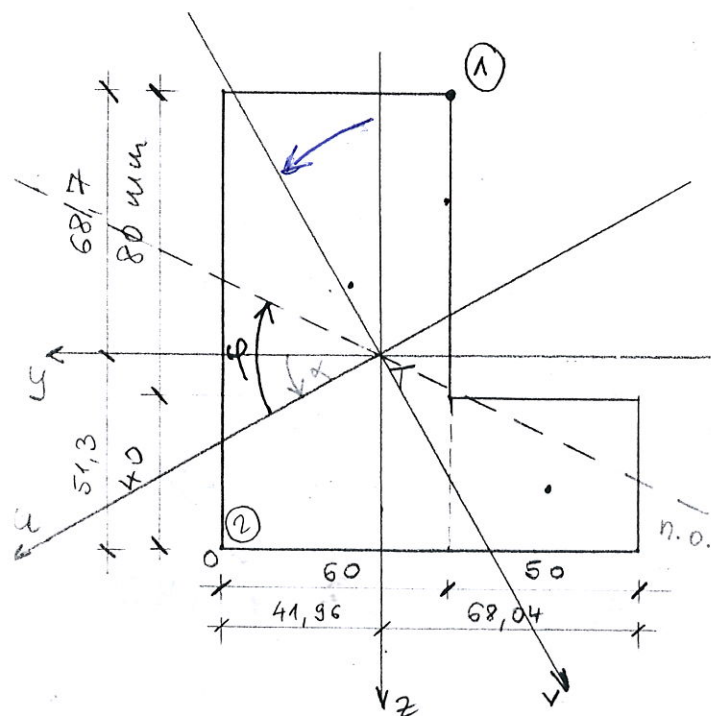
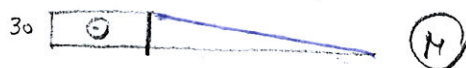
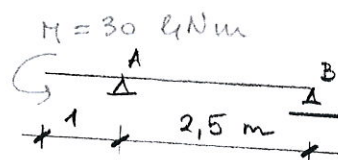


U najviše napregnutom p.p. nosača prikazanog na slici treba odrediti maksimalna normalna naprezanja i nacrtati njihov dijagram.



Ravnina djelovanja momenta savijanja ne poklapa se s jednom od ge. središnjih osi tromosti p.p. pa se radi o kosom savijanju, što znači da n.o. nije $\perp$ na ravni djelovanja rezultantnog momenta.

TEŽIŠTE

$$A_i = 60 \cdot 120 + 50 \cdot 40 = 9200 \text{ mm}^2$$

$$z_T = \frac{60 \cdot 120 \cdot 60 + 50 \cdot 40 \cdot 20}{9200} = 51,3 \text{ mm}$$

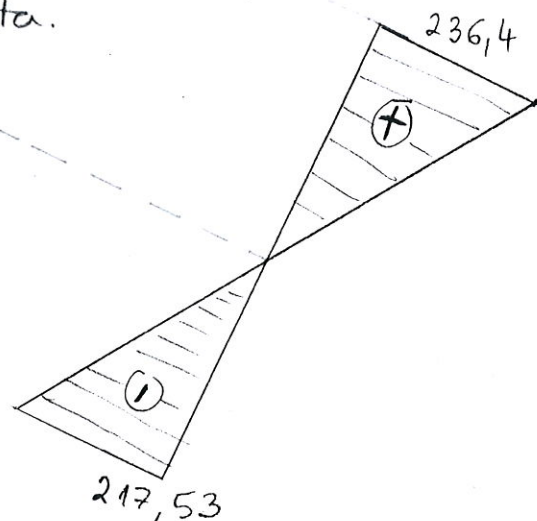
$$y_T = \frac{60 \cdot 120 \cdot 30 + 50 \cdot 40 \cdot 85}{9200} = 41,96 \text{ mm}$$

MOMENTI TROMOSTI:

$$J_y = \frac{60 \cdot 120^3}{12} + 60 \cdot 120 \cdot (60 - 51,3)^2 + \frac{50 \cdot 40^3}{12} + 50 \cdot 40 \cdot (51,3 - 20)^2 = 11,41 \cdot 10^6 \text{ mm}^4$$

$$J_z = \frac{120 \cdot 60^3}{12} + 60 \cdot 120 \cdot (41,96 - 30)^2 + \frac{40 \cdot 50^3}{12} + 50 \cdot 40 \cdot (85 - 41,96)^2 = 7,31 \cdot 10^6 \text{ mm}^4$$

$$J_{yz} = 0 + 60 \cdot 120 \cdot [-(60 - 51,3)] \cdot (41,96 - 30) + 0 + 50 \cdot 40 \cdot (51,3 - 20) \cdot [-(85 - 41,96)] = -3,44 \cdot 10^6 \text{ mm}^4$$



GLAVNI MOMENTI TROMOSTI:

$$J_{u,v} = 10^6 \left[\frac{11,41 + 7,31}{2} \pm \frac{1}{2} \sqrt{(11,41 - 7,31)^2 + 4 \cdot (-3,44)^2} \right]$$

$$= (9,36 \pm 4,00) \cdot 10^6 \text{ mm}^4$$

$$J_u = J_{\max} = 13,36 \cdot 10^6 \text{ mm}^4 \quad J_y > J_z$$

$$J_v = J_{\min} = 5,36 \cdot 10^6 \text{ mm}^4$$

SMJER GL. OSI TROMOSTI

$$\tan 2\alpha = - \frac{2 J_{yz}}{J_y - J_z} = - \frac{2 \cdot (-3,44 \cdot 10^6)}{11,41 \cdot 10^6 - 7,31 \cdot 10^6}$$

$$\alpha = 29,6^\circ \quad \alpha \rightarrow \neq y \text{ i } u$$

SMJER NEUTRALNE OSI

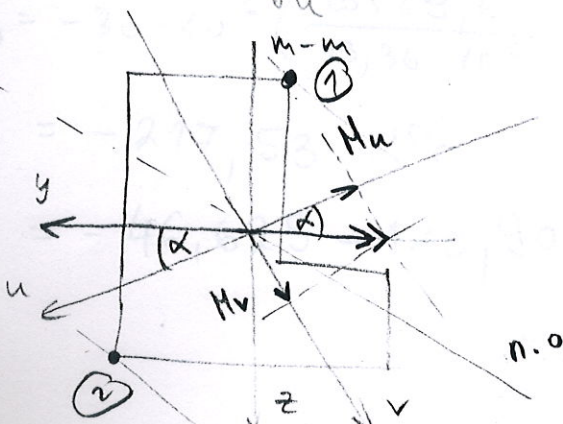
$$\tan \varphi = - \frac{J_u}{J_v} \tan \alpha \quad \varphi \rightarrow \neq h.o. \text{ i } u$$

$$\tan \varphi = - \frac{13,36}{5,36} \cdot \tan 29,6$$

$$\varphi = -54,8^\circ \quad \varphi < 0 !!!$$

$$\sigma_x = \frac{M_u}{J_u} \cdot v + \frac{M_v}{J_v} \cdot u$$

$$\sigma_x = M \left(\frac{\cos \alpha}{J_u} \cdot v + \frac{\sin \alpha}{J_v} \cdot u \right)$$

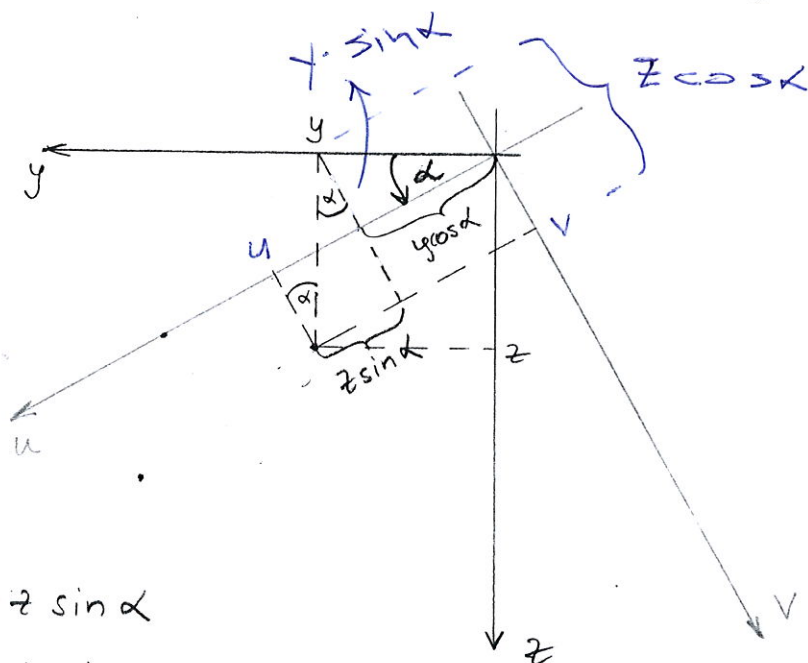


$$\vec{M} \perp z (m-m)$$

$$M_u = M \cos \alpha$$

$$M_v = M \sin \alpha$$

treba odrediti koordinate u i v u
ovisnosti o koordinatama y i z



$$u = y \cos \alpha + z \sin \alpha$$

$$v = z \cos \alpha - y \sin \alpha$$

T.	y	z	u	v
①	-18,04	-68,7	-49,62	-50,82
②	41,36	51,3	61,82	23,88

$$\alpha = 29,6^\circ$$

točke ① i ② su najviše
napregnute jer su
najudaljenije od n. o.



ili se očita u
mjerilu

$$u_1 = -50 \text{ mm}$$

$$v_1 = -51 \text{ mm}$$

$$u_2 = 62 \text{ mm}$$

$$v_2 = 24 \text{ mm}$$

$$\begin{aligned} \sigma_{(1)} &= -30 \cdot 10^6 \left[\frac{\cos 29,6}{13,36 \cdot 10^6} \cdot (-50,82) + \frac{\sin 29,6}{5,36 \cdot 10^6} \cdot (-49,62) \right] \\ &= 236,4 \text{ MPa} = 99,224 + 137,179 \text{ (vlah)} \end{aligned}$$

$$\begin{aligned} \sigma_{(2)} &= -30 \cdot 10^6 \left(\frac{\cos 29,6}{13,36 \cdot 10^6} \cdot 23,88 + \frac{\sin 29,6}{5,36 \cdot 10^6} \cdot 61,82 \right) \\ &= -217,53 \text{ MPa} \end{aligned}$$

$$= -46,625 - 170,908 \text{ (tlah)}$$