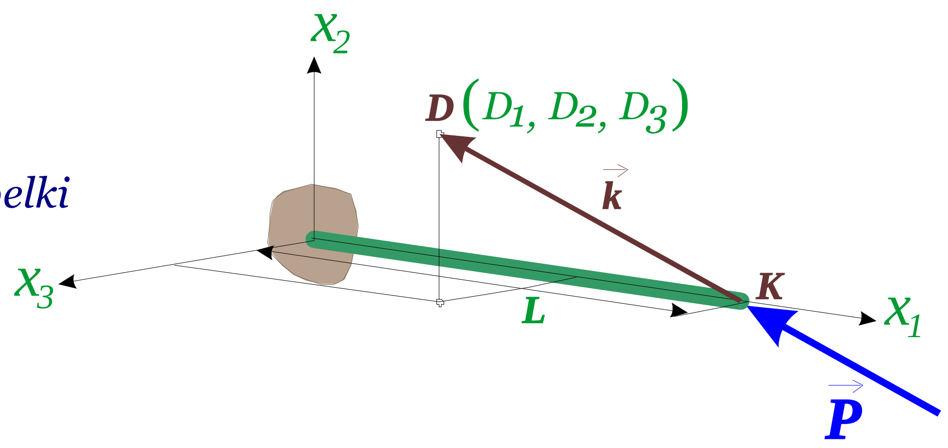
Grupa B1

$L := 6m \quad P0 := 7kN \quad b := 12cm \quad h := 18cm \quad g := 3cm$

$D := \begin{pmatrix} -2 \\ -3 \\ 4 \end{pmatrix} m$ *- współrzędne punktu przez który przechodzi kierunek siły*



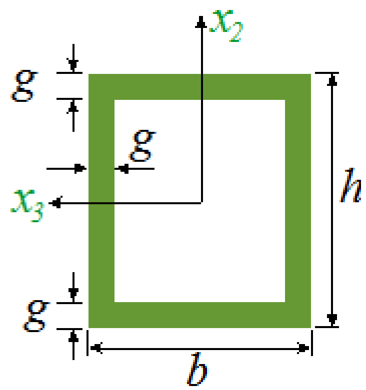
$K := \begin{pmatrix} L \\ 0 \\ 0 \end{pmatrix}$ *- współrzędne punktu K, obciążonego końca belki*

$k := D - K$ *- wektor kierunkowy siły* $\quad k = \begin{pmatrix} -8 \\ -3 \\ 4 \end{pmatrix} m$

$Lk := \sqrt{(k_1)^2 + (k_2)^2 + (k_3)^2} = 9.43398\,m$ *- moduł (długość) wektora kierunkowego*

$c := \frac{1}{Lk} \cdot k = \begin{pmatrix} -0.847998 \\ -0.317999 \\ 0.423999 \end{pmatrix}$ *- kosinusy kierunkowe wektora siły P*

$P := P0 \cdot c$ *- składowe wektora siły* $P = \begin{pmatrix} -5.936 \\ -2.226 \\ 2.968 \end{pmatrix} \cdot kN$



$N := P_1$ $T2 := P_2$ $T3 := P_3$

$N = -5.93599 \cdot kN$ $T2 = -2.226 \cdot kN$ $T3 = 2.96799 \cdot kN$

$M2 := -T3 \cdot L$ $M3 := T2 \cdot L$

$M2 = -17.80796 \cdot kN \cdot m$ $M3 = -13.35597 \cdot kN \cdot m$

$h1 := h - 2g$ $b1 := b - 2g$

$A := h \cdot b - h1 \cdot b1 = 144 \cdot cm^2$

$$J3 := \frac{b \cdot h^3}{12} - \frac{b1 \cdot h1^3}{12} = 4.968 \times 10^3 \cdot cm^4$$

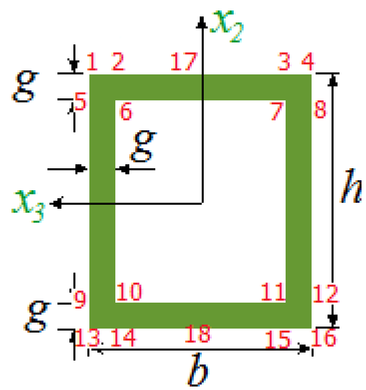
$$J2 := \frac{h \cdot b^3}{12} - \frac{h1 \cdot b1^3}{12} = 2.376 \times 10^3 \cdot cm^4$$

Naprężenia w punkcie A

$id := 6$

$y := x2_{id} \quad z := x3_{id} \qquad a2 := b2_{id} \quad a3 := b3_{id}$

$S3 := St3_{id} \quad S2 := St2_{id}$



$y = 6 \cdot cm$

$z = 3 \cdot cm$

$a2 = 6 \cdot cm$

$a3 = 6 \cdot cm$

$S2 = 243 \cdot cm^3$

$S3 = 270 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -6.767 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = -0.202 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = 0.506 \cdot MPa$$

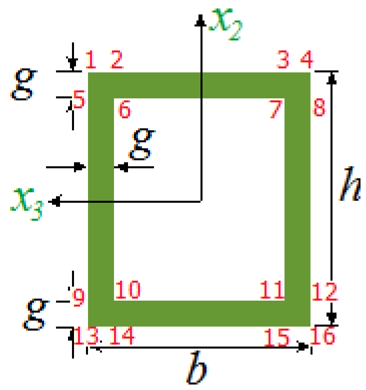
$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 6.832 \cdot MPa$$

Naprężenia w punkcie B

$id := 4$

$y := x2_{id} \quad z := x3_{id} \qquad a2 := b2_{id} \quad a3 := b3_{id}$

$S3 := St3_{id} \qquad S2 := St2_{id}$



$y = 9 \cdot cm$

$z = -6 \cdot cm$

$a2 = 18 \cdot cm$

$a3 = 12 \cdot cm$

$S2 = 0 \cdot cm^3$

$S3 = 0 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = 68.753 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.000 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = 0.000 \cdot MPa$$

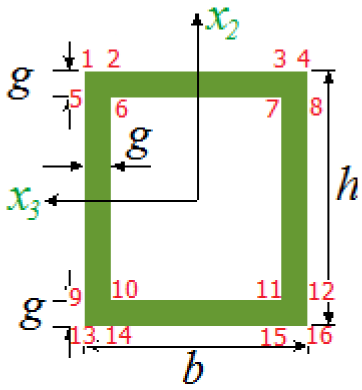
$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 68.753 \cdot MPa$$

Naprężenia w punkcie C

$id := 13$

$y := x2_{id} \quad z := x3_{id} \qquad a2 := b2_{id} \quad a3 := b3_{id}$

$S3 := St3_{id} \qquad S2 := St2_{id}$



$y = -9 \cdot cm$

$z = 6 \cdot cm$

$a2 = 18 \cdot cm$

$a3 = 12 \cdot cm$

$S2 = 0 \cdot cm^3$

$S3 = 0 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -69.577 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.000 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = 0.000 \cdot MPa$$

$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 69.577 \cdot MPa$$