

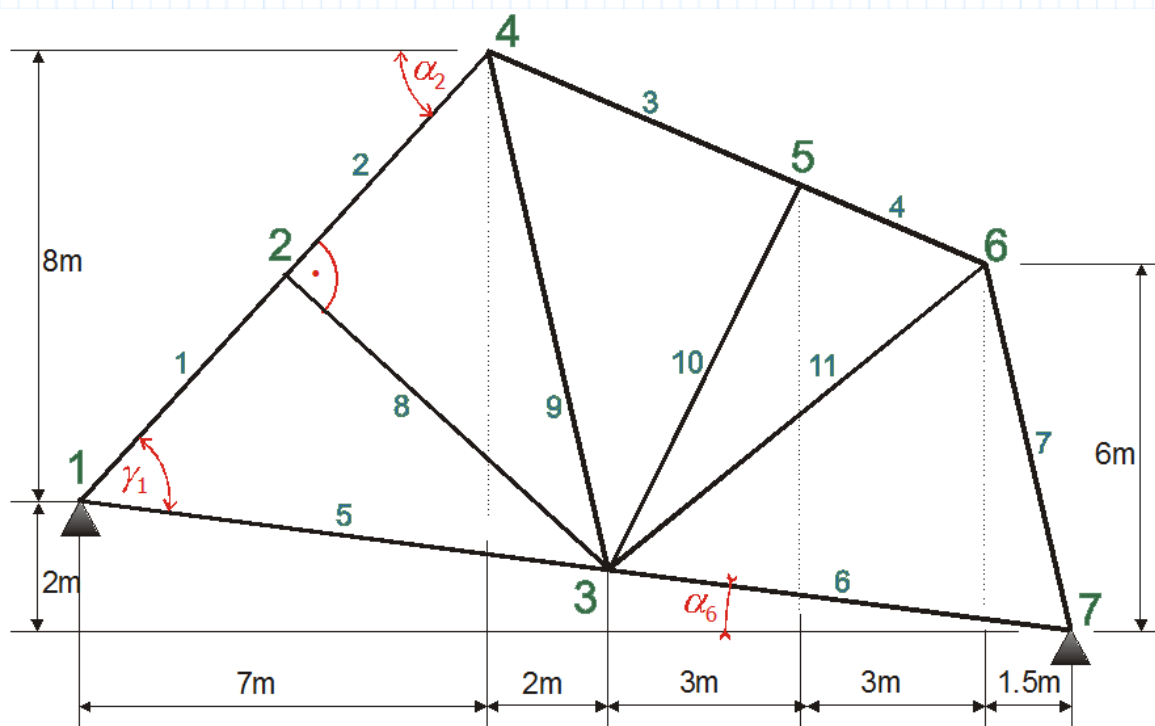
ORIGIN := 1

$EA := 28 \text{ MN}$

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

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

Wyznaczyć bloki \mathbf{J} macierzy sztywności elementów (3,5,8,11) kratownicy płaskiej.
Sładowe macierze podać z dokładnością do +/- 0.05 kN/m



$$\alpha_2 := \text{atan}\left(\frac{8}{7}\right) = 48.81407 \text{ deg}$$

$$\alpha_6 := \text{atan}\left(\frac{2}{16.5}\right) = 6.91123 \text{ deg}$$

$$\gamma_1 := \alpha_2 + \alpha_6 = 55.7253 \text{ deg}$$

$$l_5 := \sqrt{9^2 + \left(2 \cdot \frac{9}{16.5}\right)^2} \text{ m} = 9.06587 \text{ m}$$

$$l_1 := l_5 \cdot \cos(\gamma_1) = 5.10555 \text{ m}$$

$$X_2 := l_1 \cdot \cos(\alpha_2) = 3.36203 \text{ m}$$

$$Y_2 := l_1 \cdot \sin(\alpha_2) = 3.84232 \text{ m}$$

Element "3"

$$Lx := 5 \text{ m} \quad Ly := -4 \text{ m} \cdot \frac{5}{8} = -2.5 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 5.590170 \text{ m}$$

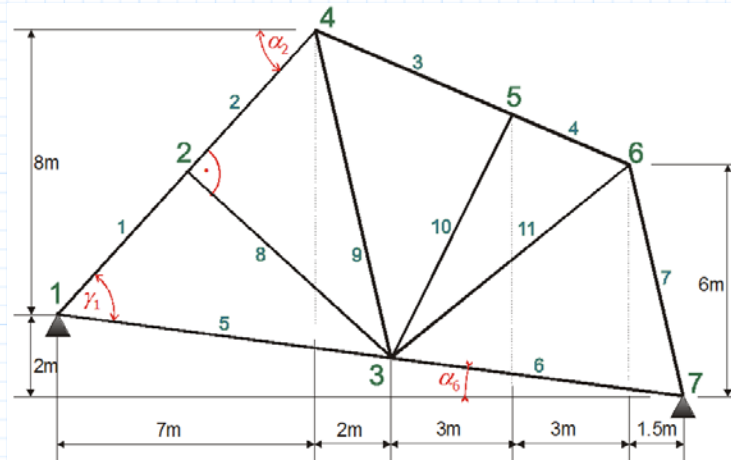
$$J^3 = \begin{bmatrix} 4007 & -2003.5 \\ -2003.5 & 1001.8 \end{bmatrix} \frac{kN}{m}$$

Element "5"

$$Lx := 9 \text{ m} \quad Ly := -2 \text{ m} \cdot \frac{9}{16.5} = -1.090909 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 9.065875 \text{ m}$$

$$J^5 = \begin{bmatrix} 3043.8 & -368.9 \\ -368.9 & 44.7 \end{bmatrix} \frac{kN}{m}$$



Element "8"

$$Lx := 9 \text{ m} - X2 = 5.637973 \text{ m}$$

$$Ly := -2 \text{ m} \cdot \frac{9}{16.5} - Y2 = -4.933226 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.491559 \text{ m}$$

$$J^8 = \begin{bmatrix} 2116.8 & -1852.2 \\ -1852.2 & 1620.7 \end{bmatrix} \frac{kN}{m}$$

Element "11"

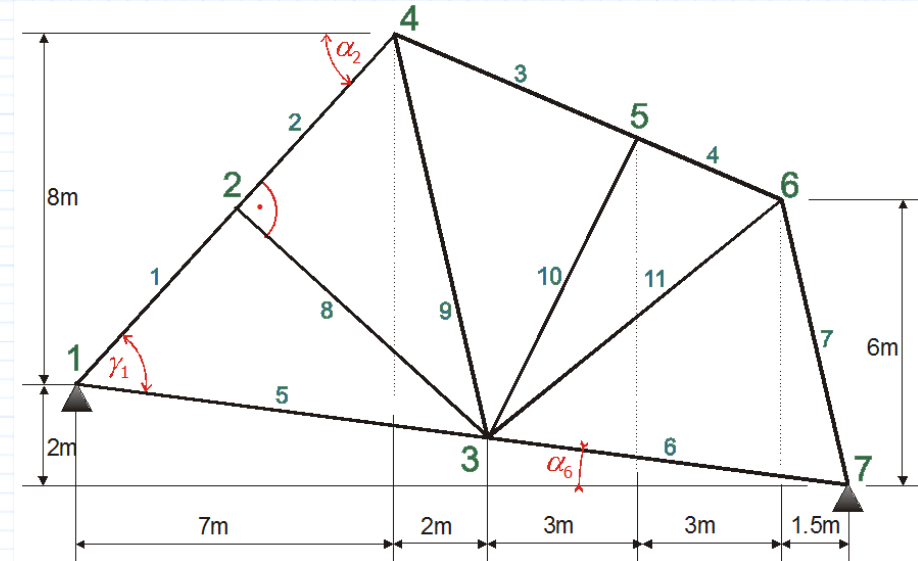
$$Lx := 6 \text{ m}$$

$$Ly := 4 \text{ m} + 2 \text{ m} \cdot \frac{9}{16.5} = 5.090909 \text{ m}$$

$$L := \sqrt{(Lx)^2 + (Ly)^2} = 7.868758 \text{ m}$$

$$J^{11} = \begin{bmatrix} 2068.9 & 1755.4 \\ 1755.4 & 1489.5 \end{bmatrix} \frac{\text{kN}}{\text{m}}$$

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



Schemat agregacji macierzy sztywności kratownicy

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