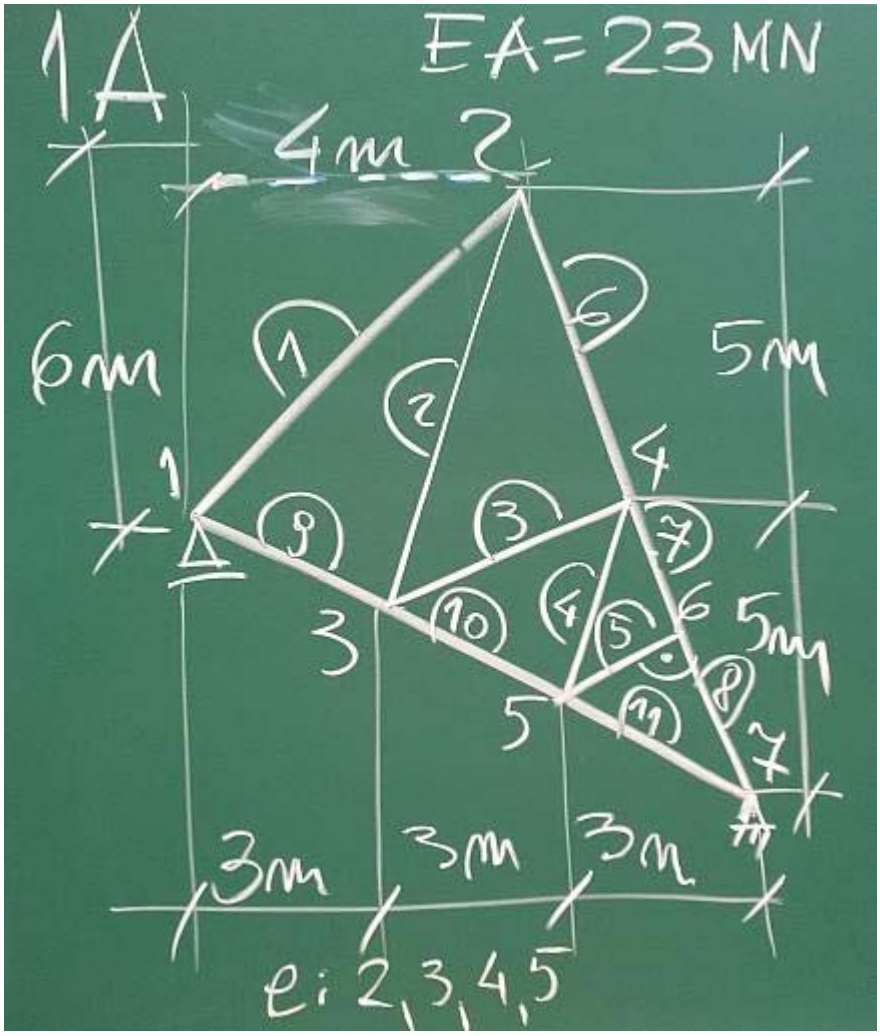
K1 - Macierze sztywności elementów kratownicy



$elementy := (2, 3, 4, 5)$ $\quad EA := 23MN$ $\quad$ *dokładnść ±0.05kN/m*

$\alpha := atan\left(\frac{4}{9}\right) = 23.962 \cdot deg$ $\quad \beta := atan\left(\frac{5}{10}\right) = 26.565 \cdot deg$

$\gamma := \frac{\pi}{2} - \beta - \alpha = 39.47246 \cdot deg$ $\quad L11 := \frac{3m}{cos(\alpha)} = 3.28295m$

$L5 := L11 \cdot sin(\gamma) = 2.087m$ $\quad L8 := L11 \cdot cos(\gamma) = 2.53421m$

$Y3 := -4m \cdot \frac{3}{9} = -1.33333m$ $\quad Y5 := -4m \cdot \frac{6}{9} = -2.66667m$ $\quad Y6 := L8 \cdot cos(\beta) - 4m$

$X4 := 9m - \frac{5m}{2} = 6.5m$ $\quad X6 := 9m - L8 \cdot sin(\beta) = 7.86667m$

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

Element "2" - blok macierzy sztywności

$Lx := 1m = 1.00000m$ $\qquad$ $Ly := 6m - Y3 = 7.33333m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.401201m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 56.7 & 416.0 \\ (416.0) & 3050.9 \end{bmatrix} \frac{kN}{m}$$

Element "3" - blok macierzy sztywności

$Lx := X4 - 3m = 3.5m$ $\qquad$ $Ly := 1m - Y3 = 2.333333m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 4.206476m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 3785.4 & 2523.6 \\ (2523.6) & 1682.4 \end{bmatrix} \frac{kN}{m}$$

Element "4" - blok macierzy sztywności

$Lx := X4 - 6m = 0.5m$ $\qquad$ $Ly := 1m - Y5 = 3.666667m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 3.700601m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 113.5 & 832.1 \\ (832.1) & 6101.7 \end{bmatrix} \frac{kN}{m}$$

Element "5" - blok macierzy sztywności

$Lx := X6 - 6m = 1.866667m$ $\qquad$ $Ly := Y6 - Y5 = 0.933333m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 2.086997m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 8816.5 & 4408.2 \\ (4408.2) & 2204.1 \end{bmatrix} \frac{kN}{m}$$

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