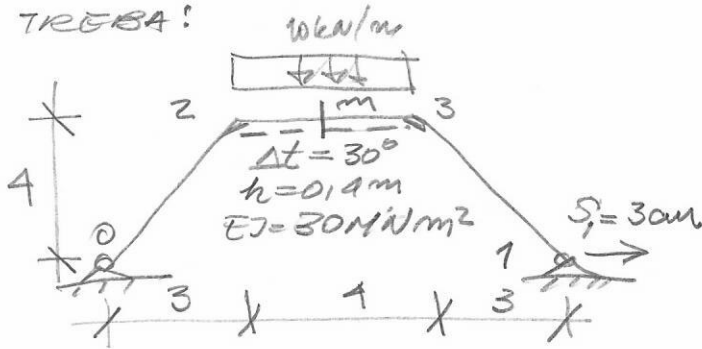


18.06.2021, 600.

OTPORNOST MATERIJALA 2.

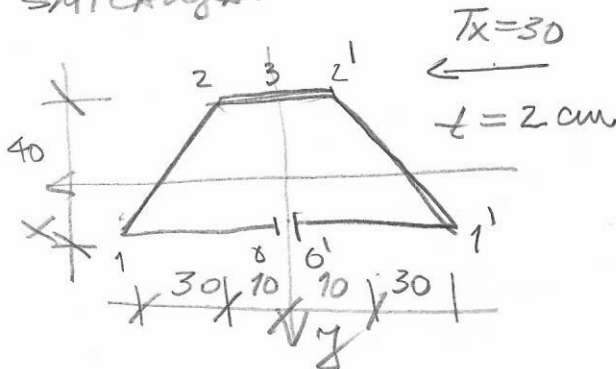
ZA NOSAČ I OPTEREĐENJE NA SKICI
 TREBA:

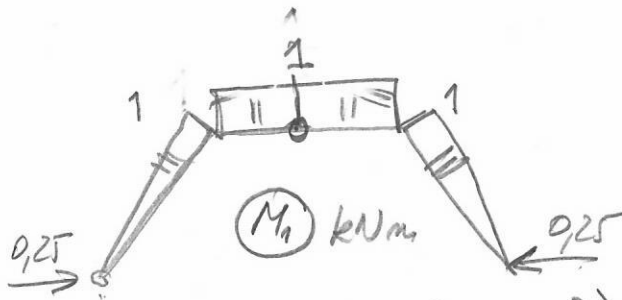
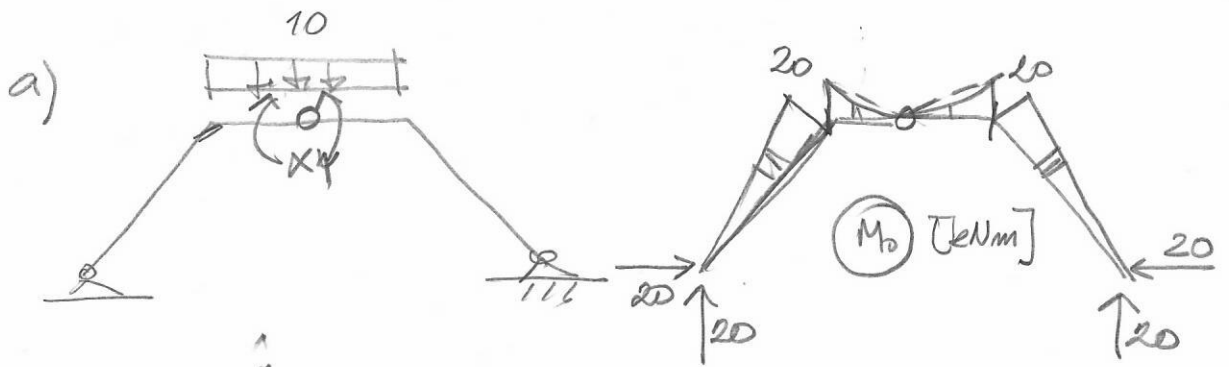


- a) NACRTATI DIJAGRAME PRESECNIH SILA OD ZADANOG OPTEREĐENJA
- b) NACRTATI DIJ. MOMENATA OD $\Delta t = 30^\circ$ NA DELU 2-3

- c) NACRTATI DIJAGRAM MOMENATA OD $S_1 = 30 \text{ kN}$
- d) ODREDITI v_m OD OPT. FOD a) I SKICIRATI DEF. OSU.

ZA ZANIKOZIJANI PRESEK NA SKICI
 ODREDITI RASPORED NAPONA SMICAJA OD
 $T_x = 30 \text{ kN}$ I ODREDITI KOLO ŽAJ CENTRA
 SMICAJA.



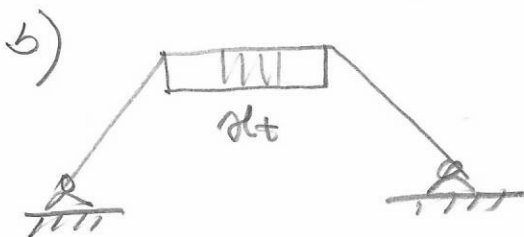
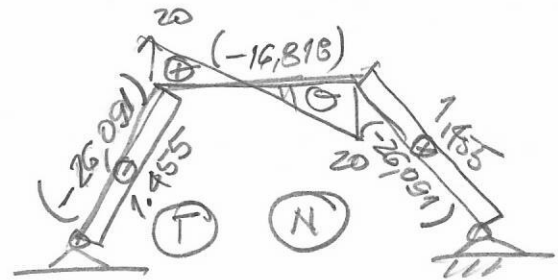
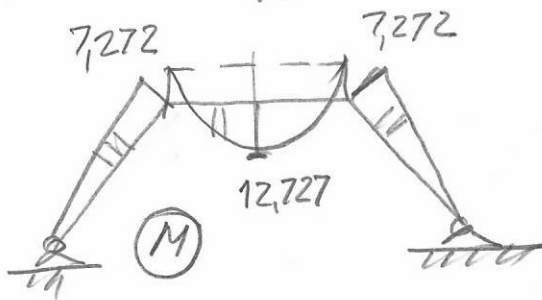


$$X_1 \delta_{11} + \delta_{10} = 0$$

$$EJ \delta_{11} = 2 \cdot \left(\frac{5}{3} \cdot 1^2 + 2 \cdot 1^2 \right) = 7,3$$

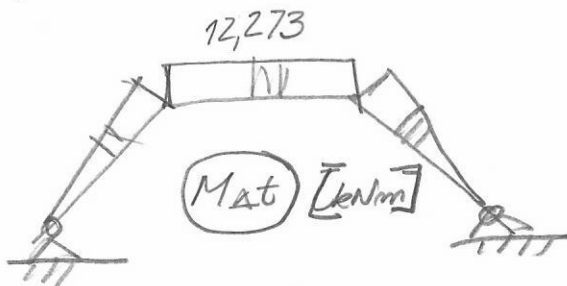
$$EJ \delta_{10} = 2 \cdot \left(\frac{5}{3} \cdot 1 \cdot 20 + \frac{2}{2} \cdot 1 \cdot 20 - \frac{2}{3} \cdot 5 \cdot 2 \cdot 1 \right) = 93,3$$

$$X_1 = \frac{-93,3}{7,3} = -12,727 \text{ kNm}$$



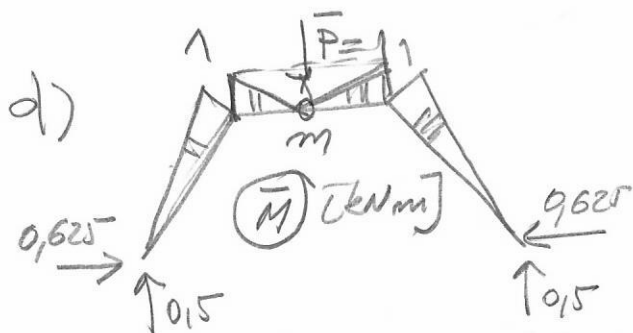
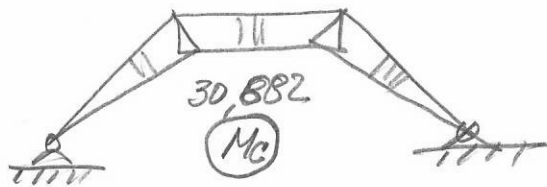
$$EJ_c \delta_{1at} = 30 \cdot 10 \cdot 1 \cdot 10 \cdot \frac{-5 \cdot 30}{0,4} \cdot (-1) \cdot 4 = -90$$

$$X_1 = \frac{90}{7,3} = 12,273$$



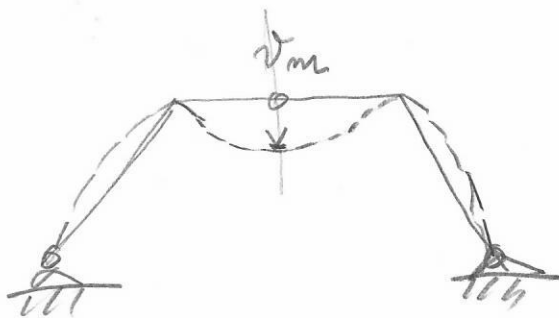
$$c) EI_c \delta_{1C} = -30 \cdot 10^3 \cdot (-0,25) \cdot 0,03 = 225$$

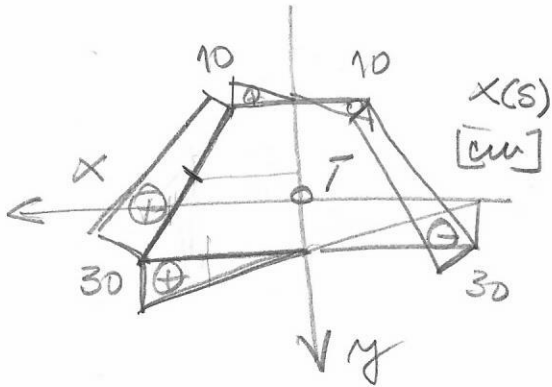
$$X_1 = \frac{-225}{7,3} = -30,682 \text{ kNm}$$



$$EI_c v_m = 2 \cdot \left[\frac{5}{3} \cdot 1 \cdot 7,272 + \frac{1 \cdot 2}{6} (2 \cdot 7,272 - 12,727) - \frac{1 \cdot 2}{3} \cdot 12,727 \right] = 8,842$$

$$v_m = \frac{8,842}{30 \cdot 10^3} = 0,293 \cdot 10^{-3} \text{ m} = 0,293 \text{ mm}$$





$$\begin{aligned}
 \bar{I}_y &= \frac{1}{6} \int x(s)^2 ds = \\
 &= 2 \cdot 2 \left[\frac{30}{3} \cdot 30^2 + \frac{10}{3} \cdot 10^2 + \right. \\
 &\quad \left. + \frac{50}{3} (30^2 + 30 \cdot 10 + 10^2) \right] = 124\,000 \text{ cm}^4
 \end{aligned}$$

$$\tilde{S}_{x,0} = 0$$

$$\tilde{S}_{x,1} = 30 \cdot 2 \cdot 15 = 900 \text{ cm}^3$$

$$\tilde{S}_{x,12} = 900 + 2 \cdot 25 \cdot 25 = 2150 \text{ cm}^3$$

$$\tilde{S}_{x,2} = 900 + 2 \cdot 50 \cdot 20 = 2900 \text{ cm}^3$$

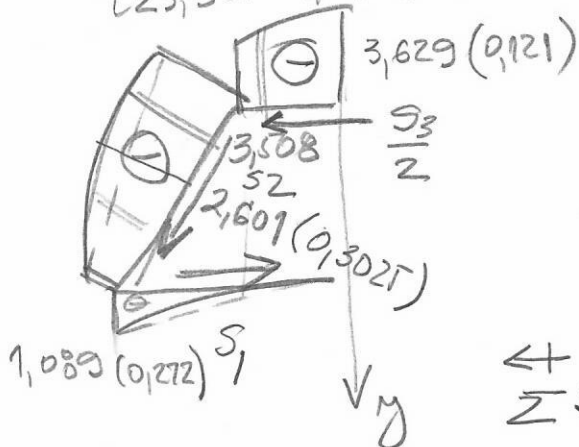
$$\tilde{S}_{x,3} = 2900 + 2 \cdot 10 \cdot 5 = 3000 \text{ cm}^3$$

$$\sigma_{25,1} = \frac{-30 \cdot 10 \cdot 900 \cdot 10^{-3}}{124\,000 \cdot 10^{-8} \cdot 2 \cdot 10^{-2}} = -1,21 \cdot 10^{-3} \cdot 900 = -1,089 \text{ MPa}$$

$$\sigma_{25,12} = -1,21 \cdot 10^{-3} \cdot 2150 = -2,601 \text{ MPa}$$

$$\sigma_{25,2} = -1,21 \cdot 10^{-3} \cdot 2900 = -3,508 \text{ MPa}$$

$$\sigma_{25,3} = -1,21 \cdot 10^{-3} \cdot 3000 = -3,629 \text{ MPa}$$

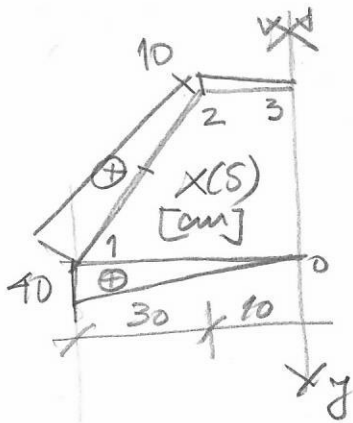


$$S_1 = 30 \cdot 10 \cdot 2 \cdot 10 \left(\frac{1,089}{2} - \frac{2}{3} \cdot 0,272 \right) \cdot 10 = 2,158 \text{ kN}$$

$$S_2 = 50 \cdot 10 \cdot 2 \cdot 10 \left(2,2985 + \frac{2}{3} \cdot 0,3025 \right) \cdot 10 = 25,002 \text{ kN}$$

$$S_3 = 20 \cdot 10 \cdot 2 \cdot 10 \left(3,508 + \frac{2}{3} \cdot 0,121 \right) \cdot 10 = 14,355 \text{ kN}$$

$$\sum S_x = 14,355 + 25,002 \cdot 2 \cdot 0,6 - 2 \cdot 2,158 = 0$$



$$J_y = \frac{2 \cdot 2}{3} \left[(40^3 + 10^3) + 50(40^2 + 40 \cdot 10 + 10^2) \right] =$$

$$J_y = 226\,666,6 \text{ cm}^4$$

$$\tilde{S}_{y,0} = 0$$

$$\tilde{S}_{y,1} = 2 \cdot 40 \cdot 20 = 1600 \text{ cm}^3$$

$$\tilde{S}_{y,12} = 1600 + 2 \cdot 25 \cdot 325 = \dots = 3225 \text{ cm}^3$$

$$\tilde{S}_{y,2} = 1600 + 2 \cdot 50 \cdot 25 = \dots = 4100 \text{ cm}^3$$

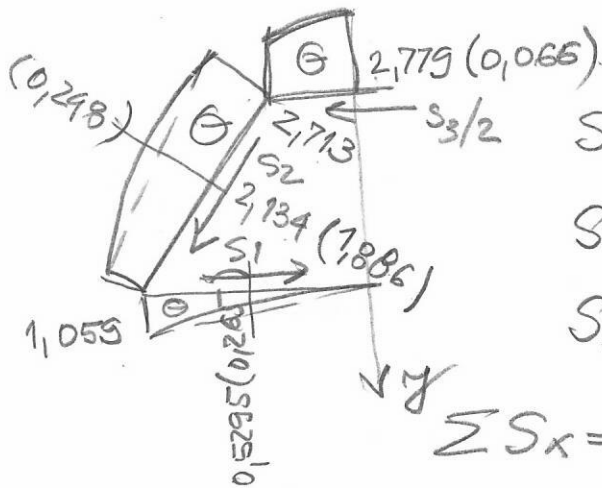
$$\tilde{S}_{y,3} = 4100 + 2 \cdot 10 \cdot 5 = \dots = 4200 \text{ cm}^3$$

$$\tau_{zs,1} = \frac{-30 \cdot 10^{-3} \cdot 1600 \cdot 10^{-6}}{226\,666,6 \cdot 10^{-8} \cdot 2 \cdot 10^{-2}} = -0,662 \cdot 10^{-3} \cdot 1600 = -1,059 \text{ MPa}$$

$$\tau_{zs,12} = -0,662 \cdot 10^{-3} \cdot 3225 = \dots = -2,134 \text{ MPa} \checkmark$$

$$\tau_{zs,2} = -0,662 \cdot 10^{-3} \cdot 4100 = \dots = -2,713 \text{ MPa} \checkmark$$

$$\tau_{zs,3} = -0,662 \cdot 10^{-3} \cdot 4200 = \dots = -2,779 \text{ MPa} \checkmark$$



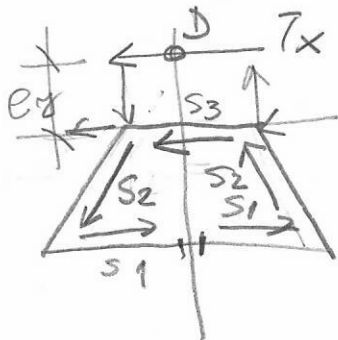
$$S_1 = 40 \cdot 10^{-2} \cdot 2 \cdot 10^{-2} \left(0,5295 - \frac{2}{3} \cdot 0,265 \right) \cdot 10^3 = 2,823 \text{ kN}$$

$$S_2 = 50 \cdot 10^{-2} \cdot 2 \cdot 10^{-2} \left(1,886 + \frac{2}{3} \cdot 0,248 \right) \cdot 10^3 = 20,513 \text{ kN}$$

$$S_3 = 20 \cdot 10^{-2} \cdot 2 \cdot 10^{-2} \left(2,713 + \frac{2}{3} \cdot 0,066 \right) \cdot 10^3 = 11,028 \text{ kN}$$

$$\sum S_x = 11,028 + (20,513 \cdot 0,6 - 2,823) \cdot 2 = 30,00 \checkmark$$

$$\sum S_y = (20,513 - 20,513) \cdot 0,8 = 0 \checkmark$$



$$\sum M_0 = (e_y + 40) S_1 - e_y (S_3 + 2S_2 \cdot x) + S_2 \cdot y \cdot 20 = 0$$

$$= (e_y + 40) 2,823 - e_y (11,028 + 2 \cdot 0,6 \cdot 20,513) +$$

$$+ 20,513 \cdot 0,8 \cdot 20 = 0$$

$$(e_y + 40) \cdot 2,823 - e_y \cdot 30,644 + 328,208 = 0$$

$$e_y (2,823 - 30,644) + 559,048 = 0 \quad e_y = 19,91 \text{ cm}$$