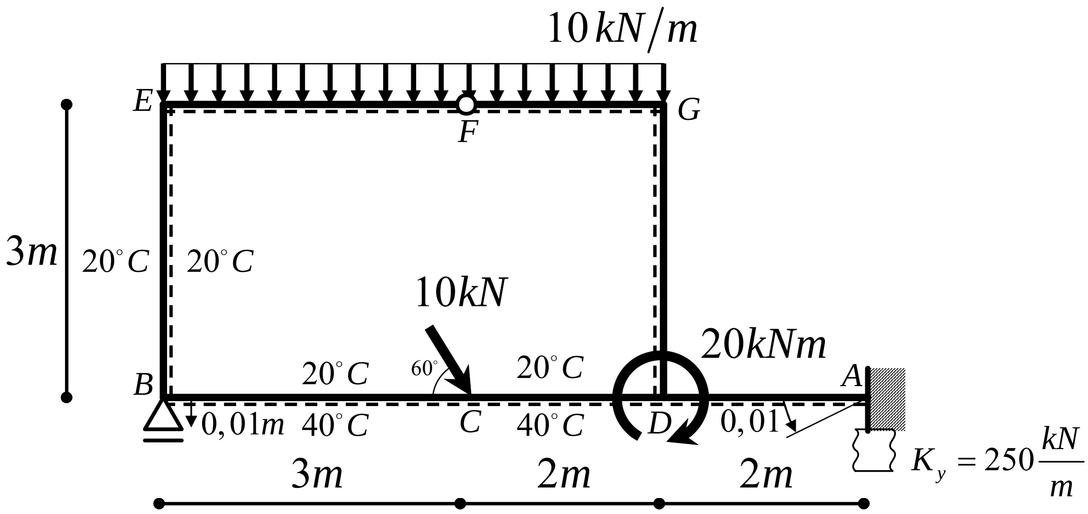
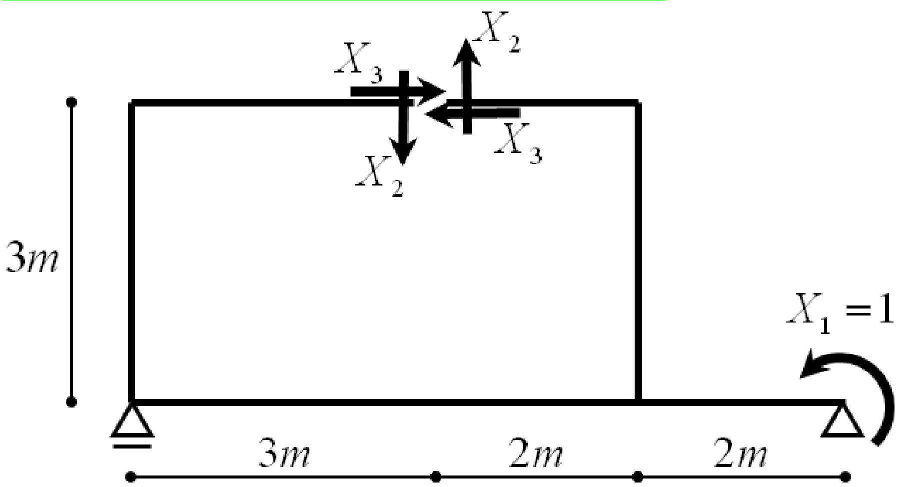


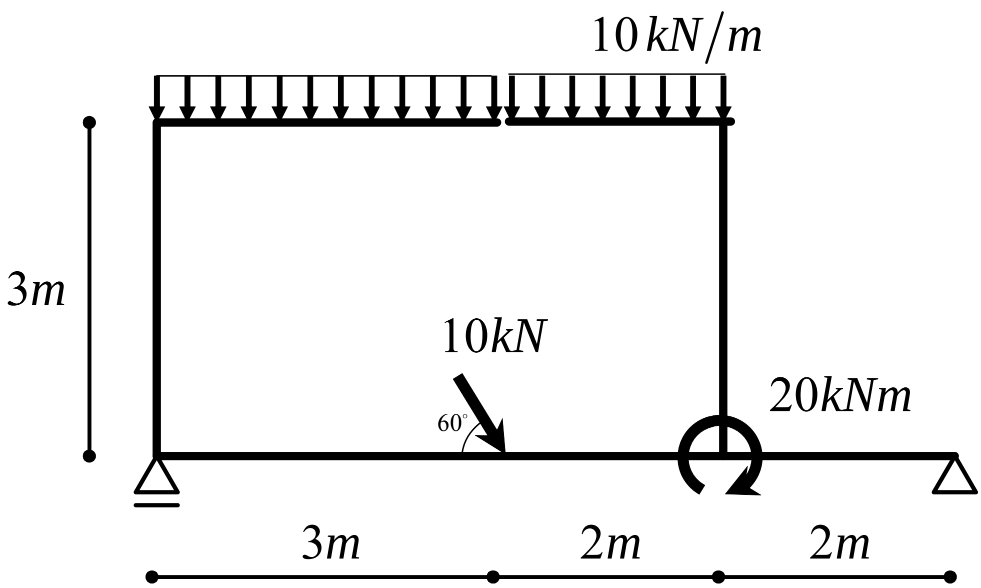
$E = 205GPa$ $\alpha_t = 1.2\cdot10^{-5}\cdot\frac{1}{K}$

Przekrój: **I200** $h = 0.2m$ $I_x = 2140cm^4$ $E\cdot I_x = 4387\cdot kN\cdot m^2$

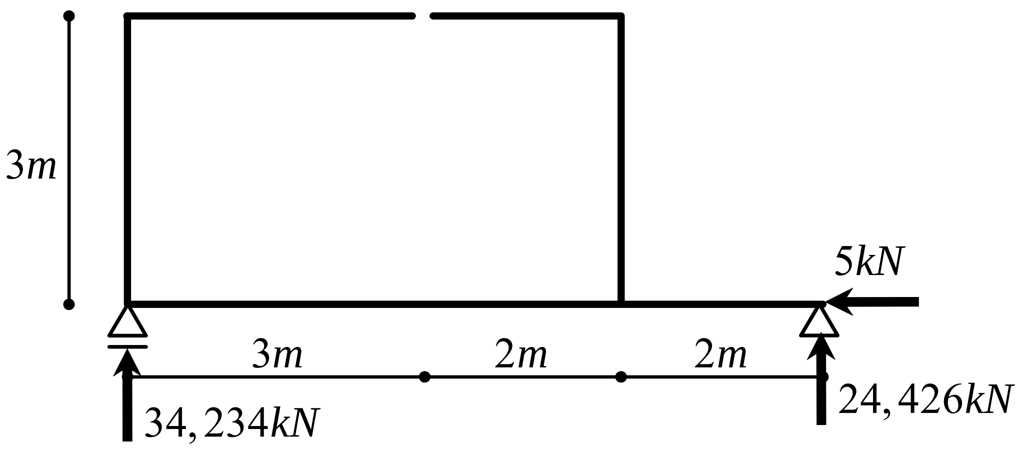
Układ podstawowy metody sił (UPMS)

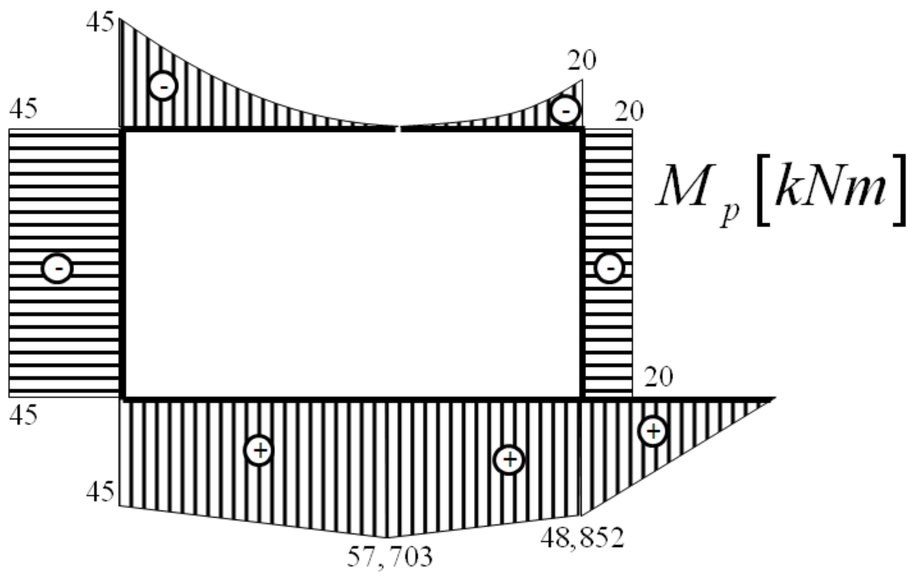


Stan "p"

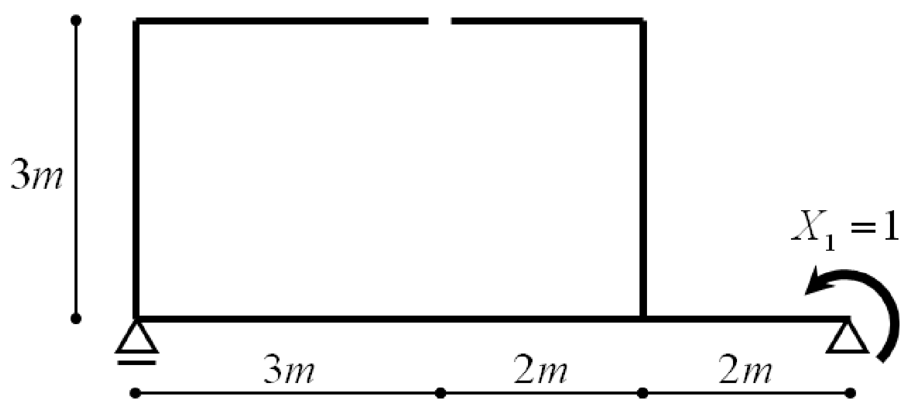


Reakcje w stanie "p"

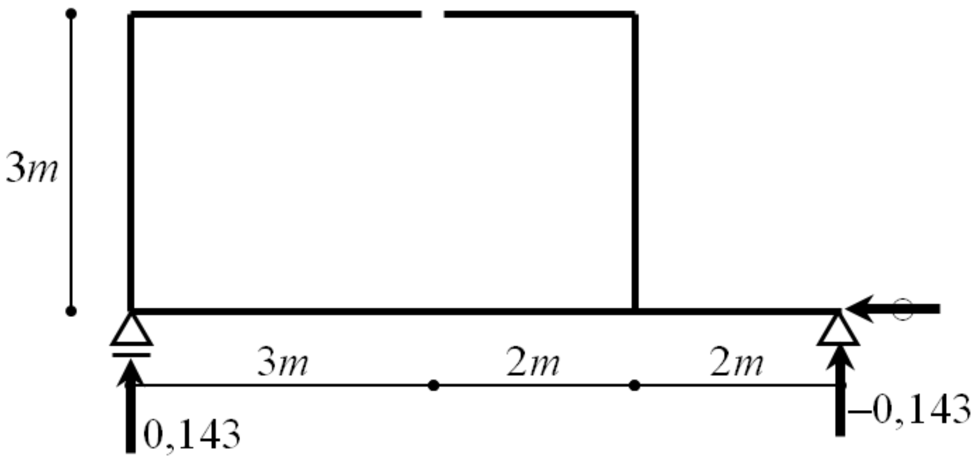


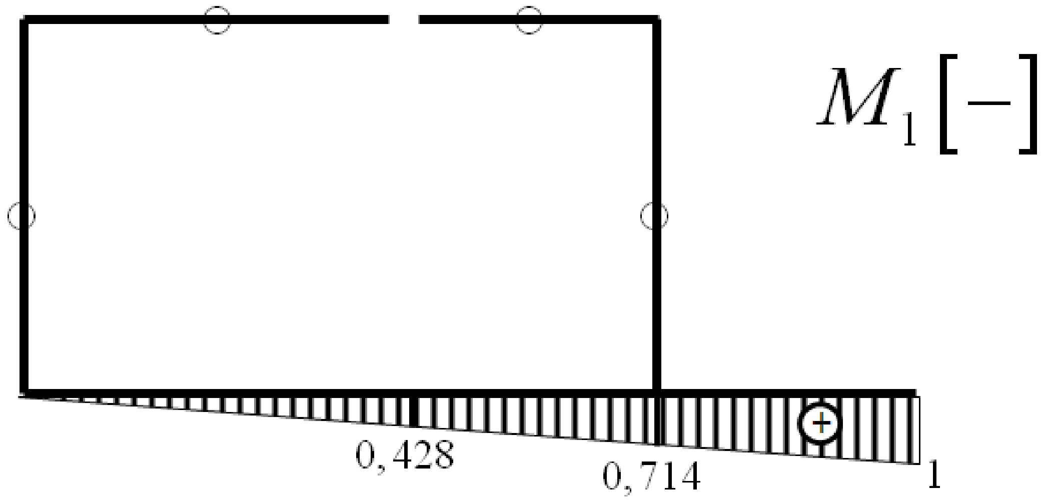


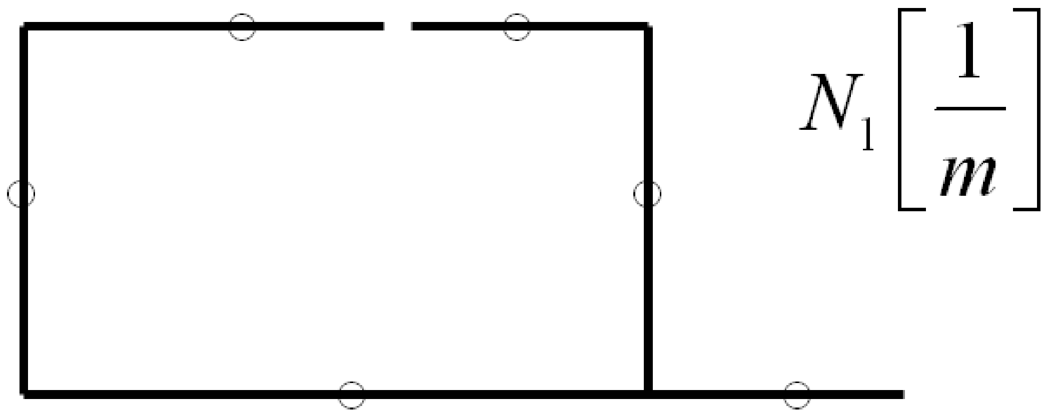
Stan X_1=1



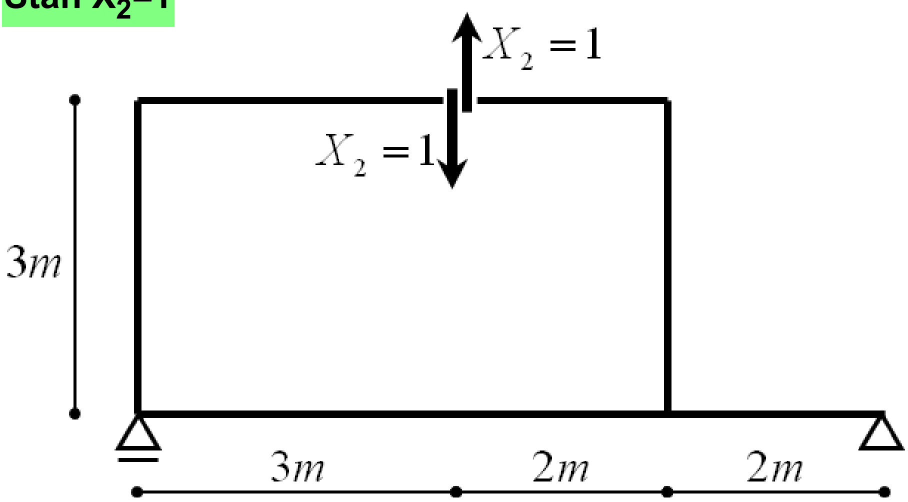
Reakcje w stanie X_1=1



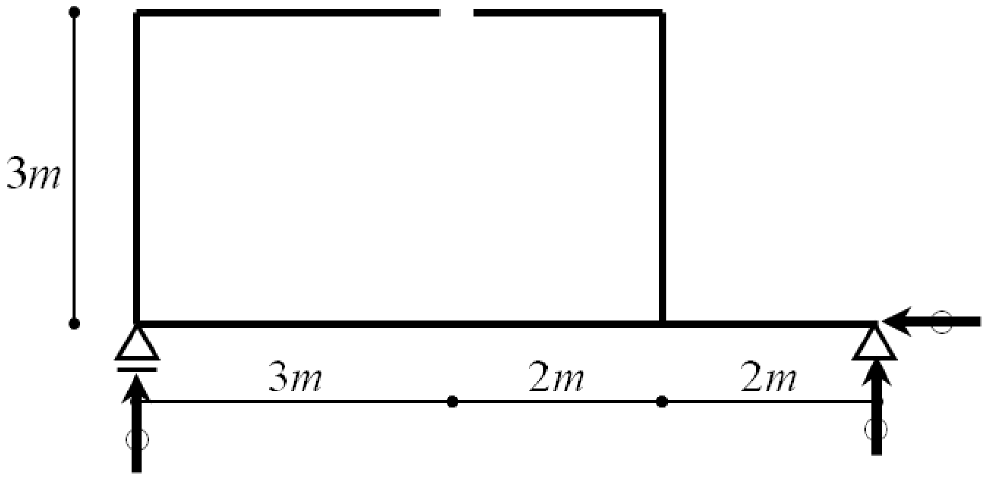


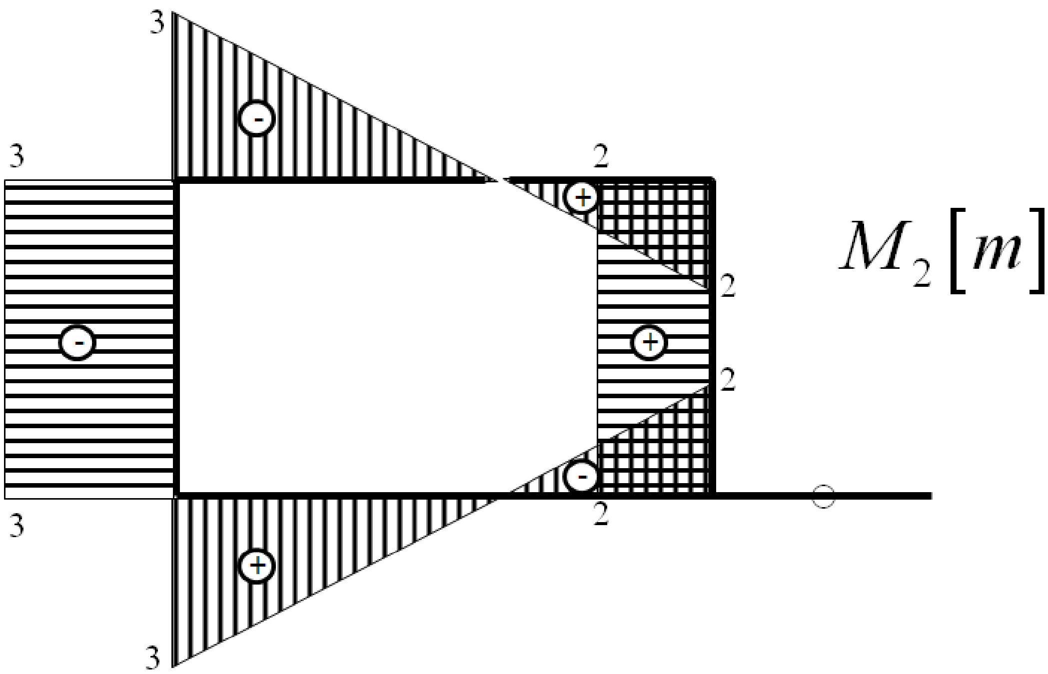


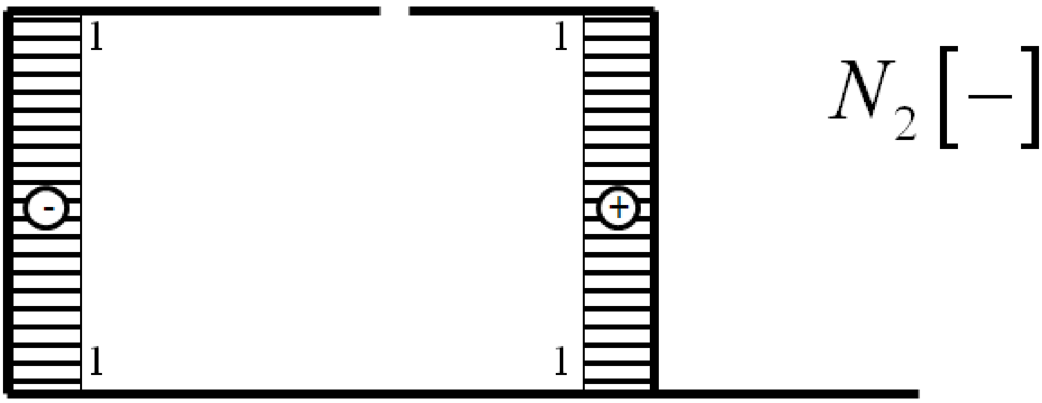
Stan X_2=1



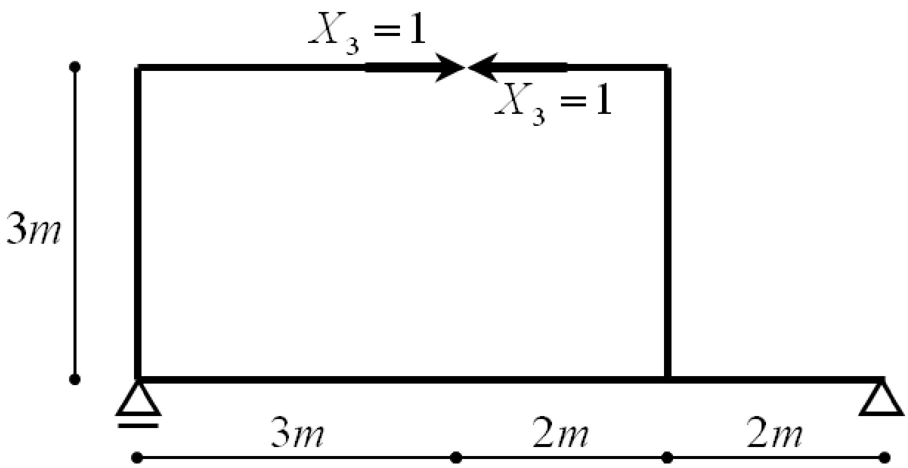
Reakcje w stanie X_2=1



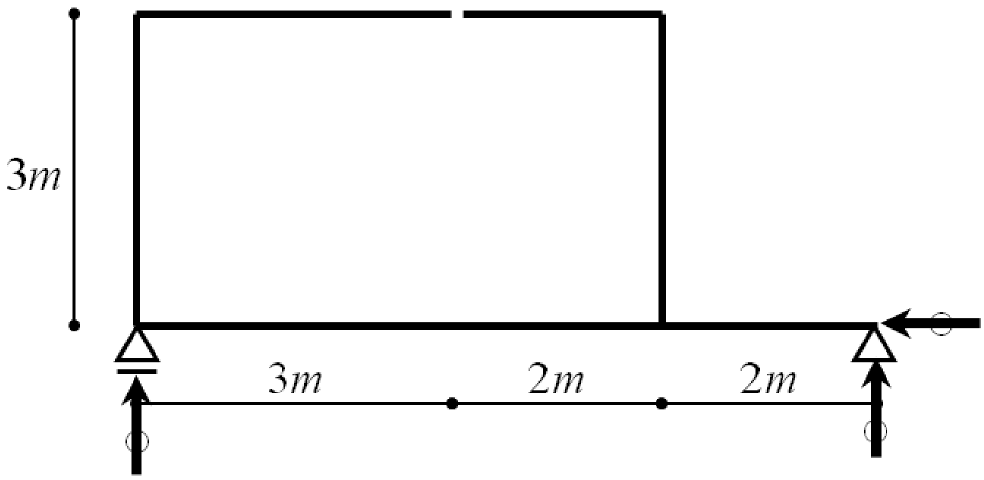


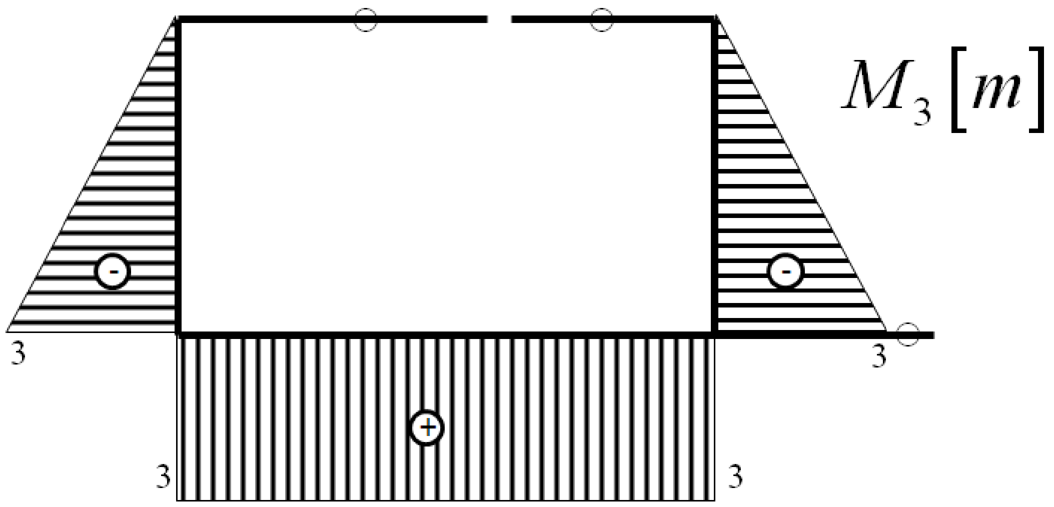


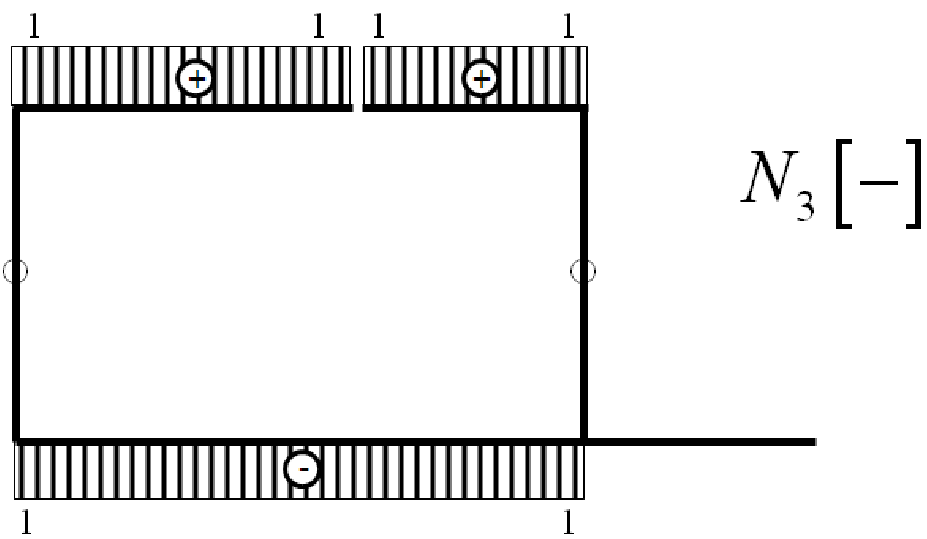
Stan X_3=1



Reakcje w stanie X_3=1

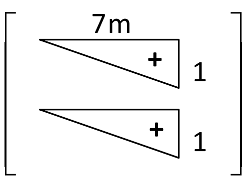






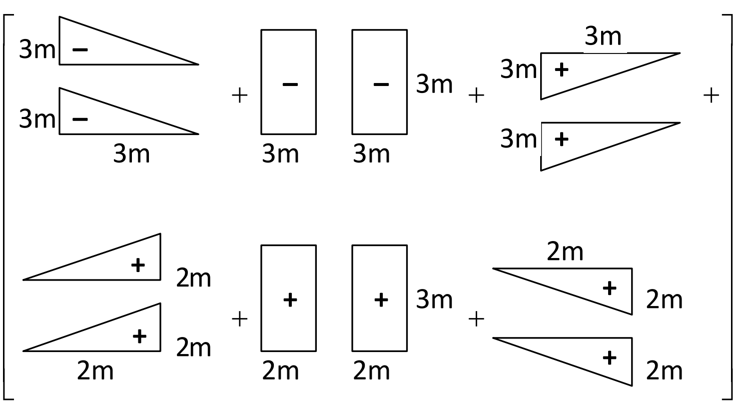
Wyznaczenie współczynników układu równań

$\delta_{11} = \frac{1}{E \cdot I_x}$



$$\delta_{11} = \frac{1}{E \cdot I_x}\left(\frac{1}{2} \cdot 1 \cdot 7m \cdot \frac{2}{3} \cdot 1\right) \qquad \delta_{11} = 5.319 \times 10^{-4} \cdot \frac{1}{kN \cdot m} \qquad E \cdot I_x \delta_{11} = 2.333\ m$$

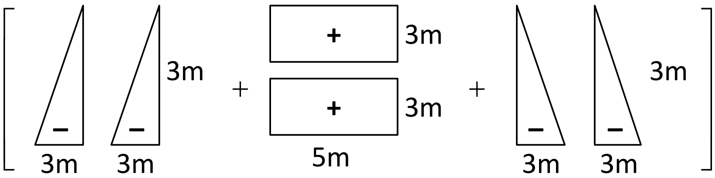
$\delta_{22} = \frac{1}{E \cdot I_x}$



$$\delta_{22} = \frac{1}{E \cdot I_x} \cdot \left(\frac{1}{2} \cdot 3 \cdot m \cdot 3 \cdot m \cdot \frac{2}{3} \cdot 3 \cdot m \cdot 2 + 3 \cdot m \cdot 3 \cdot m \cdot 3 \cdot m + \frac{1}{2} \cdot 2 \cdot m \cdot 2 \cdot m \cdot \frac{2}{3} 2m \cdot 2 + 2m \cdot 3m \cdot 2m \right)$$

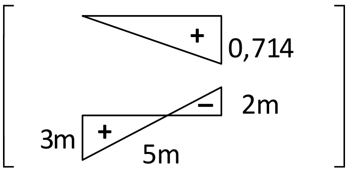
$$\delta_{22} = 1.421 \times 10^{-2} \cdot \frac{\mathrm{m}}{kN} \qquad E \cdot I_x \delta_{22} = 62.333 \cdot m^3$$

$$\delta_{33} = \frac{1}{E \cdot I_x}$$



$$\delta_{33} = \frac{1}{E \cdot I_x} \cdot \left(\frac{1}{2} \cdot 3 \cdot m \cdot 3 \cdot m \cdot \frac{2}{3} \cdot 3 \cdot m \cdot 2 + 3 \cdot m \cdot 5 \cdot m \cdot 3 \cdot m \right) \qquad \delta_{33} = 1.436 \times 10^{-2} \cdot \frac{\mathrm{m}}{kN} \qquad E \cdot I_x \delta_{33} = 63 \cdot m^3$$

$$\delta_{12} = \frac{1}{E \cdot I_x}$$

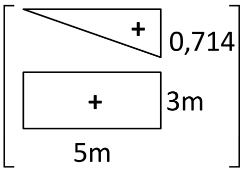


$$\delta_{12} = \frac{1}{E \cdot I_x} \cdot \left[\frac{1}{2} \cdot 0.714 \cdot 5 \cdot m \cdot \left[\frac{2}{3} \cdot (-2 \cdot m) + \frac{1}{3} \cdot 3m \right] \right]$$

$$\delta_{12} = -1.356 \times 10^{-4} \cdot \frac{1}{kN} \qquad E \cdot I_x \delta_{12} = -0.595\, m^2$$

$$\delta_{21} = \delta_{12}$$

$$\delta_{13} = \frac{1}{E \cdot I_x}$$

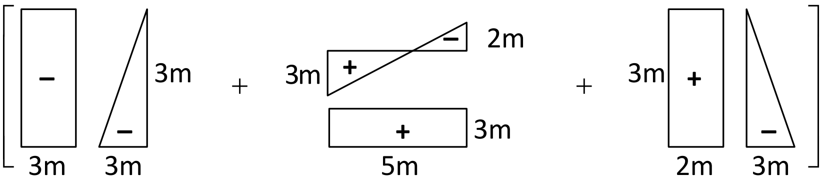


$$\delta_{13} = \frac{1}{E \cdot I_x} \cdot \left(\frac{1}{2} \cdot 5 \cdot m \cdot 0.714 \cdot 3m \right)$$

$$\delta_{13} = 1.221 \times 10^{-3} \cdot \frac{1}{kN} \qquad E \cdot I_x \delta_{13} = 5.355 \cdot m^2$$

$$\delta_{31} = \delta_{13}$$

$$\delta_{23} = \frac{1}{E \cdot I_x}$$



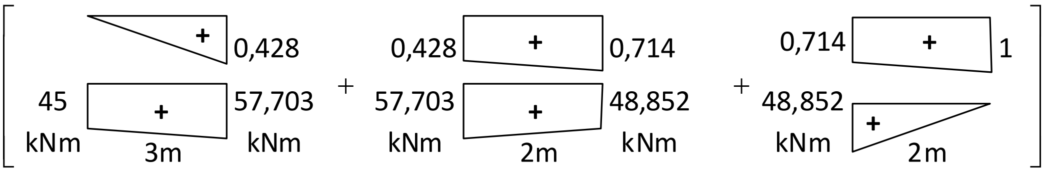
$$\delta_{23} = \frac{1}{E \cdot I_x} \cdot \left[\frac{1}{2} \cdot 3 \cdot m \cdot (-3m) \cdot (-3m) + 5m \cdot 3m \cdot \frac{1}{2} [3m + (-2m)] + 2m \cdot 3m \cdot \frac{1}{2} (-3m) \right]$$

$$\delta_{23} = 2.735 \times 10^{-3} \cdot \frac{\mathrm{m}}{kN} \qquad E \cdot I_x \delta_{23} = 12 \cdot m^3$$

$$\delta_{32} = \delta_{23}$$

Wyznaczenie wyrazów wolnych układu równań

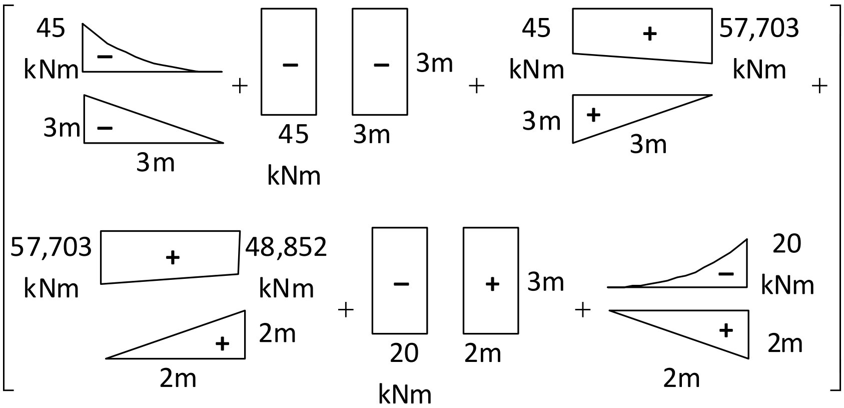
$$\Delta_{1p} = \frac{1}{E \cdot I_x}$$



$$\Delta_{1p} = \frac{1}{E \cdot I_x}\left[\frac{1}{2}\cdot 3m\cdot 0.428\cdot\left(\frac{1}{3}45kN\cdot m + \frac{2}{3}\cdot 57.703kN\cdot m\right) + \frac{1}{2}\cdot 0.428\cdot 2m\cdot\left(\frac{2}{3}57.703kN\cdot m + \frac{1}{3}\cdot 48.852kN\cdot m\right) \dots + \frac{1}{2}\cdot 0.714\cdot 2m\cdot\left(\frac{1}{3}57.703kN\cdot m + \frac{2}{3}\cdot 48.852kN\cdot m\right) + \frac{1}{2}\cdot 2m\cdot 48.852kN\cdot m\cdot\left(\frac{2}{3}0.714 + \frac{1}{3}\cdot 1\right)\right]$$

$\Delta_{1p} = 3.061 \times 10^{-2}$ $\quad E \cdot I_x \Delta_{1p} = 134.285 \cdot kN \cdot m^2$

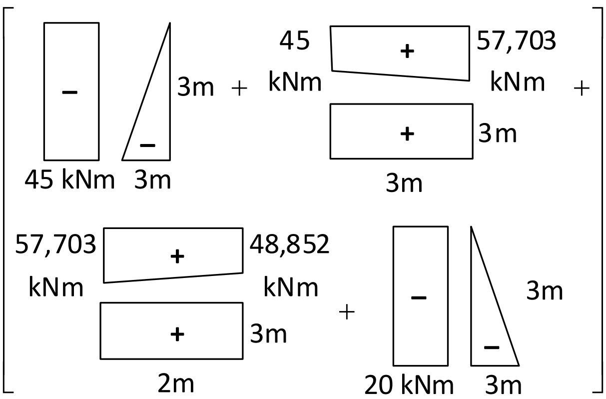
$$\Delta_{2p} = \frac{1}{E \cdot I_x}$$



$$\Delta_{2p} = \frac{1}{E \cdot I_x}\left[\frac{1}{3}(-45kN\cdot m)\cdot 3m\cdot\frac{3}{4}(-3m) + (-45kN\cdot m)\cdot 3m\cdot(-3m) + \frac{1}{2}\cdot 3m\cdot 3m\cdot\left(\frac{2}{3}45kN\cdot m + \frac{1}{3}\cdot 57.703kN\cdot m\right) \dots + \frac{1}{2}\cdot 2m\cdot(-2m)\cdot\left(\frac{2}{3}48.852kN\cdot m + \frac{1}{3}\cdot 57.703kN\cdot m\right) + (-20kN\cdot m)\cdot 2m\cdot 3m + \frac{1}{3}\cdot(-20kN\cdot m)\cdot 2m\cdot\frac{3}{4}\cdot 2m\right]$$

$\Delta_{2p} = 1.104 \times 10^{-1} m$ $\quad E \cdot I_x \Delta_{2p} = 484.2 \cdot kN \cdot m^3$

$$\Delta_{3p} = \frac{1}{E \cdot I_x}$$



$$\Delta_{3p} = \frac{1}{E \cdot I_x}\cdot\left[(-45\cdot kN\cdot m)\cdot 3\cdot m\cdot\frac{1}{2}\cdot(-3\cdot m) + 3\cdot m\cdot 3\cdot m\cdot\frac{1}{2}\cdot(45\cdot kN\cdot m + 57.703\cdot kN\cdot m) \dots + 3\cdot m\cdot 2\cdot m\cdot\frac{1}{2}\cdot(48.852\cdot kN\cdot m + 57.703\cdot kN\cdot m) + 3\cdot m\cdot(-20\cdot kN\cdot m)\cdot\frac{1}{2}\cdot(-3\cdot m)\right]$$

$\Delta_{3p} = 2.449 \times 10^{-1} m$ $\quad E \cdot I_x \Delta_{3p} = 1.074 \times 10^3 \cdot kN \cdot m^3$

$$\Delta_{1\Delta} = -[0.143\cdot(-0.01)] \qquad \Delta_{1\Delta} = 1.43\times10^{-3}$$

$$\Delta_{2\Delta} = 0$$

$$\Delta_{3\Delta} = 0$$

$$\Delta_{1t0} = 0$$

$$\Delta_{2t0} = \alpha_t\cdot 10K\cdot(-1)\cdot 3m \qquad \Delta_{2t0} = -3.6\times10^{-4}\,m$$

$$\Delta_{3t0} = \alpha_t\cdot 20K\cdot(-1)\cdot 5m \qquad \Delta_{3t0} = -1.2\times10^{-3}\,m$$

$$\Delta_{1\Delta t} = \frac{\alpha_t}{h}\cdot 20K\cdot\frac{1}{2}\cdot 5m\cdot 0.714 \qquad \Delta_{1\Delta t} = 2.142\times10^{-3} \qquad \Delta_{1\Delta t} = 2.142\times10^{-3}$$

$$\Delta_{2\Delta t} = \frac{\alpha_t}{h}\cdot 20K\cdot\left[\frac{1}{2}\cdot 3m\cdot 3m + \frac{1}{2}\cdot 2m\cdot(-2m)\right] \qquad \Delta_{2\Delta t} = 3\times10^{-3}\,m$$

$$\Delta_{3\Delta t} = \frac{\alpha_t}{h}\cdot 20K\cdot 3m\cdot 5m \qquad \Delta_{3\Delta t} = 0.018\,m$$

$$\Delta_{10} = \Delta_{1p} + \left(\Delta_{1\Delta} + \Delta_{1t0} + \Delta_{1\Delta t}\right) \qquad \Delta_{10} = 0.034$$

$$\Delta_{20} = \Delta_{2p} + \left(\Delta_{2\Delta} + \Delta_{2t0} + \Delta_{2\Delta t}\right) \qquad \Delta_{20} = 0.113\,m$$

$$\Delta_{30} = \Delta_{3p} + \left(\Delta_{3\Delta} + \Delta_{3t0} + \Delta_{3\Delta t}\right) \qquad \Delta_{30} = 0.262\,m$$

Z podporą sprężystą

$$V_{Ap} = 24.426kN \qquad V_{A1} = -0.143\cdot\frac{1}{m} \qquad V_{A2} = 0 \qquad V_{A3} = 0 \qquad K_y = 250\,\frac{kN}{m}$$

$$\delta_{11} = 5.319\times10^{-4}\cdot\frac{1}{kN\cdot m} \qquad \frac{V_{A1}\cdot V_{A1}}{K_y} = 8.18\times10^{-5}\cdot\frac{1}{kN\cdot m} \qquad \delta_{11} = \delta_{11} + \frac{V_{A1}\cdot V_{A1}}{K_y} = 6.137\times10^{-4}\cdot\frac{1}{kN\cdot m}$$

$$\delta_{22} = 1.421\times10^{-2}\cdot\frac{m}{kN} \qquad \frac{V_{A2}\cdot V_{A2}}{K_y} = 0 \qquad \delta_{22} = \delta_{22} + \frac{V_{A2}\cdot V_{A2}}{K_y} = 1.421\times10^{-2}\cdot\frac{m}{kN}$$

$$\delta_{33} = 1.436\times10^{-2}\cdot\frac{m}{kN} \qquad \frac{V_{A3}\cdot V_{A3}}{K_y} = 0 \qquad \delta_{33} = \delta_{33} + \frac{V_{A3}\cdot V_{A3}}{K_y} = 1.436\times10^{-2}\cdot\frac{m}{kN}$$

$$\delta_{12} = -1.356\times10^{-4}\cdot\frac{1}{kN} \qquad \frac{V_{A1}\cdot V_{A2}}{K_y} = 0 \qquad \delta_{12} = \delta_{12} + \frac{V_{A1}\cdot V_{A2}}{K_y} = -1.356\times10^{-4}\cdot\frac{1}{kN} \qquad \delta_{21} = \delta_{12}$$

$$\delta_{13} = 1.221\times10^{-3}\,\frac{1}{m}\cdot\frac{m}{kN} \qquad \frac{V_{A1}\cdot V_{A3}}{K_y} = 0 \qquad \delta_{13} = \delta_{13} + \frac{V_{A1}\cdot V_{A3}}{K_y} = 1.221\times10^{-3}\,\frac{1}{m}\cdot\frac{m}{kN} \qquad \delta_{31} = \delta_{13}$$

$$\delta_{23} = 2.735\times10^{-3}\cdot\frac{m}{kN} \qquad \frac{V_{A2}\cdot V_{A3}}{K_y} = 0 \qquad \delta_{23} = \delta_{23} + \frac{V_{A2}\cdot V_{A3}}{K_y} = 2.735\times10^{-3}\cdot\frac{m}{kN} \qquad \delta_{32} = \delta_{23}$$

$\Delta_{10} = 3.418 \times 10^{-2}$ $\qquad \frac{V_{A1} \cdot V_{Ap}}{K_y} = -1.397 \times 10^{-2}$ $\qquad \Delta_{10} = \Delta_{10} + \frac{V_{A1} \cdot V_{Ap}}{K_y} = 2.021 \times 10^{-2}$

$\Delta_{20} = 1.13 \times 10^{-1}\, m$ $\qquad \frac{V_{A2} \cdot V_{Ap}}{K_y} = 0 \times 10^{0}$ $\qquad \Delta_{20} = \Delta_{20} + \frac{V_{A2} \cdot V_{Ap}}{K_y} = 1.13 \times 10^{-1}\, m$

$\Delta_{30} = 2.617 \times 10^{-1}\, m$ $\qquad \frac{V_{A3} \cdot V_{Ap}}{K_y} = 0 \times 10^{0}$ $\qquad \Delta_{30} = \Delta_{30} + \frac{V_{A3} \cdot V_{Ap}}{K_y} = 2.617 \times 10^{-1}\, m$

Rozwiązanie układu równań

$$\delta_{11} \cdot X_1 + \delta_{12} \cdot X_2 + \delta_{13} \cdot X_3 + \Delta_{10} = 0.01$$

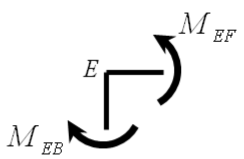
$$\delta_{21} \cdot X_1 + \delta_{22} \cdot X_2 + \delta_{23} \cdot X_3 + \Delta_{20} = 0$$

$$\delta_{31} \cdot X_1 + \delta_{32} \cdot X_2 + \delta_{33} \cdot X_3 + \Delta_{30} = 0$$

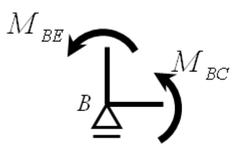
$X_1 = 20.668 \cdot kN \cdot m$ $\qquad X_2 = -4.059 \cdot kN$ $\qquad X_3 = -19.206 \cdot kN$

X1	20,668				
X2	-4,059				
X3	-19,206				
	Mp	**M1**	**M2**	**M3**	**Most**
AD	0	1	0	0	**20,668**
DA	48,852	0,714	0	0	**63,609**
DC	48,852	0,714	-2	3	**14,109**
DG	-20	0	2	-3	**29,500**
CD	57,703	0,428	0	3	**8,931**
CB	57,703	0,428	0	3	**8,931**
BC	45	0	3	3	**-24,795**
BE	-45	0	-3	-3	**24,795**
EB	-45	0	-3	0	**-32,823**
EF	-45	0	-3	0	**-32,823**
FE	0	0	0	0	**0,000**
FG	0	0	0	0	**0,000**
GF	-20	0	2	0	**-28,118**
GD	-20	0	2	0	**-28,118**

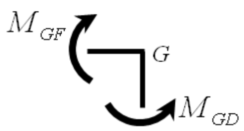
Sprawdzenie równowagi momentów w węzłach



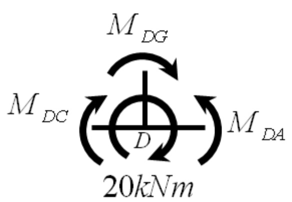
$$M_{EB} - M_{EF} = 0 \cdot kN \cdot m$$



$$M_{BE} + M_{BC} = 0 \cdot kN \cdot m$$



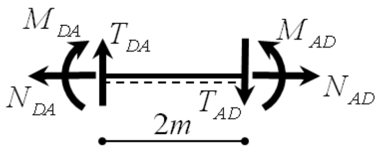
$$M_{GF} - M_{GD} = 0 \cdot kN \cdot m$$



$$M_{DC} + M_{DG} - M_{DA} + 20kN \cdot m = 0 \cdot kN \cdot m$$

Wyznaczenie sił tnących

Pręt DA



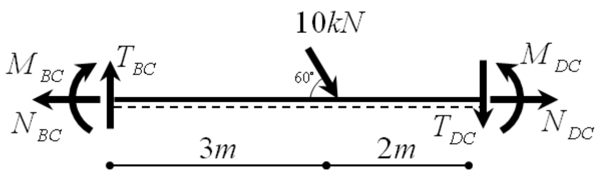
ΣM$_A$=0

$$T_{DA} \cdot 2m + M_{DA} - M_{AD} = 0$$

ΣY=0 $\quad T_{AD} = T_{DA}$

$T_{DA} = -21.471 \cdot kN \qquad T_{AD} = -21.471 \cdot kN$

Pręt BD



ΣM$_C$=0

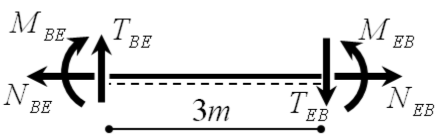
$$T_{BC} \cdot 5m + M_{BC} - M_{DC} - 10kN \cdot sin(60deg) \cdot 2m = 0$$

ΣY=0

$$T_{BC} - T_{DC} - 10kN \cdot sin(60deg) = 0$$

$T_{DC} = 2.585 \cdot kN \qquad T_{BC} = 11.245 \cdot kN$

Pręt BE



ΣM$_E$=0

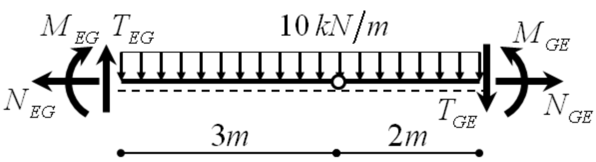
$$T_{BE} \cdot 3m + M_{BE} - M_{EB} = 0$$

ΣY=0

$T_{EB} = T_{BE}$

$T_{BE} = -19.206 \cdot kN \qquad T_{EB} = -19.206 \cdot kN$

Pręt EG



ΣM$_G$=0

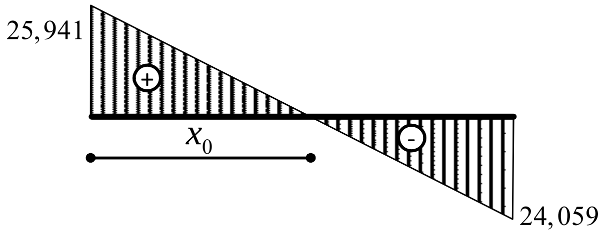
$$T_{EF} \cdot 5m + M_{EF} - M_{GF} - 10 \frac{kN}{m} \cdot 5m \cdot \frac{5m}{2} = 0$$

ΣY=0

$$T_{EF} - T_{GF} - 10\frac{kN}{m}\cdot 5m = 0$$

$$T_{GF} = -24.059\cdot kN \qquad T_{EF} = 25.941\cdot kN$$

Wyznaczenie maksymalnego momentu

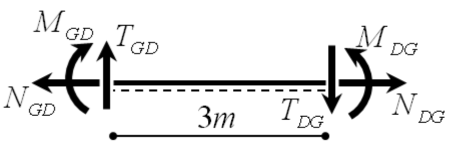


$$\frac{T_{EF}}{x_0} = \frac{-T_{GF}}{5m - x_0}$$

$$x_0 = 2.594\ m$$

$$M_{max} = M_{EF} + T_{EF}\cdot x_0 - 10\frac{kN}{m}\cdot x_0\cdot\frac{x_0}{2} \qquad M_{max} = 0.824\cdot kN\cdot m$$

Pręt GD



ΣM$_D$=0

$$T_{GD}\cdot 3m + M_{GD} - M_{DG} = 0$$

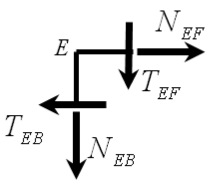
ΣY=0

$$T_{DG} = T_{GD}$$

$$T_{GD} = 19.206\cdot kN \qquad T_{DG} = 19.206\cdot kN$$

Równowaga węzłów - siły normalne i reakcje

Węzeł E



ΣX=0 $\quad N_{EF} - T_{EB} = 0$

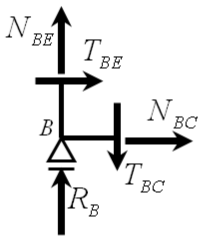
$$N_{EF} = -19.206\cdot kN$$

ΣY=0 $\quad N_{EB} + T_{EF} = 0$

$$N_{EB} = -25.941\cdot kN$$

$N_{GF} = N_{EF} \qquad N_{BE} = N_{EB}$ (z warunków równowagi prętów EG i BE)

Węzeł B



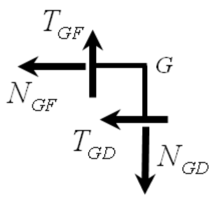
ΣX=0 $\quad N_{BC} + T_{BE} = 0$

$$N_{BC} = 19.206\cdot kN$$

ΣY=0 $\quad N_{BE} + R_B - T_{BC} = 0$

$$R_B = 37.186\cdot kN$$

Węzeł G



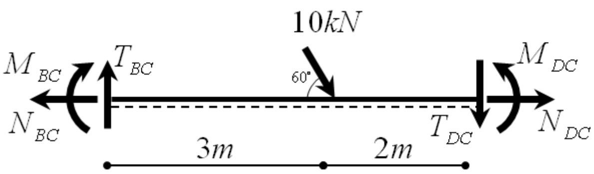
ΣX=0 $\quad T_{GD} + N_{GF} = 0 \cdot kN$ (sprawdzenie)

ΣY=0 $\quad -N_{GD} + T_{GF} = 0$

$N_{GD} = -24.059 \cdot kN$

$N_{DG} = N_{GD}$ (z warunku równowagi pręta DG)

Pręt BD

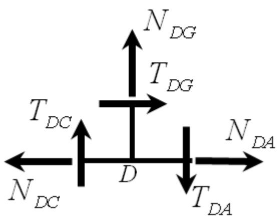


ΣX=0

$N_{DC} + 10kN \cdot cos(60deg) - N_{BC} = 0$

$N_{DC} = 14.206 \cdot kN$

Węzeł D



ΣY=0

$N_{DG} + T_{DC} - T_{DA} = -3.852 \times 10^{-3} \cdot kN$ (sprawdzenie)

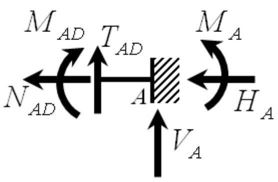
ΣX=0

$N_{DA} + T_{DG} - N_{DC} = 0$

$N_{DA} = -5 \cdot kN$

$N_{AD} = N_{DA}$ (z warunku równowagi pręta DA)

Węzeł A



$ΣM_A$=0 $\quad M_A = M_{AD} \qquad M_A = 20.668 \cdot kN \cdot m$

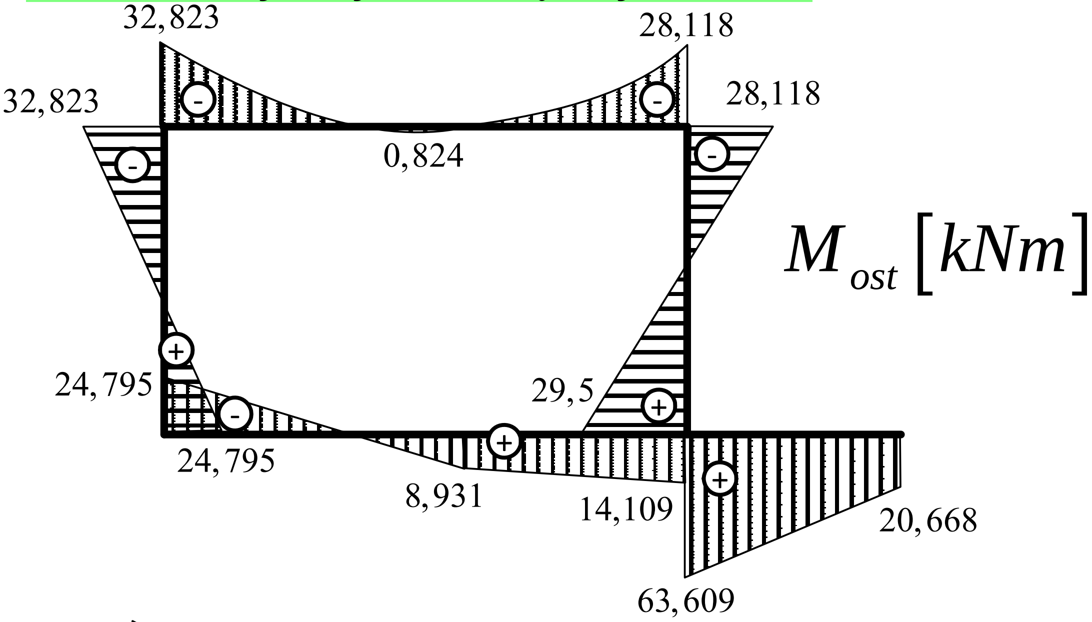
ΣX=0 $\quad H_A + N_{AD} = 0$

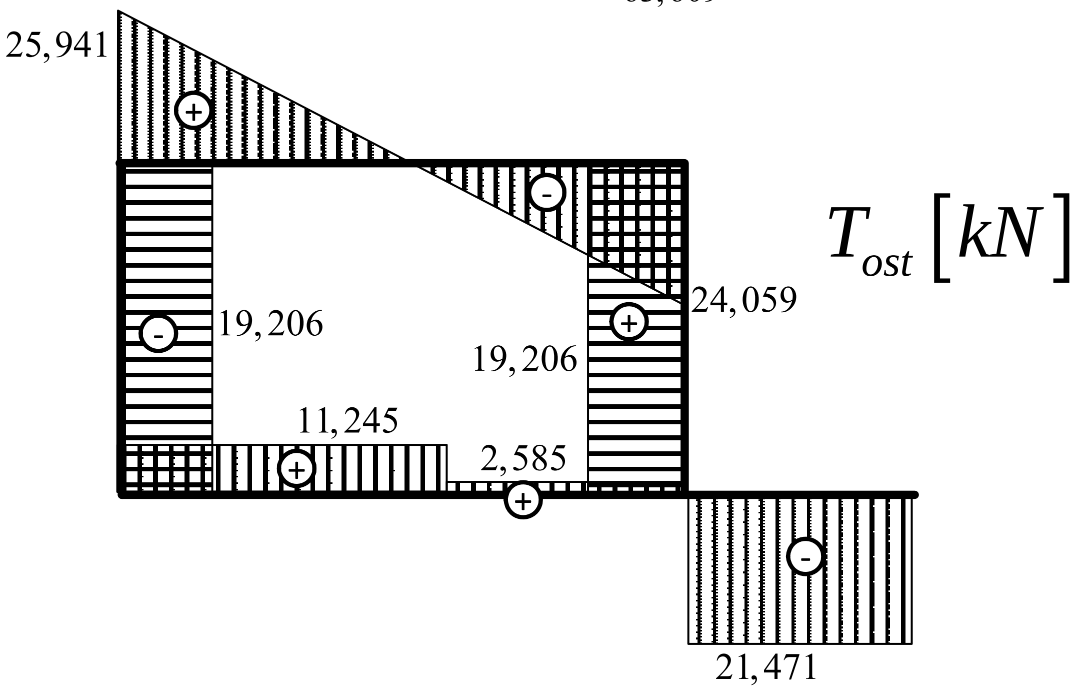
$H_A = 5 \cdot kN$

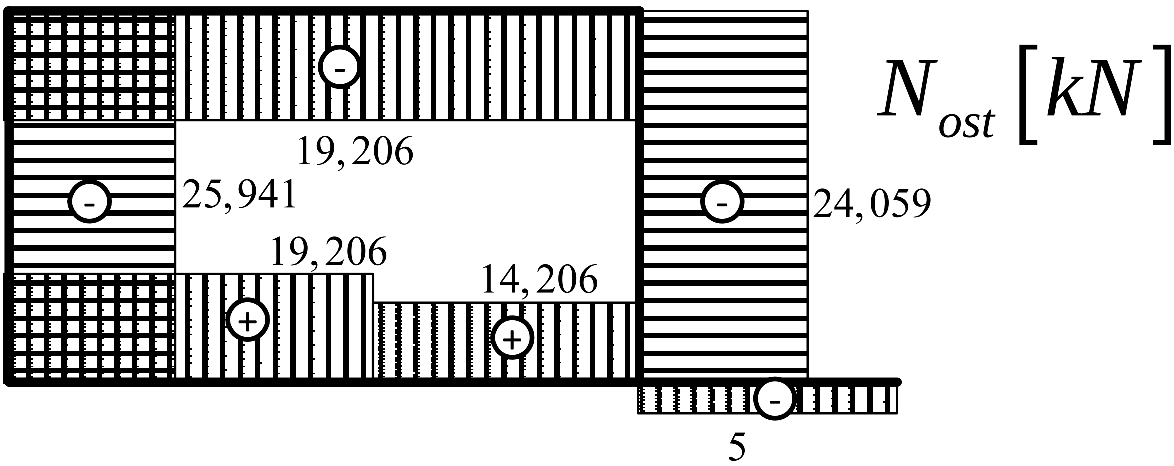
ΣY=0 $\quad V_A + T_{AD} = 0$

$V_A = 21.471 \cdot kN$

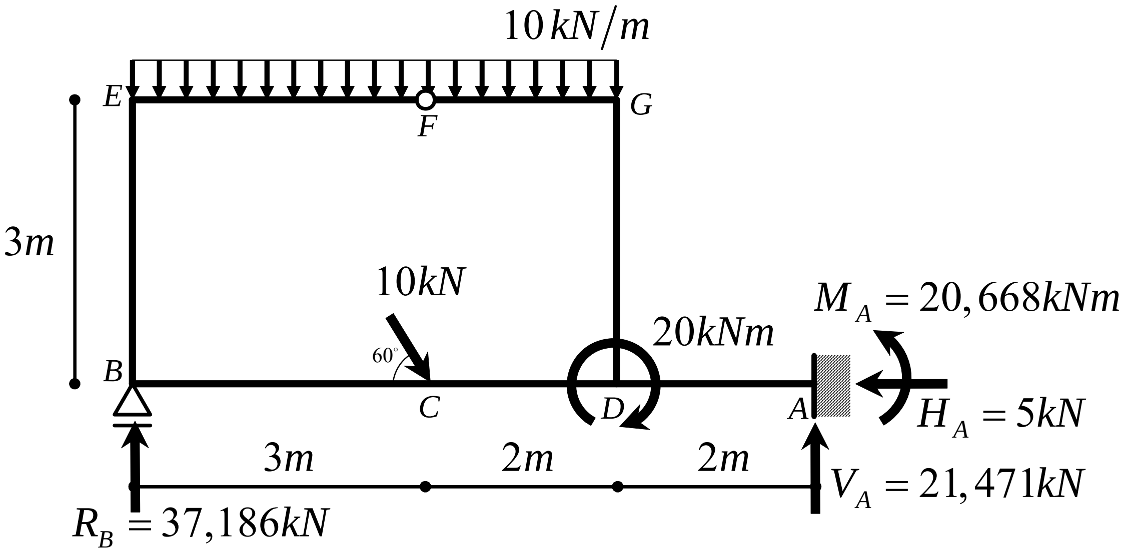
Ostateczne wykresy sił wewnętrznych







Sprawdzenia statyczne



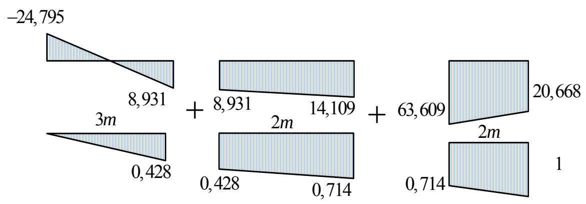
ΣX=0 $\quad -H_A + 10kN\cdot cos(60deg) = 0\cdot kN$

ΣY=0 $\quad R_B + V_A - 10kN\,sin(60deg) - 10\frac{kN}{m}\cdot 5m = -3.852\times 10^{-3}\cdot kN$

ΣM_G=0 $\quad R_B\cdot 5m - 10\frac{kN}{m}\cdot 5m\cdot\frac{5m}{2} - 10kN\cdot sin(60deg)\cdot 2m - 10kN\cdot cos(60deg)\cdot 3m\ ... = 1.091\times 10^{-14}\cdot kN\cdot m$

$+20kN\cdot m - V_A\cdot 2m + H_A\cdot 3m - M_A$

Sprawdzenie kinematyczne



$$\varphi_{1p} = \frac{1}{E\cdot I_x}\left[\frac{1}{2}\cdot 3m\cdot 0.428\cdot\left(\frac{1}{3}\cdot M_{BC} + \frac{2}{3}\cdot M_{CB}\right)\ ...\right.$$
$$+\frac{1}{2}\cdot 2m\cdot M_{CD}\cdot\left(\frac{2}{3}\cdot 0.428 + \frac{1}{3}\cdot 0.714\right) + \frac{1}{2}\cdot 2m\cdot M_{DC}\cdot\left(\frac{1}{3}\cdot 0.428 + \frac{2}{3}\cdot 0.714\right)\ ...$$
$$\left.+\frac{1}{2}\cdot 2m\cdot M_{DA}\cdot\left(\frac{2}{3}\cdot 0.714 + \frac{1}{3}\cdot 1\right) + \frac{1}{2}\cdot 2m\cdot M_{AD}\cdot\left(\frac{1}{3}\cdot 0.714 + \frac{2}{3}\cdot 1\right)\right]$$

$\varphi_{1p} = 1.871\times 10^{-2}$

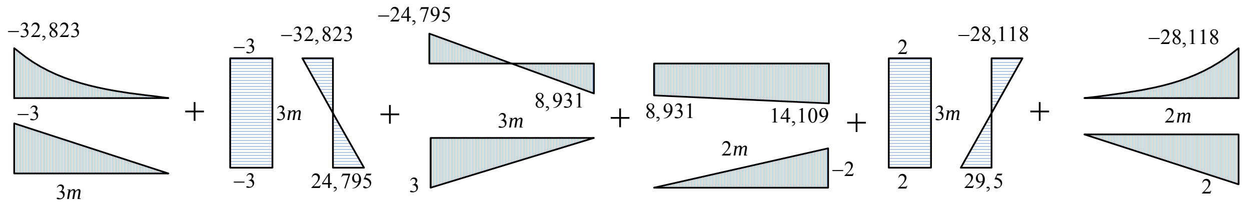
$\varphi_{1t} = \Delta_{1\Delta t} \qquad \varphi_{1t} = 2.142\times 10^{-3}$

$\varphi_{1\Delta} = -(1\cdot 0.01 - 0.143\cdot 0.01) \qquad \varphi_{1\Delta} = -8.57\times 10^{-3}$

$\varphi_{1k} = \dfrac{V_{A1}\cdot V_A}{K_y} \qquad \varphi_{1k} = -0.012$

$\varphi_1 = \varphi_{1p} + \varphi_{1t} + \varphi_{1\Delta} + \varphi_{1k} \qquad \varphi_1 = 4.695\times 10^{-6}$

$\Delta = \dfrac{\varphi_1}{\varphi_{1p}} \qquad \Delta = 0.025\cdot\%$



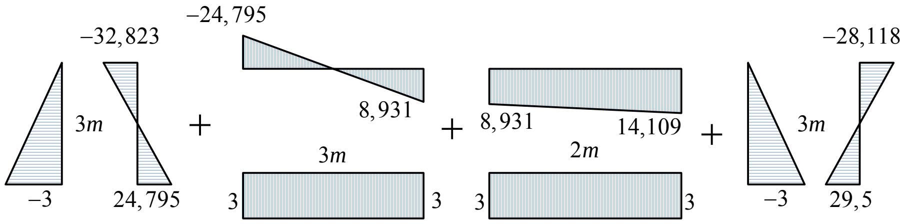
$$\Delta_{2ost} = \frac{1}{E\cdot I_x}\left[\begin{array}{l} \frac{1}{2}\cdot 3m\cdot(-3m)\cdot\frac{2}{3}\cdot(-32.823kN\cdot m) + \frac{2}{3}\cdot\frac{10\frac{kN}{m}\cdot(3m)^2}{8}\cdot 3m\cdot\frac{1}{2}\cdot(-3m)\ ... \\ + 3m\cdot(-3m)\cdot\left[\frac{1}{2}\cdot(-32.823kN\cdot m) + \frac{1}{2}\cdot 24.795kN\cdot m\right] + \frac{1}{2}\cdot 3m\cdot 3m\cdot\left[\frac{2}{3}\cdot(-24.795kN\cdot m) + \frac{1}{3}\cdot 8.931kN\cdot m\right] ... \\ + \frac{1}{2}\cdot 2m\cdot(-2m)\cdot\left(\frac{1}{3}\cdot 8.931kN\cdot m + \frac{2}{3}\cdot 14.109kN\cdot m\right) + 2m\cdot 3m\cdot\left[\frac{1}{2}\cdot 29.5\cdot kN\cdot m + \frac{1}{2}\cdot(-28.118kN\cdot m)\right] ... \\ + \frac{1}{2}\cdot 2m\cdot 2m\cdot\frac{2}{3}\cdot(-28.118kN\cdot m) + \frac{2}{3}\cdot\frac{10\frac{kN}{m}\cdot(2m)^2}{8}\cdot 2m\cdot\frac{1}{2}\cdot 2m \end{array}\right]$$

$$\Delta_{2ost} = -2.641\times 10^{-3}m$$

$$\Delta_{2t} = \Delta_{2\Delta t} + \Delta_{2t0} = 2.64\times 10^{-3}m \qquad \Delta_{2\Delta} = 0 \qquad \Delta_{2k} = \frac{V_{A2}\cdot V_A}{K_y} = 0$$

$$\Delta_2 = \Delta_{2ost} + \Delta_{2t} + \Delta_{2\Delta} + \Delta_{2k} = -1.327\times 10^{-6}m$$

$$\Delta = \frac{\Delta_2}{\Delta_{2ost}} \qquad \Delta = 0.05\cdot\%$$



$$\Delta_{3ost} = \frac{1}{E\cdot I_x}\left[\begin{array}{l} \frac{1}{2}\cdot 3m\cdot(-3m)\cdot\left[\frac{1}{3}\cdot(-32.823kN\cdot m) + \frac{2}{3}\cdot 24.795kN\cdot m\right] + 3m\cdot 3m\cdot\left[\frac{1}{2}\cdot(-24.795kN\cdot m) + \frac{1}{2}\cdot 8.931kN\cdot m\right] ... \\ + 3m\cdot 2m\cdot\left(\frac{1}{2}\cdot 8.931kN\cdot m + \frac{1}{2}\cdot 14.109kN\cdot m\right) + \frac{1}{2}\cdot 3m\cdot(-3m)\cdot\left[\frac{2}{3}\cdot 29.5\cdot kN\cdot m + \frac{1}{3}\cdot(-28.118kN\cdot m)\right] \end{array}\right]$$

$$\Delta_{3ost} = -1.681\times 10^{-2}m$$

$$\Delta_{3t} = \Delta_{3\Delta t} + \Delta_{3t0} = 1.68\times 10^{-2}m$$

$$\Delta_{3\Delta} = 0$$

$$\Delta_{3k} = \frac{V_{A3}\cdot V_A}{K_y} = 0$$

$$\Delta_3 = \Delta_{3ost} + \Delta_{3t} + \Delta_{3\Delta} + \Delta_{3k} = -9.095\times 10^{-6}m$$

$$\Delta = \frac{\Delta_3}{\Delta_{3ost}} \qquad \Delta = 0.054\cdot\%$$