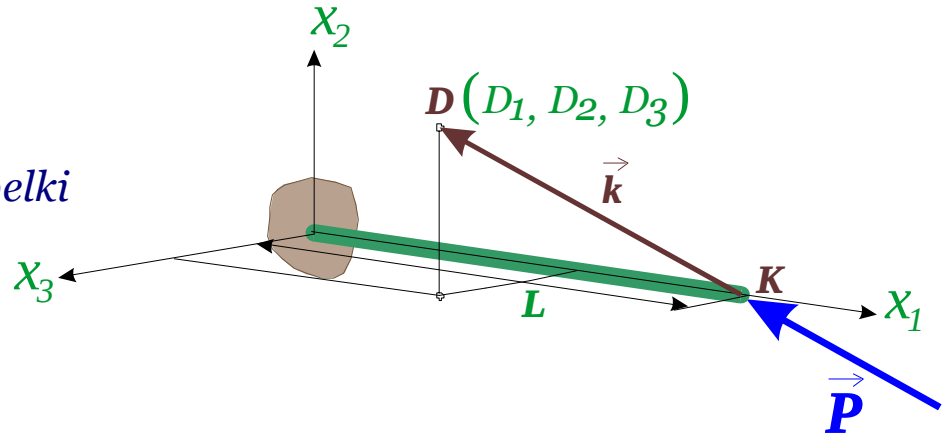
*Grupa A1*

*Zad 1*

$L := 11m \quad P0 := 4kN \quad b := 10cm \quad h := 15cm \quad g := 1cm$

$D := \begin{pmatrix} 7 \\ 3 \\ -1 \end{pmatrix} m$ - *współrzędne punktu przez który przechodzi kierunek siły*

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

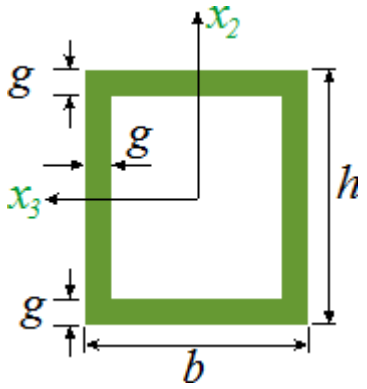



$k := D - K$ - *wektor kierunkowy siły* $\quad k = \begin{pmatrix} -4 \\ 3 \\ -1 \end{pmatrix} m$

$Lk := \sqrt{(k_1)^2 + (k_2)^2 + (k_3)^2} = 5.09902\,m$ - *moduł (długość) wektora kierunkowego*

$c := \frac{1}{Lk} \cdot k = \begin{pmatrix} -0.784465 \\ 0.588348 \\ -0.196116 \end{pmatrix}$ - *kosinusy kierunkowe wektora siły P*

$P := P0 \cdot c$ *- składowe wektora siły* $P = \begin{pmatrix} -3.138 \\ 2.353 \\ -0.784 \end{pmatrix} \cdot kN$




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

$N = -3.13786 \cdot kN$ $T2 = 2.35339 \cdot kN$ $T3 = -0.78446 \cdot kN$

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

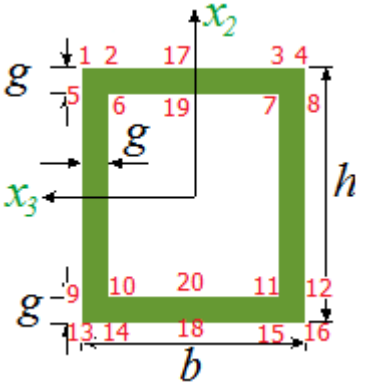
$M2 = 8.62911 \cdot kN \cdot m$ $M3 = 25.88733 \cdot kN \cdot m$

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

$A := h \cdot b - h1 \cdot b1 = 46 \cdot cm^2$

$$J3 := \frac{b \cdot h^3}{12} - \frac{b1 \cdot h1^3}{12} = 1.34783 \times 10^3 \cdot cm^4$$

$$J2 := \frac{h \cdot b^3}{12} - \frac{h1 \cdot b1^3}{12} = 6.95333 \times 10^2 \cdot cm^4$$

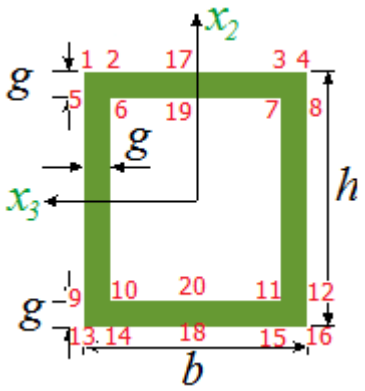


## *Naprężenia w punkcie A*

id := 4

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

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




$y = 7.5 \cdot cm$

$z = -5 \cdot cm$

$a2 = 15 \cdot cm$

$a3 = 10 \cdot cm$

$S2 = 0 \cdot cm^3$

$S3 = 0 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -206.782 \cdot MPa$$

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

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

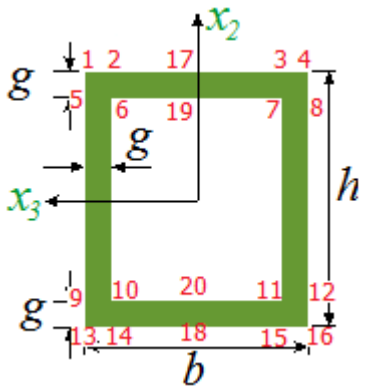
$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 206.8 \cdot MPa$$

## *Naprężenia w punkcie B*

$id := 19$

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

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




$y = 6.5 \cdot cm$

$z = 0 \cdot cm$

$a2 = 2 \cdot cm$

$a3 = 10 \cdot cm$

$S2 = 83.5 \cdot cm^3$

$S3 = 70 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -125.525 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.122 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = -0.471 \cdot MPa$$

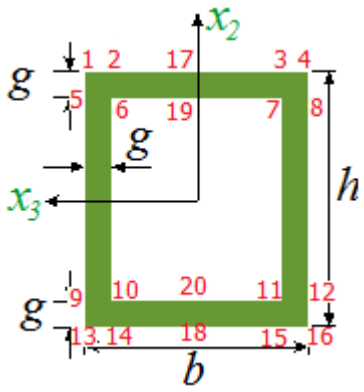
$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 125.5 \cdot MPa$$

## *Naprężenia w punkcie C*

$id := 11$

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

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




$y = -6.5 \cdot cm$

$z = -4 \cdot cm$

$a2 = 2 \cdot cm$

$a3 = 2 \cdot cm$

$S2 = 67.5 \cdot cm^3$

$S3 = 70 \cdot cm^3$

$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = 74.521 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.611 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = -0.381 \cdot MPa$$

$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 74.53 \cdot MPa$$