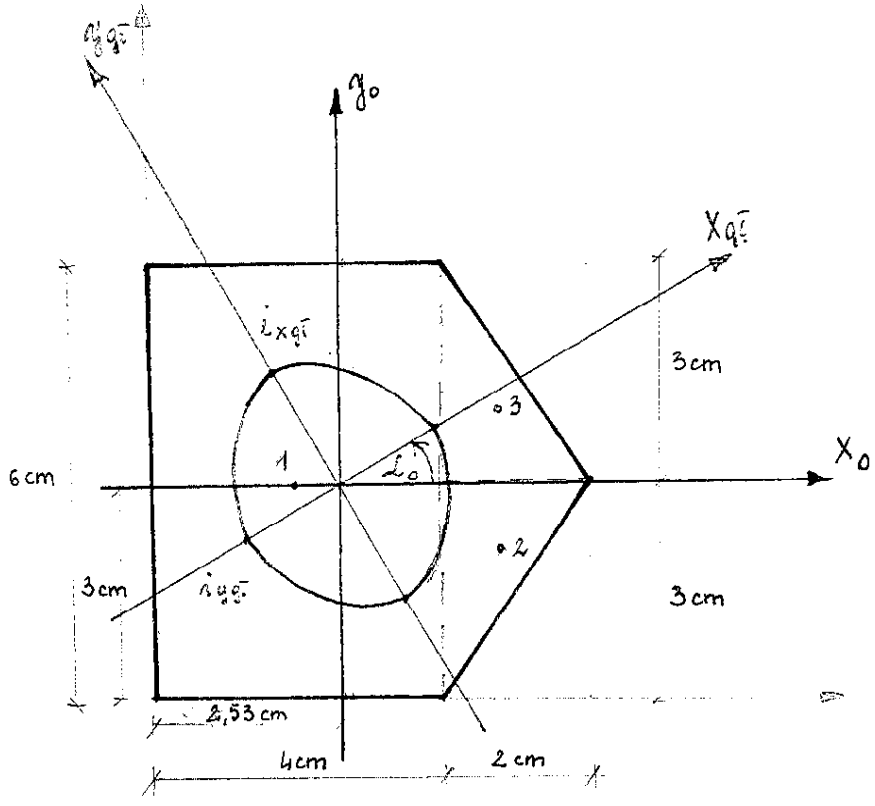
Projekt z Wytrzymałości Materiałów nr .2...	Str. ...1...

Zadanie 1

WYZNACZYĆ ŚRODKOWA, ELIPSE, BEZWŁADNOŚCI.



Sprawdzono:	..... (data)	..... (podpis)

$$A = 4cm \cdot 6cm + \frac{1}{2} \cdot 2cm \cdot 3cm + \frac{1}{2} \cdot 2cm \cdot 3cm = 30cm^2$$

$$S_x = 24cm^2 \cdot 3cm + 3cm^2 \cdot 2cm + 3cm^2 \cdot 4cm = 90cm^3$$

$$S_y = 24cm^2 \cdot 2cm + 3cm^2 \cdot \frac{14}{3}cm + 3cm^2 \cdot \frac{14}{3}cm = 76cm^3$$

$$X_0 = \frac{S}{A} = \frac{76cm}{30cm} = \frac{38}{15}cm = 2{,}53cm$$

$$Y_0 = \frac{S}{A} = \frac{90}{30}cm = 3cm$$

$$J_{x0} = [\frac{4cm \cdot (6cm)^3}{12} + (3cm - 3cm)^2 \cdot 24cm^2] + [\frac{2cm \cdot (3cm)^3}{36} + (2cm - 3cm)^2 \cdot 3cm^2] +$$

$$+ [\frac{2cm \cdot (3cm)^3}{36} + (4cm - 3cm)^2 \cdot 3cm^2] = 72cm^4 + [1{,}5cm^4 + 1cm^2 \cdot 3cm^2] +$$

$$+ [1{,}5cm^4 + 1cm^2 \cdot 3cm^2] = 72cm^4 + 4{,}5cm^4 + 4{,}5cm^4 = 81cm^4$$

$$J_{y0} = [\frac{(4cm)^3 \cdot 6cm}{12} + (2cm - 2{,}53cm)^2 \cdot 24cm^2] + [\frac{(2cm)^3 \cdot 3cm}{36} + (\frac{14}{3}cm - 2{,}53cm)^2 \cdot 3cm^2] +$$

$$+ [\frac{(2cm)^3 \cdot 3cm}{36} + (\frac{14}{3}cm - 2{,}53cm)^2 \cdot 3cm^2] = (32cm^4 + 6{,}72cm^4) + (0{,}67cm^4 + 13{,}74cm^4) +$$

$$+ (0{,}67cm^4 + 13{,}74cm^4) = 38{,}72cm^4 + 14{,}41cm^4 + 14{,}41cm^4 = 67{,}54cm^4$$

$$J_{x0y0} = [0 + (3cm - 3cm)(2cm - 2{,}53cm) \cdot 24cm^2] +$$

$$+ [\frac{(2cm)^2 \cdot (3cm)^2}{72} + (2cm - 3cm)(\frac{14}{3}cm - 2{,}53cm) \cdot 3cm^2] =$$

$$= 0 + [\frac{1}{2}cm^4 - 6{,}39cm^4] - [\frac{1}{2}cm^4 + 6{,}39cm^4] = -12{,}78cm^4$$

$$tg^2\mathcal{L}_0 = \frac{-2J_{x0y0}}{J_{x0} - J_{y0}} = \frac{-2(-12{,}78cm^4)}{81cm^4 - 67{,}54cm^4} = \frac{25{,}56cm^4}{13{,}46cm^4} = 1{,}90$$

$$2\mathcal{L}_0 = 62{,}24°$$

$$\mathcal{L}_0 = 31{,}12°$$

$$J_+ = \frac{81cm^4 + 67{,}54cm^4}{2} + \frac{1}{2}\sqrt{(81cm^4 - 67{,}54cm^4)^2 + 4 \cdot (-12{,}78cm^4)^2} =$$

$$= 74{,}27cm^4 + \frac{1}{2} \cdot 28{,}89cm^4 = 88{,}71cm^4$$

$$J_{max} = 88{,}77cm^4$$

Sprawdzono:	..... (data)	..... (podpis)

$$J_- = \frac{81cm^4 + 67,54cm^4}{2} - \frac{1}{2}\sqrt{(81cm^4 - 67,54cm^4)^2 + 4 \cdot (-12,78cm^4)^2} =$$

$$= 74,27cm^4 - \frac{1}{2} \cdot 28,89cm^4 = 59,83cm^4$$

$$J_{min} = 59,83cm^4$$

Sprawdzenie

1.

$$81cm^4 + 67,54cm^4 = 88,71cm^4 + 59,83cm^4$$

$$148,54cm^4 = 148,54cm^4$$

2.

$$J_{xgł\,ygł} = \frac{J_{x0} - J_{y0}}{2} \cdot \sin 2\mathcal{L}_0 + J_{x0y0} \cdot \cos 2\mathcal{L}_0$$

$$\frac{81cm^4 - 67,74cm^4}{2} \cdot \sin 62,61^\circ + (-12,78) \cdot \cos 62,61^\circ =$$

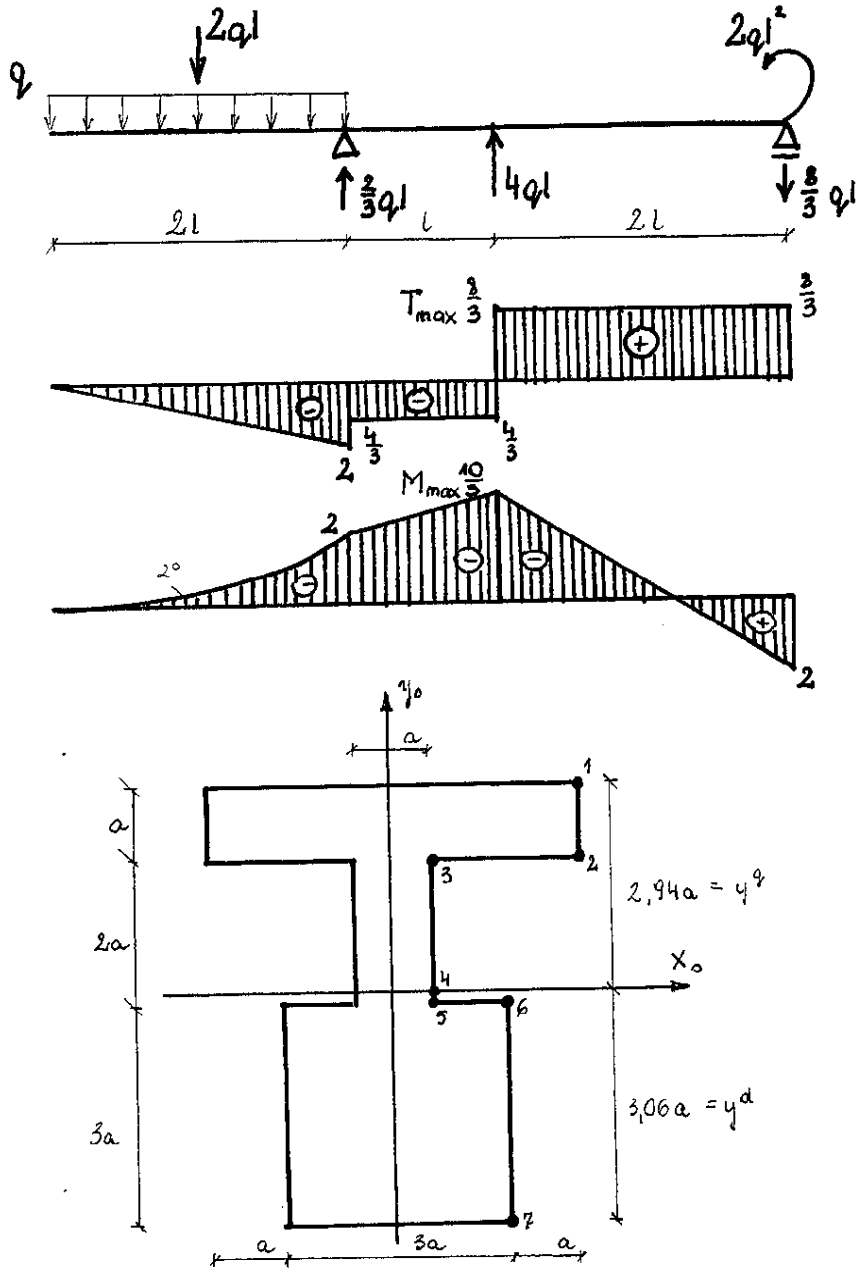
$$6,63cm^4 \cdot 0,887 + (-12,78)cm^4 \cdot 0,46 = 0,002cm^4 \approx 0$$

$$i_{xgł} = \sqrt{\frac{88,71cm}{30cm}} = 1,72cm$$

$$i_{ygł} = \sqrt{\frac{59,83cm}{30cm}} = 1,41cm$$

ZADANIE 2

Projektowanie przekroju poprzecznego belki zginanej



$R = 175MPa$ $\quad q = 1kN/m$

$R_t = 105MPa$ $\quad l = 2m$

$T_{max} = \frac{8}{3} ql \cdot 1kN/m \cdot 2m = 5{,}34kN$

$M_{max} = \frac{10}{3} ql \cdot 1kN/m \cdot (2m)^2 = 13{,}34kNm$

$\sigma_{max} = \frac{M_{max}}{W_{max}} \leq R$

$\tau_{max} = \frac{T_{max} \cdot S_x}{b \cdot J_{x0}} \leq R_t$

$A = 9a^2 + 2a^2 + 5a^2 = 16a^2$

$S_x = 9a^2 \cdot 1{,}5a + 2a^2 \cdot 4a + 5a^2 \cdot 5{,}5a = 49a^3$

$Y_0 = \frac{S_x}{A} = \frac{49a^3}{16a^2} = 3{,}06a$

$J_{x0} = [\frac{3a \cdot (3a)^3}{12} + (1{,}5a - 3{,}06a)^2 \cdot 9a^2] + [\frac{a \cdot (2a)^3}{12} + (4a - 3{,}06a)^2 \cdot 8a^2] +$

$+ [\frac{5a \cdot a^2}{12} + (5{,}5a - 3{,}06a)^2 \cdot 27{,}5a^2] = 200{,}5a^4$

$W_x^g = \frac{J_{x0}}{y^g} = \frac{200{,}5a^4}{2{,}94a} = 68{,}20a^3$

$W_x^d = \frac{J_{x0}}{y^d} = \frac{200{,}5^4}{3{,}06a} = 65{,}52a^3$

$\frac{M_{max}}{W_{max}} \leq R \rightarrow \frac{13{,}34\ kNm}{65{,}52a} \leq 175MPa \rightarrow 65{,}52a^3 \geq \frac{1334\ kNcm}{17{,}5\ kN/cm^2} \rightarrow$

$\rightarrow 65{,}52a^3 \geq 76{,}23cm^2 \rightarrow a^3 \geq 1{,}16cm^3 \rightarrow \underline{a \geq 1{,}05cm}$

$\frac{T_{max} \cdot S_x}{b \cdot J_{x0}} \leq R_t \rightarrow \tau_{max} = \tau_4 \rightarrow \frac{5{,}34\ kN\ (5a \cdot a\ 2{,}44a + a \cdot 1{,}94a \cdot 0{,}97a)}{a \cdot 200{,}5a^4} \leq 105MPa \rightarrow$

$\rightarrow \frac{75{,}19\ kN\ a^3}{200{,}5a^5} \leq 10{,}5\ kN/cm^2 \rightarrow 200{,}5a^5 \geq \frac{75{,}19kN}{10{,}5kN/cm^2} \rightarrow a^2 \geq 0{,}035cm^2 \rightarrow$

$\rightarrow \underline{a \geq 0{,}19cm}$

Sprawdzono:	..... (data)	..... (podpis)

Przyjmuję a = 1,1cm

$$\sigma_{max}^{g} = \frac{13,34kNm}{68,20a^3} = \frac{1334kNcm}{68,20\cdot(1,1cm)^3} = \frac{1334kNcm}{90,7cm} = 14,70\ kN/cm^2 = 147\ MPa < R$$

$$\sigma_{max}^{d} = \frac{13,34kNm}{65,52a^3} = \frac{1334kNcm}{65,52\cdot(1,1cm)^3} = \frac{1334kNcm}{87,14cm} = 15,31\ kN/cm^2 = 153,1\ MPa < R$$

$\tau_1 = \tau_7 = 0$

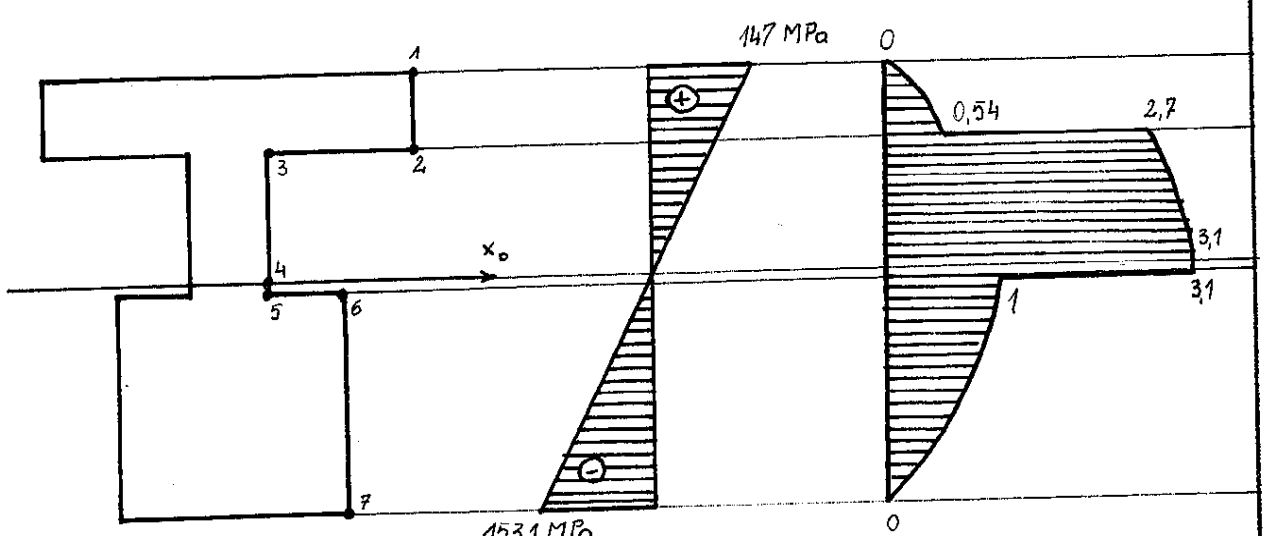
$$\tau_2 = \frac{5,34kN\ (5a^2\cdot 2,44a)}{5a\cdot 200,5a^4} = \frac{65,148kN}{1002,5a^2} = \frac{65,148kN}{1002,5(1,1cm)^2} = \frac{65,148kN}{1213,025cm^2} = 0,054\ kN/cm^2 = 0,54MPa < R_t$$

$$\tau_3 = \frac{5,34kN\ (5a^2\cdot 2,44a)}{a\cdot 200,5a^4} = \frac{65,148kN}{200,5a^2} = \frac{65,148kN}{200,5\cdot 1,21cm^2} = \frac{65,148kN}{242,605cm^2} = 0,27kN/cm^2 = 2,7MPa < R_t$$

$$\tau_4 = \frac{5,34\ kN\ (5a\cdot a\ 2,44a + a\cdot 1,94a\cdot 0,97a)}{a\cdot\ 200,5a^4} = \frac{75,19\ kN}{242,605cm^2} = 0,31kN/cm^2 = 3,1MPa < R_t$$

$$\tau_5 = \frac{5,34kN\ (3a\cdot 3a\ \cdot 1,56a)}{a\cdot 200,5a^4} = \frac{74,97\ kN}{242,605cm^2} = 0,31kN/cm^2 = 3,1MPa < R_t$$

$$\tau_6 = \frac{5,34kN\ (3a\cdot 3a\ \cdot 1,56a)}{3a\cdot 200,5a^4} = \frac{74,97\ kN}{727,815cm^2} = 0,10kN/cm^2 = 1MPa < R_t$$



Sprawdzono: ..... (data) ..... (podpis)