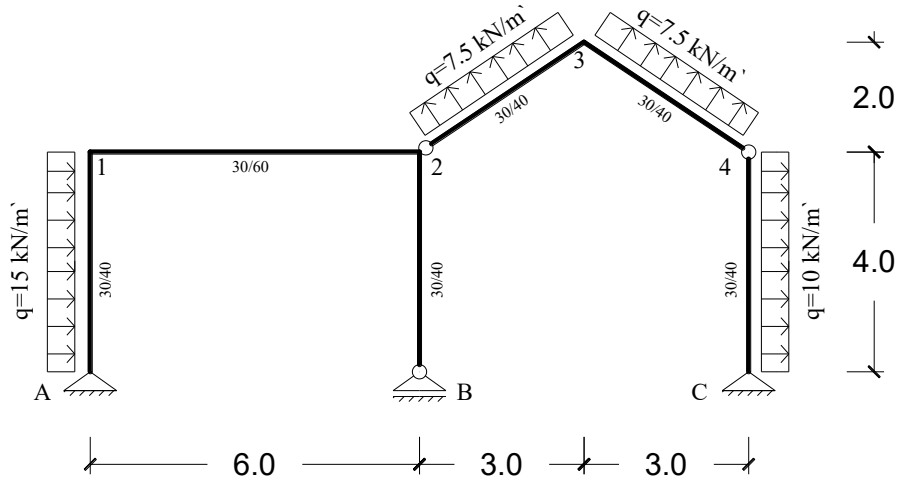
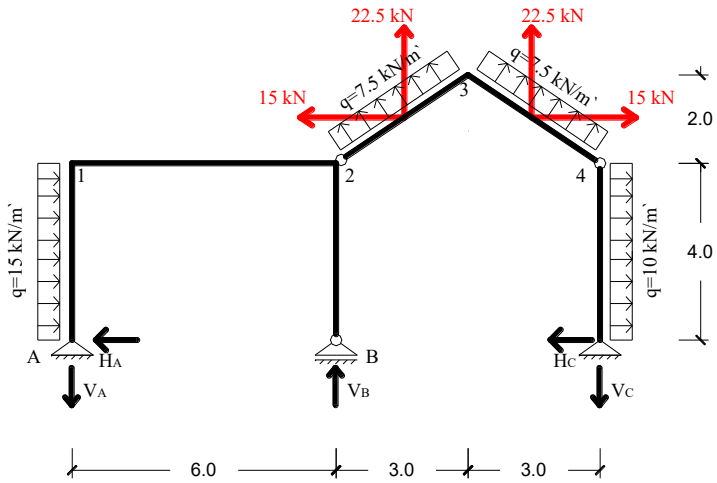
1. Za nosač na slici odrediti dijagram vertikalnog pomeranja poteza 1-2-3-4, sa ordinatama na svakih 1.5m, usled jednovremenog delovanja datog opterećenja i i temperature u osama štapova A-1, B-2 ($\boldsymbol{t^o = +25}$℃). Geometrijske karakteristike poprečnih presjeka date su na slici. Uticaj normalnih 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.$\sum \boldsymbol{M_4^{dole} = 0 \rightarrow -H_C \cdot 4 + 10 \cdot 4 \cdot 2 = 0 \rightarrow H_C = 20\ kN}$

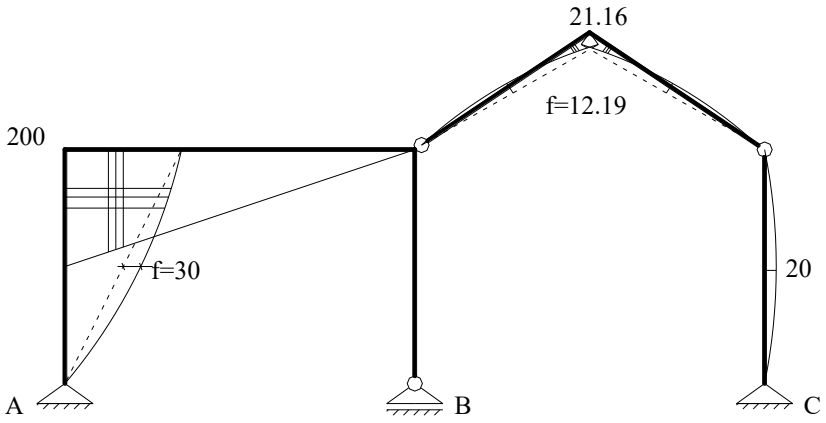
2.$\sum \boldsymbol{M_2^{desno} = 0 \rightarrow -V_C \cdot 6 - 20 \cdot 4 + 10 \cdot 4 \cdot 2 + 22.5 \cdot (4.5 + 1.5) = 0 \rightarrow V_C = 22.5\ kN}$

3.$\sum \boldsymbol{H_i = 0 \rightarrow H_A = 80\ kN}$

4.$\sum \boldsymbol{M_2^{levo} = 0 \rightarrow -V_A \cdot 6 + 80 \cdot 4 - 15 \cdot 4 \cdot 2 \rightarrow V_A = 33.33\ kN}$

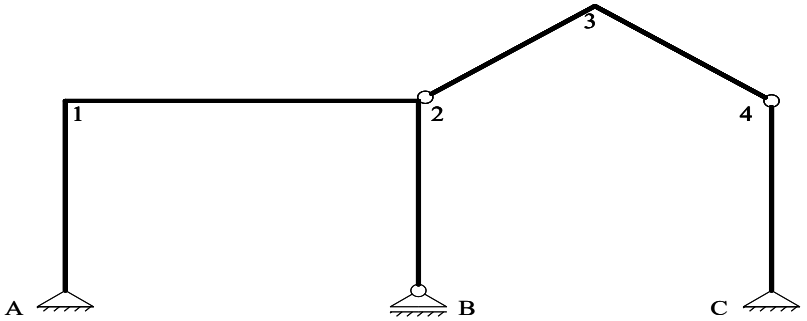
5.$\sum \boldsymbol{V_i = 0 \rightarrow V_B = 10.83\ kN}$

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

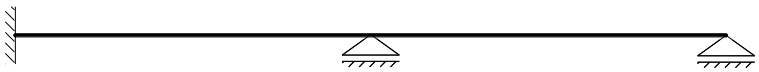


- *Fiktivni nosač*

$\boldsymbol{v \neq 0}$	$\boldsymbol{v \neq 0}$	$\boldsymbol{v \neq 0}$	$\boldsymbol{v = 0}$
$\boldsymbol{\varphi_t \neq 0}$	$\boldsymbol{\varphi_t^{\,l} \neq \varphi_t^{\,d} \neq 0}$	$\boldsymbol{\varphi_t^{\,l} = \varphi_t^{\,d} \neq 0}$	$\boldsymbol{\varphi_t \neq 0}$

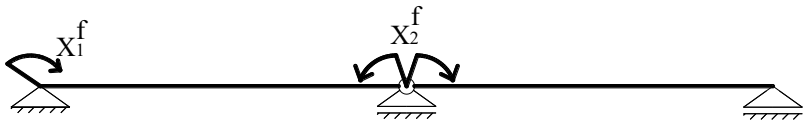


$\boldsymbol{M^f \neq 0}$	$\boldsymbol{M^f \neq 0}$	$\boldsymbol{M^f \neq 0}$	$\boldsymbol{M^f = 0}$
$\boldsymbol{T^f \neq 0}$	$\boldsymbol{T^{f^l} \neq T^{f^d} \neq 0}$	$\boldsymbol{T^{f^l} = T^{f^d} \neq 0}$	$\boldsymbol{T^f \neq 0}$

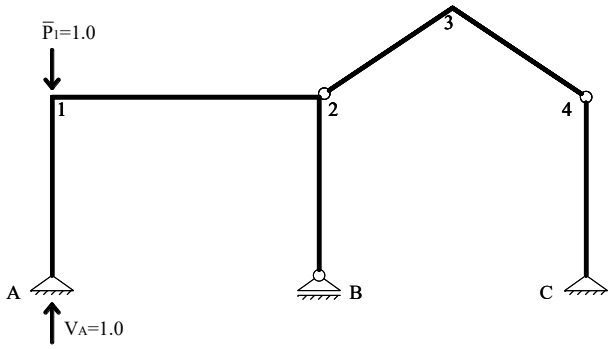


$$\boldsymbol{n = Z_s + Z_k + Z_o + Z_u - 2K = 2 + 1 + 4 + 1 - 2 \cdot 3}$$
$$\boldsymbol{= 2\ x\ stat.noodređen\ fiktivnii\ nosač}$$

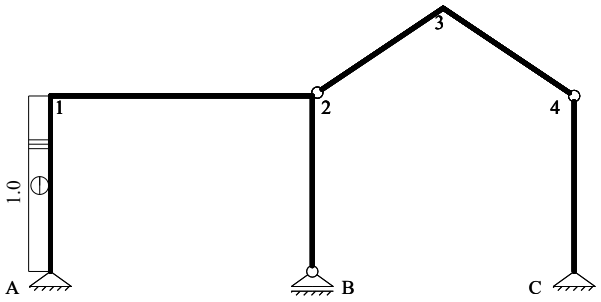
-Osnovni sistem datog statički neodređenog fiktivnog nosača



- *Statički neodređena fiktivna veličina* $\boldsymbol{X_1^f}$

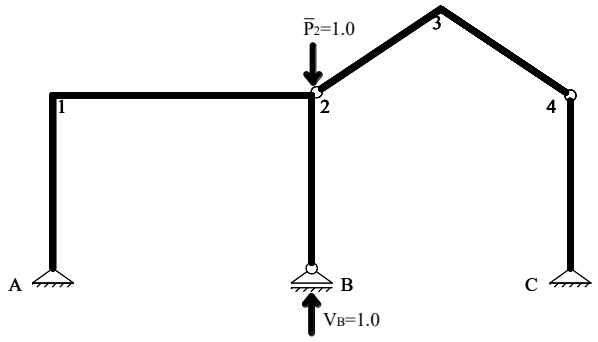


- *Dijagram normalnih sila usled generalisane sile* $(\overline{\boldsymbol{N}})$

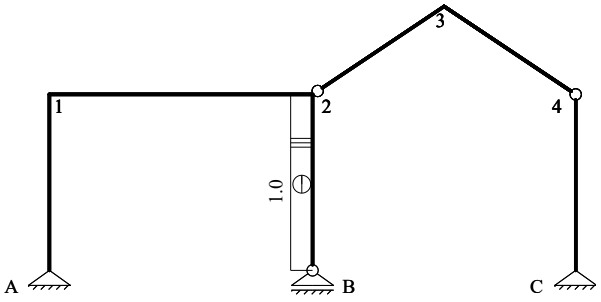


$$X_1^f = \int \overline{N}\,\alpha_t\,t^o\,d_s = -1 \cdot 25 \cdot 10^{-5} \cdot 4$$
$$= -1 \cdot 10^{-3}$$

- *Statički neodređena fiktivna veličina* $\boldsymbol{X_2^f}$



- *Dijagram normalnih sila usled generalisane sile* $(\overline{\boldsymbol{N}})$

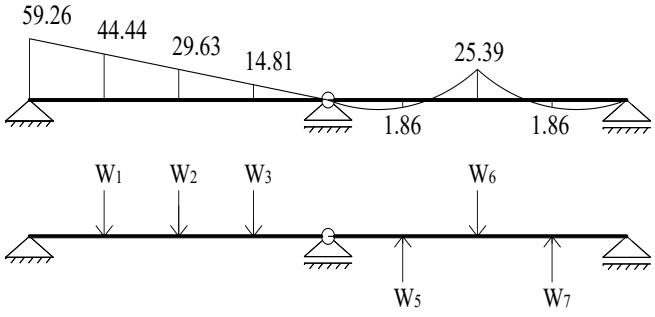


$$X_{12}^f = \int \overline{N}\,\alpha_t\,t^o\,d_s = -1 \cdot 25 \cdot 10^{-5} \cdot 4$$
$$= -1 \cdot 10^{-3}$$

- Fiktivno opterećenje raspodeljenim silama

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

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



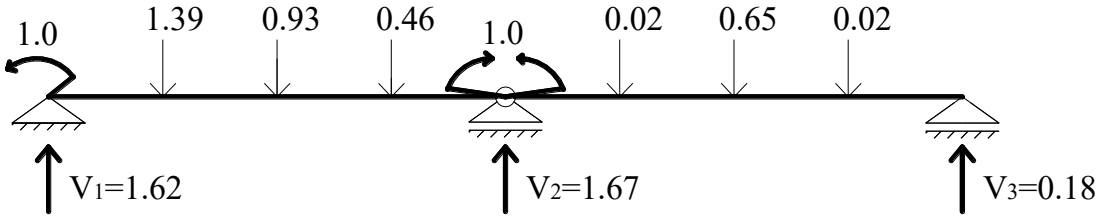
$$W_1 = \frac{1.5}{6}(59.26 + 4 \cdot 44.44 + 29.63) = 66.66$$

$$W_2 = \frac{1.5}{6}(44.44 + 4 \cdot 29.63 + 14.81) = 44.44$$

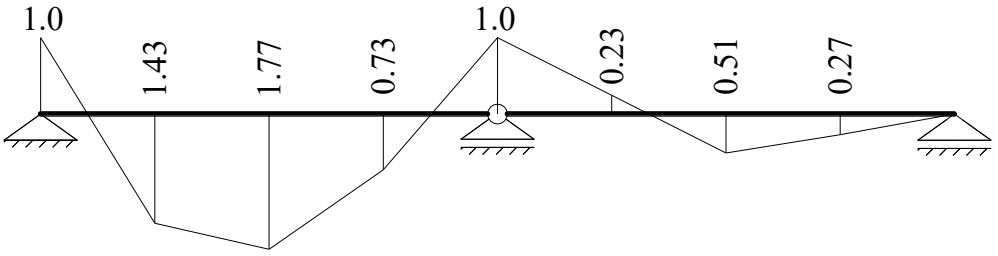
$$W_3 = \frac{1.5}{6}(29.63 + 4 \cdot 14.81 + 0) = 22.22$$

$$W_5 = W_7 = \frac{1.5}{12}(0 + 10 \cdot 1.86 - 25.39) = -0.85$$

$$W_6 = \frac{1.5}{12}(-1.86 + 10 \cdot 25.39 - 1.86) = 31.27$$



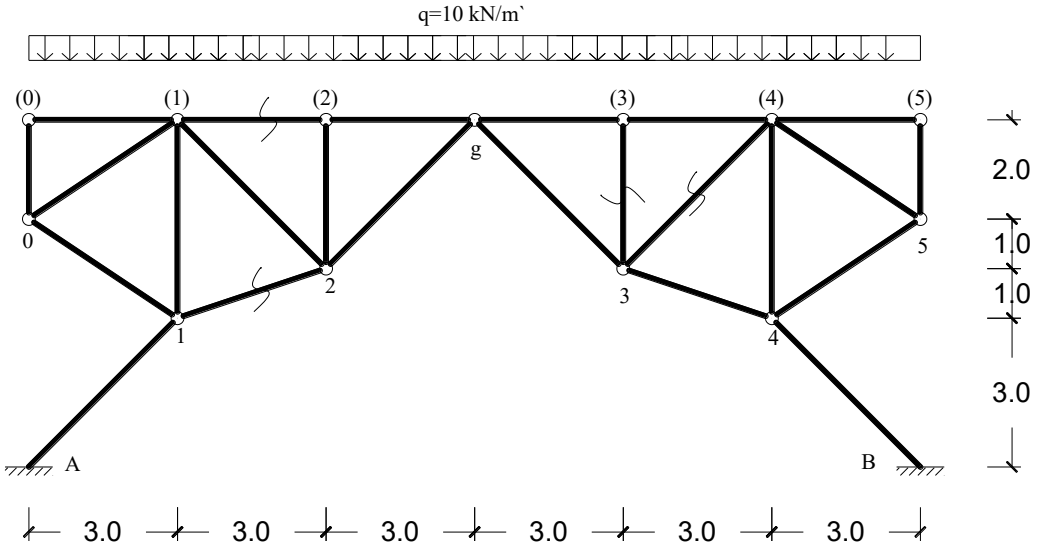
(x 10^{+3})



v[mm]

2. Za nosač na slici:

a) konstruisati uticajne linije za sile u označenim štapovima,
b) usled datog opterećenja odrediti promenu rastojanja između čvora 2-3. $\boldsymbol{I/F = 0.03}$.



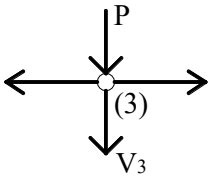
a)konstruisati uticajne linije za sile u označenim štapovima,

1.$\sum \boldsymbol{M_1}^{\boldsymbol{dole}} = \boldsymbol{0} \rightarrow \boldsymbol{M_A = -3H_A + 3V_A}$

2.$\sum \boldsymbol{M_4}^{\boldsymbol{gore}} = \boldsymbol{0} \rightarrow \boldsymbol{V_A = \frac{u_4}{12}}$

3.$\sum \boldsymbol{M_g}^{\boldsymbol{l}} = \boldsymbol{0} \rightarrow \boldsymbol{H_A = -\frac{u_g}{4} + \frac{6}{4}V_A}$

-čvor (3)

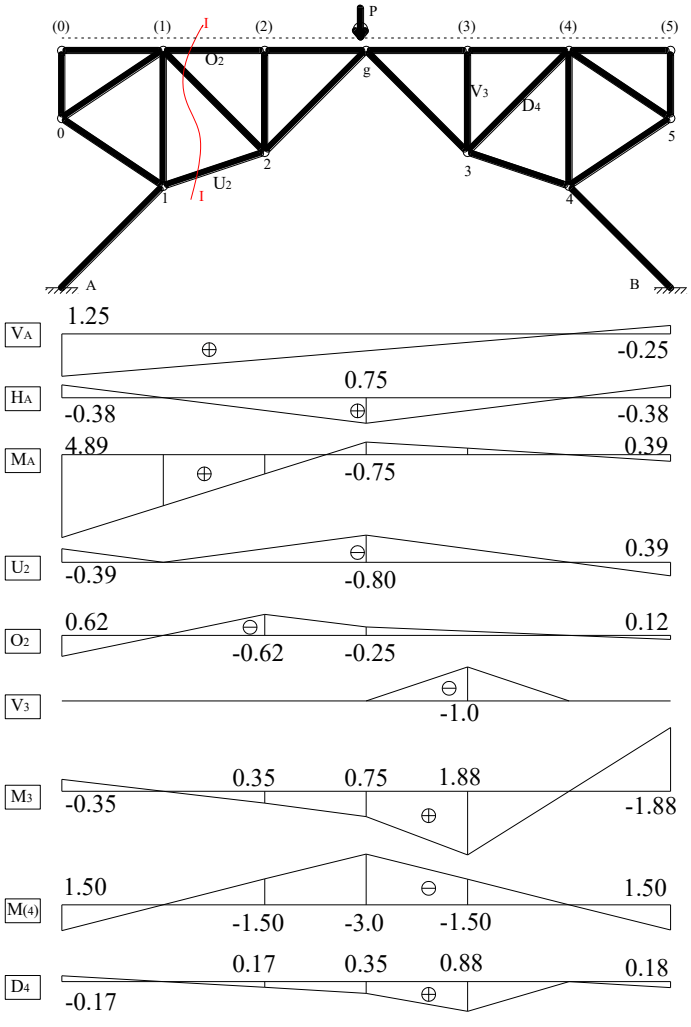


$$\sum \boldsymbol{V_i = 0 \rightarrow V_3 = -P}$$

$$\boldsymbol{M_3 = 12V_A - 4H_A - M_A - u_3}$$

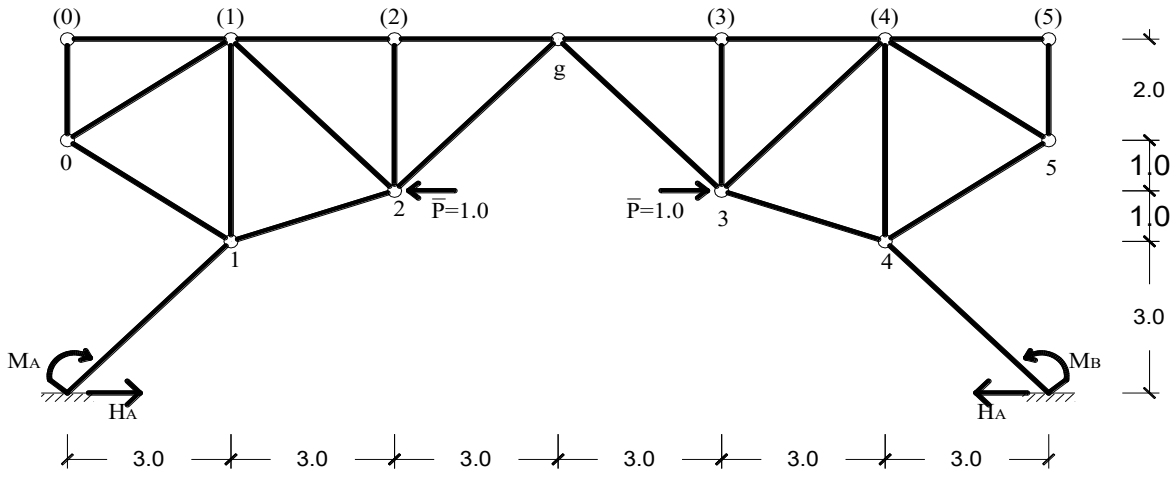
$$\boldsymbol{M_{(4)} = 15V_A - 7H_A - M_A - u_{(4)}}$$

$$\boldsymbol{D_4 = \left(\frac{M_3}{h_3} - \frac{M_4}{h_4} - H_A\right)\frac{1}{cos45}}$$



b) promena rastojanja između čvora 2-3

-Uticaji na nosaču usled generalisane sila za promenu rastojanja dvije tačke

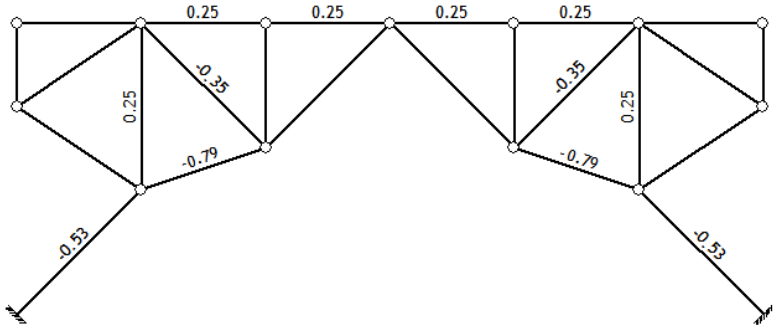


1.$\sum \boldsymbol{M_1}^{\boldsymbol{dole}} = \boldsymbol{0} \rightarrow \boldsymbol{M_A} = \boldsymbol{3H_A} - \boldsymbol{3V_A} \rightarrow \boldsymbol{M_A} = \boldsymbol{2.25} = \boldsymbol{M_B}$

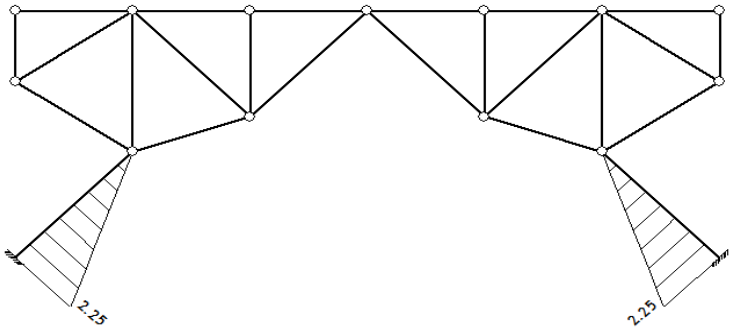
2.$\sum \boldsymbol{M_4}^{\boldsymbol{gore}} = \boldsymbol{0} \rightarrow \boldsymbol{V_A} = \boldsymbol{0} = \boldsymbol{V_B}$

3.$\sum \boldsymbol{M_g}^{\boldsymbol{l}} = \boldsymbol{0} \rightarrow \boldsymbol{H_A} = \boldsymbol{0.75} = \boldsymbol{H_B}$

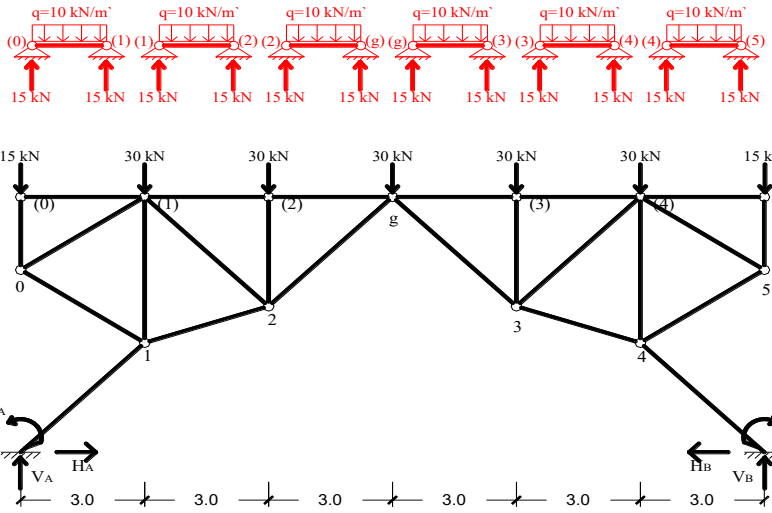
- Dijagram normalnih sila usled generalisane sile $(\overline{\boldsymbol{N}})$



-Dijagram momenata savijanja usled generalisane sile $(\overline{\boldsymbol{M}})$



-Uticaji na nosaču usled zadatog opterećenja

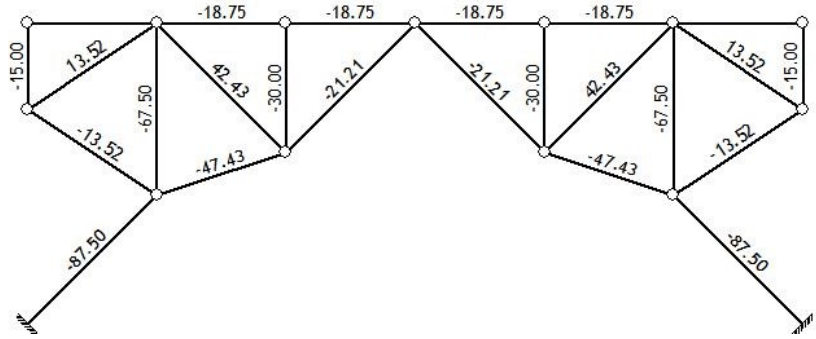


1.$\sum \boldsymbol{M_1}^{\boldsymbol{dole}} = \boldsymbol{0} \rightarrow \boldsymbol{M_A} = -\boldsymbol{3H_A} + \boldsymbol{3V_A} \rightarrow \boldsymbol{M_A} = \boldsymbol{168.75\ kNm} = \boldsymbol{M_B}$

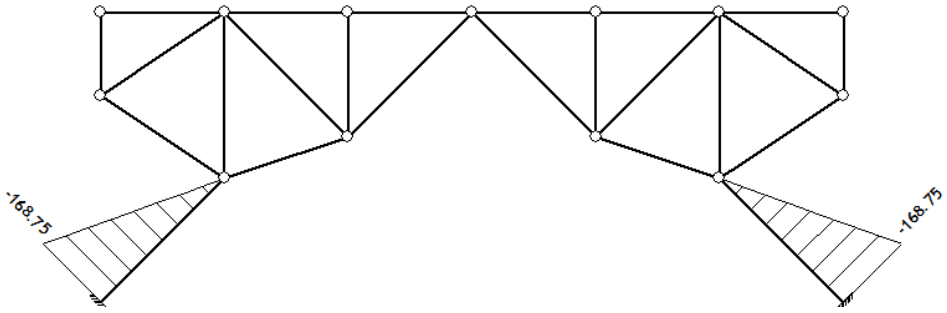
2.$\sum \boldsymbol{M_4}^{\boldsymbol{gore}} = \boldsymbol{0} \rightarrow \boldsymbol{V_A} = \boldsymbol{90\ kN} = \boldsymbol{V_B}$

3.$\sum \boldsymbol{M_g}^{\boldsymbol{l}} = \boldsymbol{0} \rightarrow \boldsymbol{H_A} = \boldsymbol{33.75\ kN} = \boldsymbol{H_B}$

- *Dijagram normalnih sila usled zadatog opterećenja* ($\boldsymbol{N[kN]}$)



- *Dijagram momenata savijanja usled zadatog opterećenja* ($\boldsymbol{M[kNm]}$)



$$\boldsymbol{EI\ l_{2-3}} = \int \boldsymbol{M\ \bar{M}\ d_s} + \frac{\boldsymbol{I}}{\boldsymbol{F}} \int \boldsymbol{N\ \bar{N}\ d_s}$$

$$= \boldsymbol{2}\left[-\frac{\boldsymbol{4,24}}{\boldsymbol{3}}\boldsymbol{168.75 \cdot 2.25} + \boldsymbol{0.03}(\boldsymbol{3 \cdot (-0.25 \cdot 18.75 \cdot 2)} - \boldsymbol{4 \cdot 67.5 \cdot 0.25}\right.$$

$$\left. - \boldsymbol{4.24}(\boldsymbol{0.35 \cdot 42.43} - \boldsymbol{0.53 \cdot 87.5}) + \boldsymbol{3,16 \cdot 0.79 \cdot 47.43})\right] = \boldsymbol{-1063.86}$$