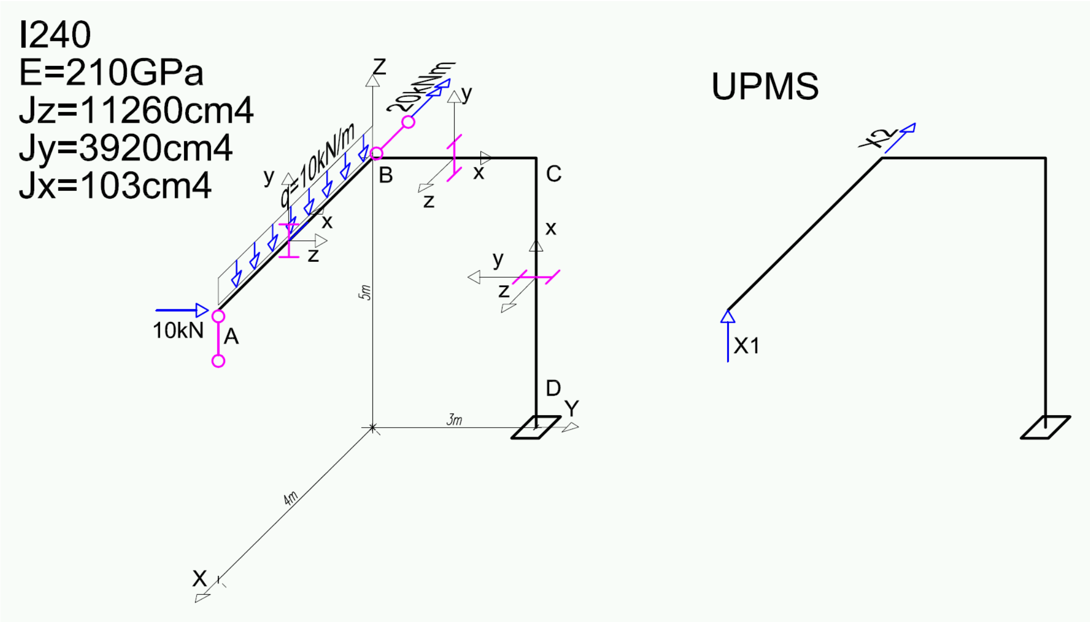
$$E := 210 \cdot 10^3 \cdot MPa \qquad \nu := 0.3$$

$$G := \frac{E}{2(1+\nu)} = 8.077 \times 10^4 \cdot MPa$$

$$Jz := 11280 \cdot cm^4 \qquad Jy := 3920 \cdot cm^4 \qquad Jx := 103 \cdot cm^4$$



$$\delta_{11} := \left(\frac{1}{2}\cdot 4\cdot 4\cdot \frac{2}{3}\cdot 4 + \frac{1}{2}\cdot 3\cdot 3\cdot \frac{2}{3}\cdot 3 + 3\cdot 5\cdot 3\right)\cdot \frac{m^3}{E\cdot Jz} + (4\cdot 5\cdot 4)\cdot \frac{m^3}{E\cdot Jy} + (4\cdot 3\cdot 4)\cdot \frac{m^3}{G\cdot Jx} = 0.59\, m\cdot \frac{1}{kN}$$

$$\delta_{12} := (0)\cdot \frac{m^3}{E\cdot Jz} + \left(\frac{1}{2}\cdot 5\cdot 5\cdot 4\right)\cdot \frac{m^3}{E\cdot Jy} + 0\cdot \frac{m^3}{G\cdot Jx} = 6.074 \times 10^{-3}\, m\cdot \frac{1}{kN}$$

$$\delta_{22} := (0)\cdot \frac{m^3}{E\cdot Jz} + \left(\frac{1}{2}\cdot 3\cdot 3\cdot \frac{2}{3}\, 3 + \frac{1}{2}\cdot 5\cdot 5\cdot \frac{2}{3}\, 5\right)\cdot \frac{m^3}{E\cdot Jy} + (3\cdot 5\cdot 3)\cdot \frac{m^3}{G\cdot Jx} = 0.547\, m\cdot \frac{1}{kN}$$

$$\Delta_{1p} := \left[\frac{-1}{2}\cdot 4\cdot 4\cdot \frac{2}{3}\cdot 80 + \frac{2}{3}\cdot 4\cdot \frac{10\cdot 4^2}{8}\, \frac{1}{2}\, 4 + \frac{1}{2}\, 3\cdot 3\cdot \left(\frac{1}{3}\, 20 - \frac{2}{3}\, 100\right) - 3\cdot 5\cdot 75\right]\cdot \frac{kN\cdot m^3}{E\cdot Jz} \ldots$$
$$+ \left[(-4\cdot 5\cdot 80)\cdot \frac{kN\cdot m^3}{E\cdot Jy} + (-4\cdot 3\cdot 80)\cdot \frac{kN\cdot m^3}{G\cdot Jx}\right]$$

$$\Delta_{1p} = -11.806\, m$$

$$\Delta_{2p} := (0)\cdot \frac{kN\cdot m^3}{E\cdot Jz} + \left(\frac{-1}{2}\cdot 3\cdot 3\cdot 40 - \frac{1}{2}\cdot 5\cdot 5\cdot 80\right)\cdot \frac{kN\cdot m^3}{E\cdot Jy} + (-3\cdot 5\cdot 40)\cdot \frac{kN\cdot m^3}{G\cdot Jx}$$

$$\Delta_{2p} = -7.356\, m$$

Rozewiązanie układu równań

$$D := \begin{pmatrix} \delta_{11} & \delta_{12} \\ \delta_{12} & \delta_{22} \end{pmatrix} \qquad P := \begin{pmatrix} -\Delta_{1p} \\ -\Delta_{2p} \end{pmatrix}$$

$$X := D^{-1} \cdot P \qquad X = \begin{pmatrix} 19.87874 \\ 13.22464 \end{pmatrix} \cdot kN$$

Momenty												
	Stan X1=1			Stan X2=1			Stan P			Most		
	Mx	My	Mz	Mx	My	Mz	Mx	My	Mz	Mx	My	Mz
A-B	0	0	0	0	0	0	0	0	0	0	0	0
B-A	0	0	4	0	0	0	0	-40	-80	0	-40	-0.484
B-C	4	0	0	0	0	0	-80	-40	20	-0.484	-40	20
C-B	4	0	3	0	-3	0	-80	40	-100	-0.484	0.325	-40.363
C-D	0	-4	-3	-3	0	0	40	80	100	0.325	0.484	40.363
D-C	0	-4	-3	-3	-5	0	40	80	50	0.325	-65.641	-9.637

TNĄCE												
	Stan X1=1			Stan X2=1			Stan P			Siły ost		
	Nx	Ty	Tz	Nx	Ty	Tz	Nx	Ty	Tz	Nx	Ty	Tz
A-B	0	1	0	0	0	0	0	0	10	0	19.879	10
B-A	0	-1	0	0	0	0	0	40	-10	0	20.121	-10
B-C	0	1	0	0	0	-1	-10	-40	0	-10	-20.121	-13.225
C-B	0	-1	0	0	0	1	-10	40	0	-10	20.121	13.225
C-D	1	0	0	0	0	-1	-40	-10	0	-20.121	-10	-13.225
D-C	1	0	0	0	0	1	-40	10	0	-20.121	10	13.225

REAKCJE				
	Stan X1=1	Stan X2=1	Stan P	Rost
RDX	0	1	0	13.225
RDY	0	0	-10	-10
RDZ	-1	0	40	20.121
MDX	3	0	-50	9.637
MDY	4	5	-80	65.641
MDZ	0	3	-40	-0.325

Sprawdzenie kinematyczne

$$u_{Az} = \int \frac{M1y \cdot Mosty}{E \cdot Jy} ds + \int \frac{M1z \cdot Mostz}{E \cdot Jz} ds + \int \frac{M1x \cdot Mostx}{G \cdot Jx} ds$$

$$u_{Az} := \left[\frac{-1}{2} \cdot 4 \cdot 4 \cdot \frac{2}{3} \cdot 0.484 + \frac{2}{3} \cdot 4 \cdot \frac{10 \cdot 4^2}{8} \frac{1}{2} 4 + \frac{1}{2} 3 \cdot 3 \cdot \left(\frac{1}{3} 20 - \frac{2}{3} 40.363 \right) + 3 \cdot 5 \cdot \frac{1}{2} (9.627 - 40.363) \right] \cdot \frac{kN \cdot m^3}{E \cdot Jz} \ldots$$
$$+ \left[\left[4 \cdot 5 \cdot \frac{1}{2} (65.641 - 0.484) \right] \cdot \frac{kN \cdot m^3}{E \cdot Jy} + (-4 \cdot 3 \cdot 0.484) \cdot \frac{kN \cdot m^3}{G \cdot Jx} \right]$$

$$u_{Az} = 1.539 \times 10^{-4} m$$

błąd względny

$$blad1 := \frac{|u_{Az}|}{|\Delta_{1p}|} = 1.303 \times 10^{-3} \cdot \%$$

$$u_{Bx} = \int \frac{M2y \cdot Mosty}{E \cdot Jy} ds + \int \frac{M2z \cdot Mostz}{E \cdot Jz} ds + \int \frac{M2x \cdot Mostx}{G \cdot Jx} ds$$

$$u_{Bx} := (0) \cdot \frac{kN \cdot m^3}{E \cdot Jz} + \left[\frac{-1}{2} \cdot 3 \cdot 3 \cdot \frac{1}{2} (40 + 0.325) + \frac{1}{2} \cdot 5 \cdot 5 \cdot \frac{1}{2} (65.641 - 0.484) \right] \cdot \frac{kN \cdot m^3}{E \cdot Jy} + (-3 \cdot 5 \cdot 0.325) \cdot \frac{kN \cdot m^3}{G \cdot Jx}$$

$u_{Bx} = -0.02\,m$

$$blad2 := \frac{|u_{Bx}|}{|\Delta_{2p}|} = 0.274 \cdot \%$$

Sprawdzenie statyczne

$RDx := -13.225 + 13.225 = 0$

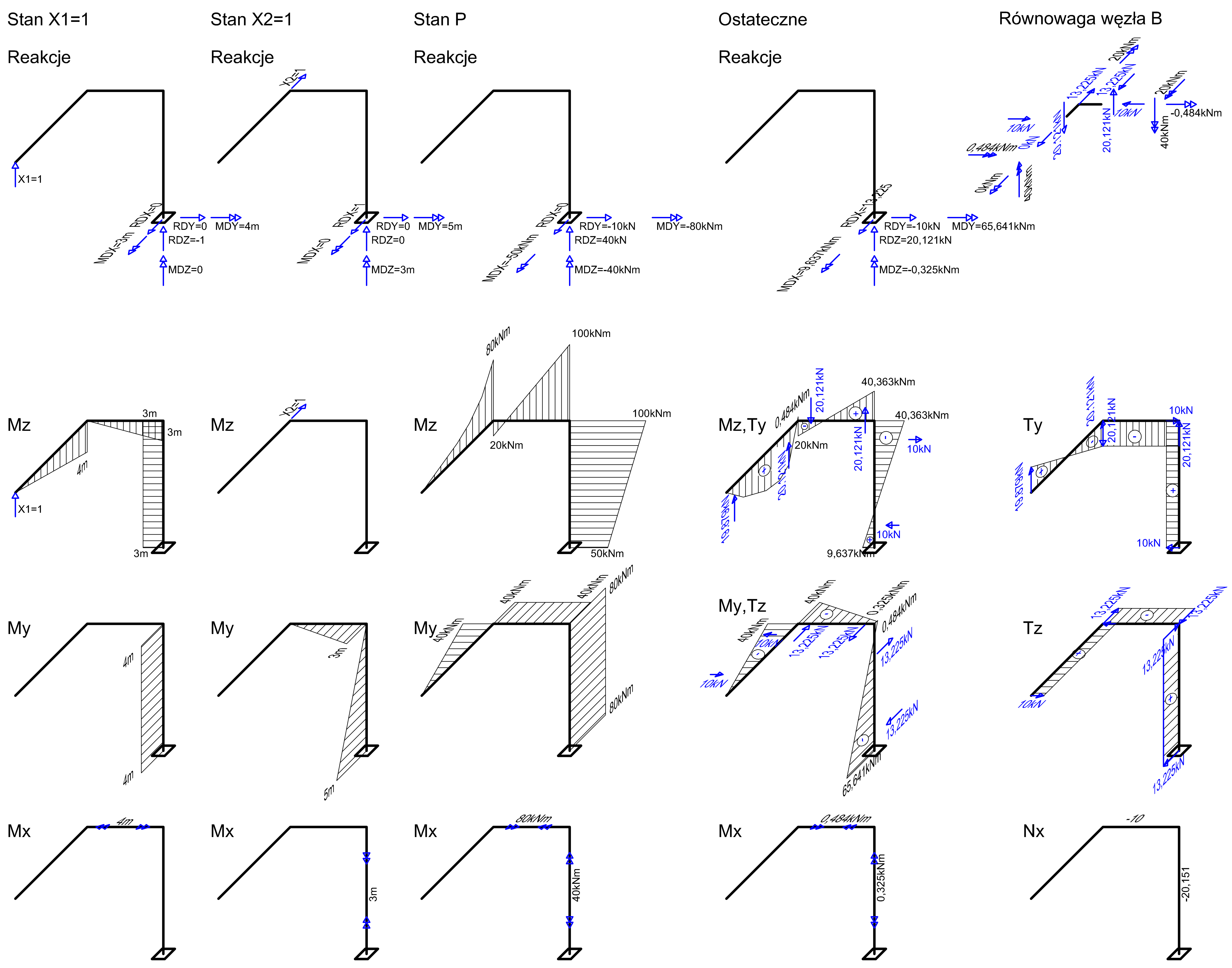
$RDy := 10 - 10 = 0$

$RDz := -40 + 19.879 + 20.121 = 0$

$MDx := -10 \cdot 5 - 20 + 40 \cdot 3 + 9.637 - 19.879 \cdot 3 = 0$

$MDy := -19.879 \cdot 4 + 10 \cdot 4 \cdot 2 - 13.225 \cdot 5 + 65.641 = 0$

$MDz := -0.325 + 10 \cdot 4 - 13.225 \cdot 3 = 0$



Stan X1=1
Reakcje
Stan X2=1
Reakcje
Stan P
Reakcje
Ostateczne
Reakcje
Równowaga węzła B
X1=1
RDX=0
MDX=3m
RDY=0
MDY=4m
RDZ=-1
MDZ=0
X2=1
RDX=1
MDX=0
RDY=0
MDY=5m
RDZ=0
MDZ=3m
RDX=0
MDX=-50kNm
RDY=-10kN
MDY=-80kNm
RDZ=40kN
MDZ=-40kNm
RDX=-13,225
MDX=-9,637kNm
RDY=-10kN
MDY=65,641kNm
RDZ=20,121kN
MDZ=-0,325kNm
Mz
My
Mx
Mz,Ty
My,Tz
Ty
Tz
Nx
3m
4m
5m
80kNm
100kNm
20kNm
50kNm
40kNm
40,363kNm
0,484kNm
20,121kN
10kN
9,637kNm
19,879kN
0,325kNm
65,641kNm
13,225kN
-0,484kNm
-10
-20,151

JEŻELI UKŁAD LOKALNY PRĘTA C-D WYGLĄDA TAK, TOZ ZNAKI WYKRESÓW MAJĄ POSTAĆ