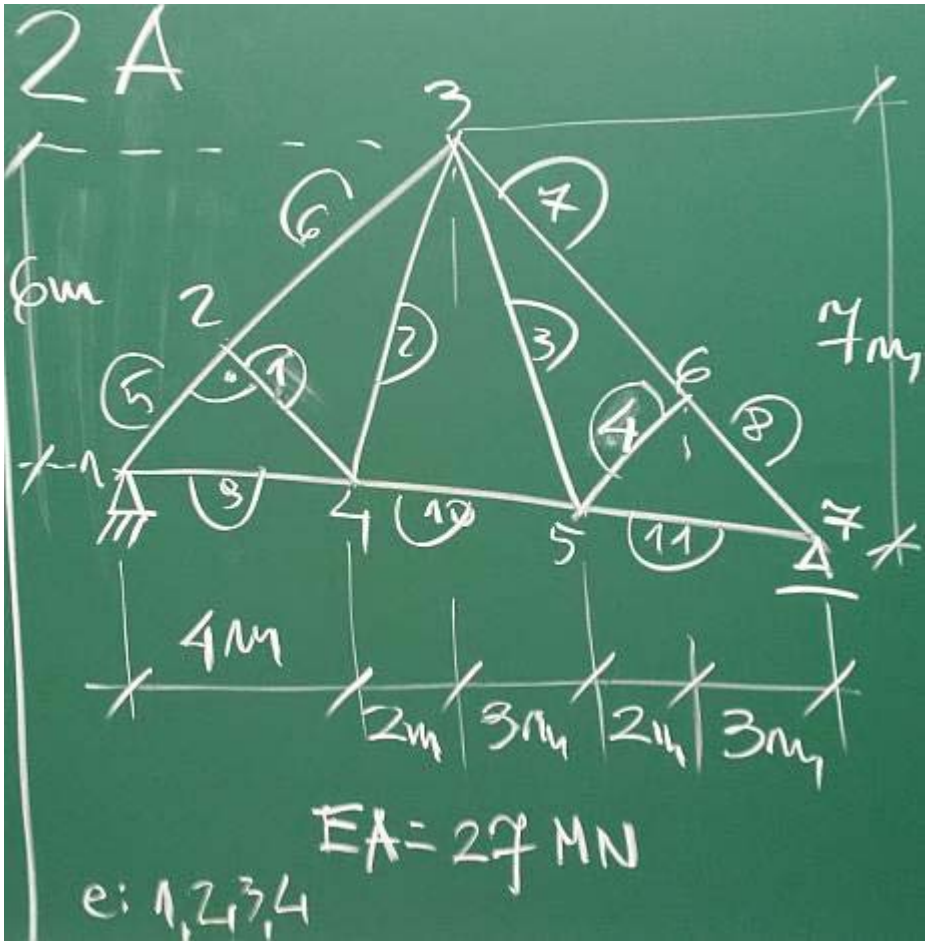
K1 - Macierze sztywności elementów kratownicy



$elementy := (1, 2, 3, 4)$ $\quad EA := 27MN$ $\quad$ *dokładnść ±0.05kN/m*

$\alpha := \mathrm{atan}\left(\frac{1}{14}\right) = 4.086 \cdot deg$ $\quad \beta := \mathrm{atan}\left(\frac{6}{6}\right) = 45 \cdot deg$

$\gamma := \frac{\pi}{2} - \beta + \alpha = 49.08562 \cdot deg$ $\quad L9 := \frac{4m}{\cos(\alpha)} = 4.01019\ m$

$L5 := L9 \cdot \cos(\gamma) = 2.6264\ m$ $\quad L1 := L9 \cdot \sin(\gamma) = 3.03046\ m$

$Y2 := L5 \cdot \cos(\beta) = 1.85714\ m$ $\quad X2 := L5 \cdot \sin(\beta) = 1.85714\ m$

$Y4 := -1m \cdot \frac{4}{14} = -0.28571\ m$ $\quad Y5 := -1m \cdot \frac{9}{14} = -0.64286\ m$

$Y6 := 7m \cdot \frac{3}{8} - 1m = 1.625\ m$

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

Element "1" - blok macierzy sztywności

$Lx := 4m - X2 = 2.14286m$ $\qquad$ $Ly := Y4 - Y2 = -2.14286m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 3.030458m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 4454.8 & -4454.8 \\ (-4454.8) & 4454.8 \end{bmatrix} \frac{kN}{m}$$

Element "2" - blok macierzy sztywności

$Lx := 2m = 2m$ $\qquad$ $Ly := 6m - Y4 = 6.285714m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 6.596227m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 376.3 & 1182.7 \\ (1182.7) & 3716.9 \end{bmatrix} \frac{kN}{m}$$

Element "3" - blok macierzy sztywności

$Lx := 3m = 3m$ $\qquad$ $Ly := Y5 - 6m = -6.642857m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.288865m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 627.5 & -1389.5 \\ (-1389.5) & 3076.8 \end{bmatrix} \frac{kN}{m}$$

Element "4" - blok macierzy sztywności

$Lx := 2m = 2m$ $\qquad$ $Ly := Y6 - Y5 = 2.267857m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 3.023769m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 3906.4 & 4429.6 \\ (4429.6) & 5022.8 \end{bmatrix} \frac{kN}{m}$$

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