Grupa B2

Zad 1

$L := 10m$ $P0 := 7kN$ $b := 12cm$ $h := 15cm$ $g := 2cm$ $h1 := h - 2g$ $b1 := b - g$

$D := \begin{pmatrix} -2 \\ 3 \\ -1 \end{pmatrix} m$ *- współrzędne punktu przez który przechodzi kierunek siły*

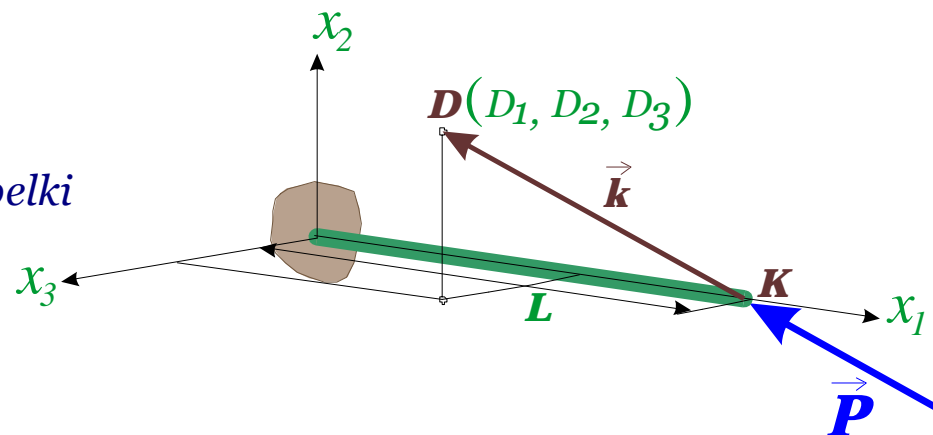$K := \begin{pmatrix} L \\ 0 \\ 0 \end{pmatrix}$ *- współrzędne punktu K, obciążonego końca belki*

$k := D - K$ *- wektor kierunkowy siły* $k = \begin{pmatrix} -12 \\ 3 \\ -1 \end{pmatrix} m$

$Lk := \sqrt{(k_1)^2 + (k_2)^2 + (k_3)^2} = 12.40967\, m$ *- moduł (długość) wektora kierunkowego*

$c := \dfrac{1}{Lk} \cdot k = \begin{pmatrix} -0.966988 \\ 0.241747 \\ -0.080582 \end{pmatrix}$ *- kosinusy kierunkowe wektora siły P*

$P := P0 \cdot c$ *- składowe wektora siły* $P = \begin{pmatrix} -6.769 \\ 1.692 \\ -0.564 \end{pmatrix} \cdot kN$

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

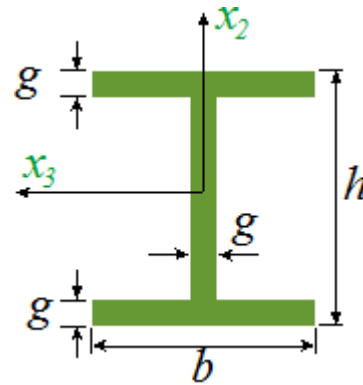$N = -6.76891 \cdot kN \qquad T2 = 1.69223 \cdot kN \qquad T3 = -0.56408 \cdot kN$

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

$M2 = 5.64076 \cdot kN \cdot m \qquad M3 = 16.92228 \cdot kN \cdot m$

$A := h \cdot b - h1 \cdot b1 = 70 \cdot cm^2$

$J3 := \dfrac{b \cdot h^3}{12} - \dfrac{b1 \cdot h1^3}{12} = 2265.833 \cdot cm^4$

$J2 := \dfrac{b^3 \cdot g}{6} + \dfrac{h1 \cdot g^3}{12} = 583.333 \cdot cm^4$

Naprężenia w punkcie A

id := 1

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

$y = 7.5 \cdot cm$

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

$z = 6 \cdot cm$

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

$a2 = 4 \cdot cm$

$a3 = 12 \cdot cm$

$\sigma 11 := \dfrac{N}{A} - \dfrac{M3 \cdot y}{J3} + \dfrac{M2 \cdot z}{J2} = 1.039 \cdot MPa$

$S2 = 0 \cdot cm^3$

$S3 = 0 \cdot cm^3$

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

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

$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2 \right)} = 1.039 \cdot MPa$

Naprężenia w punkcie B

$\text{id} := 6$

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

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

$S3 = 156 \cdot cm^3$ $S2 = 70 \cdot cm^3$

$y = 5.5 \cdot cm$

$z = 1 \cdot cm$

$a2 = 4 \cdot cm$

$a3 = 2 \cdot cm$

$S2 = 70 \cdot cm^3$

$S3 = 156 \cdot cm^3$
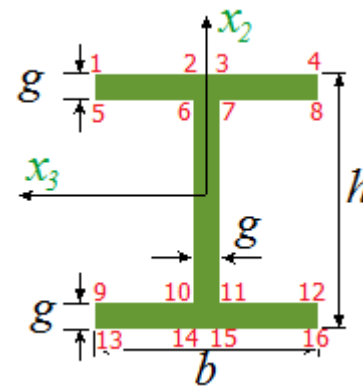
$$\sigma 11 := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = -32.374 \cdot MPa$$

$$\tau 12 := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.583 \cdot MPa$$

$$\tau 13 := \frac{T3 \cdot S2}{a2 \cdot J2} = -0.169 \cdot MPa$$

$$\sigma_{HMH} := \sqrt{\sigma 11^2 + 3 \cdot \left(\tau 12^2 + \tau 13^2\right)} = 32.39 \cdot MPa$$

Naprężenia w punkcie C

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

$$\underset{\sim}{S3} := St3_{id} \qquad \underset{\sim}{S2} := St2_{id}$$
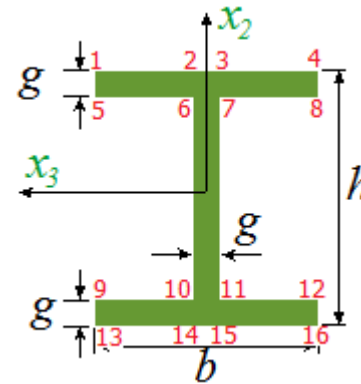
$$\underset{\sim}{\sigma11} := \frac{N}{A} - \frac{M3 \cdot y}{J3} + \frac{M2 \cdot z}{J2} = 98.129 \cdot MPa$$

$$\underset{\sim}{\tau12} := \frac{T2 \cdot S3}{a3 \cdot J3} = 0.097 \cdot MPa$$

$$\underset{\sim}{\tau13} := \frac{T3 \cdot S2}{a2 \cdot J2} = 0.000 \cdot MPa$$

$$\underset{\sim}{\sigma_{HMH}} := \sqrt{\sigma11^2 + 3 \cdot \left(\tau12^2 + \tau13^2\right)} = 98.13 \cdot MPa$$

$$\underset{\sim}{id} := 9$$

$$y = -5.5 \cdot cm$$

$$z = 6 \cdot cm$$

$$a2 = 4 \cdot cm$$

$$a3 = 12 \cdot cm$$

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

$$S3 = 156 \cdot cm^3$$