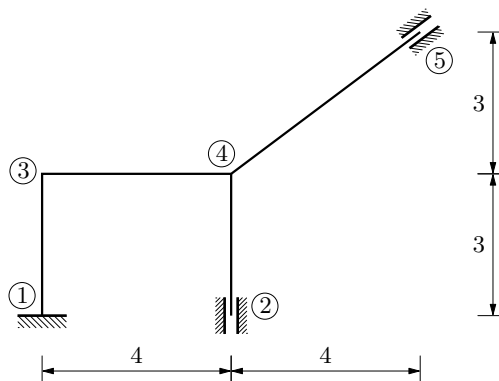


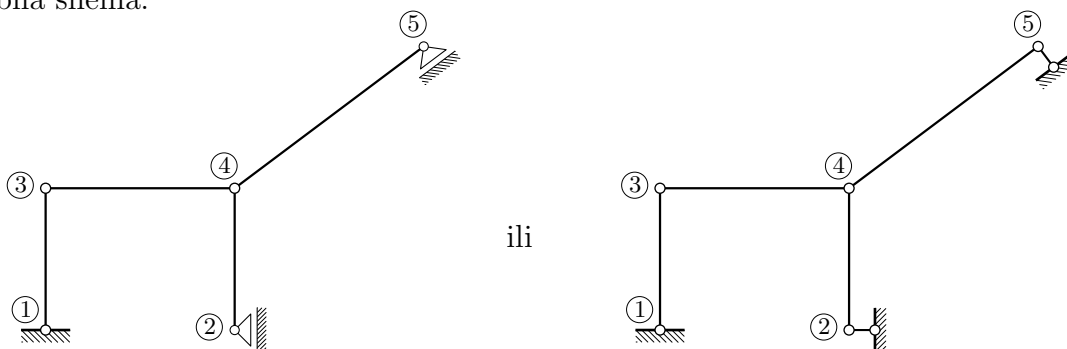
GS 2. — kolokvij (2023./2024.)

Zadatak A1.

Nabrojite nepoznanice za proračun prikazanoga sistema inženjerskom metodom pomakā! Za neovisne translacijske pomake skicirajte plan(ove) pomakā ili dijagram(e) projekcija pomakā!



zglobna shema:

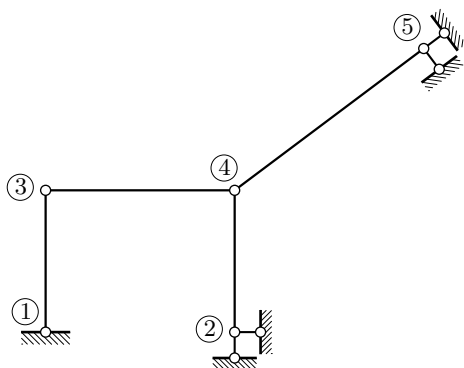


slobodni čvorovi: 2, 3, 4, 5

$$s_{\min} = 4 \cdot 2 - 6 = 2$$

dodavanje spojeva čvorova s podlogom (kinematička analiza zglobne sheme):

1.



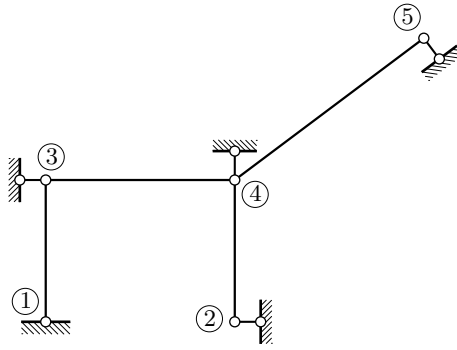
[čvor 1 – ležajni (nepomičan)]

čvorovi 2 i 5 nepomični

→ čvor 4 nepomičan

→ čvor 3 nepomičan

ili: 2.



[čvor 1 – ležajni]

čvor 3 nepomičan

→ čvor 4 nepomičan

→ čvorovi 2 i 5 nepomični

1. (ili 2.) $\Rightarrow s = s_{\min} = 2$

nepoznanice:

- $\varphi_3, \varphi_4, w_2$ i δ_5 (po kosom pravcu) ili u_5 (horizontalna komponenta)
ili w_5 (vertikalna komponenta)

(2 i 5 su „vodeći” čvorovi neovisnih pomaka; pomiču se, naravno, i drugi čvorovi)

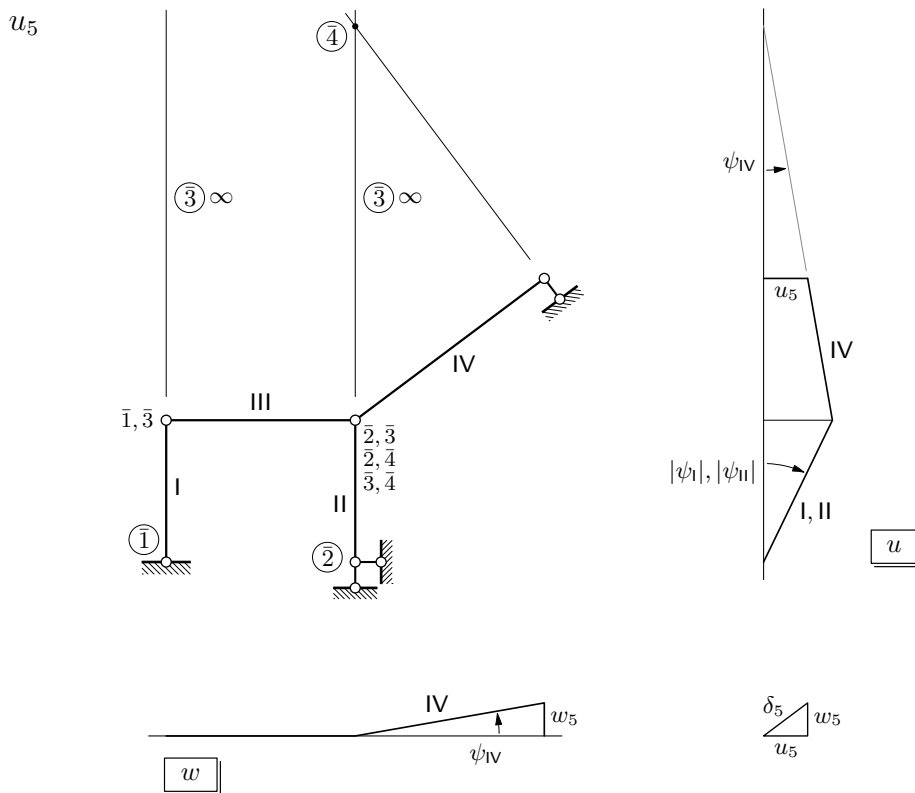
ili:

- $\varphi_3, \varphi_4, u_3$ i w_4

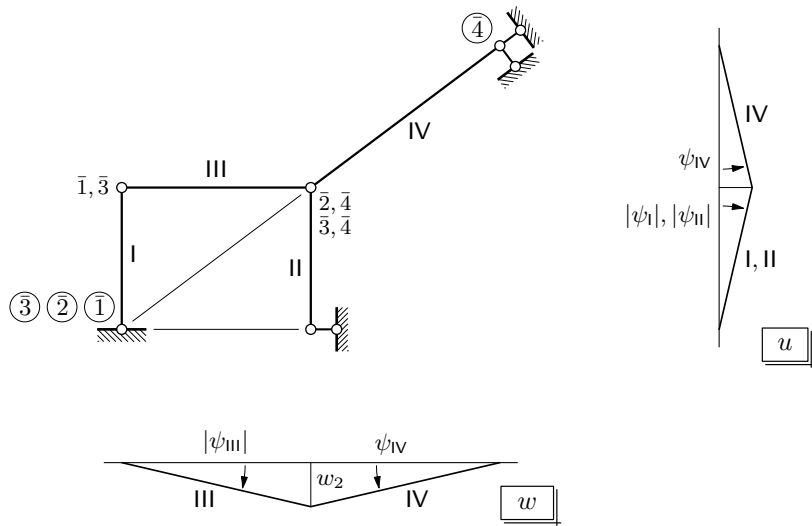
(3 i 4 su „vodeći” čvorovi neovisnih pomaka)

dijagrami projekcija pomakā:

1.



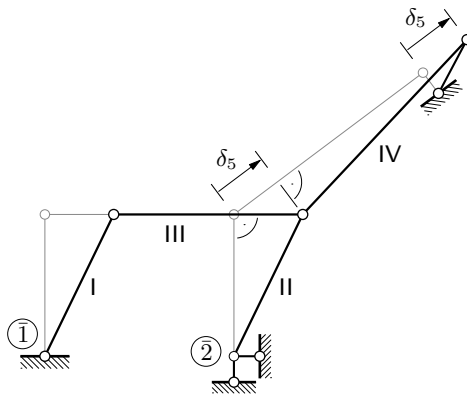
w_2



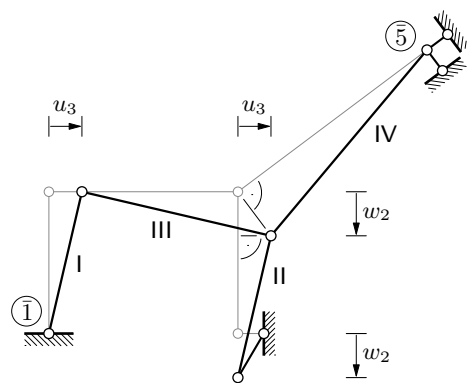
planovi pomakā:

1.

$\delta_5 (u_5)$

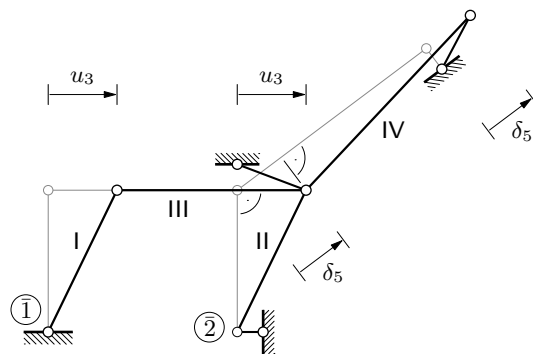


w_2

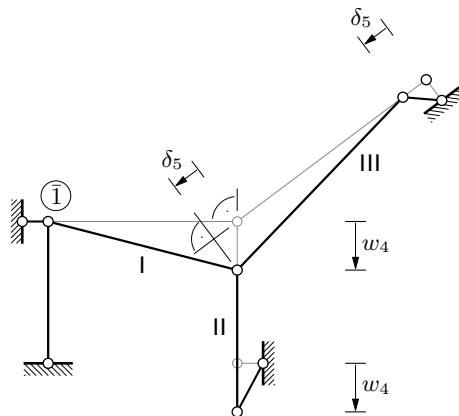


ili: 2.

u_3



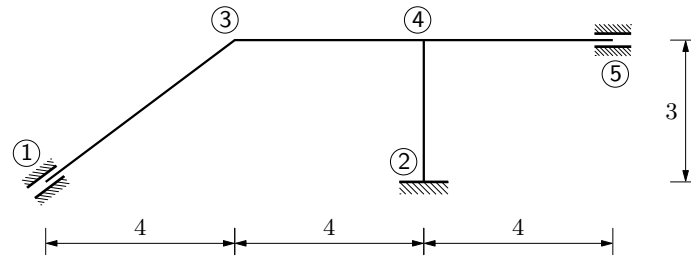
w_4



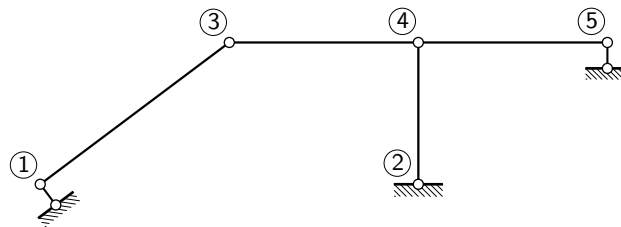
[Crtanje dijagrama projekcija pomakā za mehanizme iz kinematičke analize 2. ostavljam vam za domaću zabavu.]

Zadatak B1.

Nabrojite nepoznanice za proračun prikazanoga sistema inženjerskom metodom pomakā! Za neovisne translacijske pomake skicirajte plan(ove) pomakā ili dijagram(e) projekcija pomakā!



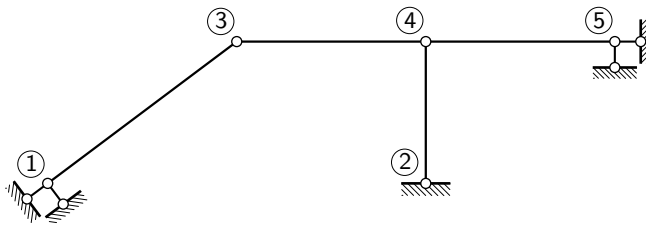
zglobna shema:



slobodni čvorovi: 1, 3, 4, 5

$$s_{\min} = 4 \cdot 2 - 6 = 2$$

dodavanje spojeva čvorova s podlogom (kinematička analiza zglobne sheme):



[čvor 2 – ležajni (nepomičan)]

čvor 5 nepomičan

→ čvor 4 nepomičan

čvorovi 1 i 4 nepomični

→ čvor 3 nepomičan

$$\Rightarrow s = s_{\min} = 2$$

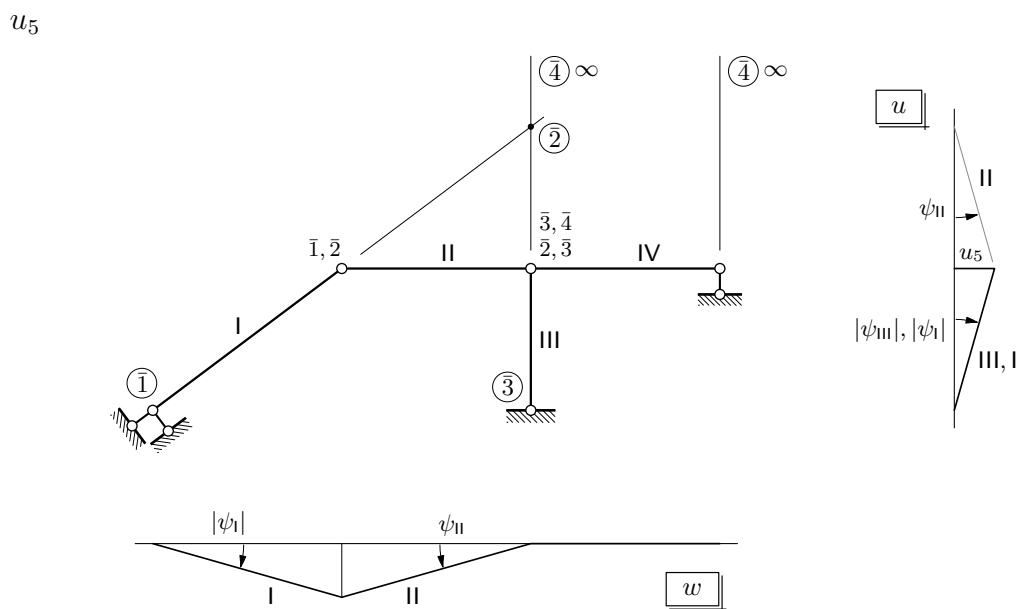
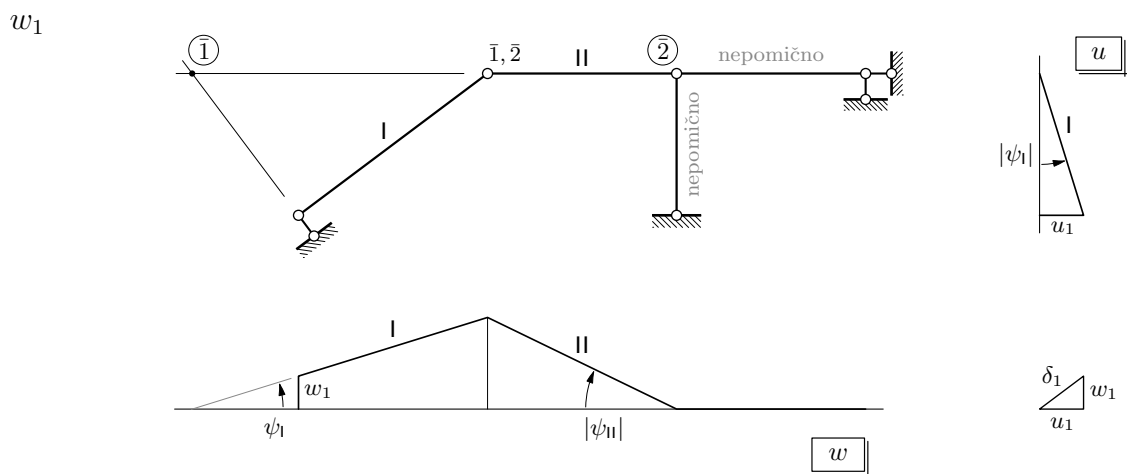
nepoznanice:

φ_3 , φ_4 , u_5 i δ_1 (po kosom pravcu) ili u_1 (horizontalna komponenta)

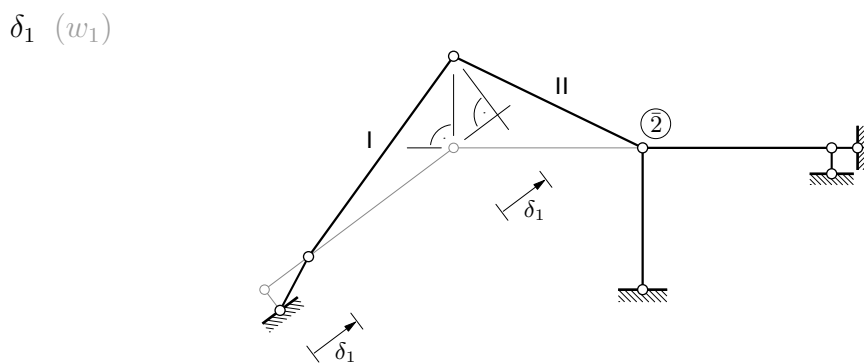
ili w_1 (vertikalna komponenta)

(1 i 5 su „vodeći” čvorovi neovisnih pomaka; pomiču se, naravno, i drugi čvorovi)

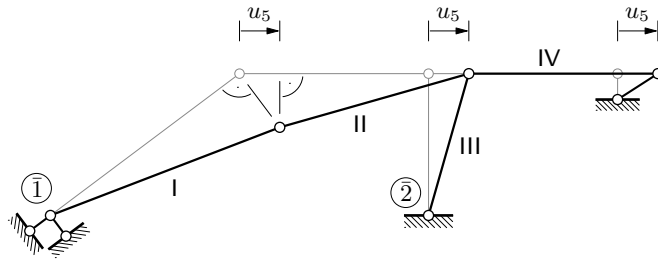
dijagrami projekcija pomakā:



planovi pomakā:



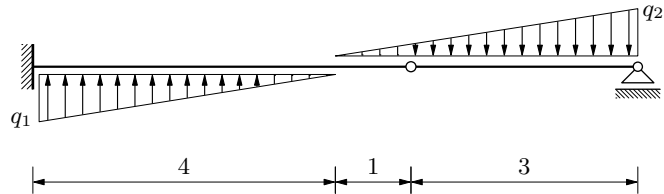
u_5



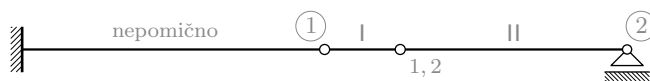
Zadatak A2.

Pomoću utjecajnih linija izračunajte vrijednosti momenta savijanja i poprečne sile u presjeku $x = 4!$ (Ishodište je u lijevom ležaju).

$$q_1 = q_2 = 75 \text{ kN/m'}$$

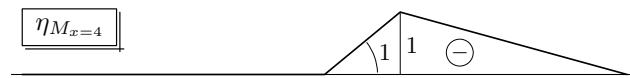


moment savijanja:



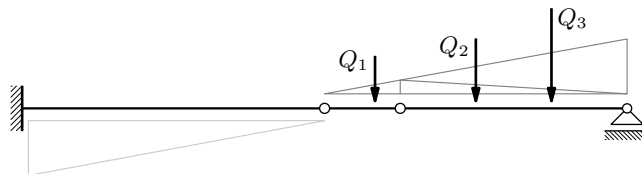
$$Q_1 = \frac{1}{2} \cdot \frac{75}{4} \cdot 1$$

$$= 9,375 \text{ kN}$$



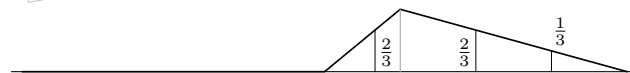
$$Q_2 = \frac{1}{2} \cdot \frac{75}{4} \cdot 3$$

$$= 28,125 \text{ kN}$$



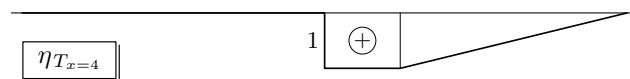
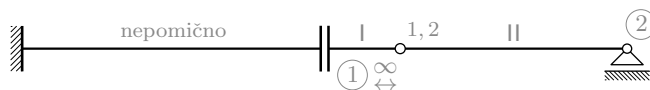
$$Q_3 = \frac{1}{2} \cdot 75 \cdot 3$$

$$= 112,5 \text{ kN}$$



$$M_{x=4} = 9,375 \cdot \left(-\frac{2}{3}\right) + 28,125 \cdot \left(-\frac{2}{3}\right) + 112,5 \cdot \left(-\frac{1}{3}\right) = -62,5 \text{ kNm}$$

poprečna sila:

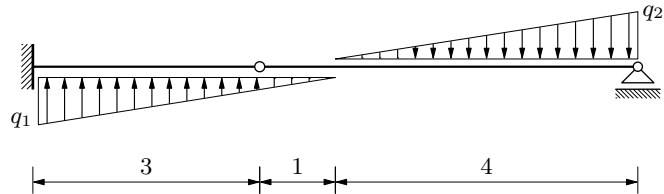


$$T_{x=4} = 9,375 \cdot 1 + 28,125 \cdot \frac{2}{3} + 112,5 \cdot \frac{1}{3} = 65,625 \text{ kN}$$

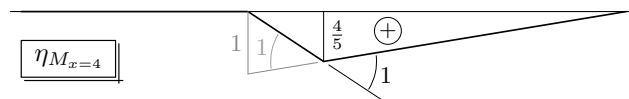
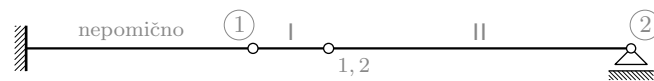
Zadatak B2.

Pomoću utjecajnih linija izračunajte vrijednosti momenta savijanja i poprečne sile u presjeku $x = 4$! (Ishodište je u lijevom ležaju).

$$q_1 = q_2 = 75 \text{ kN/m'}$$

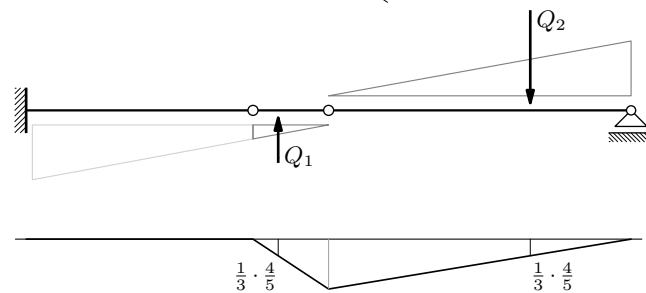


moment savijanja:



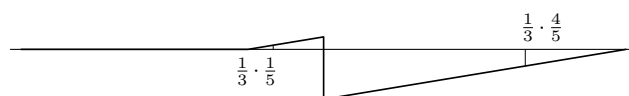
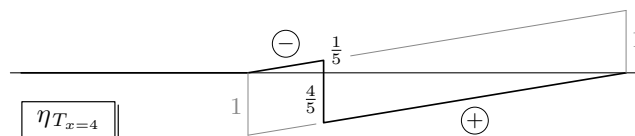
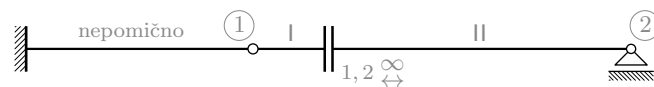
$$Q_1 = \frac{1}{2} \cdot \frac{75}{4} \cdot 1 = 9,375 \text{ kN}$$

$$Q_2 = \frac{1}{2} \cdot 75 \cdot 4 = 150 \text{ kN}$$



$$M_{x=4} = -9,375 \cdot \left(\frac{1}{3} \cdot \frac{4}{5}\right) + 150 \cdot \left(\frac{1}{3} \cdot \frac{4}{5}\right) = 37,5 \text{ kNm}$$

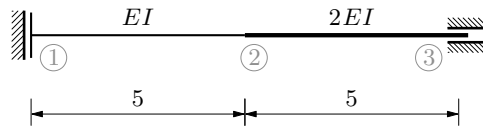
poprečna sila:



$$T_{x=4} = -9,375 \cdot \left(-\frac{1}{3} \cdot \frac{1}{5}\right) + 150 \cdot \left(\frac{1}{3} \cdot \frac{4}{5}\right) = 40,625 \text{ kN}$$

Zadatak A3.

Nacrtajte utjecajnu liniju za reaktivni moment u lijevom ležaju!



izbor metode crtanja momentnoga dijagrama:

inženjerska metoda pomakā: nepoznanice: $\varphi_2, w_1, w_2 \Rightarrow 3$ nepoznanice

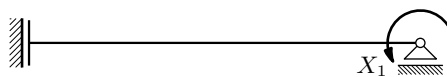
inženjerska metoda pomakā sa statičkom kondenzacijom:

nepoznanice: $\varphi_2, w_2 \Rightarrow 2$ nepoznanice

metoda sila: sistem je jedanput statički neodređen $\Rightarrow 1$ nepoznanica

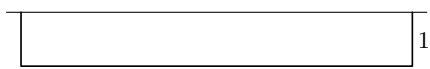
smisao vrtnje reaktivnoga momenta: \curvearrowright

metoda sila:



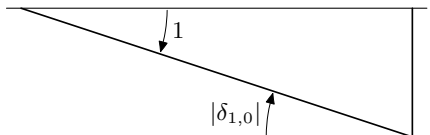
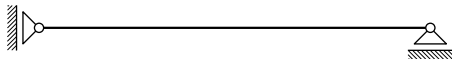
o. s.

$$\delta_{1,1} X_1 + \delta_{1,0} = 0$$



m_1

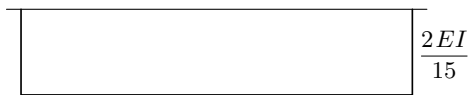
$$\begin{aligned} \delta_{1,1} &= \frac{1}{EI} (1 \cdot 5) \cdot 1 + \frac{1}{2EI} (1 \cdot 5) \cdot 1 \\ &= \frac{15}{2EI} \end{aligned}$$



w

$$\delta_{1,0} = -1$$

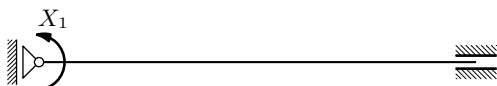
$$X_1 = \frac{2EI}{15}$$



M

$$M(x) = X_1 m_1(x)$$

ili (jednostavnije):



o. s.

$$\delta_{1,1} X_1 = \bar{\delta}_{1,0} = -1$$

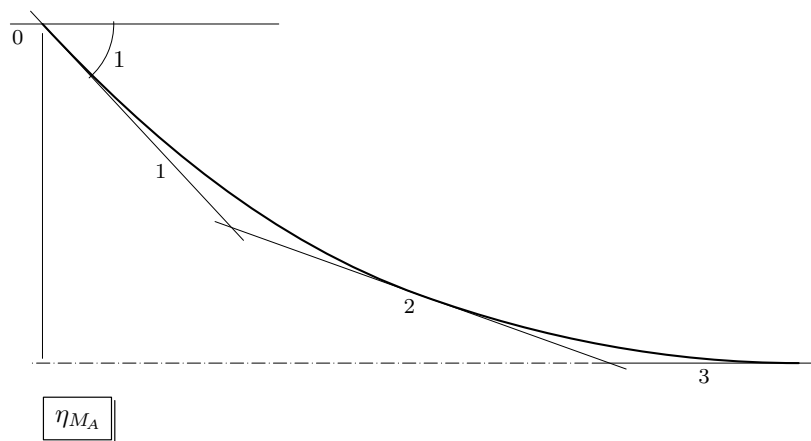
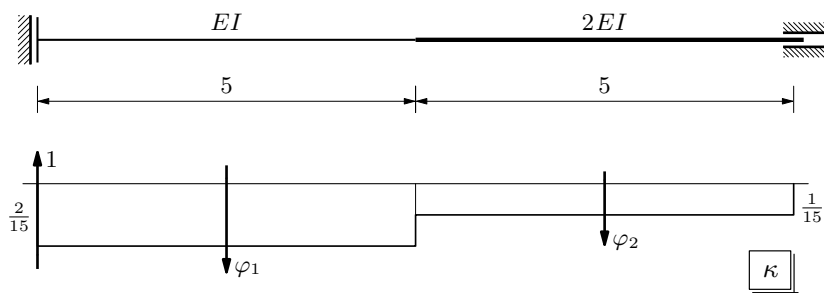


m_1

$$\delta_{1,1} = \frac{15}{2EI}$$

$$X_1 = -\frac{2EI}{15} \quad \text{\textcircled{E}td.}$$

utjecajna linija:

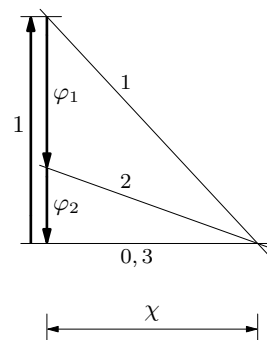


mjerilo duljina:

$$1 \text{ [cm]} :: 1 \text{ [m]}$$

mjerilo kutova:

$$1 \text{ [cm]} :: \frac{1}{3}$$



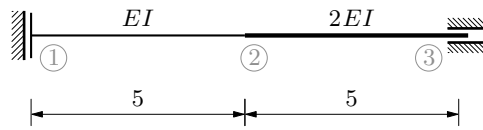
$$\varphi_1 = \frac{2}{15} \cdot 5 = \frac{2}{3}$$

$$\varphi_2 = \frac{1}{15} \cdot 5 = \frac{1}{3}$$

$$\chi = 1$$

Zadatak B3.

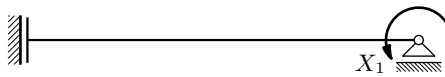
Nacrtajte utjecajnu liniju za reaktivni moment u desnom ležaju!



izbor metode crtanja momentnoga dijagrama: kao u A3

smisao vrtnje reaktivnoga momenta: \curvearrowright

metoda sila:



o. s.

$$\delta_{1,1} X_1 = \bar{\delta}_{1,0} = 1$$



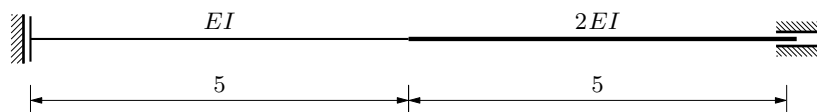
m_1

$$\begin{aligned} \delta_{1,1} &= \frac{1}{EI} (1 \cdot 5) \cdot 1 + \frac{1}{2EI} (1 \cdot 5) \cdot 1 \\ &= \frac{15}{2EI} \end{aligned}$$

$$X_1 = \frac{2EI}{15}$$

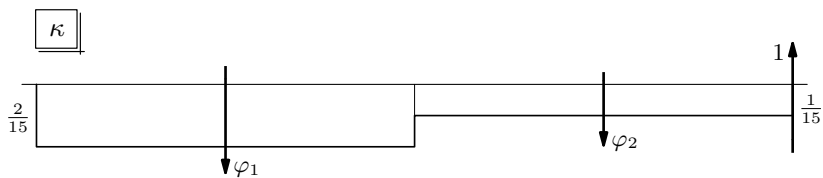
utjecajna linija na sljedećoj stranici

utjecajna linija:



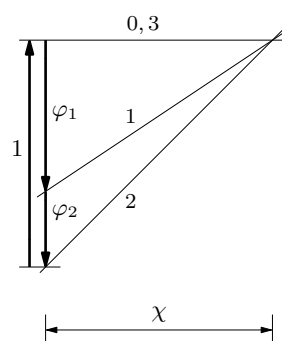
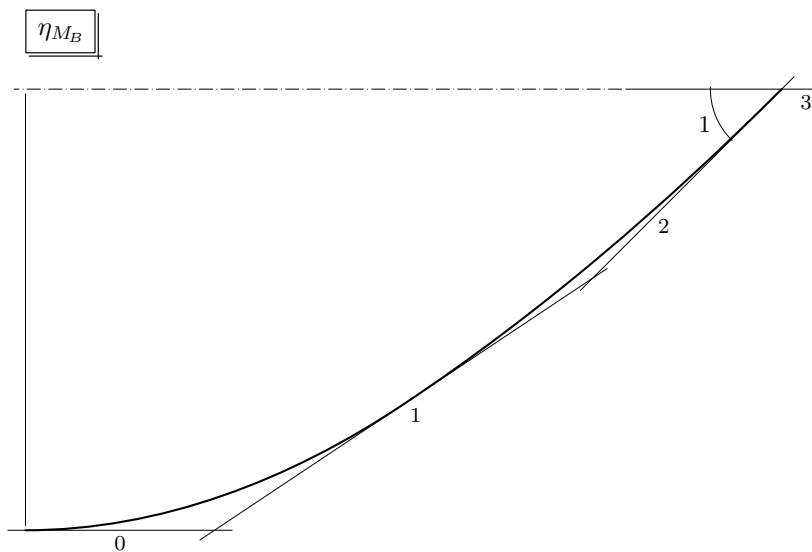
mjerilo duljina:

$$1 \text{ [cm]} :: 1 \text{ [m]}$$



mjerilo kutova:

$$1 \text{ [cm]} :: \frac{1}{3}$$



$$\varphi_1 = \frac{2}{15} \cdot 5 = \frac{2}{3}$$

$$\varphi_2 = \frac{1}{15} \cdot 5 = \frac{1}{3}$$

$$\chi = 1$$