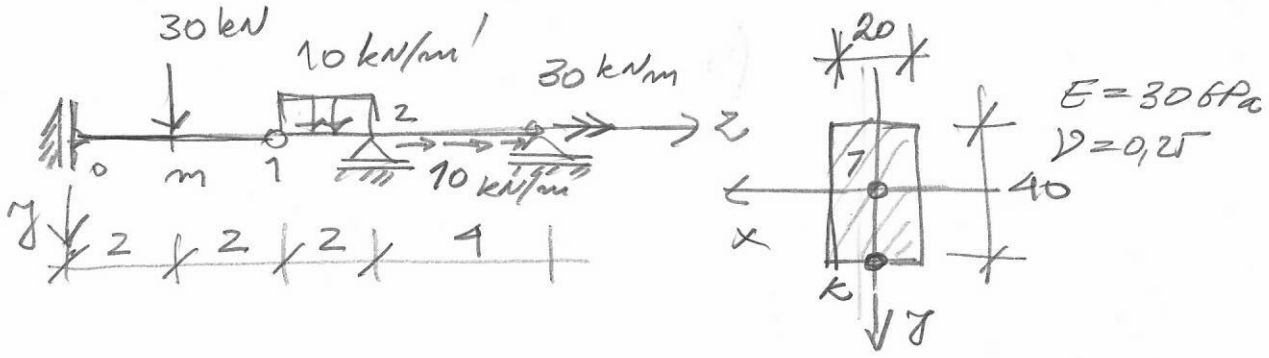
UNIVERZITET U BANJALUCI
ARHITEKTONSKO-GRAĐEVINSKO-GEODETSKI FAKULTET
KATEDRA ZA MEHANIKU I TEORIJU KONSTRUKCIJA
STUDIJSKI PROGRAM GRAĐEVINARSTVO

25.09.2020.

OTPORNOST MATERIJALA 1.

ZA NOSAČ I OPTEREĆENJE NA SKICI TREBA



a) NACRTATI DIJAGRAME KOMPONENTALNIH NAPONA U PRESEKU m DESNO (OSCILOVAO JE TORZIONO KRUT)

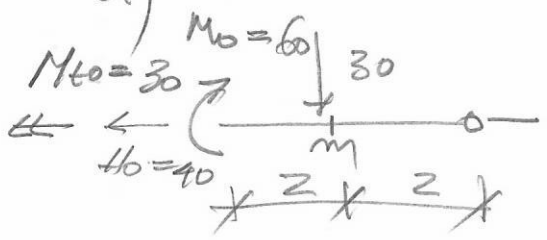
b) IZVRŠITI ANALIZU STANJA NAPONA U TAČKI K I NACRTATI MOROV KRUG NAPONA

c) INTEGRACIJOM DIF. JEDNAČINE ELASTIČNE LINIJE ODREDITI φ_m, φ_{zm}, w_m

d) MOR-MAKSVELOVOM ANALOGIJOM ODREDITI V_1, φ_{id}, V_m

e) SKICIRATI DEFORMISANU OSU NOSAČA

a)



$M_0 - 2 \cdot 30 = 0 \quad \underline{M_0 = 60}$

$M_m = M_0 = 60\ kNm$

$T_{md} = -30\ kN$

$N_{md} = H_0 = 40\ kN$

$M_{tmd} = 30\ kNm$

$F = 20 \cdot 40 = 800\ cm^2$

$J_x = 20 \cdot \frac{40^3}{12} = 106666{,}6\ cm^4$

$h/b = 40/20 = 2 \Rightarrow \alpha = 0{,}457 \quad \beta = 0{,}493 \quad \gamma = 0{,}795$

$W_t = 0{,}493 \cdot 20^3 = 3944\ cm^3$

$J_t = 0{,}457 \cdot 20^4 = 73120\ cm^4$

$\sigma_z(N) = \frac{40 \cdot 10^{-3}}{800 \cdot 10^{-4}} = 0{,}5\ MPa$

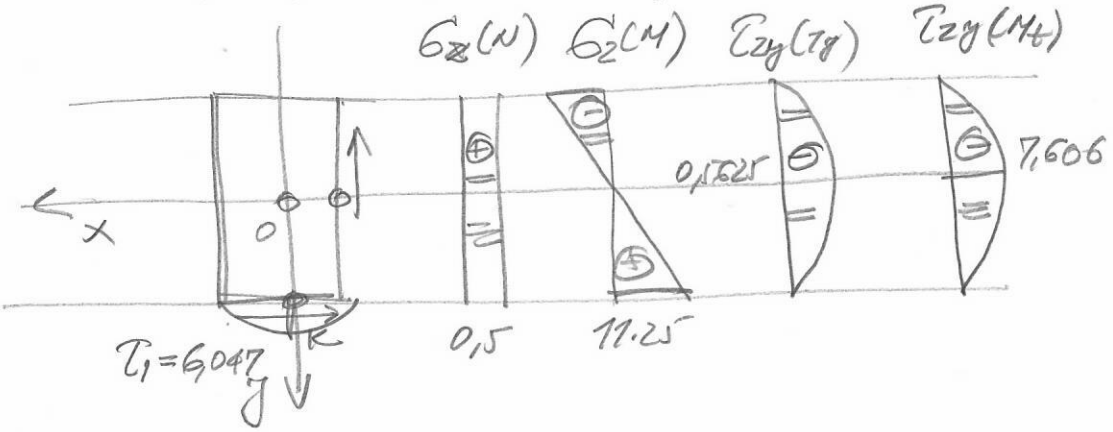
$\sigma_z(M) = \frac{60 \cdot 10^{-3} \cdot 20 \cdot 10^{-2}}{106666{,}6 \cdot 10^{-9}} = 11.25\ MPa$

$\max \tau_{zy}(T_y) = \frac{3}{2} \cdot \frac{(-30) \cdot 10^{-3}}{800 \cdot 10^{-4}} = -0{,}5625\ MPa$

$\max \tau_{zx}(M_t) = \frac{30 \cdot 10^{-3}}{3944 \cdot 10^{-6}} = 7{,}606\ MPa$

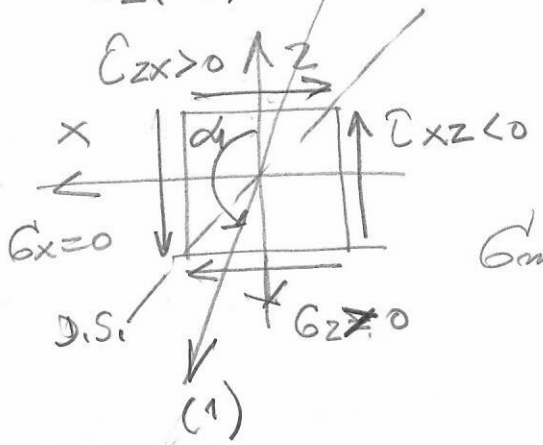
$\tau_1 = 0{,}795 \cdot 7{,}606 = 6{,}047\ MPa$

$\sigma_z(N) \quad \sigma_z(M) \quad \tau_{zy}(T_y) \quad \tau_{zy}(M_t)$



b) $\sigma_z = 11{,}25 + 0{,}5 = 11.75\ MPa$

$\tau_{zx}^K = 6{,}047\ MPa$



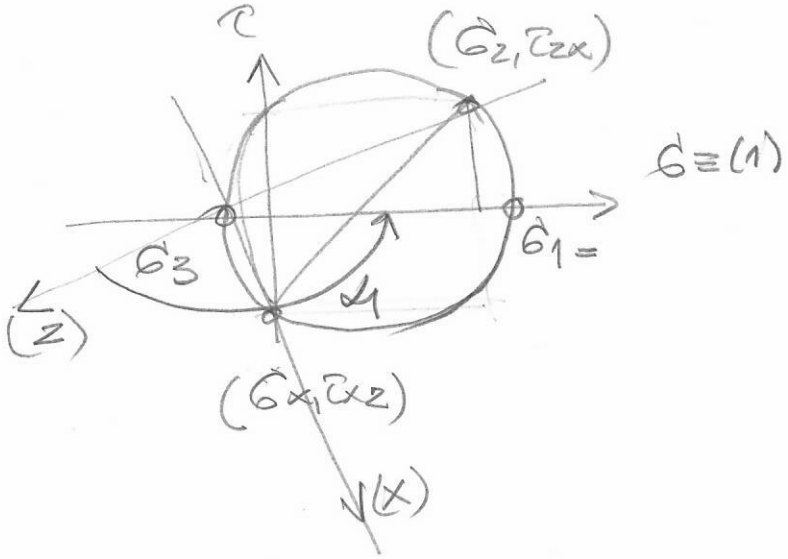
$tg\,2\alpha_1 = \frac{-2\tau_{zx}}{\sigma_z - \sigma_x} = \frac{-2 \cdot 6{,}047}{11.75} \underset{(+)}{\overset{(-)}{=}} 1{,}029$

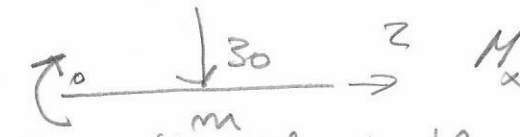
$2\alpha_1 + \theta = 360^\circ$

$\alpha_1 = 180 - \frac{1}{2} arctg\ 1.029 = 150{,}08^\circ$

$\sigma_{1,2,3} = \frac{11.75}{2} \pm \sqrt{\left(\frac{11.75}{2}\right)^2 + 6{,}047^2} =$

$= 5{,}871 \pm 8{,}431 = \begin{cases} 14.306 = \sigma_1 \\ 0 = \sigma_2 \\ -2{,}556 = \sigma_3 \end{cases}$



c) 

$M_x(z) = 60$

$\varphi_{mL} = \varphi_{md} = \varphi_m$

$EJ_x = 30 \cdot 10^3 \cdot 106\,666{,}6 \cdot 10^{-8}$

$EJ_x = 32\ MNm^2$

$EJ_x v''(z) = -60$

$EJ_x v'(z) = C_1 - 60z \qquad EJ_x v'(0) = C_1 - 60 \cdot 0 = 0 \quad C_1 = 0$

$EJ_x v'(2) = EJ_x \varphi_m = -60 \cdot 2 = -120$

$$\varphi_m = \frac{-120 \cdot 10^{-3}}{32} = -3{,}75 \cdot 10^{-3}\ rad.$$

$$G = \frac{E}{2(1+\nu)} = \frac{30}{2(1+0{,}25)} = 12\ GPa$$

$GJ_t = 12 \cdot 10^3 \cdot 73120 \cdot 10^{-8} = 0{,}7749\ MNm^2$

$GJ_t \varphi'(z) = 30$

$GJ_t \varphi(z) = C_1 + 30z \qquad GJ_t \varphi(0) = C_1' + 30 \cdot 0 = 0 \quad C_1 = 0$

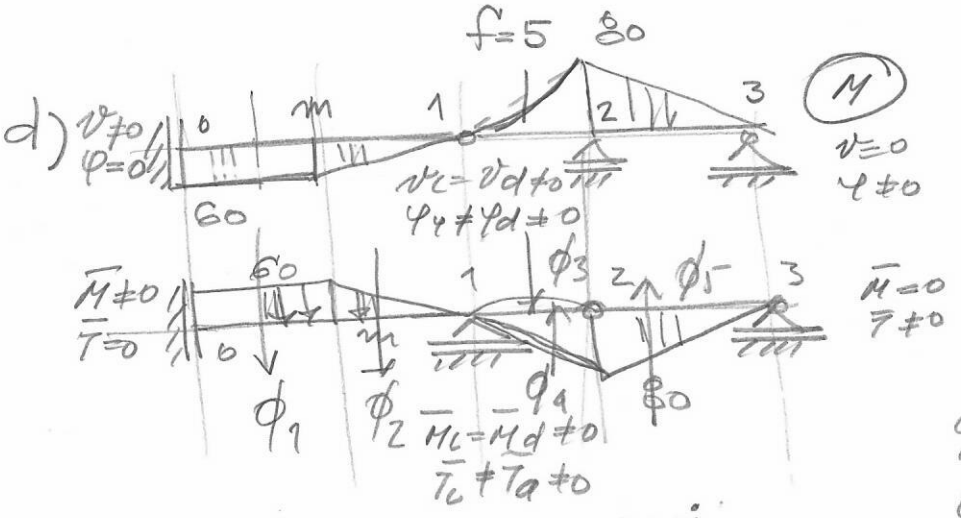
$GJ_t \varphi(2) = 30 \cdot 2 = 60 \qquad \varphi_m = \varphi(z) = \frac{60 \cdot 10^{-3}}{0{,}7749} = 6{,}838 \cdot 10^{-3}\ rad$

$EF w'(z) = 40$

$EF w(z) = C_1 + 40z \qquad EF w(0) = C_1 + 40 \cdot 0 = 0 \quad C_1 = 0$

$EF w(2) = 40 \cdot 2 = 80$

$$w_m = w(z) = \frac{80 \cdot 10^{-3}}{30 \cdot 10^3 \cdot 800 \cdot 10^{-4}} = 0{,}03 \cdot 10^{-3}\ m$$



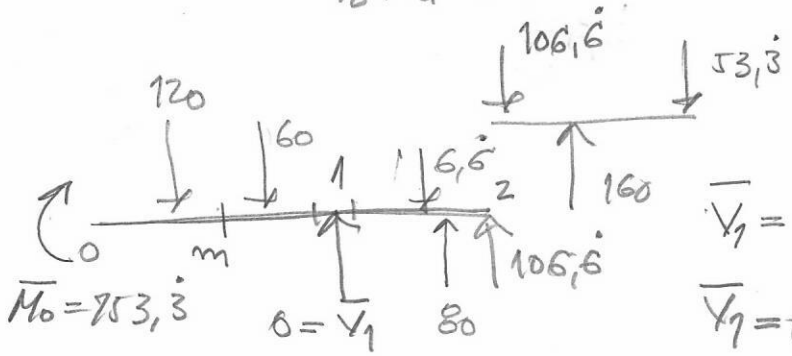
$\phi_1 = 60 \cdot 2 = 120$

$\phi_2 = 60 \cdot \frac{2}{2} = 60$

$\phi_3 = \frac{2}{3} \cdot 5 \cdot 2 = 6,6^{\cdot}$

$\phi_4 = \frac{80 \cdot 2}{2} = 80$

$\phi_5 = 80 \cdot \frac{4}{2} = 160$



$\bar{V}_1 = 120 + 60 + 6,6^{\cdot} - 80 - 106,6^{\cdot}$

$\bar{V}_1 = 0$

$\Sigma \bar{M}_2 = 80 \cdot \frac{2}{3} - 6,6^{\cdot} \cdot 1 - 60 \cdot \left(2 + \frac{4}{3}\right) - 120 \cdot 5 + \bar{M}_0 = 0$

$\bar{M} = 753,3^{\cdot}$

$EJ\, v'_m = 753,3^{\cdot} - 120 \cdot 1 = 633,3^{\cdot}$

$v_m = \frac{633,3^{\cdot} \cdot 10^{-3}}{32} = 19,79 \cdot 10^{-3}$ m

$EJ\, \varphi_m = -120$

$\varphi_m = \frac{-120 \cdot 10^{-3}}{32} = -3,75^{\cdot} \cdot 10^{-3}$ rad

$EJ\, \varphi_{1d} = -120 - 60 = -180$

$\varphi_{1d} = \varphi_{1L} = \frac{-180 \cdot 10^{-3}}{32} = -5,625 \cdot 10^{-3}$ rad

$EJ\, v_1 = 2 \cdot 106,6^{\cdot} + 80 \cdot \frac{4}{3} - 6,6^{\cdot} \cdot 1 = 313,3^{\cdot}$

$v_1 = \frac{313,3^{\cdot} \cdot 10^{-3}}{32} = 9,79 \cdot 10^{-3}$ m