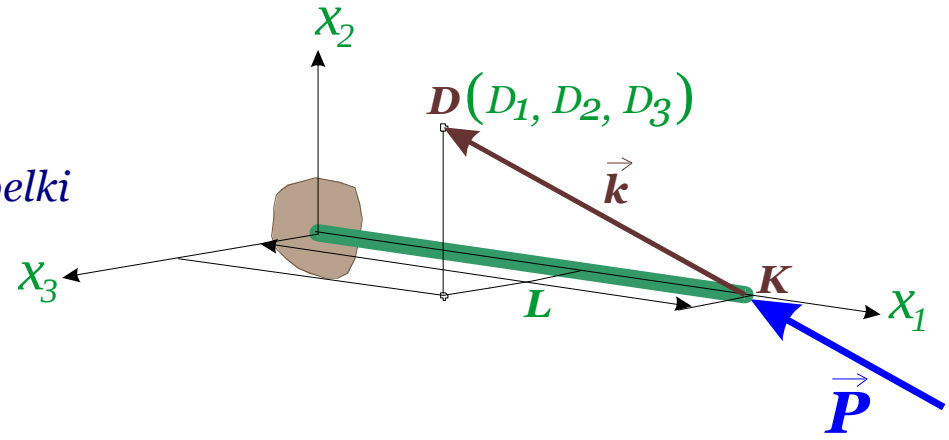
Grupa A

Zad 1

$L := 5m \qquad P0 := 11kN \qquad b := 11cm \qquad h := 20cm \qquad g := 2cm \qquad h1 := h - 2g \qquad b1 := b - g$

$D := \begin{pmatrix} -3 \\ 2 \\ -1 \end{pmatrix} m$ *- 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* $\qquad k = \begin{pmatrix} -8 \\ 2 \\ -1 \end{pmatrix} m$

$Lk := \sqrt{(k_1)^2 + (k_2)^2 + (k_3)^2} = 8.30662\,m$ *- moduł (długość) wektora kierunkowego*

$c := \frac{1}{Lk} \cdot k = \begin{pmatrix} -0.963087 \\ 0.240772 \\ -0.120386 \end{pmatrix}$ *- kosinusy kierunkowe wektora siły P*

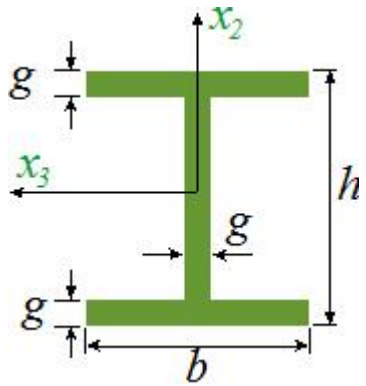
$P := P0 \cdot c$ *- składowe wektora siły* $P = \begin{pmatrix} -10.594 \\ 2.648 \\ -1.324 \end{pmatrix} \cdot kN$

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

$N = -10.59396 \cdot kN \qquad T2 = 2.64849 \cdot kN \qquad T3 = -1.32424 \cdot kN$

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

$M2 = 6.62122 \cdot kN \cdot m \qquad M3 = 13.24244 \cdot kN \cdot m$



$A := h \cdot b - h1 \cdot b1 = 76 \cdot cm^2$

$$J3 := \frac{b \cdot h^3}{12} - \frac{b1 \cdot h1^3}{12} = 4261.333 \cdot cm^4$$

$$J2 := \frac{b^3 \cdot g}{6} + \frac{h1 \cdot g^3}{12} = 454.333 \cdot cm^4$$

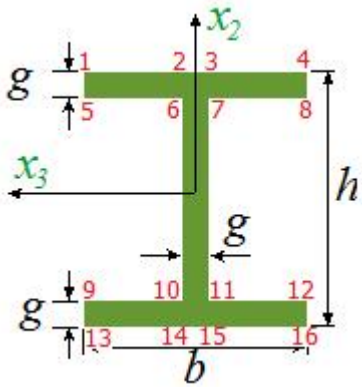
Naprężenia w punkcie A

$id := 1$

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

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

$S3 = 0 \cdot cm^3 \quad S2 = 0 \cdot cm^3$



$y = 10 \cdot cm$

$z = 5.5 \cdot cm$

$a2 = 4 \cdot cm$

$a3 = 11 \cdot cm$

$S2 = 0 \cdot cm^3$

$S3 = 0 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = 47.684 \cdot MPa$$

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

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

$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 47.684 \cdot MPa$$

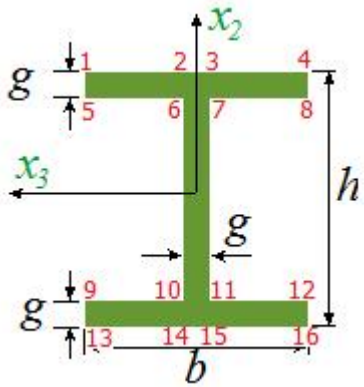
Naprężenia w punkcie B

$id := 6$

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

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

$S3 = 198 \cdot cm^3$ $S2 = 58.5 \cdot cm^3$



$y = 8 \cdot cm$

$z = 1 \cdot cm$

$a2 = 4 \cdot cm$

$a3 = 2 \cdot cm$

$S2 = 58.5 \cdot cm^3$

$S3 = 198 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -11.681 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.615 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = -0.426 \cdot MPa$$

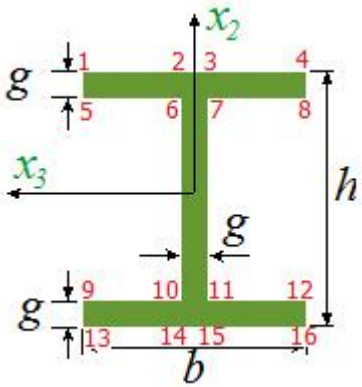
$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 11.753 \cdot MPa$$

Naprężenia w punkcie C

$id := 15$

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

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



$y = -10 \cdot cm$

$z = -1 \cdot cm$

$a2 = 4 \cdot cm$

$a3 = 11 \cdot cm$

$S2 = 58.5 \cdot cm^3$

$S3 = 0 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = 15.108 \cdot MPa$$

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

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = -0.426 \cdot MPa$$

$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 15.126 \cdot MPa$$