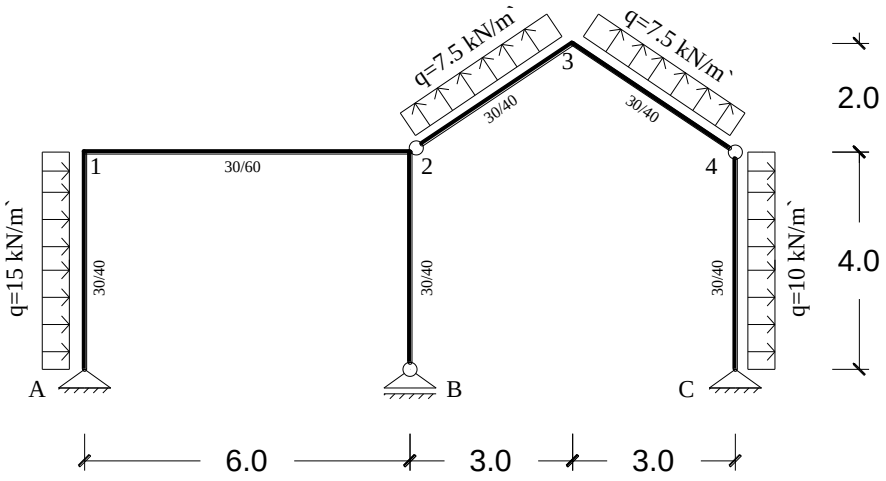
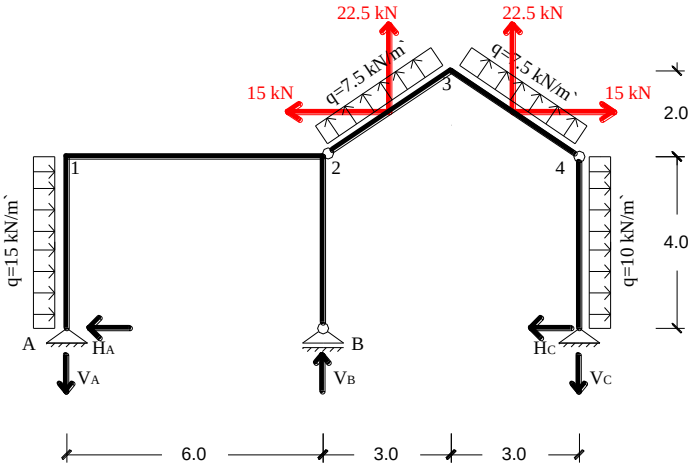
Zadatak: *Za nosač na slici odrediti dijagram vertikalnog pomeranja poteza 1-2-3-4, sa ordinatama na svakih 1.5m, usled jednovremenog delovanja datog opterećenja i temperature u osama štapova A-1, B-2 (*$\boldsymbol{t^o = +25}$℃*). Geometrijske karakteristike poprečnih presjeka date su na slici. Uticaj normalnih sila na deformaciju zanemariti.*$\boldsymbol{E = 3 \cdot 10^7\ kN/m^2}$, $\boldsymbol{\alpha_t = 10^{-5}\ \frac{1}{℃}}$

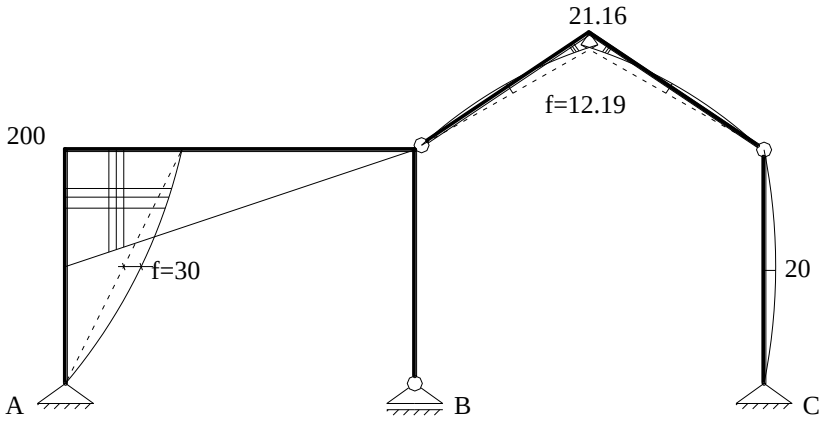


a) *Reakcije oslonaca i dijagrami presečnih sila*

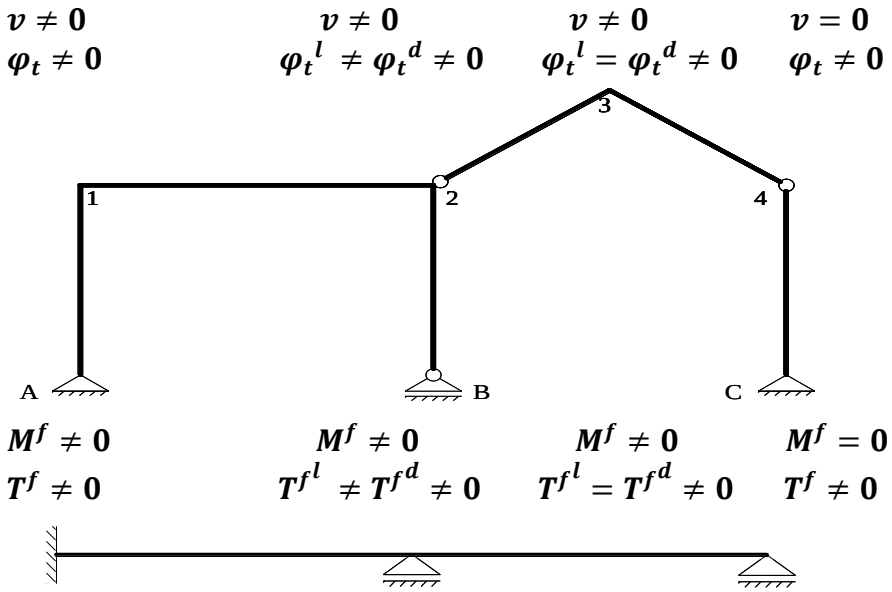


$1.\sum M_4^{dole} = 0 \rightarrow -H_C \cdot 4 + 10 \cdot 4 \cdot 2 = 0 \rightarrow$
$H_C = 20\ kN$
$2.\sum M_2^{desno} = 0 \rightarrow -V_C \cdot 6 - 20 \cdot 4 + 10 \cdot 4 \cdot 2 +$
$22.5 \cdot (4.5 + 1.5) = 0 \rightarrow V_C = 22.5\ kN$
$3.\sum H_i = 0 \rightarrow H_A = 80\ kN$
$4.\sum M_2^{levo} = 0 \rightarrow -V_A \cdot 6 + 80 \cdot 4 - 15 \cdot 4 \cdot 2 \rightarrow$
$V_A = 33.33\ kN$
$5.\sum V_i = 0 \rightarrow V_B = 10.83\ kN$

- *dijagram momenata savijanja (M [kNm])*

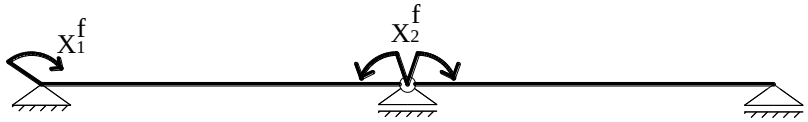


- *Određivanje fiktivnog nosača*

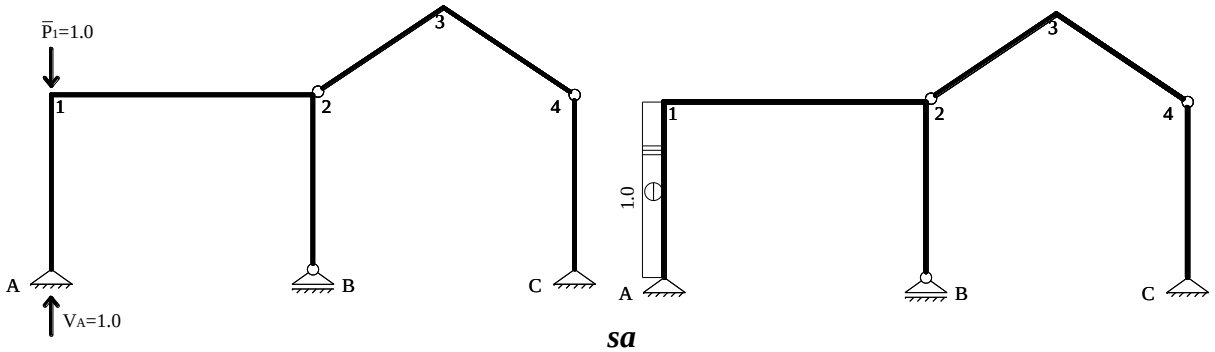


$$n = Z_s + Z_k + Z_o + Z_u - 2K = 2 + 1 + 4 + 1 - 2 \cdot 3$$
$$= 2 \; x\; stat.noedređen\; fiktivnii\; nosač$$

-Osnovni sistem datog statički neodređenog fiktivnog nosača



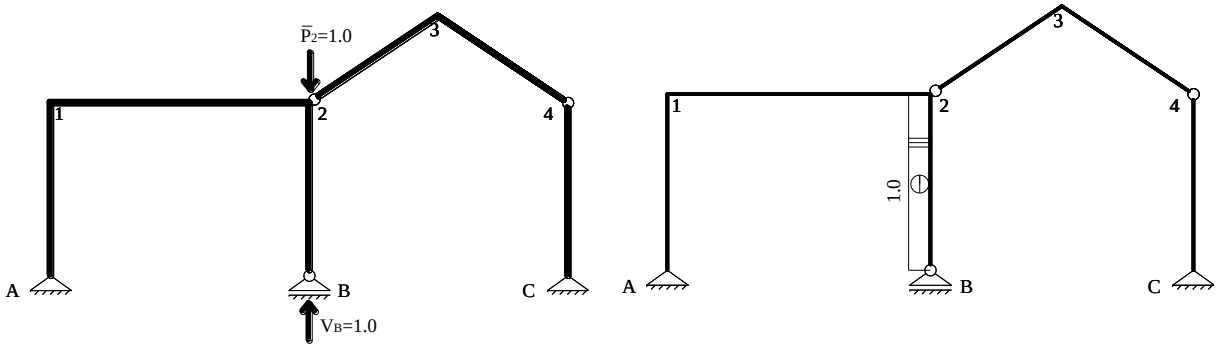
-Statički neodređena fiktivna veličina $\boldsymbol{X_1^f}$*- Dijagram normalnih sila usled generalisane sile* ($\overline{\boldsymbol{N}}$)



sa

$$X_1^f = \int \overline{N}\, \alpha_t\, t^o\, d_s = -1 \cdot 25 \cdot 10^{-5} \cdot 4 = -1 \cdot 10^{-3}$$

-Statički neodređena fiktivna veličina $\boldsymbol{X_2^f}$*- Dijagram normalnih sila usled generalisane sile* $(\overline{\boldsymbol{N}})$

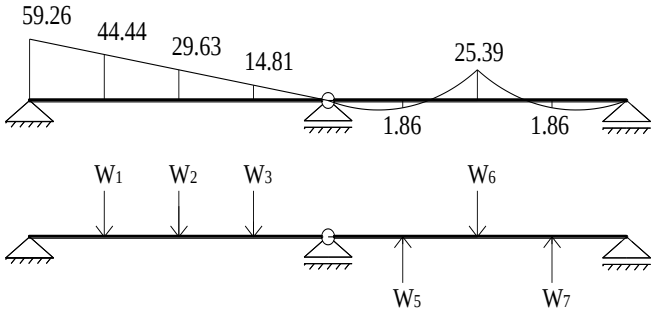


$$X_{12}^f = \int \overline{N}\,\alpha_t\,t^o\,d_s = -1\cdot 25\cdot 10^{-5}\cdot 4 = -1\cdot 10^{-3}$$

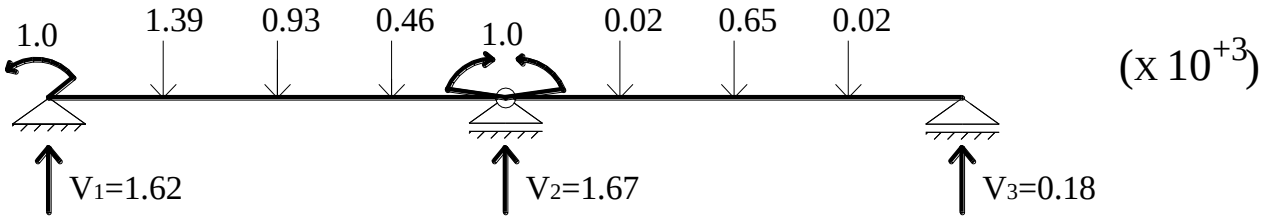
- Fiktivno opterećenje raspodeljenim silama

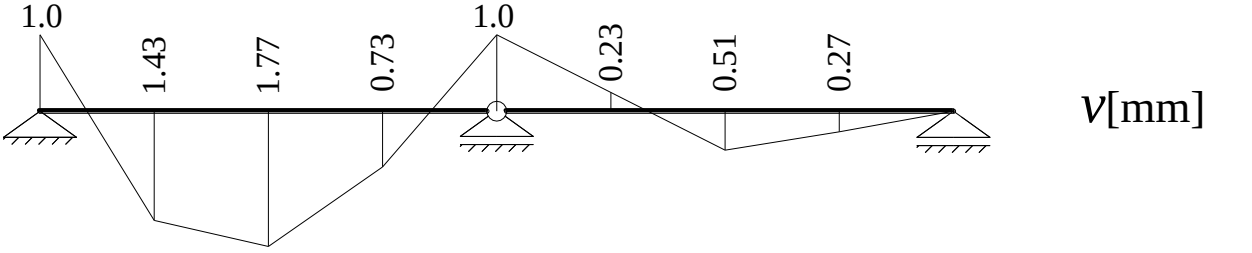
$$I_c = \frac{0.3\cdot 0.4^3}{12} = 1.6\cdot 10^{-3} m^4, \qquad EI_c = 48000 kNm^2$$

$$p^f = \left(\frac{M}{EI} + \alpha_t \frac{\Delta t^o}{h}\right)\frac{1}{cos\alpha} \;\rightarrow\; EI_c p^f = \frac{I_c}{I} M \frac{1}{cos\alpha}$$



$$W_1 = \frac{1.5}{6}(59.26 + 4\cdot 44.44 + 29.63) = 66.66$$
$$W_2 = \frac{1.5}{6}(44.44 + 4\cdot 29.63 + 14.81) = 44.44$$
$$W_3 = \frac{1.5}{6}(29.63 + 4\cdot 14.81 + 0) = 22.22$$
$$W_5 = W_7 = \frac{1.5}{12}(0 + 10\cdot 1.86 - 25.39) = -0.85$$
$$W_6 = \frac{1.5}{12}(-1.86 + 10\cdot 25.39 - 1.86) = 31.27$$

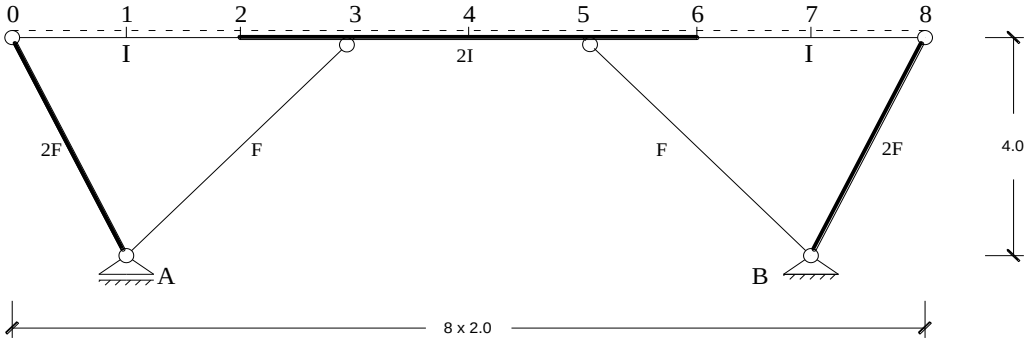




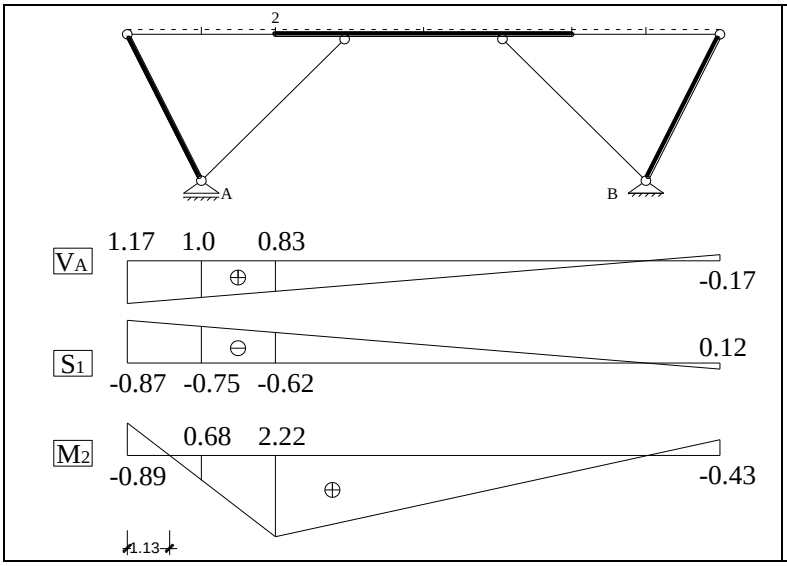
Za nosač na slici:

a) sračunati ekstremne vrednosti momenta u preseku 2 usled jednako podeljenog pokretnog opterećenja *p=20 kN/m*, proizvoljne dužine,
b) konstruisati uticajnu liniju za vertikalno pomeranje čvora 3.

Uticaj normalnih sila uzeti samo za proste štapove. $E = 210\ GPa,\ I = 4 \cdot 10^5\ cm^4,\ F = 100\ cm^2$.

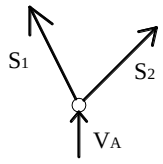


a) ekstremne vrednosti momenta M_2



$1.\sum M_B = 0 \rightarrow \boxed{V_A = \frac{u_b}{12}}$

-čvor A



$2.\sum H_i = 0 \rightarrow S_2 = \frac{cos63.43}{cos45} S_1$

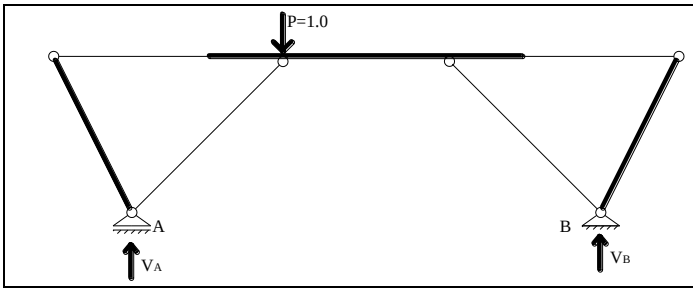
$3.\sum V_i = 0 \rightarrow \boxed{S_1 = -0.745\ V_A}$

$\boxed{M_2 = -sin\ 63.43\ S_1 \cdot 4 - P \cdot u_2}$

$max\ M_2 = 20 \cdot \frac{1}{2} \cdot 12.87 \cdot 2.22 = 285.71\ kNm$

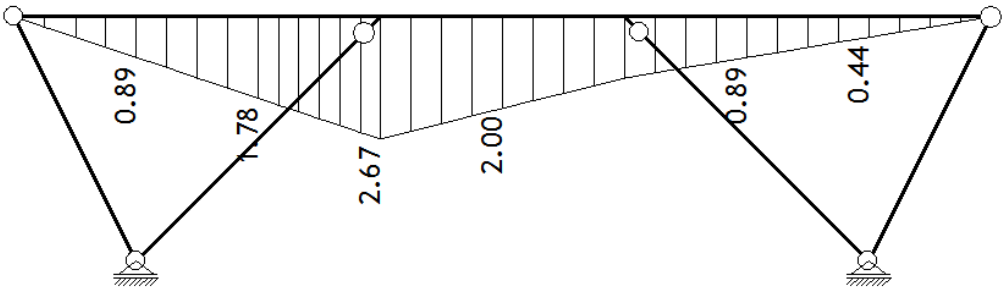
$min\ M_2 = 20 \cdot \frac{1}{2} \cdot (-0.89 \cdot 1.13 - 0.43 \cdot 2) = -18.66\ kN$

b) Uticajna linija za vertikalno pomeranje čvora 3

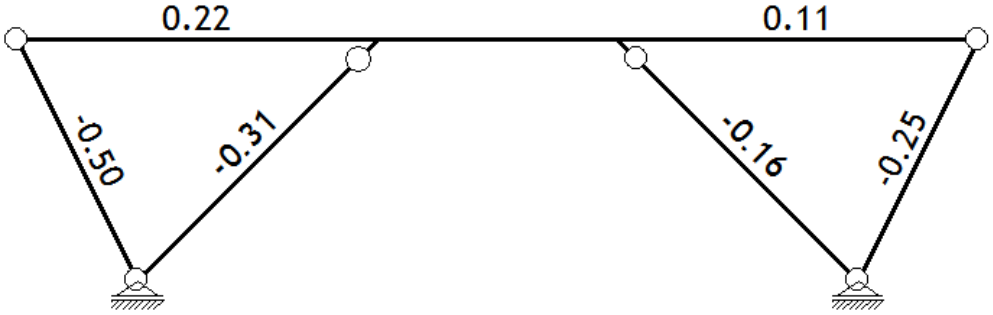


$1.\sum M_B = 0 \rightarrow V_A = 0.66$
$2.\sum M_A = 0 \rightarrow V_B = 0.33$

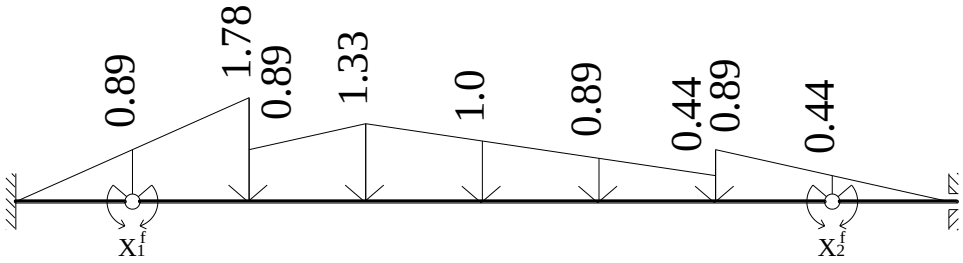
-dijagram momenata (M)



-dijagram normalnih sila (N)

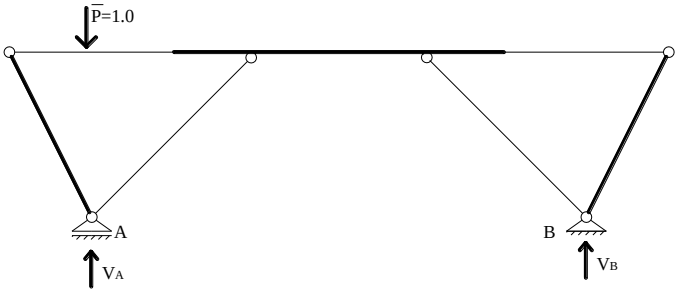


-fiktivni nosač i raspodeljeno fiktivno opterećenje



Fiktivni nosač je dva puta statički neodređen

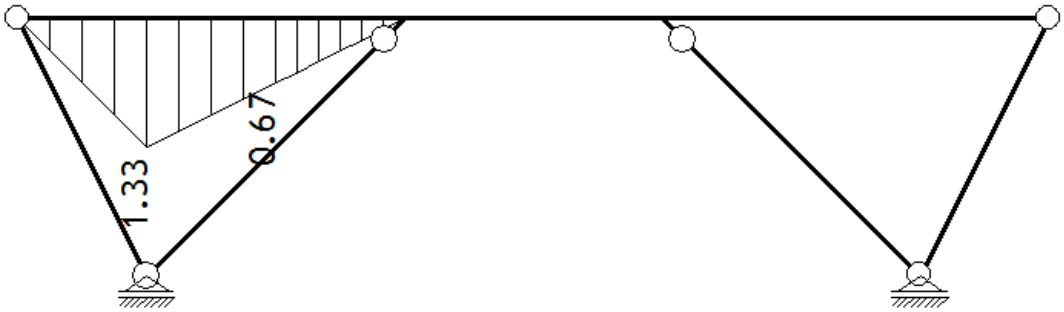
-vrednost statički neodređene $\boldsymbol{X_1^f}$ *i* $\boldsymbol{X_2^f}$



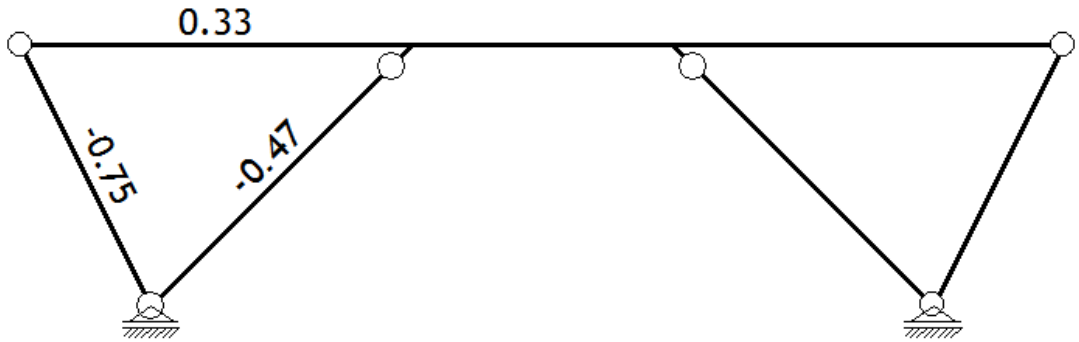
$1.\sum M_B = 0 \rightarrow V_A = 1{,}0$

$2.\sum M_A = 0 \rightarrow V_B = 0$

-dijagram momenata ($\boldsymbol{\bar{M}}$*)*



-dijagram normalnih sila ($\bar{N}$)



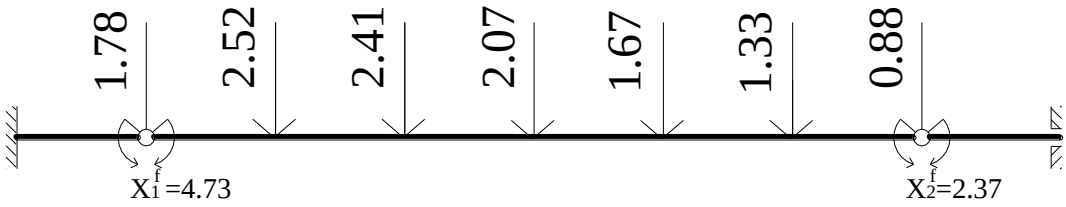
$$EI_c x_1^f = \int M\,\overline{M}\frac{I_c}{I}ds + \frac{I_c}{F_c}\int N\,\overline{N}\frac{F_c}{F}ds$$

$$I_c = I, \qquad F_c = F, \qquad \frac{I_c}{F_c} = 0.4\ m^2, \qquad EI_c = 840\ kNm^2$$

$$EI_c x_1^f = \frac{2}{3}\cdot 0{,}89 \cdot 1.33 + \frac{2}{6}[0.89(2\cdot 1.33 + 0.67) + 1.78(1.33 + 2\cdot 0.67)]$$
$$+ \frac{1}{2}\frac{2}{6}0.67(2\cdot 1.78 + 2.67) + 0.4\left(0.5\cdot 0.75\cdot 4.47\frac{1}{2} + 0.31\cdot 0.47\cdot 5.66\right)$$
$$= 4.06 + 0.67 = 4.73$$

$$x_2^f = 0.5x_1^f$$

-Elastične težine



-dijagram pomeranja čvora 3