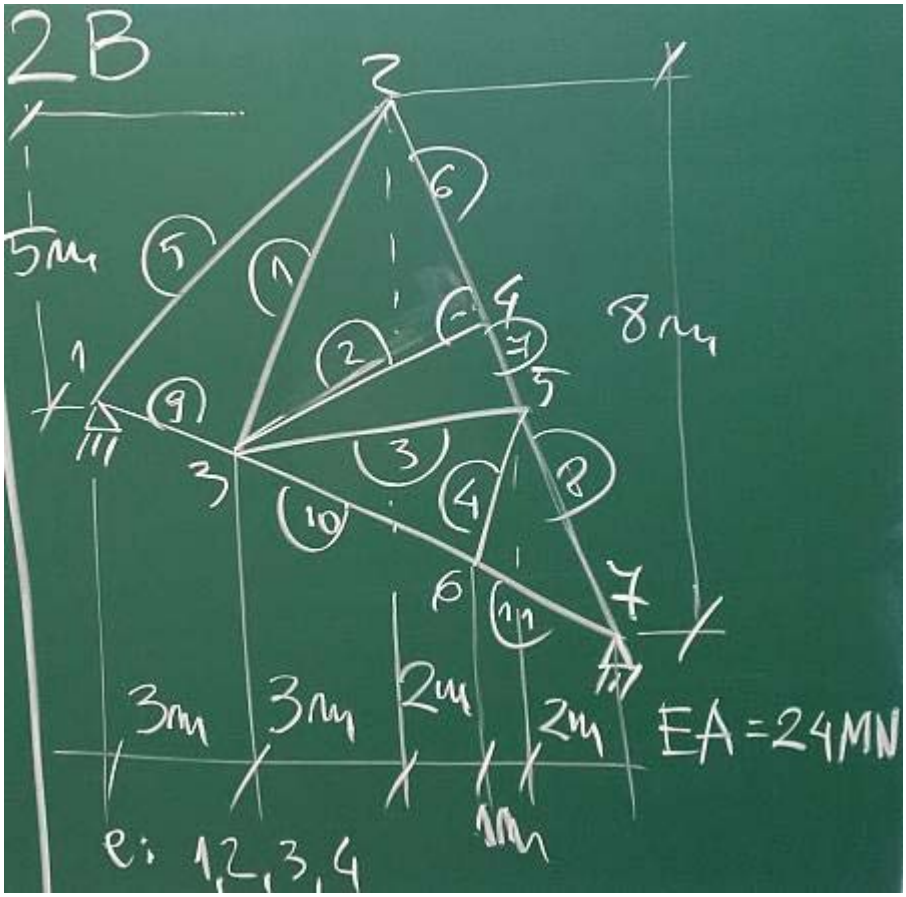
K1 - Macierze sztywności elementów kratownicy



$elementy := (1, 2, 3, 4)$ $\quad EA := 24MN$ $\quad$ *dokładnść ±0.05kN/m*

$\alpha := atan\left(\frac{3}{11}\right) = 15.255 \cdot deg$ $\quad \beta := atan\left(\frac{5}{8}\right) = 32.005 \cdot deg$

$\gamma := \frac{\pi}{2} - \beta - \alpha = 42.7395 \cdot deg$ $\quad L1011 := \frac{8m}{\cos(\alpha)} = 8.29218m$

$L2 := L1011 \cdot \sin(\gamma) = 5.62763m$ $\quad L78 := L1011 \cdot \cos(\gamma) = 6.09017m$

$Y3 := -3m \cdot \frac{3}{11} = -0.81818m$ $\quad Y6 := -3m \cdot \frac{8}{11} = -2.18182m$

$Y5 := 8m \cdot \frac{2}{5} - 3m = 0.2m$ $\quad Y4 := L78 \cdot \cos(\beta) = 5.16445m$

$X4 := 11m - L78 \cdot \sin(\beta) = 7.77222m$

Warunki brzegowe: $\quad ux_1 = 0 \quad uy_1 = 0 \quad ux_7 = 0 \quad uy_7 = 0$

Element "1" - blok macierzy sztywności

$Lx := 3m = 3.00000m$ $\qquad$ $Ly := 5m - Y3 = 5.81818m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 6.546086m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 770.0 & 1493.4 \\ (1493.4) & 2896.3 \end{bmatrix} \frac{kN}{m}$$

Element "2" - blok macierzy sztywności

$Lx := X4 - 3m = 4.772217m$ $\qquad$ $Ly := Y4 - Y3 = 5.982635m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.652841m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 1219.5 & 1528.8 \\ (1528.8) & 1916.6 \end{bmatrix} \frac{kN}{m}$$

Element "3" - blok macierzy sztywności

$Lx := 6m = 6m$ $\qquad$ $Ly := Y5 - Y3 = 1.018182m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 6.085778m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 3833.2 & 650.5 \\ (650.5) & 110.4 \end{bmatrix} \frac{kN}{m}$$

Element "4" - blok macierzy sztywności

$Lx := 1m = 1m$ $\qquad$ $Ly := Y5 - Y6 = 2.381818m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 2.583226m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 1392.3 & 3316.1 \\ (3316.1) & 7898.4 \end{bmatrix} \frac{kN}{m}$$

$$
\mathbf{K} = \begin{array}{c}
\begin{array}{ccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array} \\
\begin{bmatrix}
J^5+J^9 & -J^5 & -J^9 & & & & \\
 & J^1+J^5+J^6 & -J^1 & -J^6 & & & \\
 & & J^1+J^2+J^3+ \\ +J^9+J^{10} & -J^2 & -J^3 & -J^{10} & \\
 & & & J^2+J^6+J^7 & -J^7 & & \\
\text{Symetria} & \text{Symetria} & \text{Symetria} & \text{Symetria} & J^3+J^4+ \\ +J^7+J^8 & -J^4 & -J^8 \\
 & & & & & J^4+J^{10}+J^{11} & -J^{11} \\
 & & & & & & J^8+J^{11}
\end{bmatrix}
\end{array}
\begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{array}
$$