

### KRATOWNICA

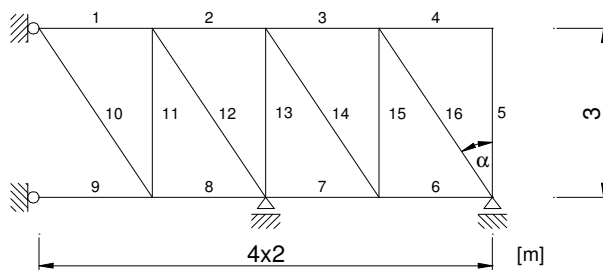
Zadana kratownica:

Pas górny kratownicy doznał ogrzania o  $t_0$  [°C]

Dane:

$$t_0 = 30 [C^\circ]$$

$$\alpha_i = 1,2 \cdot 10^{-5} \left[ \frac{1}{C^\circ} \right]$$



Przyjęto profil prętów I120

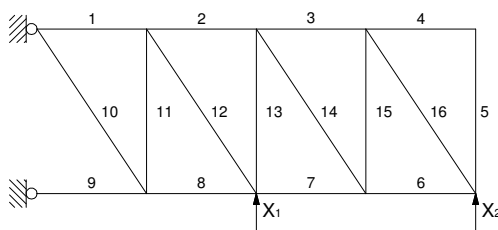
$$A = 14,20 \text{ cm}^2$$

$$E = 205 \text{ GPa}$$

$$EA = 291100 \text{ kN}$$

Stopień statycznej niewyznaczalności układu:  $SSN = 2$

Układ podstawowy:

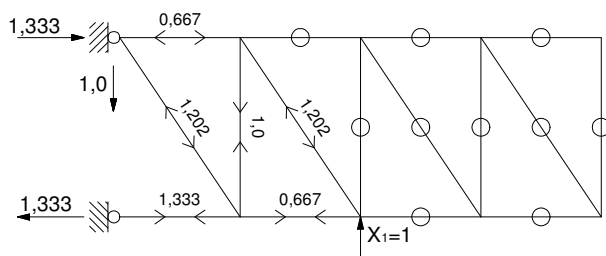


Układ równań kanonicznych:  $\begin{cases} \delta_{11}X_1 + \delta_{12}X_2 + \delta_{1t} = 0 \\ \delta_{21}X_1 + \delta_{22}X_2 + \delta_{2t} = 0 \end{cases}$

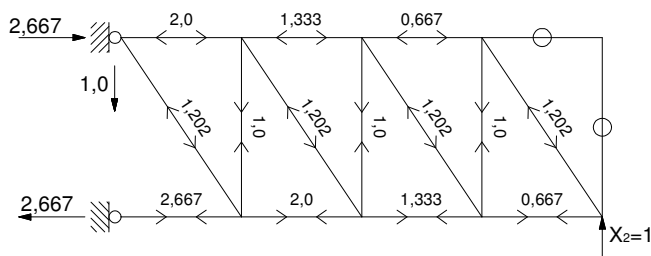
$$\delta_{it} = \sum N_i \cdot t_0 \cdot \alpha_i \cdot l$$

$$\delta_{ik} = \sum \frac{N_i N_k}{EA} \cdot l$$

Stan  $X_1=1$



Stan  $X_2=1$



| Lp. | l     | $N_1$  | $N_2$  | $N_1^2/l/EA$           | $N_2^2/l/EA$           | $N_1 N_2/l/EA$         | $\delta_{1t}$ | $\delta_{2t}$ | $N^{(n)}$ |
|-----|-------|--------|--------|------------------------|------------------------|------------------------|---------------|---------------|-----------|
| 1   | 2,000 | -0,667 | -2,000 | 0,889                  | 8,000                  | 2,667                  | -0,00048      | -0,00144      | -25,934   |
| 2   | 2,000 | 0,000  | -1,333 | 0,000                  | 3,556                  | 0,000                  | 0             | -0,00096      | -25,871   |
| 3   | 2,000 | 0,000  | -0,667 | 0,000                  | 0,889                  | 0,000                  | 0             | -0,00048      | -12,936   |
| 4   | 2,000 | 0,000  | 0,000  | 0,000                  | 0,000                  | 0,000                  | 0             | 0             | 0,000     |
| 5   | 3,000 | 0,000  | 0,000  | 0,000                  | 0,000                  | 0,000                  | -             | -             | 0,000     |
| 6   | 2,000 | 0,000  | 0,667  | 0,000                  | 0,889                  | 0,000                  | -             | -             | 12,936    |
| 7   | 2,000 | 0,000  | 1,333  | 0,000                  | 3,556                  | 0,000                  | -             | -             | 25,871    |
| 8   | 2,000 | 0,667  | 2,000  | 0,889                  | 8,000                  | 2,667                  | -             | -             | 25,934    |
| 9   | 2,000 | 1,333  | 2,667  | 3,556                  | 14,222                 | 7,111                  | -             | -             | 25,996    |
| 10  | 3,606 | -1,202 | -1,202 | 5,208                  | 5,208                  | 5,208                  | -             | -             | -0,112    |
| 11  | 3,000 | 1,000  | 1,000  | 3,000                  | 3,000                  | 3,000                  | -             | -             | 0,093     |
| 12  | 3,606 | -1,202 | -1,202 | 5,208                  | 5,208                  | 5,208                  | -             | -             | -0,112    |
| 13  | 3,000 | 0,000  | 1,000  | 0,000                  | 3,000                  | 0,000                  | -             | -             | 19,404    |
| 14  | 3,606 | 0,000  | -1,202 | 0,000                  | 5,208                  | 0,000                  | -             | -             | -23,320   |
| 15  | 3,000 | 0,000  | 1,000  | 0,000                  | 3,000                  | 0,000                  | -             | -             | 19,404    |
| 16  | 3,606 | 0,000  | -1,202 | 0,000                  | 5,208                  | 0,000                  | -             | -             | -23,320   |
|     |       |        |        | 18,749                 | 68,943                 | 25,860                 | -0,00048      | -0,00288      |           |
|     |       |        |        | $EA \cdot \delta_{11}$ | $EA \cdot \delta_{22}$ | $EA \cdot \delta_{12}$ | $\delta_{1t}$ | $\delta_{2t}$ |           |
|     |       |        |        | 6,441E-05              | 0,000237               | 8,884E-05              |               |               |           |

$$EA \cdot \delta_{11} = 18,749 \left[ \frac{\text{m}}{\text{kN}} \right]$$

$$\delta_{1t} = -0,00048 \text{ [m]}$$

$$EA \cdot \delta_{22} = 68,943 \left[ \frac{\text{m}}{\text{kN}} \right]$$

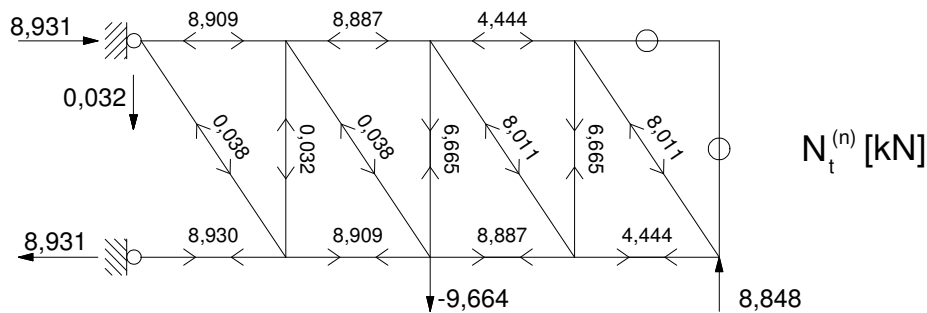
$$\delta_{2t} = -0,00288 \text{ [m]}$$

$$EA \cdot \delta_{12} = 25,860 \left[ \frac{\text{m}}{\text{kN}} \right]$$

$$\begin{cases} 18,749x_1 + 25,860x_2 = 0,00048 \cdot EA \\ 25,860x_1 + 68,943x_2 = 0,00288 \cdot EA \end{cases}$$

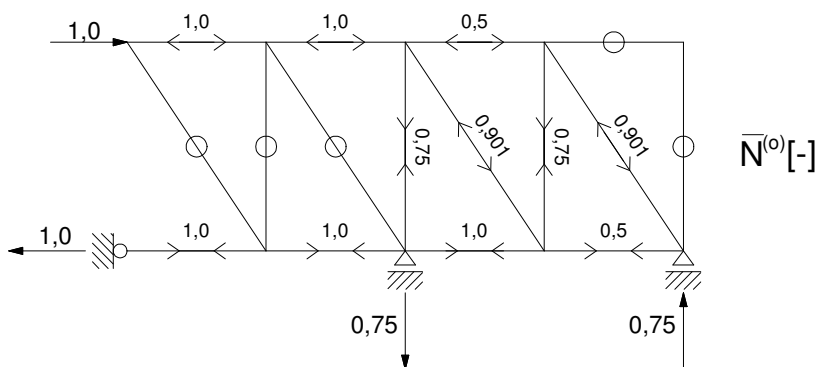
$$\begin{cases} 18,749x_1 + 25,860x_2 = 139,728 \\ 25,860x_1 + 68,943x_2 = 838,368 \end{cases}$$

$$\begin{cases} x_1 = -19,3104 \text{ kN} \\ x_2 = 19,40357 \text{ kN} \end{cases}$$



Sprawdzenie kinematyczne:

$$\bar{1},0 \cdot V_K = \sum_i \frac{N_t^{(n)} \bar{N}^o}{EA} \cdot l + \sum_i \bar{N}^o \cdot t_0 \cdot \alpha_t \cdot l$$



| Lp. | l     | N <sup>(n)</sup> | N <sup>(o)</sup> | N <sup>(n)</sup> · N <sup>(o)</sup> · l / EA | N <sup>(o)</sup> · α <sub>t</sub> · l |
|-----|-------|------------------|------------------|--|---------------------------------------|
| 1   | 2,000 | -25,934          | -1,000           | 51.867098                                    | -0.00072                              |
| 2   | 2,000 | -25,871          | -1,000           | 51.742859                                    | -0.00072                              |
| 3   | 2,000 | -12,936          | -0,500           | 12.935715                                    | -0.00036                              |
| 4   | 2,000 | 0,000            | 0,000            | 0  | 0                                     |
| 5   | 3,000 | 0,000            | 0,000            | 0  | -                                     |
| 6   | 2,000 | 12,936           | 0,500            | 12.935715                                    | -                                     |
| 7   | 2,000 | 25,871           | 1,000            | 51.742859                                    | -                                     |
| 8   | 2,000 | 25,934           | 1,000            | 51.867098                                    | -                                     |
| 9   | 2,000 | 25,996           | 1,000            | 51.991336                                    | -                                     |
| 10  | 3,606 | -0,112           | 0,000            | 0  | -                                     |
| 11  | 3,000 | 0,093            | 0,000            | 0  | -                                     |
| 12  | 3,606 | -0,112           | 0,000            | 0  | -                                     |
| 13  | 3,000 | 19,404           | 0,750            | 43.658038                                    | -                                     |
| 14  | 3,606 | -23,320          | -0,901           | 75.790623                                    | -                                     |
| 15  | 3,000 | 19,404           | 0,750            | 43.658038                                    | -                                     |
| 16  | 3,606 | -23,320          | -0,901           | 75.790623                                    | -                                     |
|     |       |                  |                  | 523.98                                       | -0.0018                               |

$$\bar{1},0 \cdot V_K = \frac{523,98}{EA} - 0,0018 = 0,00$$