

$$\bar{\psi}_t = -0,0006$$

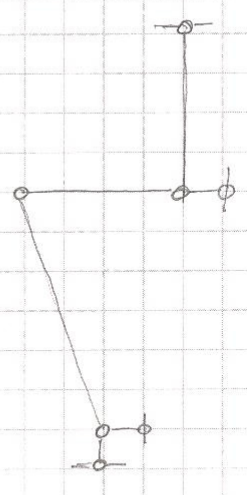
$$M = -360 \text{ kNm}$$

$$t_s = 21^\circ\text{C}$$

$$EJ = 162000 \text{ kNm}^2$$

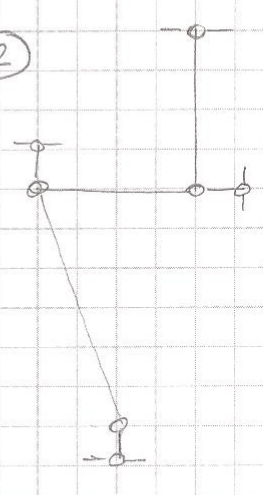
$$\alpha_t = 10^{-5} \text{ K}^{-1}$$

①



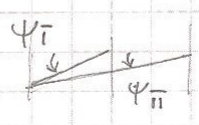
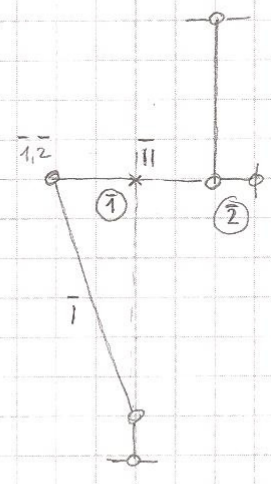
NEP.:
 $\psi_2,$
 u_1, u_{23}

②



NEP.:
 $\psi_2,$
 u_{23}, w_2

①



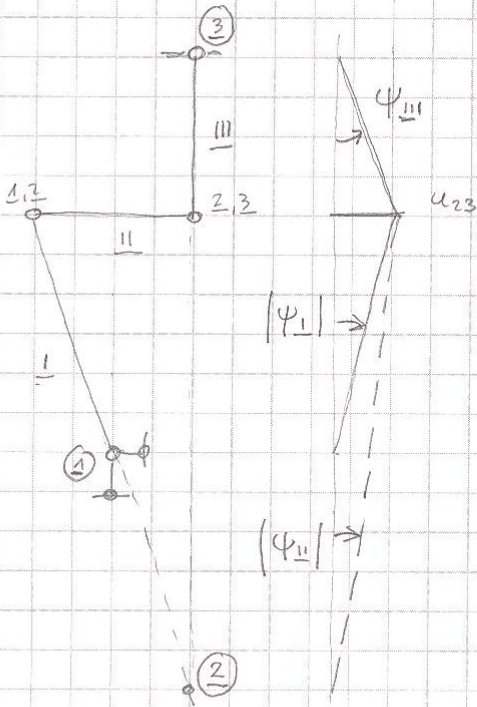
$$\psi_I = \frac{u_1}{3} = \psi_{12}$$

$$\psi_{II} = \frac{1}{2} \psi_I = \frac{u_1}{6} = \psi_{23}$$

$$\delta \psi_{12} = \frac{\delta u_1}{3}$$

$$\psi_{12}^{(1)} = \frac{1}{3}$$

$$\psi_{23}^{(1)} = \frac{1}{6}$$



$$\psi_I = -\frac{u_{23}}{3} = \psi_{12}$$

$$\psi_{II} = -\frac{u_{23}}{6} = \psi_{23}$$

$$\psi_{III} = \frac{u_{23}}{2} = \psi_{34}$$

$$\delta k_{12} = -\frac{\delta u_{23}}{3}$$

$$\psi_{12}^{(1)} = -\frac{1}{3}$$

$$\psi_{23}^{(1)} = -\frac{1}{6}$$

$$\psi_{34}^{(1)} = \frac{1}{2}$$

$$\psi_{12} = \psi_{12} + \psi_{12} = \frac{u_1}{3} - \frac{u_{23}}{3}$$

$$\psi_{23} = \psi_{23} + \psi_{23} = \frac{u_1}{6} - \frac{u_{23}}{6}$$

$$\psi_{34} = \psi_{34} + \psi_{34} = \frac{u_{23}}{2}$$

u

$$M_{12} = 2k_{12} \psi_2 - 6k_{12} \psi_{12} + \bar{M}_{12} = 2k_{12} \psi_2 - 6k_{12} \left(\frac{u_1}{3} - \frac{u_{23}}{3} \right) + \bar{M}_{12}$$

$$M_{21} = 4k_{12} \psi_2 - 6k_{12} \psi_{12} + \bar{M}_{21} = 4k_{12} \psi_2 - 6k_{12} \left(\frac{u_1}{3} - \frac{u_{23}}{3} \right) + \bar{M}_{21}$$

$$M_{23}^c = 3k_{23} \psi_2 - 3k_{23} \psi_{23} + \bar{M}_{23}^c = 3k_{23} \psi_2 - 3k_{23} \left(\frac{u_1}{6} - \frac{u_{23}}{6} \right) + \bar{M}_{23}^c$$

$$\bar{M}_{43}^c = -3k_{34} \psi_{34} + \bar{M}_{43}^c = -3k_{34} \frac{u_{23}}{2} + \bar{M}_{43}^c$$

$$M_{12} = 2k_{12} \varphi_2 - 2k_{12} u_1 + 2k_{12} u_{23} + \overline{M}_{12}$$

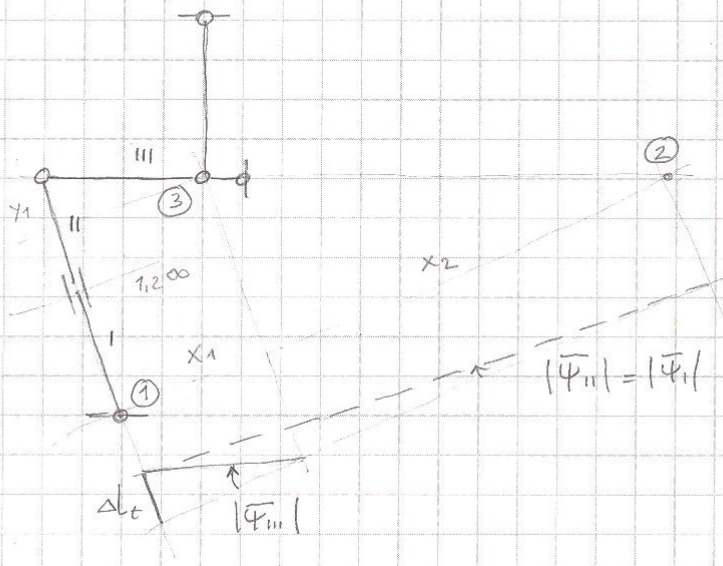
$$M_{21} = 4k_{12} \varphi_2 - 2k_{12} u_1 + 2k_{12} u_{23} + \overline{M}_{21}$$

$$M_{23}^c = 3k_{23} \varphi_2 - \frac{1}{2} k_{23} u_1 + \frac{1}{2} k_{23} u_{23} + \overline{M}_{23}^c$$

$$M_{43}^c = -\frac{3}{2} k_{34} u_{23} + \overline{M}_{43}^c$$

$$k_{12} = \frac{2EJ}{l_{12}} = \frac{2EJ}{\sqrt{10}} = \sqrt{\frac{2}{5}} EJ = 102458 \text{ kNm}^2$$

$$k_{23} = k_{34} = \frac{EJ}{2} = 81000 \text{ kNm}^2$$



$$\frac{x_1}{2} = \frac{3}{l_{12}} \quad x_1 = \frac{6}{l_{12}}$$

$$\frac{y_1}{x_1} = \frac{1}{3}$$

$$\frac{x_1 + x_2}{x_1} = \frac{l_{12}}{y_1}$$

$$x_1 + x_2 = \frac{x_1}{y_1} l_{12} = 3 l_{12}$$

$$\overline{\Psi}_{III} = -\frac{\Delta l_t}{x_1} = \overline{\Psi}_{23} = -0,00035$$

$$\overline{\Psi}_I = -\frac{\Delta l_t}{3 l_{12}} = \overline{\Psi}_{12} = -0,00007$$

$$\Delta l_t = \alpha_t \cdot t_s \cdot l_{12} = 10^{-5} \cdot 21 \cdot \sqrt{10} = 0,000664$$

$$\bar{M}_{12}^t = \bar{M}_{21}^t = -6k_{12} \bar{\psi}_{12} = -6 \cdot 102458 \cdot (-0,0007) = 43,03 \text{ kNm}$$

$$\bar{M}_{23}^t = -3k_{23} \bar{\psi}_{23} = -3 \cdot 81000 \cdot (-0,00035) = 85,05 \text{ kNm}$$

$$\bar{M}_{43}^d = 3k_{34} \bar{\psi}_{43} = -145,8 \text{ kNm}$$

$$\bar{M}_{23}^M = \bar{M}_{23}^{M,nc} - \frac{1}{2} \bar{M}_{32}^{M,nc} = \frac{M}{4} - \frac{1}{2} \frac{M}{4} = \frac{M}{8} = -45 \text{ kNm}$$

$$\bar{M}_{23} = \bar{M}_{23}^t + \bar{M}_{23}^M = 40,05 \text{ kNm}$$

RAUNOŠTERA MOMENATA U (2):

$$-M_{21} - M_{23} = 0 \Rightarrow M_{21} + M_{23} = 0$$

$$[4k_{12} \psi_2 - 2k_{12} u_1 + 2k_{12} u_{23} + \bar{M}_{21}] + [3k_{23} \psi_2 - \frac{1}{2} k_{23} u_1 + \frac{1}{2} k_{23} u_{23} + \bar{M}_{23}] = 0$$

$$(4k_{12} + 3k_{23}) \psi_2 + (-2k_{12} - \frac{1}{2} k_{23}) u_1 + (2k_{12} + \frac{1}{2} k_{23}) u_{23} = -\bar{M}_{21} - \bar{M}_{23}$$

$$\boxed{652831 \psi_2 - 245416 u_1 + 295416 u_{23} = -83,08} \quad (1)$$

RAO NA ψ_{41} :

$$(M_{12} + M_{21}) \psi_{12}^{(1)} + M_{23} \psi_{23}^{(1)} + M_{43} \psi_{34}^{(1)} + M \psi_{23}^{(1)} = 0$$

$$(6k_{12} \psi_2 - 4k_{12} u_1 + 4k_{12} u_{23} + \bar{M}_{12} + \bar{M}_{21}) \cdot \frac{1}{3}$$

$$+ (3k_{23} \psi_2 - \frac{1}{2} k_{23} u_1 + \frac{1}{2} k_{23} u_{23} + \bar{M}_{23}) \cdot \frac{1}{6} + M \cdot \frac{1}{6} = 0$$

$$(2k_{12} + \frac{1}{2} k_{23}) \psi_2 - (\frac{4}{3} k_{12} + \frac{1}{12} k_{23}) u_1 + (\frac{4}{3} k_{12} + \frac{1}{12} k_{23}) u_{23} = -\frac{1}{3} (\bar{M}_{12} + \bar{M}_{21}) - \frac{1}{6} (\bar{M}_{23} + M)$$

-360

$$245416 \psi_2 - 143360 u_1 + 143360 u_{23} = 29,64$$

$$\boxed{-245416 \psi_2 + 143360 u_1 - 143360 u_{23} = -29,64} \quad (2)$$

RAD NA δu_{23} :

$$(M_{12} + M_{21}) \psi_{12}^{(1)} + M_{23} \psi_{23}^{(1)} + M_{43} \psi_{34}^{(1)} + M \psi_{23}^{(a)} = 0$$

$$\begin{aligned} & (6k_{12} \varphi_2 - 4k_{12} u_1 + 4k_{12} u_{23} + \bar{M}_{12} + \bar{M}_{21}) \left(-\frac{1}{3}\right) \\ & + (3k_{12} \varphi_2 - \frac{1}{2} k_{23} u_1 + \frac{1}{2} k_{23} u_{23} + \bar{M}_{13}) \left(-\frac{1}{6}\right) \\ & + \left(-\frac{3}{2} k_{34} u_{23} + \bar{M}_{43}\right) \cdot \frac{1}{2} + M \left(-\frac{1}{6}\right) = 0 \end{aligned}$$

$$-245\,416 \varphi_2 + 143\,360 u_1 - 204\,110 u_{23} = 48,26$$

$$\boxed{245\,416 \varphi_2 - 143\,360 u_1 + 204\,110 u_{23} = -48,26} \quad (3)$$

$$\varphi_2 = -0,0005383$$

$$u_1 = -0,002293$$

$$u_{23} = -0,0012$$

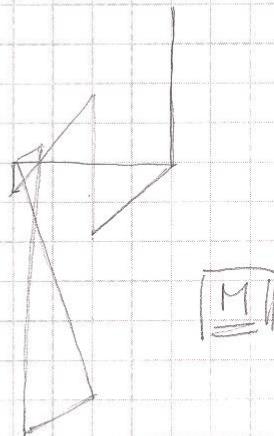
$$M_{12} = 2k_{12} (-0,0005383) - 2k_{12} (-0,002293) + 2k_{12} (-0,0012) + \bar{M}_{12}$$

$$M_{12} = 156,77$$

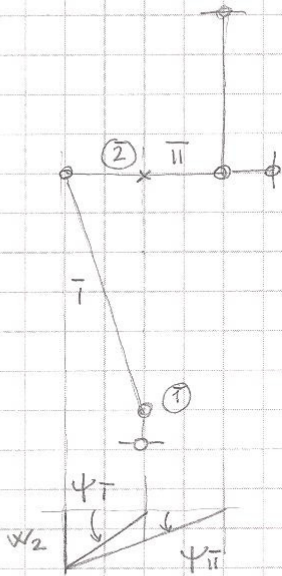
$$M_{21} = 46,47$$

$$M_{23} = -46,47$$

$$M_{43} = 0$$



(2)

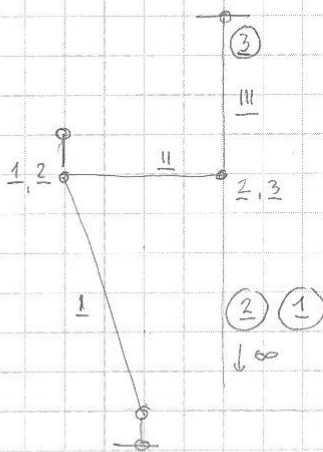


$$\psi_I = \frac{w_2}{1} = \psi_{12}$$

$$\psi_{II} = \frac{w_2}{2} = \psi_{23}$$

$$\psi_{12}^{(1)} = 1$$

$$\psi_{23}^{(1)} = \frac{1}{2}$$



$$\psi_{III} = \frac{u_{23}}{2} = \psi_{34}$$

$$\psi_{12} = \psi_{23} = 0$$

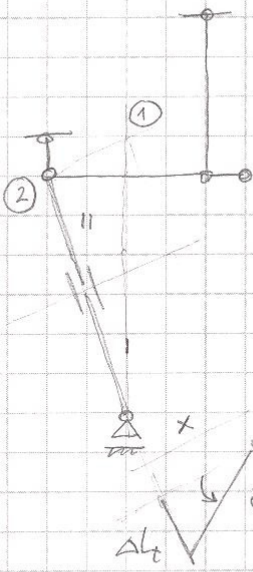
$$\psi_{34}^{(1)} = \frac{1}{2}$$

$$M_{12} = 2k_{12} \varphi_2 - 6k_{12} \psi_{12} + \bar{M}_{12} = 2k_{12} \varphi_2 - 6k_{12} w_2 + \bar{M}_{12}$$

$$M_{21} = 4k_{12} \varphi_2 - 6k_{12} w_2 + \bar{M}_{21}$$

$$M_{23}^c = 3k_{23} \varphi_2 - 3k_{23} \psi_{23} + \bar{M}_{23}^c = 3k_{23} \varphi_2 - \frac{3}{2} k_{23} w_2 + \bar{M}_{23}^c$$

$$M_{43}^c = -3k_{34} \psi_{34} + \bar{M}_{43}^c = -\frac{3}{2} k_{34} u_{23} + \bar{M}_{43}^c$$



$$\frac{x}{1} = \frac{L_{12}}{3} \quad x = \frac{L_{12}}{3}$$

$$\bar{\Psi}_1 = \bar{\Psi}_{12} = \frac{\Delta L_t}{x} = \frac{3\Delta L_t}{L_{12}} = 0,00063$$

$$\bar{M}_{12} = \bar{M}_{21} = -6 k_{12} \bar{\Psi}_{12} = -387,29 \text{ kNm}$$

$$\bar{M}_{13} = -145,8 \text{ kNm}$$

$$\bar{M}_{23} = -45 \text{ kNm}$$

RAVNOTEŽA MOMENATA U (2):

$$-M_{21} - M_{23} = 0$$

$$(4k_{12} \varphi_2 - 6k_{12} w_2 + \bar{M}_{21}) + (3k_{23} \varphi_2 - \frac{3}{2} k_{23} w_2 + \bar{M}_{23}) = 0$$

$$(4k_{12} + 3k_{23}) \varphi_2 + (-6k_{12} - \frac{3}{2} k_{23}) w_2 = -\bar{M}_{21} - \bar{M}_{23}$$

$$652\,832 \varphi_2 - 736\,248 w_2 = 432,29 \quad (1)$$

RAD NA δw_2 :

$$(M_{12} + M_{21}) \varphi_{12}^{(1)} + M_{23} \varphi_{23}^{(1)} + M \varphi_{23}^{(1)} = 0$$

$$(6k_{12} \varphi_2 - 12k_{12} w_2 + \bar{M}_{12} + \bar{M}_{21}) \cdot 1$$

$$+ (3k_{23} \varphi_2 - \frac{3}{2} k_{23} w_2 + \bar{M}_{23}) \cdot \frac{1}{2} + M \cdot \frac{1}{2} = 0$$

$$(6k_{12} + \frac{3}{2} k_{23}) \varphi_2 + (-12k_{12} - \frac{3}{4} k_{23}) w_2 = -\bar{M}_{12} - \bar{M}_{21} - \frac{1}{2} \bar{M}_{23} - \frac{1}{2} M$$

$$736\,248 \varphi_2 - 1290\,250 w_2 = 977,08 \quad (2)$$

RAD NA δu_{23} :

$$M_{43} \cdot \psi_{39}^{(1)} = 0$$

$$\left(-\frac{3}{4} k_{39} u_{23} + M_{43}\right) \cdot \frac{1}{2} = 0$$

$$\boxed{-60750 u_{23} = 72,9} \quad (3)$$

$$u_{23} = -0,0012 \quad |z (3)$$

$$\left. \begin{aligned} \psi_2 &= -0,0005382 \\ w_2 &= -0,001064 \end{aligned} \right\} |z (1), (2)$$

ITD.