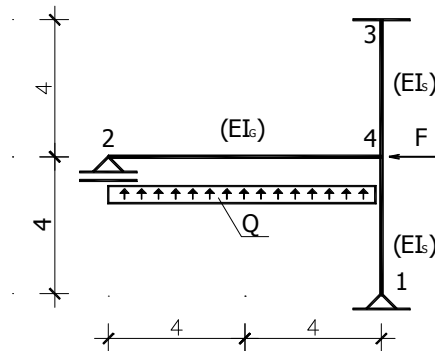
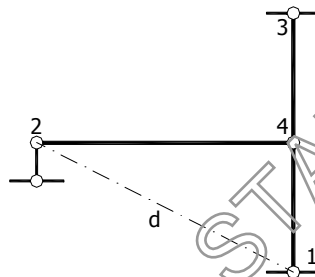


1. Tehničkom metodom pomaka riješiti dani sustav, te nacrtati M, T i N dijagrame.

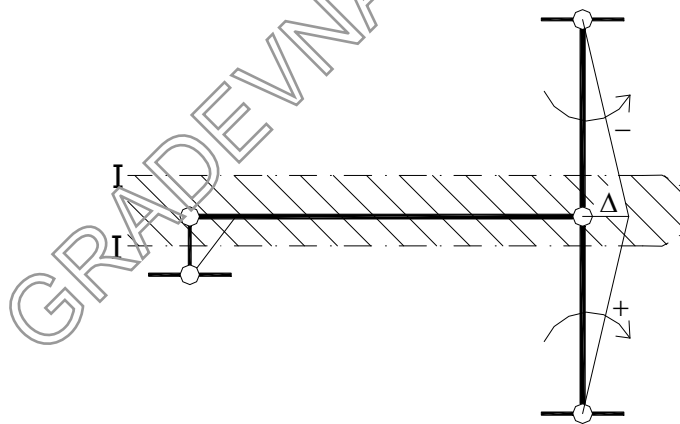


Opterećenje koje djeluje na konstrukciju je $F=20\text{kN}$ i $Q=10\text{kN/m}$. Momenti tromosti su u odnosu $2I_G=I_S$, dok je Youngov modul elastičnosti $E=\text{const}$.

Zglobna shema ovog sustava je:



a shema pomjeranja izgleda:



tako da su nepoznate:

-kut zaokreta φ_4 i pomjeranje Δ .

Odredimo sada krutosti pojedinih čipova:

$$K_{42} = K_{\text{greda}} = \frac{2EI}{\ell} = \frac{2EI_G}{8} = \frac{EI_G}{4} = K$$

$$K_{41} = K_{43} = K_{\text{stupa}} = \frac{2EI_S}{4} = \frac{4EI_G}{4} = 4K$$

Postavimo jednačbe iz kojih odredimo nepoznati kut zaokreta φ_4 i pomjeranje Δ .

$$\varphi_4 \longrightarrow \sum M_4 = 0$$

$$\Delta \longrightarrow \sum X^{I-I} = 0$$

$$\sum M_4 = 0$$

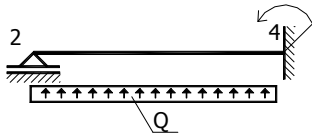
$$M_{41} + M_{42} + M_{43} = 0$$

$$M_{41} = ?$$



$$\begin{aligned} M_{41} &= K_{41}(1,5\varphi_4 - 1,5\Psi_{41}) + \bar{M}_{41}^0 = \\ &= 4K(1,5\varphi_4 - 1,5\frac{\Delta}{4}) = \\ &= 6K\varphi_4 - 1,5K\Delta \end{aligned}$$

$$M_{42} = ?$$



$$\begin{aligned} M_{42} &= K_{42}(1,5\varphi_4 - 1,5\Psi_{42}) + \bar{M}_{42}^0 = \\ &= 1,5K\varphi_4 - 80 \\ M_{42} &= -\frac{1}{8}Q\ell^2 = -80\text{kNm} \end{aligned}$$

$$M_{43} = ?$$



$$\begin{aligned} M_{43} &= K_{43}(2\varphi_4 + \varphi_3 - 3\Psi_{43}) + \bar{M}_{43}^0 = \\ &= 4K(2\varphi_4 + 3\frac{\Delta}{4}) = \\ &= 8K\varphi_4 - 3K\Delta \end{aligned}$$

$$\begin{aligned} M_{41} + M_{42} + M_{43} &= 0 \\ 6K\varphi_4 - 1,5K\Delta + 1,5K\varphi_4 - 80 + 8K\varphi_4 + 3K\Delta &= 0 \\ 15,5K\varphi_4 + 1,5K\Delta &= 80 \end{aligned} \tag{1.1}$$

$$\sum X^{I-1} = 0$$

$$\sum R_0 - \sum \frac{M_i + M_k}{\ell_{ik}} = T$$

$$R_0 = 0 \quad T = -20$$

$$\sum \frac{M_i + M_k}{\ell_{ik}} = \frac{M_{14} + M_{41}}{4} - \frac{M_{34} + M_{43}}{4}$$

$$\begin{aligned} M_{34} &= K_{34}(2\varphi_3 + \varphi_4 - 3\Psi_{34}) + \bar{M}_{34}^0 = \\ &= 4K(\varphi_4 + 3\frac{\Delta}{4}) = 4K\varphi_4 + 3K\Delta \end{aligned}$$

$$\begin{aligned} \sum \frac{M_i + M_k}{\ell_{ik}} &= \frac{6K\varphi_4 - 1,5K\Delta}{4} - \frac{4K\varphi_4 + 3K\Delta + 8K\varphi_4 + 3K\Delta}{4} = \\ &= \dots = -1,5K\varphi_4 - 1,875K\Delta \end{aligned}$$

Nakon uvrštavanja dobivamo:

$$1,5K\varphi_4 + 1,875K\Delta = -20 \tag{1.2}$$

Dobili smo sustav dvije jednačbe s dvije nepoznate:

$$15,5K\varphi_4 + 1,5 K\Delta = 80$$

$$1,5 K\varphi_4 + 1,875K\Delta = -20$$

Rješenje sustava: $\Delta = -\frac{16,04}{K}$ $\varphi_4 = \frac{6,71}{K}$

Vrijednosti momenata su:

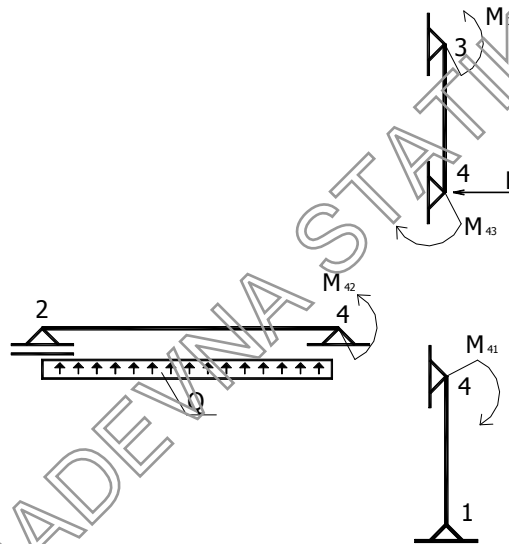
$$M_{41} = 6K\varphi_4 - 1,5K\Delta = 64,32 \text{ kNm}$$

$$M_{42} = 1,5K\varphi_4 - 80 = -69,935 \text{ kNm}$$

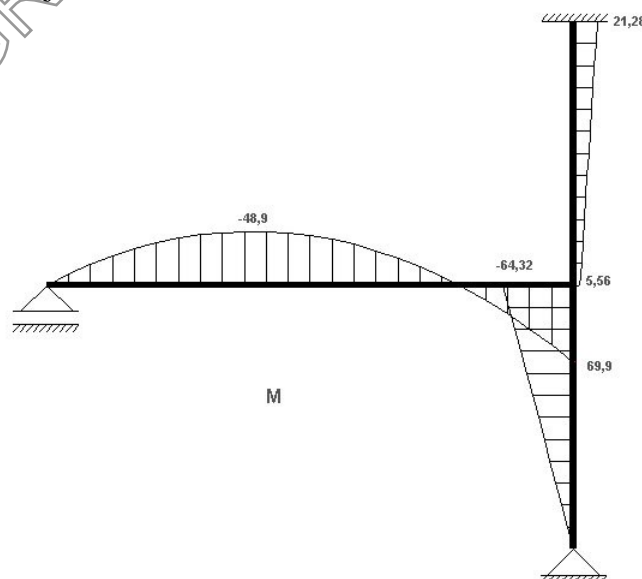
$$M_{43} = 8K\varphi_4 + 3K\Delta = 5,56 \text{ kNm}$$

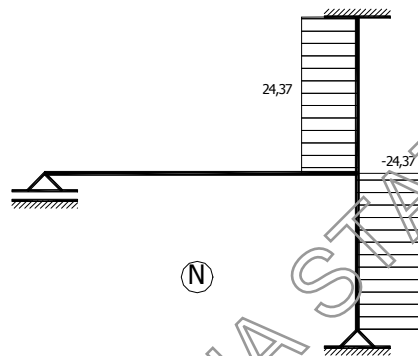
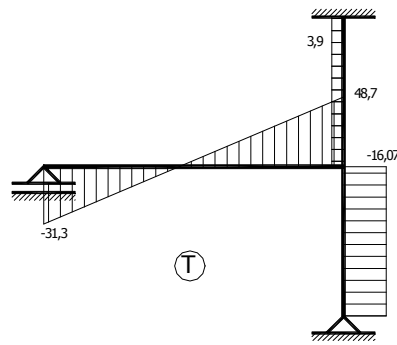
$$M_{34} = 4K\varphi_4 + 3K\Delta = -21,28 \text{ kNm}$$

Dijagrame M, T i N crtamo na osnovu presječnih veličina dobivenih rješavanjem sustava prostih greda opterećenih momentima (nanosimo ih na grede u skladu sa predznacima usvojenim za ovu metodu) i vanjskim opterećenjem, a kao na donjem crtežu:



Dijagrami izgledaju:





GRADEVNA STATIKA II