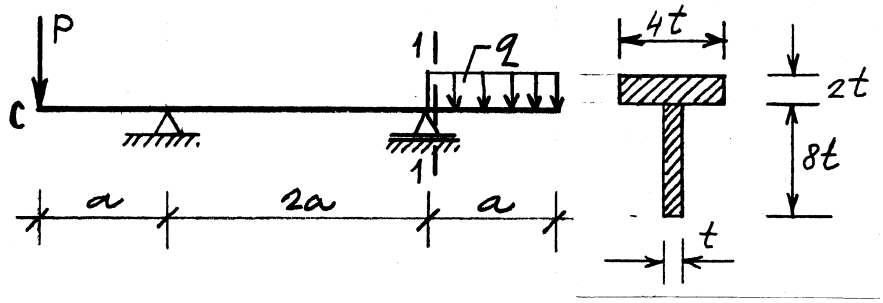
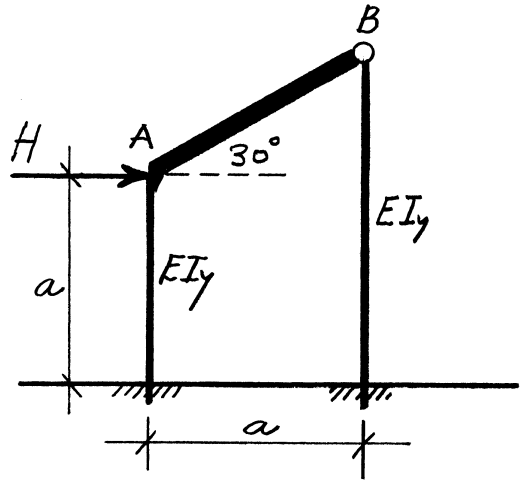
1. Previsni nosilec T–prereza je obtežen, kot kaže skica. Dovoljena normalna napetost je $[\sigma_n] = 16.5\,kN/cm^2$.
   a. Dimenzioniraj nosilec (določi parameter t)!
   b. Nariši diagrama normalnih in strižnih napetosti v prečnem prerezu 1–1!
   c. S *Castigliano*-vim izrekom določi navpični pomik prereza C!



$E = 20\,000\,kN/cm^2$

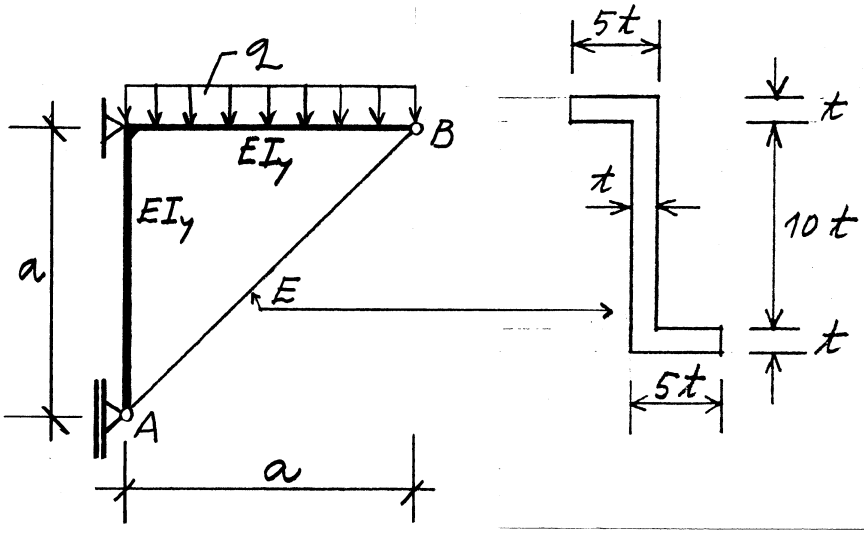
$a = 2\,m$
$P = 10\,kN$
$q = 10\,kN/m^1$

2. Določi vektor pomika vozlišča B ter notranje sile v togi prečki AB! Vpliv osnih sil na pomike stebrov lahko zanemariš.



$E = 20\,000\,kN/cm^2$
$I_y = 4\,000\,cm^4$
$a = 4\,m$
$H = 40\,kN$

3. Določi uklonsko varnost palice AB!

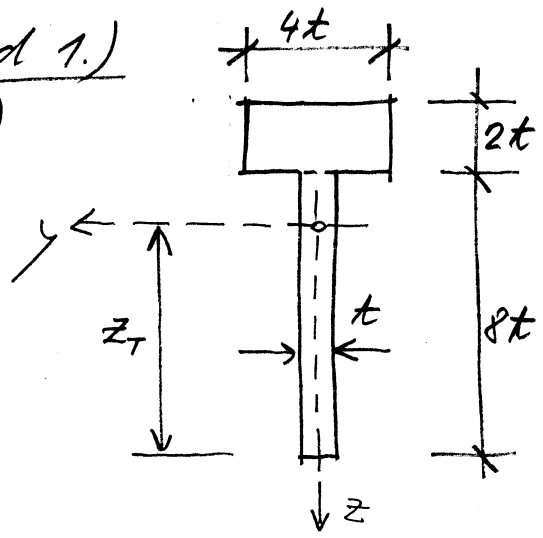


$E = 21\,000\,kN/cm^2$
$I_y = 1\,800\,cm^4$
$a = 2.4\,m$
$t = 1\,cm$
$q = 40.89\,kN/m^1$

TRDNOST IZPIT 5.9.94

Ad 1.)

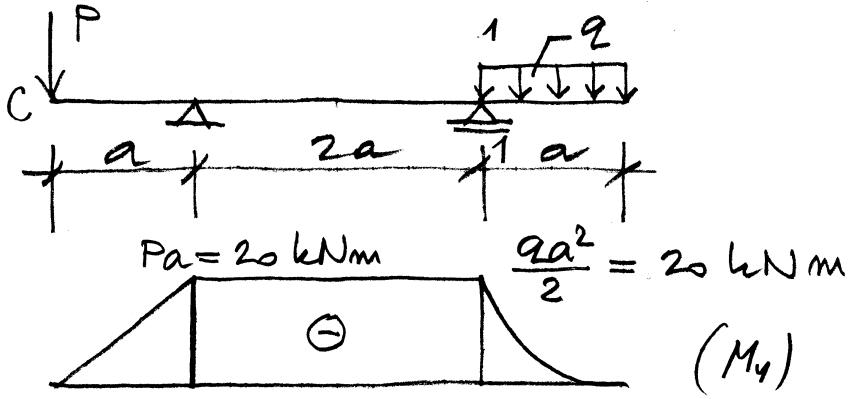
a)

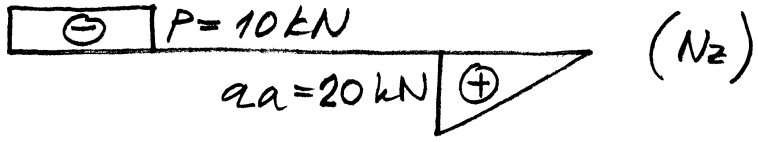


$$A_x = 16\,t^2$$

$$z_T = 6{,}5\,t$$

$$I_y = 145{,}33\,t^4$$





1-1 : $M_y = -20\ kNm = -2000\ kNcm$

$N_z = 20\ kN$

$$\sigma_{xx} = \frac{M_y}{I_y} z = -\frac{2000}{145{,}33\,t^4} z = -\frac{13{,}762}{t^4} \cdot z$$

$$\sigma_{xx}^z = -\frac{13{,}762}{t^4}(-3{,}5\,t) \longrightarrow \sigma_{xx}^z = \frac{48{,}166}{t^3} \leq [\sigma_n]$$

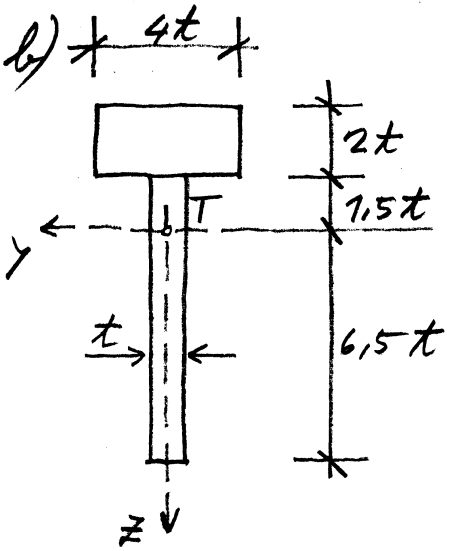
$$\sigma_{xx}^s = -\frac{13{,}762}{t^4} \cdot 6{,}5\,t \longrightarrow |\sigma_{xx}^s| = \frac{89{,}452}{t^3} \leq [\sigma_n]$$

$$t^3 \geq \sqrt{\frac{89,452}{16,5}} \longrightarrow \boxed{t = 1,8\ cm}$$

$$\sigma_{xx}^{z} = \frac{48,166}{1,8^3} = 8,26\ kN/cm^2$$

$$\sigma_{xx}^{s} = -\frac{89,452}{1,8^3} = -15,33\ kN/cm^2$$

b)



$z = -1,5\,t$:

$$S_y^* = -8t^2 \cdot 2,5t = -20t^3$$

$$b_p^* = 4t \quad , \quad b_s^* = t$$

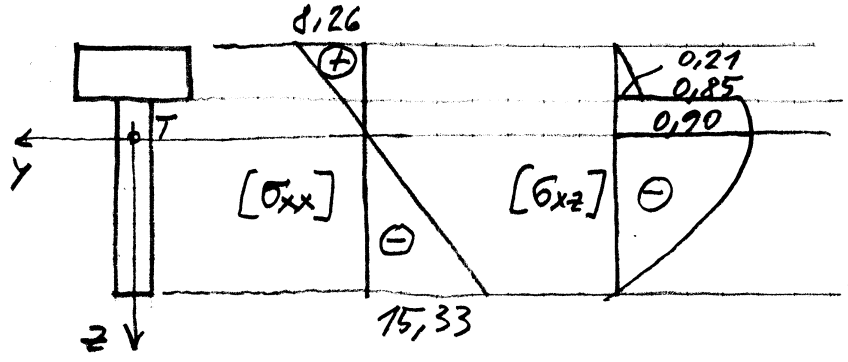
$$\sigma_{xz} = -N_z \frac{S_y^*}{b^* I_y}$$

$$\sigma_{xz}^{p} = 20 \cdot \frac{-20t^3}{4t \cdot 145,33\,t^4} \longrightarrow \boxed{\sigma_{xz}^{p} = -0,21\ kN/cm^2}$$

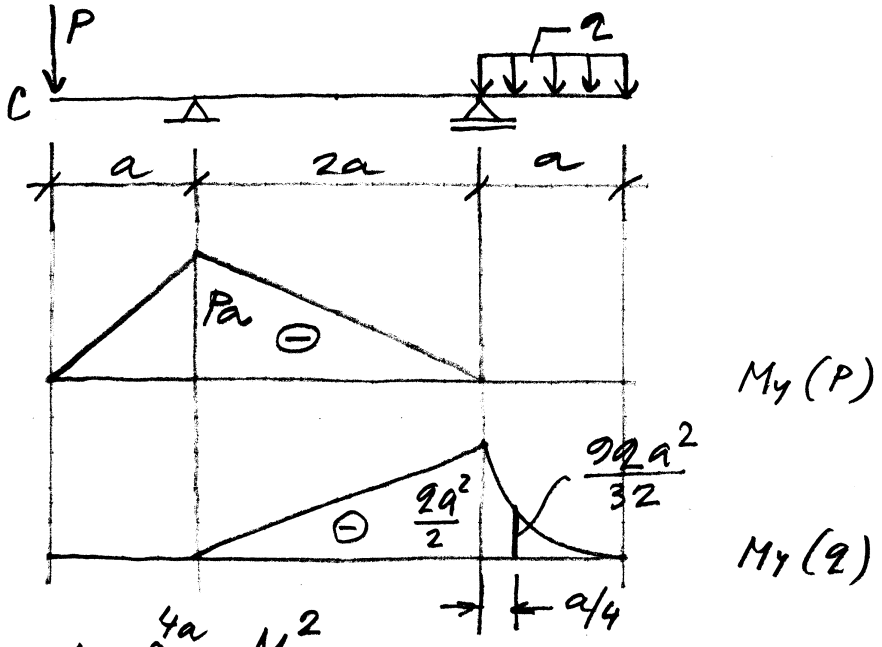
$$\sigma_{xz}^{s} = 20 \cdot \frac{-20t^3}{t \cdot 145,33\,t^4} \longrightarrow \boxed{\sigma_{xz}^{s} = -0,85\ kN/cm^2}$$

$z = 0 \longrightarrow S_y^* = -20t^3 - 1,5t^2 \cdot 0,75t = -21,125\,t^3$

$$\sigma_{xz}(T) = 20 \frac{-21,125\,t^3}{t \cdot 145,33\,t^4} \longrightarrow \boxed{\sigma_{xz}(T) = -0,90\ kN/cm^2}$$



c)



$$D = \frac{1}{2}\int_0^{4a} \frac{M_y^2}{EI_y}\,dx$$

$$D = \frac{1}{2EI_y}\left(\frac{Pa^2}{2}\cdot\frac{2Pa}{3} + \frac{2Pa^2}{2}\cdot\frac{2Pa}{3} + \frac{2Pa^2}{2}\cdot\frac{2qa^2}{2\cdot 3} + \right.$$
$$\left. + \frac{2qa^3}{4}\cdot\frac{Pa}{3} + \frac{2qa^3}{4}\cdot\frac{2qa^2}{2\cdot 3} + \frac{2a^3}{2}\cdot\frac{9qa^2}{32\cdot 3}\right)$$

$$D = \frac{1}{2EI_y}\left(P^2a^3 + Pq\frac{a^4}{3} + q^2\frac{3a^5}{16}\right)$$

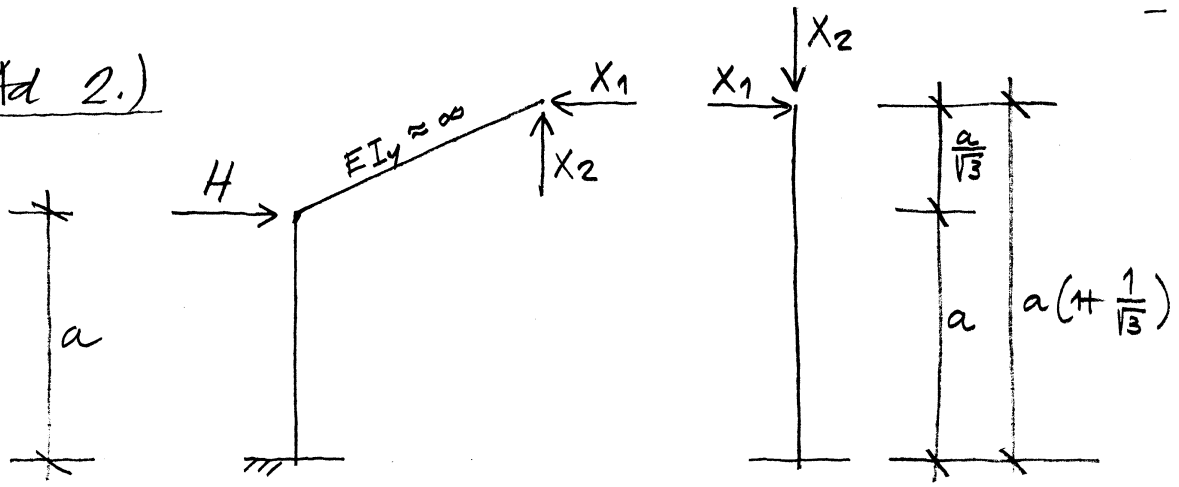
$$\boxed{w_C = \frac{\partial D}{\partial P} = P\frac{a^3}{EI_y} + q\frac{a^4}{6EI_y}}$$

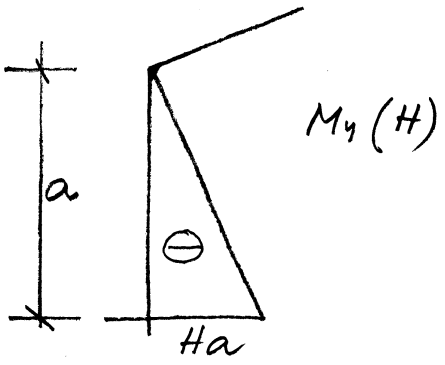
$$w_C = \frac{a^3}{6EI_y}(6P + qa)$$

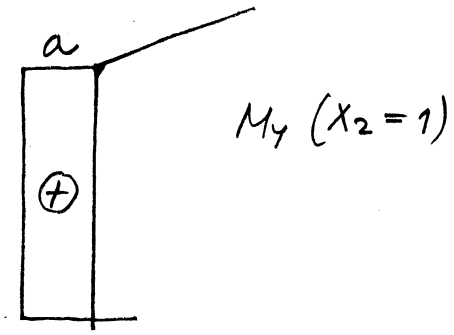
$$w_C = \frac{200^3}{6\cdot 20000\cdot 145{,}53\cdot 1{,}84}(6\cdot 10 + 10\cdot 2)$$

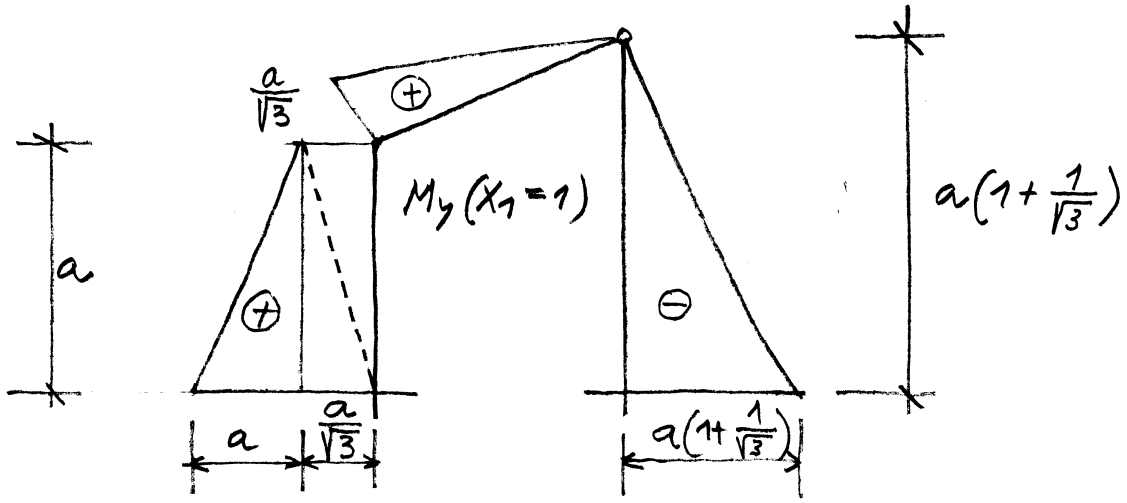
$$\boxed{w_C = 3{,}5\ cm}$$

Ad 2.)









$$EI_y\, a_{11} = \frac{a^2}{2}\left(\frac{2a}{3} + \frac{a}{\sqrt{3}}\right) + \frac{a^2}{\sqrt{3}}\left(\frac{a}{\sqrt{3}} + \frac{a}{2}\right) +$$

$$+ \frac{a^2}{2}\left(1+\frac{1}{\sqrt{3}}\right)^2 \cdot \frac{2a}{3}\left(1+\frac{1}{\sqrt{3}}\right)$$

$$\frac{EI_y}{a^3}\, a_{11} = \frac{2}{3} + \frac{1}{\sqrt{3}} + \frac{1}{3}\left(1+\frac{1}{\sqrt{3}}\right)^3 = 2{,}5522$$

$$\frac{EI_y}{a^3}\, a_{22} = 1$$

$$EI_y\, b_1 = -H\frac{a^2}{2}\left(\frac{2a}{3}+\frac{a}{\sqrt{3}}\right)$$

$$\frac{EI_y}{a^3}\, b_1 = -H\left(\frac{1}{3}+\frac{1}{2\sqrt{3}}\right) = -0{,}6220\,H$$

$$EI_y\, b_2 = -H\frac{a^2}{2}\cdot a \longrightarrow \frac{EI_y}{a^3}\, b_2 = -0{,}5\,H$$

$$EI_y\, a_{12} = \left(\frac{a^2}{2}+\frac{a^2}{\sqrt{3}}\right)\cdot a \longrightarrow \frac{EI_y}{a^3}\, a_{12} = \frac{1}{2}+\frac{1}{\sqrt{3}} = 1{,}0774$$

$$a_{11}X_1 + a_{12}X_2 + b_1 = 0 \longrightarrow u$$
$$a_{21}X_1 + a_{22}X_2 + b_2 = 0$$

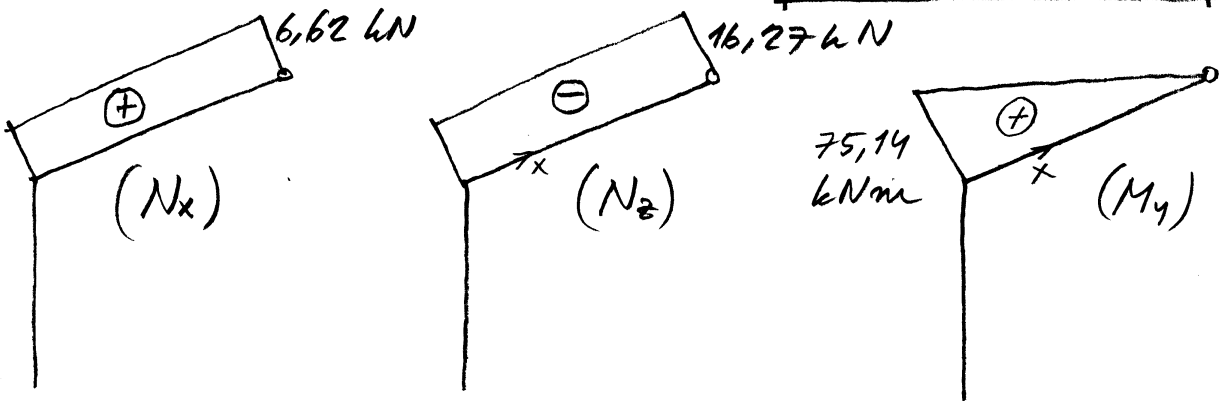
$$\begin{bmatrix} 2{,}5522 & 1{,}0774 \\ 1{,}0774 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = H \begin{bmatrix} 0{,}6220 \\ 0{,}5 \end{bmatrix}$$

$$X_1 = 0{,}060 \cdot H = 2{,}40\ kN$$
$$X_2 = 0{,}435\ H = 17{,}40\ kN$$

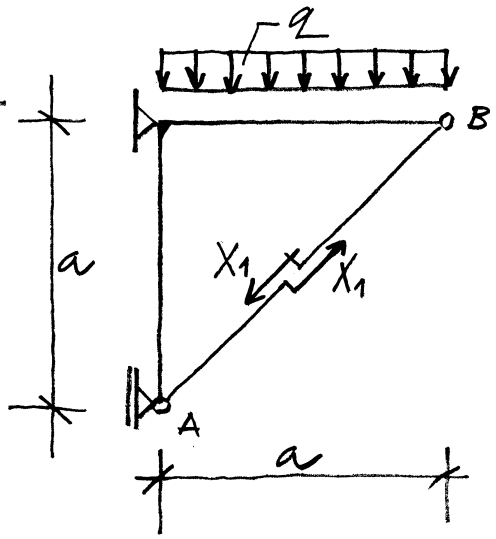
$$u_B = \frac{1}{EI_y}\cdot\frac{a^2}{2}\left(1+\frac{1}{\sqrt{3}}\right)^2\cdot\frac{2a}{3}\left(1+\frac{1}{\sqrt{3}}\right)\cdot X_1$$

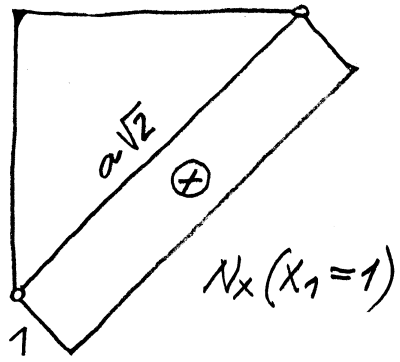
$$u_B = X_1\frac{a^3}{EI_y}\cdot\frac{1}{3}\left(1+\frac{1}{\sqrt{3}}\right)^3 \longrightarrow$$

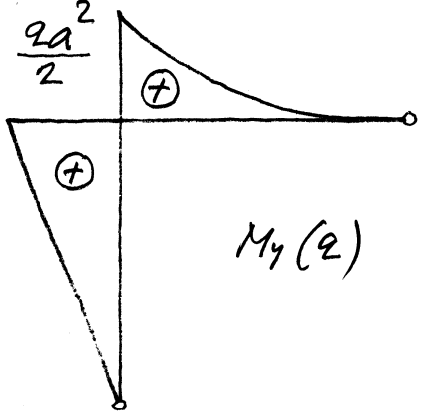
$$u_B = 1{,}0465\ cm$$
$$w_B = 0$$

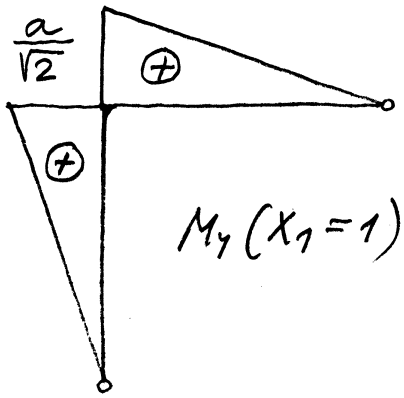


Ad 3.)







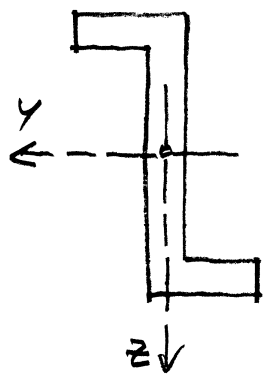


$$a_{11} = 2 \cdot \frac{a}{\sqrt{2}} \cdot \frac{a}{2} \cdot \frac{2}{3} \cdot \frac{a}{\sqrt{2}} \cdot \frac{1}{EI_y} + a\sqrt{2} \cdot 1 \cdot 1 \cdot \frac{1}{EA_v}$$

$$\boxed{a_{11} = \frac{a^3}{3EI_y} + \frac{a\sqrt{2}}{EA_v}}$$

$$b_1 = \frac{1}{EI_y}\left(\frac{qa^2}{2} \cdot \frac{a}{3} \cdot \frac{3}{4} \cdot \frac{a}{\sqrt{2}} + \frac{qa^2}{2} \cdot \frac{a}{2} \cdot \frac{2}{3} \cdot \frac{a}{\sqrt{2}}\right)$$

$$\boxed{b_1 = \frac{7\sqrt{2}\,a^4}{24\sqrt{2}\,EI_y}}$$



$$\boxed{\begin{aligned} A_x &= 20\ cm^2 \\ I_{min} &= 27,94\ cm^4 \end{aligned}}$$

$$a_{11} = \frac{1}{21000}\left(\frac{240^3}{3 \cdot 1800} + \frac{240\sqrt{2}}{20}\right) \rightarrow a_{11} = 0,1227$$

$$b_1 = \frac{7 \cdot 0,4089 \cdot 240^4}{24\sqrt{2} \cdot 21000 \cdot 1800} \rightarrow b_1 = 7,4019$$

$$X_1 = -\frac{b_1}{a_{11}} = -\frac{7,4019}{0,1227} \rightarrow \boxed{X_1 = -60,319\ kN}$$

$$l_w = a\sqrt{2}$$

$$N_{kr} = \frac{\pi^2 E I_{min}}{l_w^2} = \frac{\pi^2 \cdot 21000 \cdot 27,94}{(240\sqrt{2})^2}$$

$$\boxed{N_{kr} = 50,268\ kN}$$

$$\nu = \frac{N_{kr}}{N_{obj}} = \frac{50,268}{60,319} \rightarrow \boxed{\nu = 0,833 < 1}\ !$$