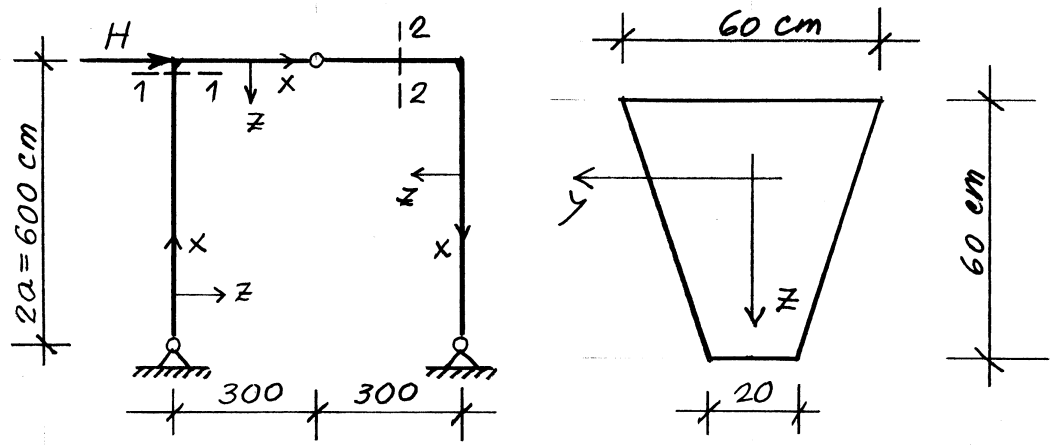
1. Tričlenski okvir je sestavljen iz elementov trapeznega prečnega prereza, in sicer tako, da je daljša osnovnica na zunanji strani okvira. Okvir je obtežen z vodoravno silo H, kot kaže skica. Dovoljena normalna napetost v prečnem prerezu je $[\sigma_n] = 10\,\mathrm{MPa}$.

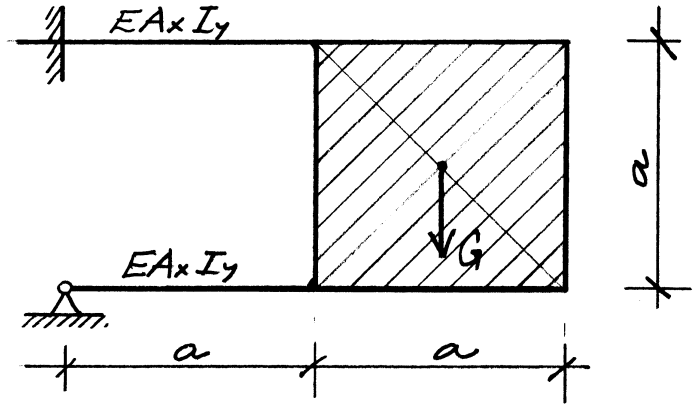
   a. Določi in skiciraj jedro prikazanega trapeznega prereza!

   b. Določi največjo dovoljeno obtežbo H ! Določi in skiciraj potek normalnih napetosti v prerezu 1-1!

   c. Določi strižno napetost v težišču prereza 2-2!

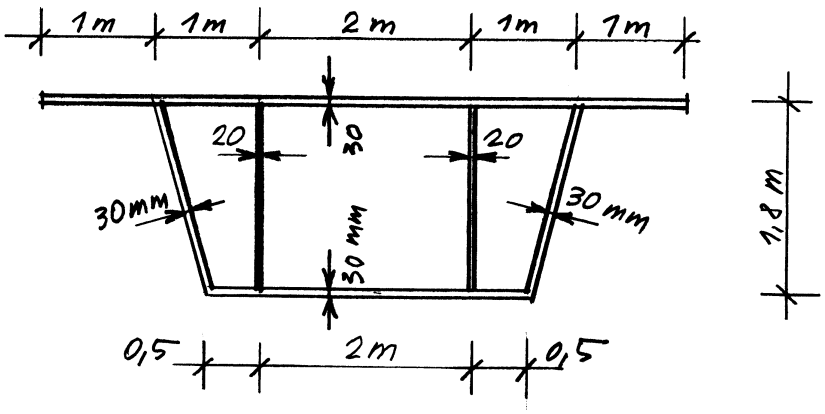


2. Enakomerno debela toga homogena plošča teže G je togo pritrjena na dva vodoravna nosilca. Določi zasuk plošče v ravnini (x, z)!



$$E = 200\,000\,MPa$$
$$A_x = 12\,cm^2$$
$$I_y = 400\,cm^4$$
$$G = 32\,kN$$
$$a = 2{,}4\,m$$

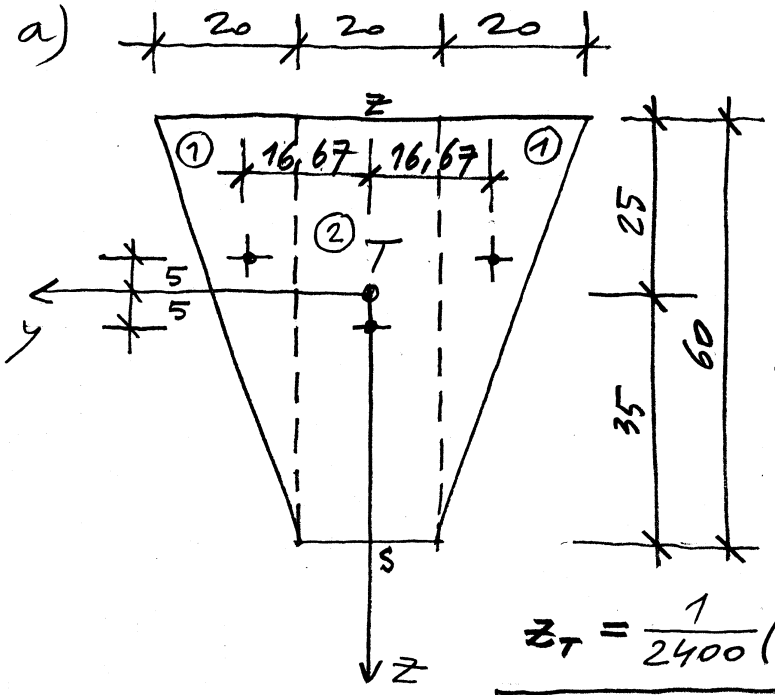
3. Določi dopustni torzijski moment pri čisti torzijski obtežbi prikazanega škatlastega mostnega nosilca! Dovoljena strižna napetost je $[\tau] = 100\,\mathrm{MPa}$. Kolikšen je dovoljeni torzijski moment, če izvedemo prerez brez notranjih stojin?



TRDNOST IZPIT 12.6.1995

Ad 1.)

a)



$$A_1 = \frac{20 \cdot 60}{2} = 600\ cm^2$$

$$A_2 = 20 \cdot 60 = 1200\ cm^2$$

$$A_x = 2 \times 600 + 1200$$

$$\boxed{A_x = 2400\ cm^2}$$

$$z_T = \frac{1}{2400}(2 \cdot 600 \cdot 20 + 1200 \cdot 30)$$

$$\boxed{z_T = 25\ cm}$$

$$I_y = \frac{2}{18} \cdot 600 \cdot 60^2 + \frac{1}{12} \cdot 20 \cdot 60^3 + 2 \cdot 600 \cdot 5^2 +$$

$$+ 1200 \cdot 5^2 \longrightarrow \boxed{I_y = 660.000\ cm^4}$$

$$I_z = \frac{2}{18} \cdot 600 \cdot 20^2 + \frac{1}{12} \cdot 60 \cdot 20^3 + 2 \cdot 600 \cdot 16{,}67^2$$

$$\boxed{I_z = 400.000\ cm^4}$$

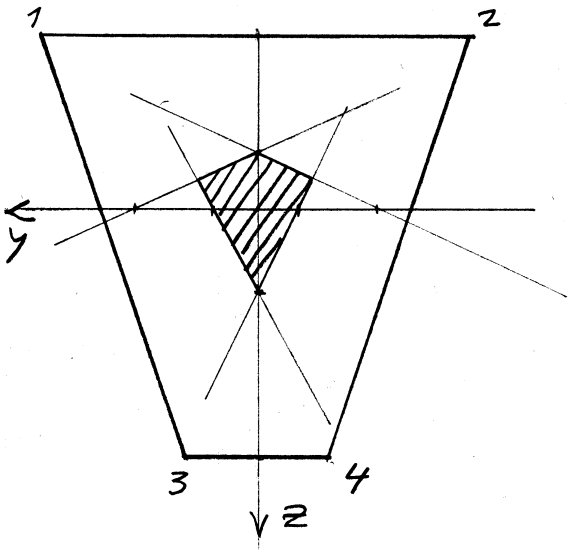
$$i_y^2 = \frac{I_y}{A_x} = \frac{660\,000}{2400} \longrightarrow \boxed{i_y^2 = 275\ cm^2}$$

$$i_z^2 = \frac{I_z}{A_x} = \frac{400\,000}{2400} \longrightarrow \boxed{i_z^2 = 166{,}67\ cm^2}$$

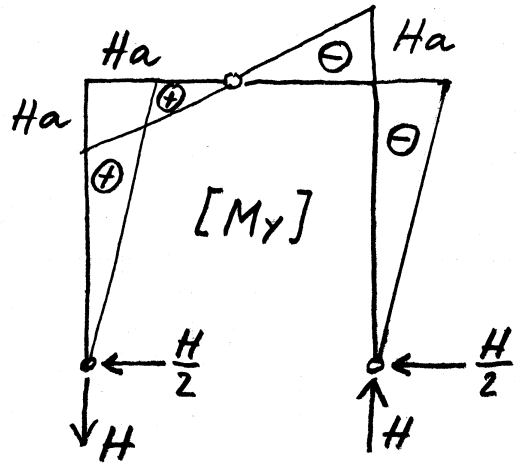
$$W_y^s = \frac{660\,000}{35} \longrightarrow \boxed{W_y^s = 18857\ cm^3}$$

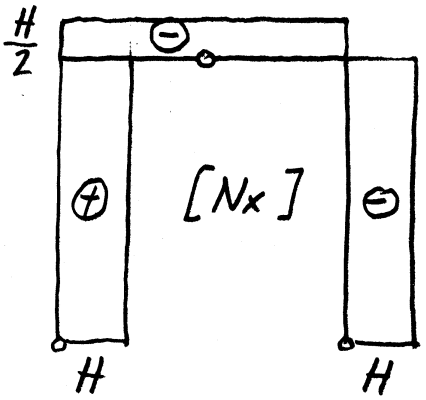
$$W_y^z = \frac{660\,000}{25} \longrightarrow \boxed{W_y^z = 26400\ cm^3}$$

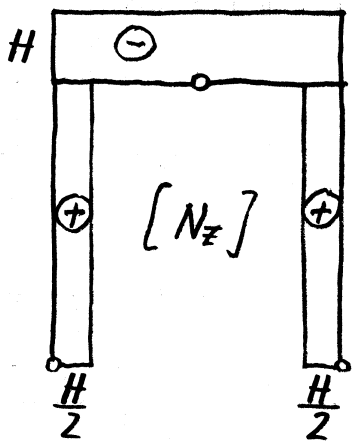
tč	y_o	z_o	$m = -\frac{i_z^2}{y_o}$	$n = -\frac{i_y^2}{z_o}$
1	30	-25	-5,56	11
2	-30	-25	5,56	11
3	10	35	-16,67	-7,86
4	-10	35	16,67	-7,86



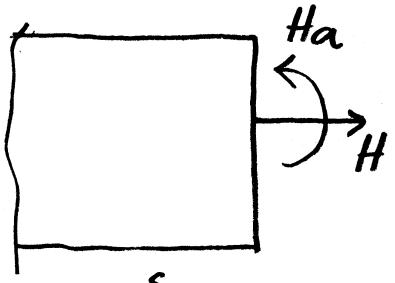
b)

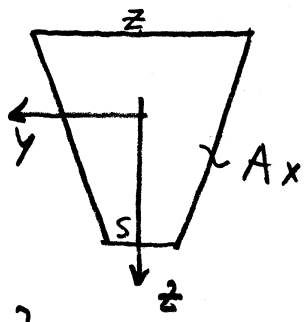






Prerez 1-1:





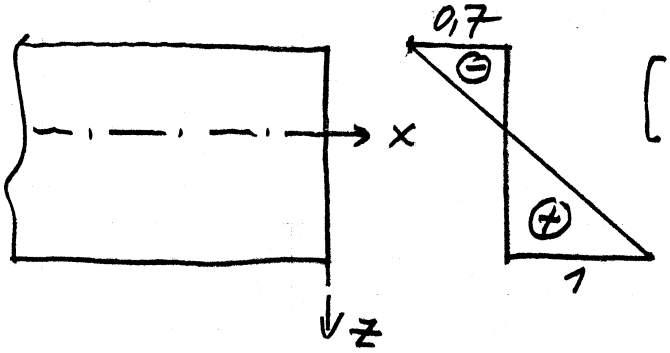
$$\sigma_{xx}^{s} = \frac{H}{Ax} + \frac{Ha}{W_y^s} = H\,\frac{W_y^s + aAx}{Ax\,W_y^s} = [\sigma_n]$$

$$[H] = [\sigma_n]\,\frac{Ax\,W_y^s}{W_y^s + aAx} \longrightarrow \boxed{[H] = 61{,}25\ kN}$$

$$\boxed{\sigma_{xx}^{s} = 1\ kN/cm^2}$$

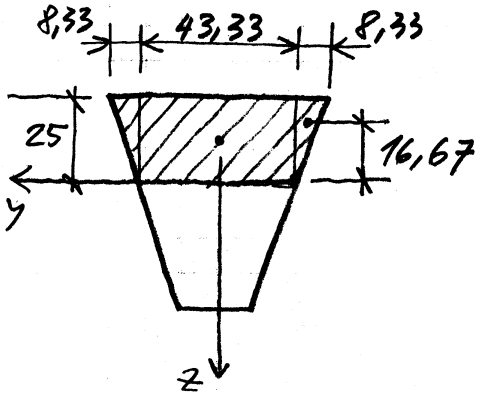
$$\sigma_{xx}^{z} = \frac{H}{Ax} - \frac{Ha}{W_y^z} = 61{,}25\left(\frac{1}{2400} - \frac{300}{26400}\right)$$

$$\boxed{\sigma_{xx}^{z} = -0{,}7\ kN/cm^2}$$



$[\sigma_{xx}(z)]$

c) $\boxed{N_z = -H = -61{,}25\ kN}$ ... v prerezu 2-2



$b^* = 43{,}33\ cm$

$-S_y^* = 43{,}33 \times 25 \cdot 12{,}5 +$

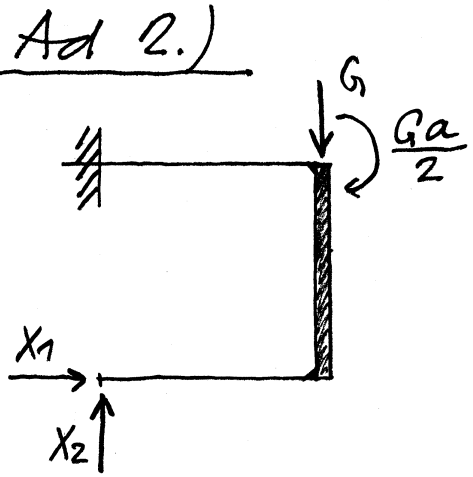
$+ 2 \times \frac{1}{2} \times 8{,}33 \times 25 \times 16{,}67$

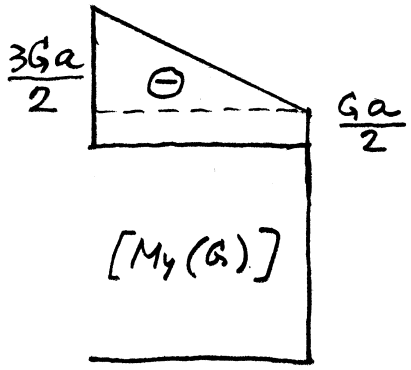
$-S_y^* = 17\,012\ cm^3$

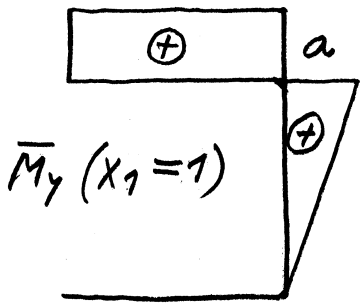
$$\sigma_{xz}^{T} = -N_z \frac{S_y^*}{b^* I_y} = 61{,}25 \frac{-17012}{43{,}33 \cdot 660\,000}$$

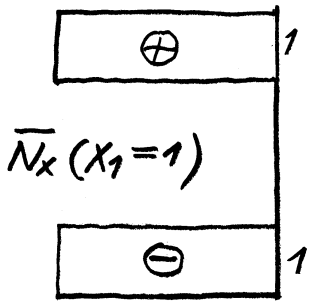
$$\boxed{\sigma_{xz}^{T} = -0{,}036\ kN/cm^2}$$

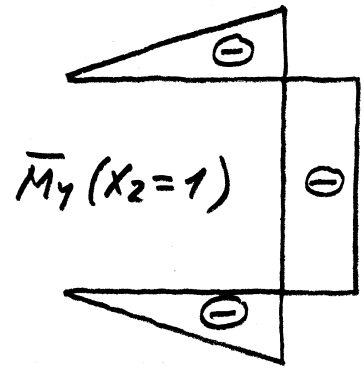
Ad 2.)

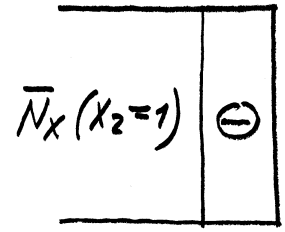












$$a_{11} = \frac{a^3}{E I_y} + \frac{2a}{E A_x}$$

$$a_{12} = -\frac{a^3}{2 E I_y}$$

$$a_{22} = \frac{2a^3}{3 E I_y}$$

$$b_1 = -G\frac{a^3}{EI_y} \qquad b_2 = G\frac{5a^3}{12EI_y}$$

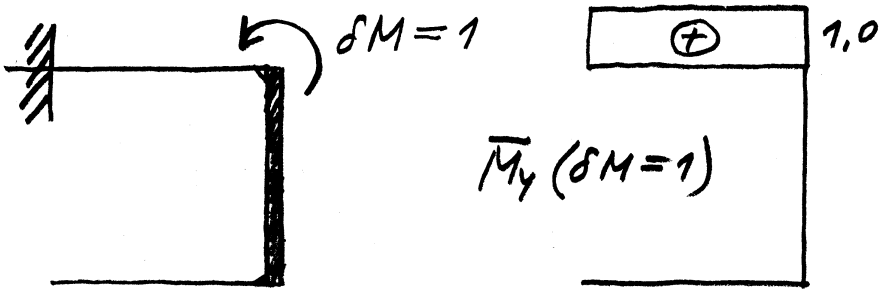
$$\begin{bmatrix} \frac{a^3}{EI_y} + \frac{2a}{EA_x} & -\frac{a^3}{2EI_y} \\ -\frac{a^3}{2EI_y} & \frac{2a^3}{3EI_y} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = G \begin{bmatrix} \frac{a^3}{EI_y} \\ \frac{5a^3}{12EI_y} \end{bmatrix}$$

$$X_1 = G\frac{11a^2A_x}{2(11a^2A_x + 16I_y)}$$

$$X_1 = 35{,}135 \text{ kN}$$

$$X_2 = \frac{3}{2}\left(-\frac{5G}{12} + \frac{1}{2}X_1\right)$$

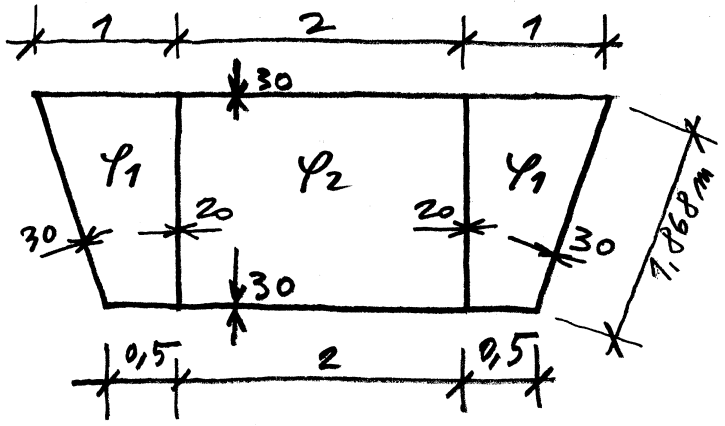
$$X_2 = 6{,}351 \text{ kN}$$



$$\omega_P = \frac{1}{EI_y}\left(-\frac{Ga^2}{2} - \frac{Ga^2}{2} + X_1 a^2 - X_2\frac{a^2}{2}\right)$$

$$\omega_P = -0{,}279 \cdot 10^{-3}$$

Ad 3.)



$A_1 = \frac{1}{2}(100+50)\cdot 180 = 13500\ cm^2$

$A_2 = 200\cdot 180 = 36000\ cm^2$

$a_{11} = \frac{1}{3}(100+187+50) + \frac{1}{2}\cdot 180 = 202,27$

$a_{22} = \frac{1}{3}\cdot 2\cdot 200 + \frac{1}{2}\cdot 2\cdot 180 = 313,33$

$a_{12} = a_{21} = -\frac{180}{2} = -90$

$$\left.\begin{aligned} 202,27\,\varphi_1 - 90\,\varphi_2 &= 27000 \\ -2\cdot 90\,\varphi_2 + 313,33\,\varphi_2 &= 72000 \end{aligned}\right\} \quad \boxed{\begin{aligned}\varphi_1 &= 316,7\ cm^2 \\ \varphi_2 &= 411,7\ cm^2\end{aligned}}$$

$I_x^r = 2(2\varphi_1 A_1 + \varphi_2 A_2)$

$I_x^r = 2(2\cdot 316,7\cdot 13500 + 411,7\cdot 36000)$

$$\boxed{I_x^r = 46.744.200\ cm^4}$$

$$\sigma_{x\xi}^{max} = -\frac{M_x}{I_x}\left(\frac{\partial\varphi}{\partial\eta}\right)_{max} = +\frac{M_x}{I_x}\cdot\frac{411,7}{3}$$

$$\left|\sigma_{x\xi}^{max}\right| = M_x\,\frac{411,7}{3\cdot 46744200} = [\tau] = 10\ kN/cm^2$$

$$\boxed{[M_x]^r = 3.406.184\ kNcm}$$

~Brez notranjih stojin:

$A_s = 2A_1 + A_2 = 63000\ cm^2$

$\oint_{C_s}\frac{ds}{\delta} = \frac{1}{3}(400+300+2\cdot 187) = 295,6$

$$I_x = \frac{4A_s^2}{\oint_{Cs} \frac{ds}{\delta}} = \frac{4 \cdot 63000^2}{295,6}$$

$$I_x = 53.707.713 \ cm^4$$

$$\sigma_{xz} = \frac{M_x}{2A_s\delta} \longrightarrow [M_x] = 10 \cdot 2 \cdot 63000 \cdot 3$$

$$\boxed{[M_x] = 3.780.000 \ kNcm}$$