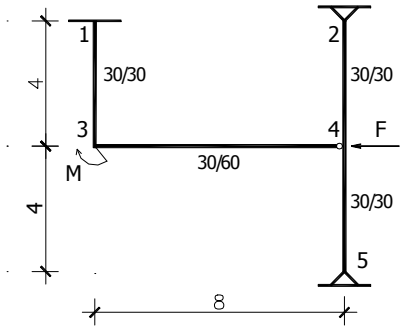
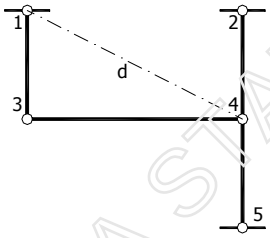
2 Tehni□kom metodom pomaka rije□iti dani sustav, te nacrtati M dijagram.

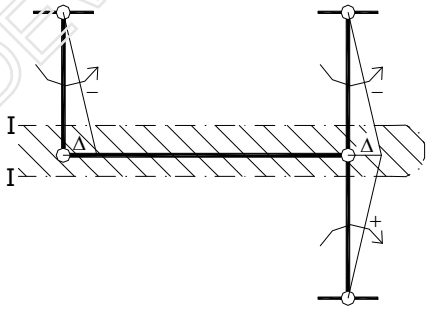


Optere□enje koje djeluje na konstrukciju je F=20kN i M=20kNm. Momenti tromosti greda i stubova zadani su na crtežu preko odnosa visine i □irine popre□nog presjeka b/h, dok je Youngov modul elasti□nosti E=const.

Zglobna shema ovog sustava je:



a ***shema pomjeranja*** izgleda:



tako da su nepoznate:

-kutovi zaokreta φ_3, φ_4 i pomjeranje Δ.

Odredimo sada krutosti pojedinih □tapova:

$$I_G = \frac{0,3\cdot 0,6^3}{12}, I_S = \frac{0,3\cdot 0,3^3}{12} \Rightarrow \frac{I_G}{I_S} = 8 \Rightarrow I_G = 8\cdot I_S$$

$$K_{greda} = \frac{2EI}{\ell} = \frac{2EI_G}{8} = \frac{2E\cdot 8I_S}{8}\cdot\frac{4}{4} = 4K$$

$$K_{stupa} = \frac{2EI}{\ell} = \frac{2EI_S}{4} = K$$

Postavimo jednadžbe iz kojih odre□ujemo nepoznate kutove zaokreta φ_3, φ_4 i pomjeranje Δ.

GRADEVNA STATIKA II

$$\varphi_3 \longrightarrow \sum M_3 = 20$$

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

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

$$\sum M_3 = 20$$

$$M_{31} + M_{34} = 20$$

$M_{31} = ?$

$$M_{31} = K_{31}(2\varphi_3 + \varphi_1 - 3\Psi_{31}) + \overline{M}^0_{31} =$$
$$= K(2\varphi_3 - 3\frac{(-\Delta)}{4}) =$$
$$= 2K\varphi_3 + 0,75K\Delta$$

$M_{34} = ?$

$$M_{34} = K_{34}(1,5\varphi_3 - 1,5\Psi_{34}) + \overline{M}^0_{34} =$$
$$= 4K(1,5\varphi_3) = 6K\varphi_3$$

Nakon uvr□tavanja, dobit □emo prvu jednadžbu:

$$M_{31} + M_{34} = 20$$
$$2K\varphi_3 + 0,75K\Delta + 6K\varphi_3 = 20$$
$$8K\varphi_3 + 0,75K\Delta = 20$$

Drugi uvjet je:

$$\sum M_4 = 0$$

$$M_{42} + M_{45} = 0$$

$M_{42} = ?$

$$M_{42} = K_{42}(1,5\varphi_4 - 1,5\Psi_{42}) + \overline{M}^0_{42} =$$
$$= K(1,5\varphi_4 - 1,5\frac{(-\Delta)}{4}) =$$
$$= 1,5K\varphi_4 + 0,375K\Delta$$

$M_{45} = ?$

$$M_{45} = K_{45}(1,5\varphi_4 - 1,5\Psi_{45}) + \overline{M}^0_{45} =$$
$$= K(1,5\varphi_4 - 1,5\frac{\Delta}{4})$$
$$= 1,5K\varphi_4 - 0,375K\Delta$$

Druga jednadžba je:

$$M_{42} + M_{45} = 0$$
$$1,5K\varphi_4 + 0,375K\Delta + 1,5K\varphi_4 - 0,375K\Delta = 0$$
$$3K\varphi_4 = 0 \Rightarrow \varphi_4 = 0$$

GRADEVNA STATIKA II

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

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

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

$$\sum \frac{M_i + M_k}{\ell_{ik}} = -\frac{M_{31} + M_{13}}{4} - \frac{M_{42} + M_{24}}{4} + \frac{M_{45} + M_{54}}{4}$$

$$M_{13} = K_{13}(2\varphi_1 + \varphi_3 - 3\Psi_{13}) + \overline{M}^0_{13} =$$
$$= K(\varphi_3 - 3\frac{(-\Delta)}{4}) = K\varphi_3 + 0,75K\Delta$$

$$\sum \frac{M_i + M_k}{\ell_{ik}} = \cdots = -0,75K\varphi_3 + 0,5625K\Delta$$

Nakon uvrštavanja dobivamo treću jednadžbu:

$$0,75K\varphi_3 + 0,5625K\Delta = -20$$

Budući smo iz druge jednadžbe dobili da je φ_4=0, sada dobijamo sustav dvije jednadžbe s dvije nepoznate:

$$8K\varphi_3 + 0,75\ K\Delta = \ 20$$
$$0,75K\varphi_3 + 0,5625K\Delta = -20$$

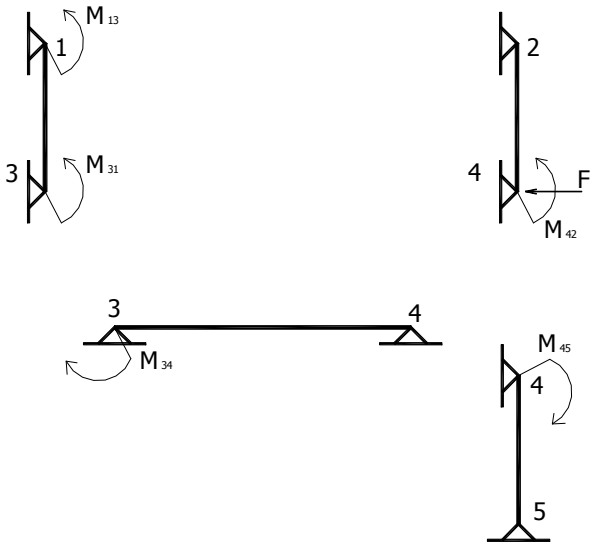
Rješenje sustava: $\Delta = -\frac{44,44}{K}$ $\qquad \varphi_3 = \frac{6,67}{K}$

Vrijednosti momenata su:

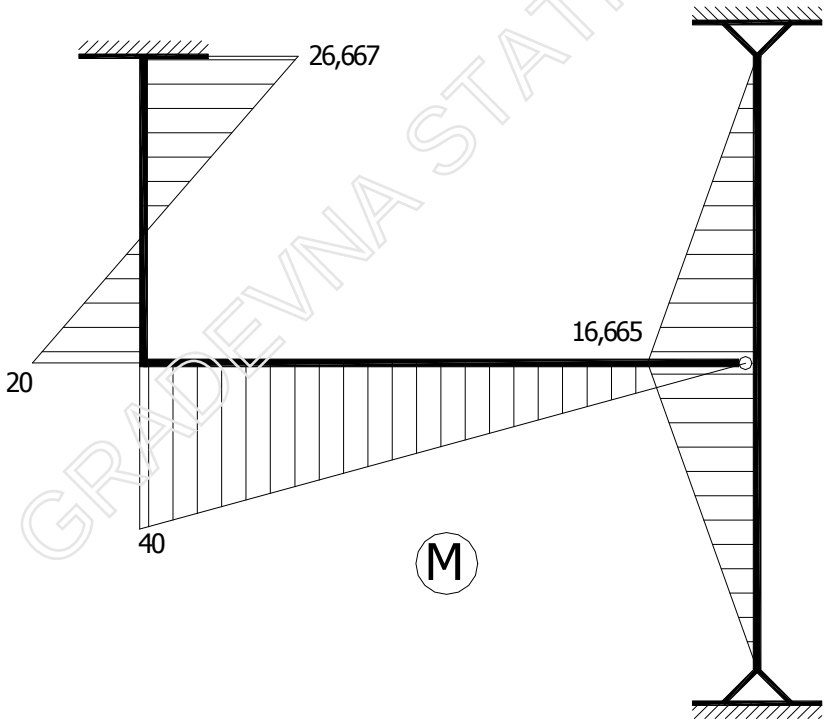
$$M_{13} = \cdots = -26,667 \text{ kNm}$$
$$M_{31} = \cdots = -20 \text{ kNm}$$
$$M_{34} = \cdots = 40 \text{ kNm}$$
$$M_{42} = \cdots = -16,665 \text{ kNm}$$
$$M_{45} = \cdots = 16,665 \text{ kNm}$$

Dijagram M 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:

GRAĐEVINA STATIKA II



Dijagrami izgledaju:



GRAĐEVNA STATIKA II