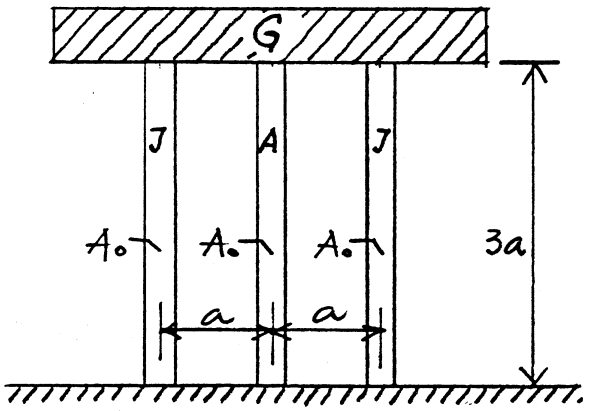
MTT IZPIT 5. 3. 1992

Absolutno togo gredo teže G centrično položimo na tri enako visoke stebre, od katerih je srednji iz aluminija, krajna dva pa sta jeklena. Določi napetosti v stebrih! Za koliko moramo spremeniti temperaturo stebrov, da bodo napetosti v vseh stebrih enake?



$E_J = 21000\ kN/cm^2$
$E_A = 7000\ kN/cm^2$
$\alpha_J = 1.25 \cdot 10^{-5}/K$
$\alpha_A = 2 \cdot 10^{-5}/K$
$A_0 = 25.4\ cm^2$
$a = 1\ m$
$G = 300\ kN$

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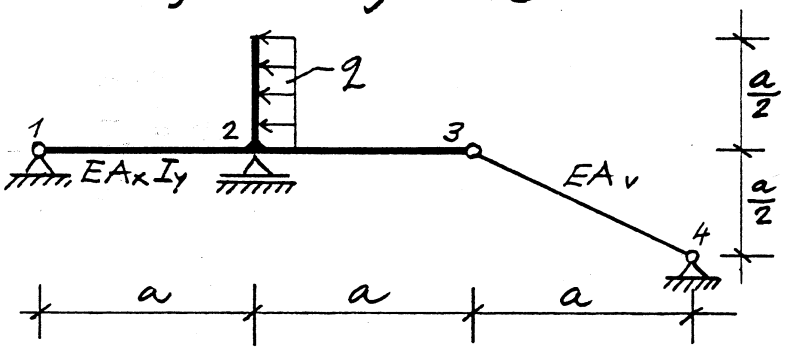
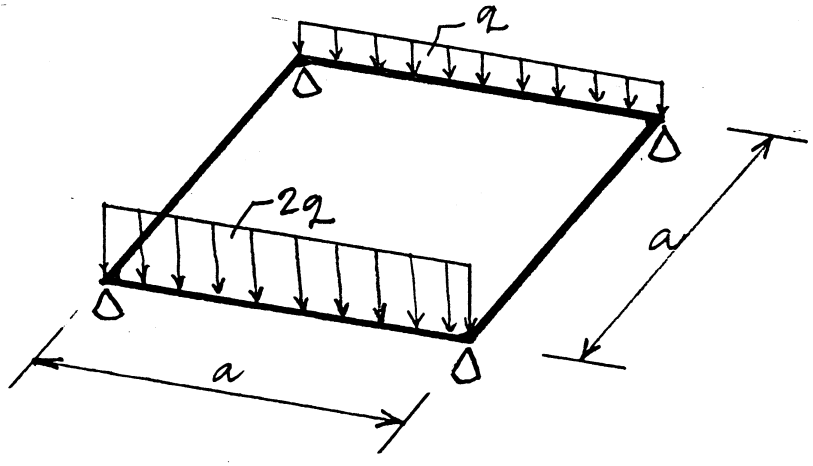
2. Dopustni navpični pomik vozlišča 3 je 1 cm. Določi potrebni prečni prerez A_V vrvi $\overline{34}$ ter skiciraj notranje sile!



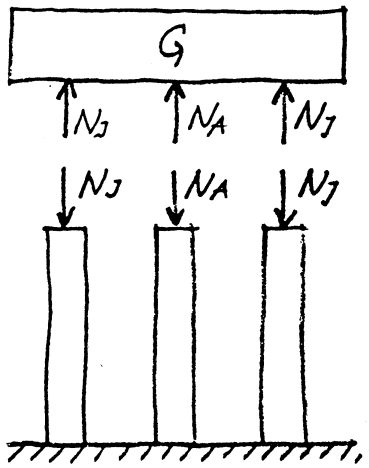
$a = 3\ m$
$A_x = 30\ cm^2$
$I_y = 2000\ cm^4$
$E = 21000\ kN/cm^2$
$q = 120\ kN/m'$

Določi in skiciraj notranje sile!



$EI_y \cong GI_x$

Ad 1.)



$$\boxed{2N_J + N_A = G}$$

$$\sigma_J = -\frac{N_J}{A_0}, \quad \sigma_A = -\frac{N_A}{A_0}$$

$$\varepsilon_J = \frac{\sigma_J}{E_J}, \quad \varepsilon_A = \frac{\sigma_A}{E_A}$$

$$\varepsilon_J = \varepsilon_A \longrightarrow \boxed{\sigma_A = \sigma_J \cdot \frac{E_A}{E_J}}$$

$$N_J = -A_0 \sigma_J, \quad N_A = -A_0 \sigma_J \frac{E_A}{E_J}$$

$$-2A_0\sigma_J - A_0\sigma_J \frac{E_A}{E_J} = G$$

$$\sigma_J = -\frac{G}{A_0}\frac{E_J}{2E_J + E_A} \longrightarrow \boxed{\begin{aligned}\sigma_J &= -5{,}06\ kN/cm^2\\ \sigma_A &= -1{,}69\ kN/cm^2\end{aligned}}$$

$$\sigma_A = \sigma_J \longrightarrow N_A = N_J = \frac{G}{3} \longrightarrow \sigma_A = \sigma_J = -\frac{G}{3A_0}$$

$$\boxed{\sigma = \sigma_A = \sigma_J = -3{,}94\ kN/cm^2}$$

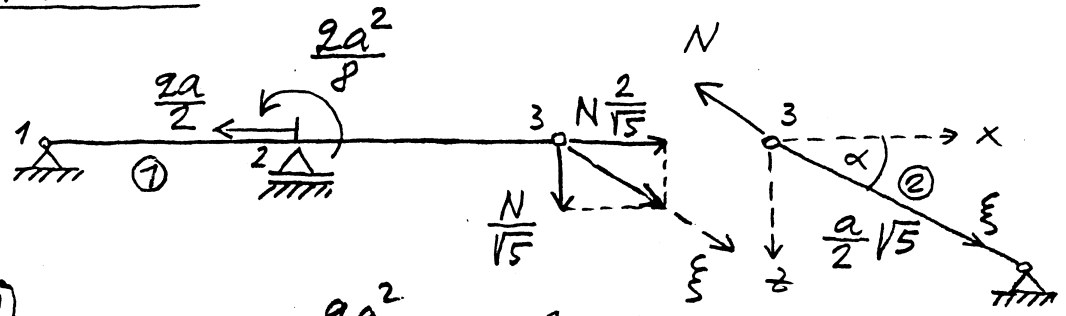
$$\varepsilon_J = \frac{\sigma_J}{E_J} + \alpha_J \Delta T, \quad \varepsilon_A = \frac{\sigma_A}{E_A} + \alpha_A \Delta T$$

$$\varepsilon_J = \varepsilon_A \longrightarrow \frac{\sigma}{E_J} + \alpha_J \Delta T = \frac{\sigma}{E_J} + \alpha_A \Delta T$$

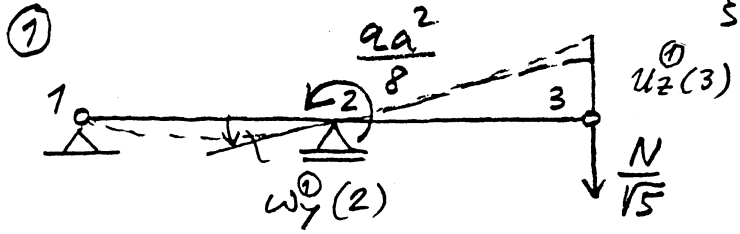
$$\Delta T(\alpha_A - \alpha_J) = \sigma\left(\frac{1}{E_J} - \frac{1}{E_A}\right)$$

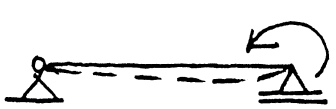
$$\Delta T = -\sigma \frac{E_J - E_A}{E_J E_A (\alpha_A - \alpha_J)} \longrightarrow \boxed{\Delta T = 50\ K}$$

Ad 2.)



$$e_{\xi x} = \frac{2}{\sqrt{5}}, \quad e_{\xi z} = \frac{1}{\sqrt{5}}$$





$$w_y^{①}(2) = \left(\frac{qa^2}{8} - \frac{Na}{\sqrt{5}}\right) \cdot \frac{a}{3EI_y}$$

$$u_z^{①}(3) = -w_y^{①}(2) \cdot a + \frac{N}{\sqrt{5}} \cdot \frac{a^3}{3EI_y}$$

$$\boxed{u_z^{①}(3) = -\frac{qa^4}{24EI_y} + \frac{2Na^3}{3\sqrt{5}EI_y}}$$

$$\boxed{u_z^{①}(3) = -9{,}64286 + 0{,}19166\,N}$$

$$u_z^{①}(3) = -1\,cm \longrightarrow \boxed{N = 45{,}095\,kN}$$

$$\boxed{u_x^{①}(3) = \frac{2N}{\sqrt{5}} \cdot \frac{2a}{EA_x} - \frac{qa}{2} \cdot \frac{a}{EA_x}}$$

$$u_x^{①}(3) = 0{,}03841 - 0{,}08571 = -0{,}04730$$

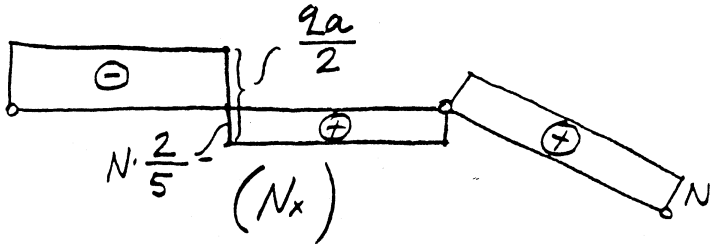
② $$\boxed{u_\xi^{②}(3) = -\frac{Na\sqrt{5}}{2EA_v}} \longrightarrow \boxed{u_\xi^{②}(3) = -\frac{0{,}72024}{A_v}}$$

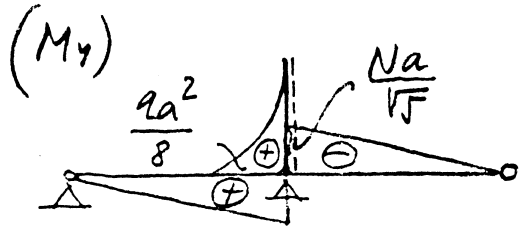
V stičišču 3: $$\boxed{u_x^{①} e_{\xi x} + u_z^{①} e_{\xi z} = u_\xi^{②}}$$

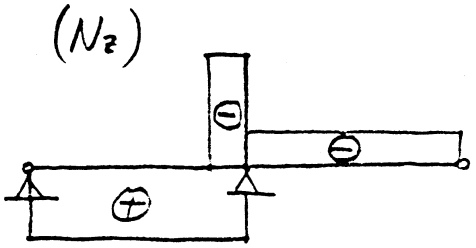
$$-0,04730 \cdot \frac{2}{\sqrt{5}} + \left(-9,64286 + 0,19166 \cdot 45,095\right) \cdot \frac{1}{\sqrt{5}} = -\frac{0,72024}{A_v}$$

$$-0,04231 - 4,31242 + 3,86520 = -\frac{0,72024}{A_v}$$

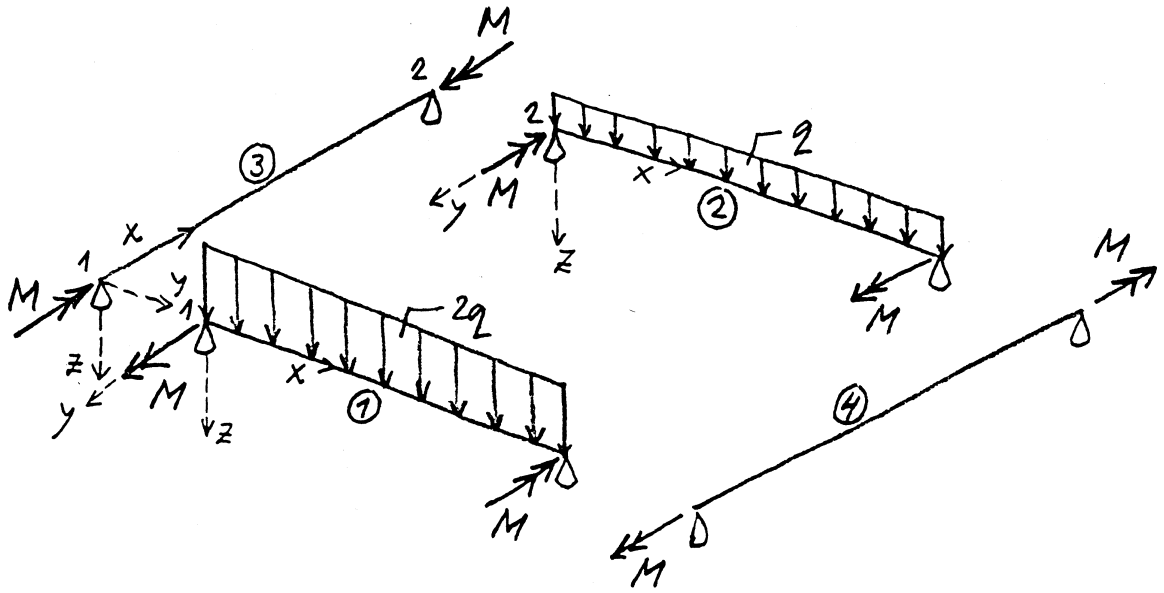
$$\boxed{A_v = 1,47 \text{ cm}^2}$$



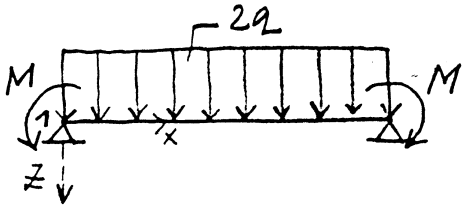




Ad 3.)

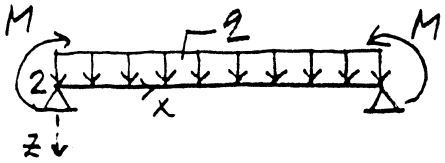


①



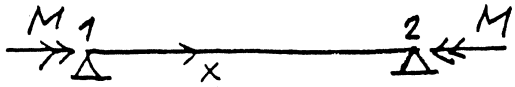
$$\omega_y^{①}(1) = \frac{Ma}{2EI_y} - \frac{2qa^3}{24EI_y}$$

②



$$\omega_y^{②}(2) = -\frac{Ma}{2EI_y} - \frac{qa^3}{24EI_y}$$

③



$$M_x = -M$$

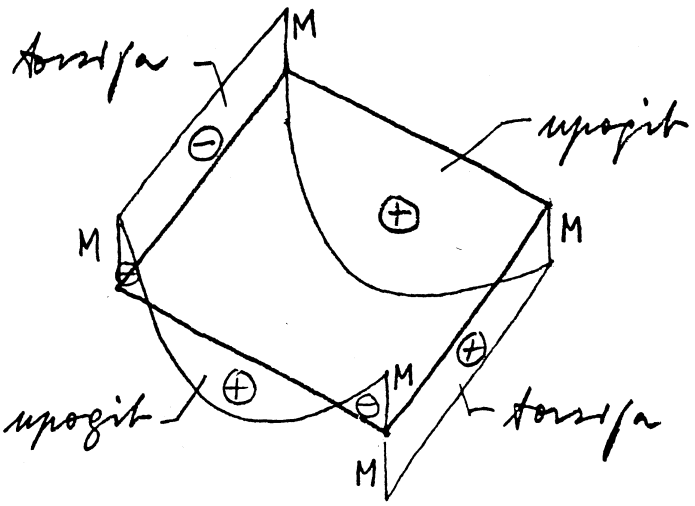
$$\frac{d\omega_x}{dx} = \frac{M_x}{GI_x} = -\frac{M}{GI_x} \longrightarrow \omega_x^{③} = -\frac{Mx}{GI_x} + C_1$$

$$x=0 \ldots \omega_x^{③}(1) = -\omega_y^{①}(1) \longrightarrow C_1 = -\omega_y^{①}(1)$$

$$x=a \ldots \omega_x^{③}(2) = -\omega_y^{①}(1) - \frac{Ma}{GI_x} = -\omega_y^{②}(2)$$

$$\frac{Ma}{2EI_y} - \frac{2qa^3}{24EI_y} + \frac{Ma}{GI_x} = -\frac{Ma}{2EI_y} - \frac{2a^3}{24EI_y}$$

$$\boxed{M = \frac{2a^2}{48}}$$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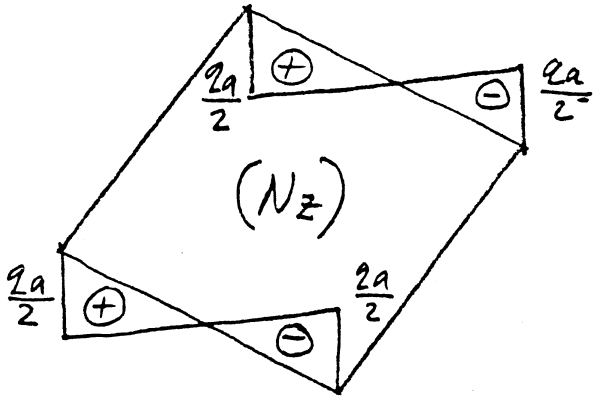
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