

ORIGIN := 1

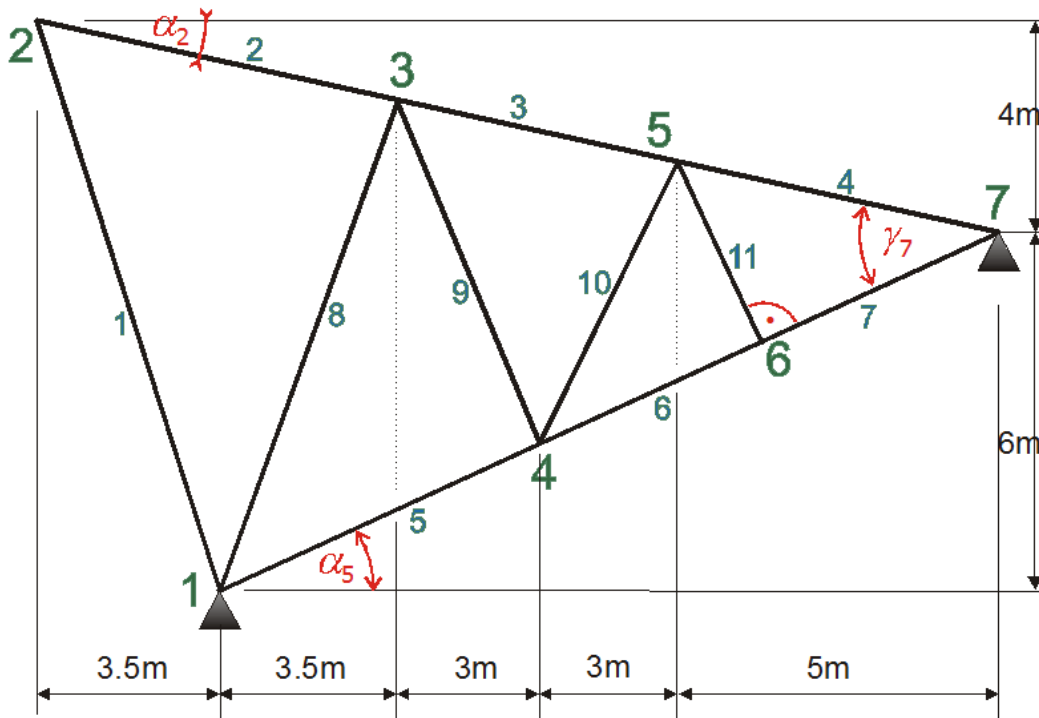
B1

$EA := 28 \text{ MN}$

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

$$J(Lx, Ly) := \frac{EA}{L(Lx, Ly)^3} \begin{bmatrix} Lx^2 & Lx \cdot Ly \\ Lx \cdot Ly & Ly^2 \end{bmatrix}$$

Wyznaczyć bloki **J** macierzy sztywności elementów (1,2,8,11) kratownicy płaskiej.  
Sładowe macierze podać z dokładnością do +/- 0.05 kN/m



$$\alpha_2 := \text{atan}\left(\frac{4}{18}\right) = 12.52881 \text{ deg}$$

$$\alpha_5 := \text{atan}\left(\frac{6}{14.5}\right) = 22.47943 \text{ deg}$$

$$\gamma_7 := \alpha_2 + \alpha_5 = 35.00824 \text{ deg}$$

$$l_4 := \sqrt{5^2 + \left(4 \cdot \frac{5}{18}\right)^2} \text{ m} = 5.12197 \text{ m}$$

$$l_7 := l_4 \cdot \cos(\gamma_7) = 4.19525 \text{ m}$$

$$X_6 := 14.5 \text{ m} - l_7 \cdot \cos(\alpha_5) = 10.62352 \text{ m}$$

$$Y_6 := 6 \text{ m} - l_7 \cdot \sin(\alpha_5) = 4.39594 \text{ m}$$

$$l_{11} := l_4 \cdot \sin(\gamma_7) = 2.93844 \text{ m}$$

Element "1"

$$Lx := 3.5 \text{ m}$$

$$Ly := -10 \text{ m} = -10 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 10.594810 \text{ m}$$

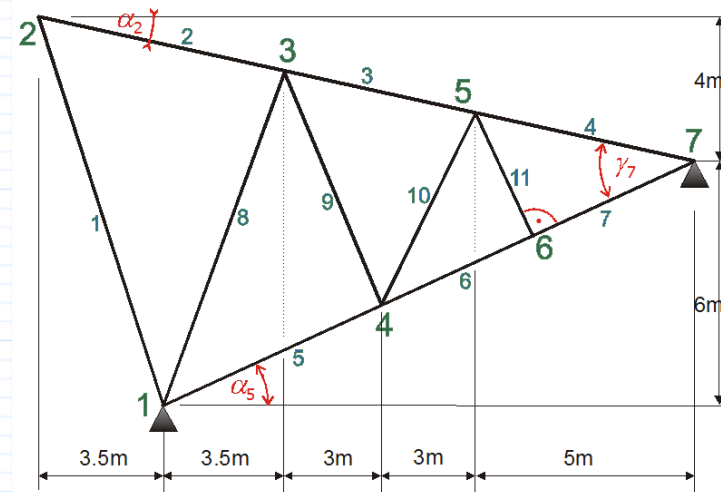
$$J^1 = \begin{bmatrix} 288.4 & -824.0 \\ -824.0 & 2354.4 \end{bmatrix} \frac{kN}{m}$$

Element "2"

$$Lx := 7 \text{ m} \quad Ly := -4 \cdot \frac{7}{18} \text{ m} = -1.555556 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.170757 \text{ m}$$

$$J^2 = \begin{bmatrix} 3721.0 & -826.9 \\ -826.9 & 183.8 \end{bmatrix} \frac{kN}{m}$$



Element "8"

$$Lx := 3.5 \text{ m} = 3.5 \text{ m}$$

$$Ly := 10 \text{ m} - 4 \text{ m} \cdot \frac{7}{18} = 8.444444 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 9.141042 \text{ m}$$

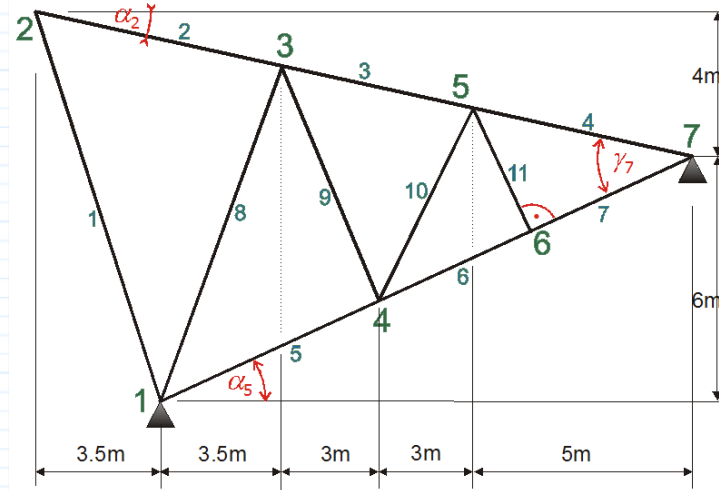
$$J^8 = \begin{bmatrix} 449.1 & 1083.5 \\ 1083.5 & 2614.0 \end{bmatrix} \frac{kN}{m}$$

### Element "11"

$$Lx := l_{11} \cdot \sin(\alpha_5) = 1.123519 \text{ m} \quad Ly := -l_{11} \cdot \cos(\alpha_5) = -2.715172 \text{ m} \quad L := \sqrt{(Lx)^2 + (Ly)^2} = 2.938444 \text{ m}$$

$$J^{11} = \begin{bmatrix} 1393.1 & -3366.5 \\ -3366.5 & 8135.8 \end{bmatrix} \frac{\text{kN}}{\text{m}}$$

$$O := \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \frac{\text{kN}}{\text{m}} \quad \leftarrow \text{Blok "zerowy"}$$



### Schemat agregacji macierzy sztywności kratownicy

$$K = \begin{bmatrix} J^1 + J^5 + J^8 & -J^1 & -J^8 & -J^5 & O & O & O \\ -J^1 & J^1 + J^2 & -J^2 & O & O & O & O \\ -J^8 & -J^2 & J^2 + J^3 + J^8 + J^9 & -J^9 & -J^3 & O & O \\ -J^5 & O & -J^9 & J^5 + J^6 + J^9 + J^{10} & -J^{10} & -J^6 & O \\ O & O & -J^3 & -J^{10} & J^3 + J^4 + J^{10} + J^{11} & -J^{11} & -J^4 \\ O & O & O & -J^6 & -J^{11} & J^6 + J^7 + J^{11} & -J^7 \\ O & O & O & O & -J^4 & -J^7 & J^4 + J^7 \end{bmatrix}$$