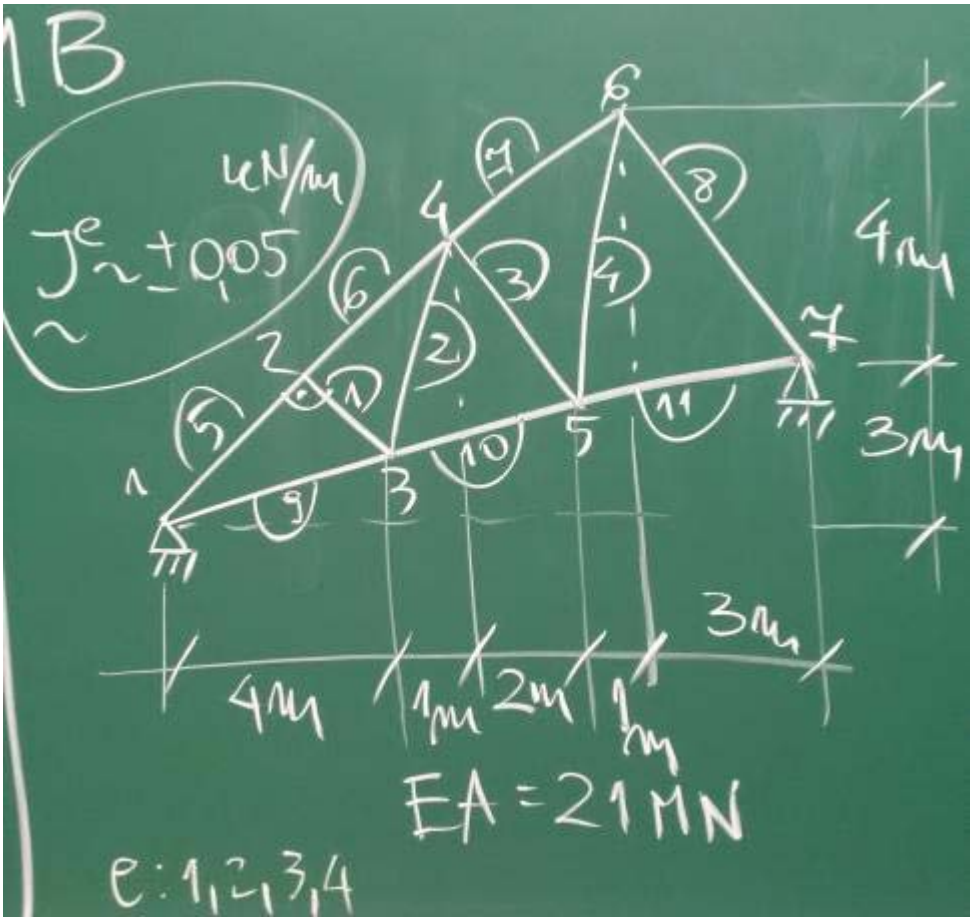
K1 - Macierze sztywności elementów kratownicy



$elementy := (1, 2, 3, 4)$ $\quad EA := 21MN$ $\quad$ *dokładność ±0.05kN/m*

$\alpha := atan\left(\frac{3}{11}\right) = 15.255 \cdot deg$ $\quad \beta := atan\left(\frac{8}{7}\right) = 48.814 \cdot deg$

$\gamma := \frac{\pi}{2} - \beta - \alpha = 25.93081 \cdot deg$ $\quad L9 := \frac{4m}{cos(\alpha)} = 4.14609m$

$L5 := L9 \cdot cos(\gamma) = 3.72868m$ $\quad L1 := L9 \cdot sin(\gamma) = 1.81303m$

$Y2 := L5 \cdot cos(\beta) = 2.45535m$ $\quad X2 := L5 \cdot sin(\beta) = 2.80611m$

$Y4 := 7m \cdot \frac{5}{8} = 4.375m$ $\quad Y3 := 3m \cdot \frac{4}{11} = 1.09091m$ $\quad Y5 := 3m \cdot \frac{7}{11} = 1.90909m$

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

Element "1" - blok macierzy sztywności

$Lx := 4m - X2 = 1.19389m$ $\qquad$ $Ly := Y3 - Y2 = -1.36444m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 1.813026m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 5022.7 & -5740.2 \\ (-5740.2) & 6560.2 \end{bmatrix} \frac{kN}{m}$$

Element "2" - blok macierzy sztywności

$Lx := 1m = 1m$ $\qquad$ $Ly := Y4 - Y3 = 3.284091m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 3.432966m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 519.1 & 1704.6 \\ (1704.6) & 5598.1 \end{bmatrix} \frac{kN}{m}$$

Element "3" - blok macierzy sztywności

$Lx := 2m = 2m$ $\qquad$ $Ly := Y5 - Y4 = -2.465909m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 3.175013m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 2624.5 & -3235.9 \\ (-3235.9) & 3989.7 \end{bmatrix} \frac{kN}{m}$$

Element "4" - blok macierzy sztywności

$Lx := 1m = 1m$ $\qquad$ $Ly := 7m - Y5 = 5.090909m$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 5.188194m$$

$$J := \frac{EA}{(L)^3} \cdot \begin{bmatrix} (Lx)^2 & Lx \cdot Ly \\ Lx \cdot Ly & (Ly)^2 \end{bmatrix} \qquad J = \begin{bmatrix} 150.4 & 765.5 \\ (765.5) & 3897.3 \end{bmatrix} \frac{kN}{m}$$

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