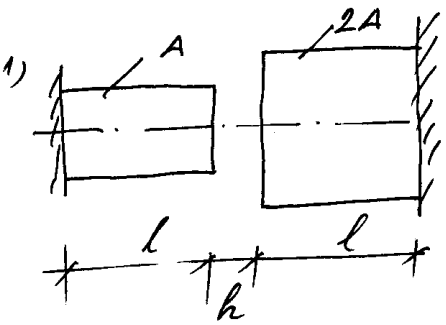
1)



$l = 500$ mm $\quad A = 45\,cm^2$

$E = 2 \cdot 10^5$ MPa

$\alpha = 12 \cdot 10^{-6}$ 1/°C

$h = 0{,}48$ mm

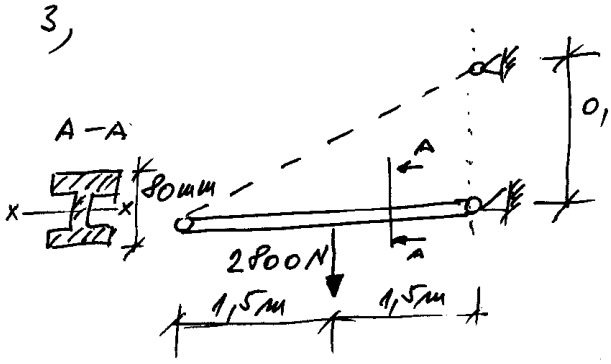
Mindkét rúd hőmérsékletét $\Delta t = 100$ °C-kal megemeljük. Mekkora feszültség ébred az egyes rudakban?

2,

$$\underline{\underline{\phi}} = \begin{bmatrix} 2 & 0 & 4 \\ 0 & 2 & 0 \\ 4 & 0 & -4 \end{bmatrix}$$

A feszültségtenzor adatai alapján határozza meg a MOHR féle redukált feszültséget!

3,

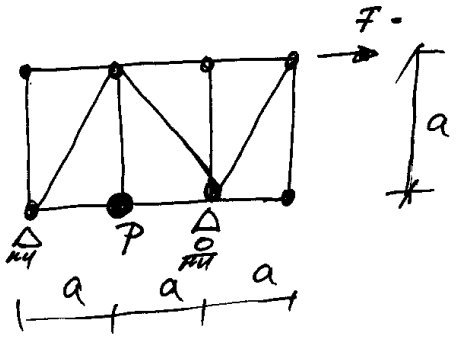


$A = 7{,}58\,cm^2$

$J_x = 77{,}8\,cm^4$

Határozza meg az I keresztmetszetű hajlított rúd veszélyes keresztmetszetében keletkező legnagyobb σ feszültség értékét!

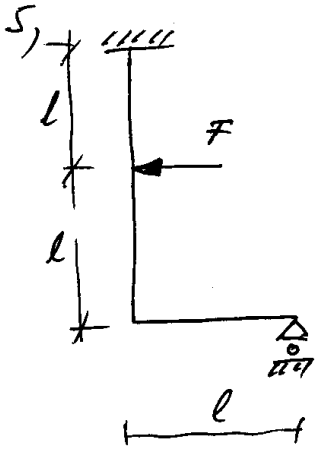
4,



AE = áll.

Határozza meg a kijelölt P pont függőleges irányú elmozdulását!

5,



Rajzolja meg a tartó nyomatéki ábráját!

IE = áll.

①

$$\lambda_t = \lambda_{t_1} + \lambda_{t_2} = 2\alpha \ell \Delta t = 2 \cdot 12 \cdot 10^{-6} \cdot 500 \cdot 100 = 1{,}2 \text{ mm}$$

$\lambda_t > h \rightarrow$ összenyomódik

$$\lambda_t + \lambda = h$$

$$\lambda_t + \frac{N\ell}{AE} + \frac{N\ell}{2AE} = h$$

$$N = \frac{h - \lambda_t}{\frac{\ell}{AE} + \frac{\ell}{2AE}} = \frac{E}{\ell} \frac{h - \lambda_t}{\frac{1}{A} + \frac{1}{2A}} = \frac{2 \cdot 10^5}{500} \frac{0{,}48 - 1{,}2}{\frac{1}{4500} + \frac{1}{9000}} =$$

$$= -864000 \text{ N} = -864 \text{ kN}$$

$$\boxed{\sigma_1 = \frac{N}{A} = \frac{-864 \cdot 10^3}{4500} = -192 \text{ MPa}}$$

$$\sigma_2 = \frac{N}{2A} = \frac{-864 \cdot 10^3}{9000} = -96 \text{ MPa}$$

②

$$\det\left(\underline{\underline{E}} - \sigma_i \underline{\underline{E}}\right) = \begin{vmatrix} 2-\sigma_i & 0 & 4 \\ 0 & 2-\sigma_i & 0 \\ 4 & 0 & -4-\sigma_i \end{vmatrix} = (2-\sigma_i)\left[(2-\sigma_i)(-4-\sigma_i) - 4^2\right] = 0$$

$\sigma_i = 2$ MPa

$$\sigma_i^2 + 2\sigma_i - 24 = 0$$

$$\sigma_i = \frac{-2 \pm \sqrt{4 + 4 \cdot 24}}{2} = -1 \pm 5 = \begin{cases} +4 \\ -6 \end{cases}$$

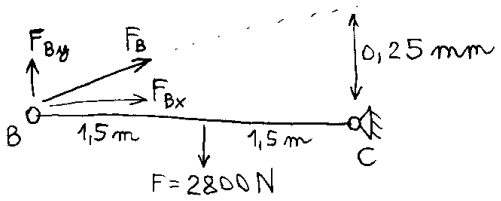
$\sigma_1 = 4$ MPa

$\sigma_2 = 2$ MPa

$\sigma_3 = -6$ MPa

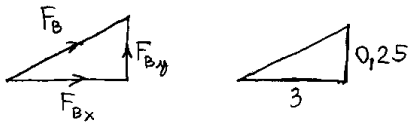
$$\boxed{\sigma_{red,MOHR} = \sigma_1 - \sigma_3 = 4 - (-6) = 10 \text{ MPa}}$$

③

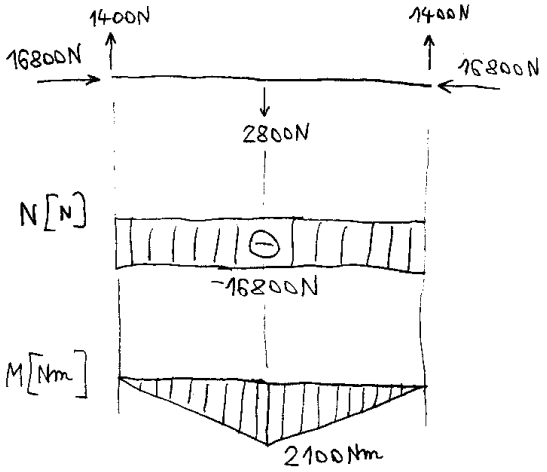


$$\sum M_C = 0 = -F_{By} \cdot 3 + F \cdot 1,5$$

$$F_{By} = \frac{1}{2} F = \frac{1}{2} \cdot 2800 = 1400 \text{ N}$$



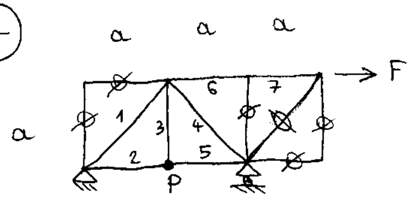
$$\frac{F_{Bx}}{F_{By}} = \frac{3}{0,25} \rightarrow F_{Bx} = \frac{3}{0,25} F_{By} = \frac{3}{0,25} \cdot 1400 = 16\,800 \text{ N}$$



$$\boxed{\sigma_{max} = |\sigma_{N/My}| + \sigma_{hajl} = \left|\frac{N}{A}\right| + \frac{M_x}{I_x} y_{max} = \frac{16800}{758} + \frac{2100 \cdot 10^3}{77,8 \cdot 10^4} \cdot 40 =}$$

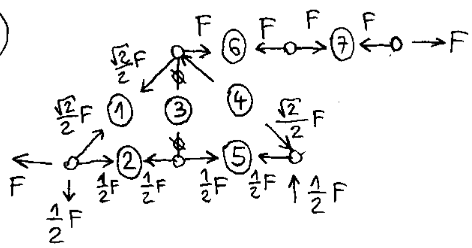
$$= 22,16 + 108,0 = \boxed{130,2 \text{ MPa}}$$

(4)

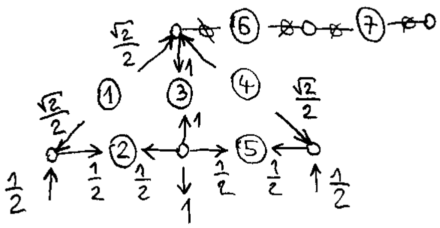


i	A_i	E_i	ℓ_i	N_i	n_i	$\frac{N_i n_i \ell_i}{A_i E_i}$
1			$\sqrt{2}a$	$+\frac{\sqrt{2}}{2}F$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{2}}{2}\frac{Fa}{AE}$
2			a	$+\frac{1}{2}F$	$+\frac{1}{2}$	$+\frac{1}{4}\frac{Fa}{AE}$
3			a	0	$+1$	
4	A	E	$\sqrt{2}a$	$-\frac{\sqrt{2}}{2}F$	$-\frac{\sqrt{2}}{2}$	$+\frac{\sqrt{2}}{2}\frac{Fa}{AE}$
5			a	$+\frac{1}{2}F$	$+\frac{1}{2}$	$+\frac{1}{4}\frac{Fa}{AE}$
6			a	$+F$	0	0
7			a	$+F$	0	0

(N_i)

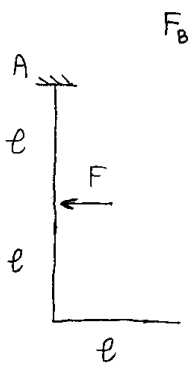


(n_i)

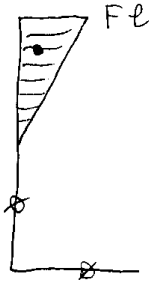


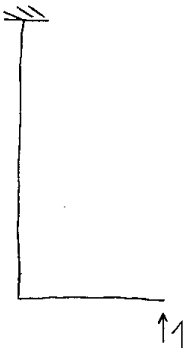
$$f_y^{(P)} = \sum_{(i)} \frac{N_i n_i \ell_i}{A_i E_i} = \frac{1}{2}\frac{Fa}{AE} \quad (\downarrow)$$

(5)

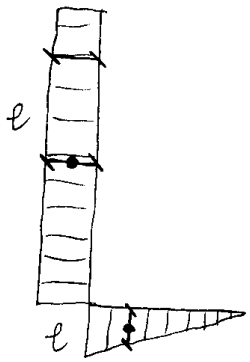


(M_0)





(m_1)



$$\delta_{10} = \frac{1}{IE}\left[\frac{-1}{2}\,\ell \cdot F\ell\left(\ell\right)\right] = \frac{-1}{2}\,\frac{F\ell^3}{IE}$$

$$\delta_{11} = \frac{1}{IE}\left[2\ell \cdot \ell\left(\ell\right) + \frac{1}{2}\ell \cdot \ell\left(\frac{2}{3}\ell\right)\right] = \frac{7}{3}\,\frac{\ell^3}{IE}$$

$$F_B = X_1 = \frac{-\delta_{10}}{\delta_{11}} = \frac{\frac{1}{2}\frac{F\ell^3}{IE}}{\frac{7}{3}\frac{\ell^3}{IE}} = \frac{3}{14}F\ (\uparrow)$$

(M)