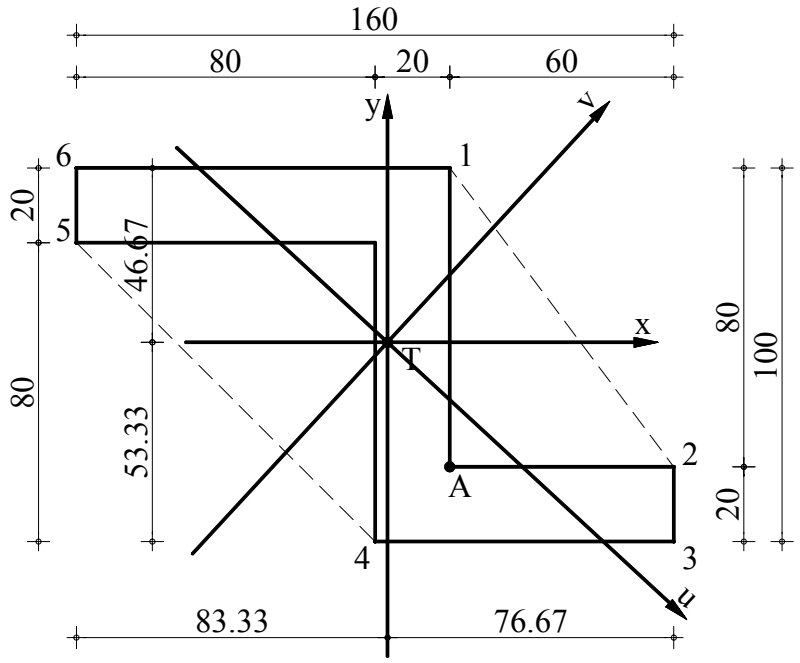
2.2. Za zadani presjek treba odrediti jezgru presjeka, te služeći se jezgrom:

a. Odrediti ekstremna naprezanja uslijed momenta savijanja M=30kNm koji djeluje u horizontalnoj ravnini koja prolazi težištem presjeka.

b. Odrediti ekstremna naprezanja od ekscentrične sile P=50kN koja djeluje u točki A.



a) Glavne osi tromosti i elipsa tromosti

Težište presjeka

$$A = 4800\text{cm}^2$$

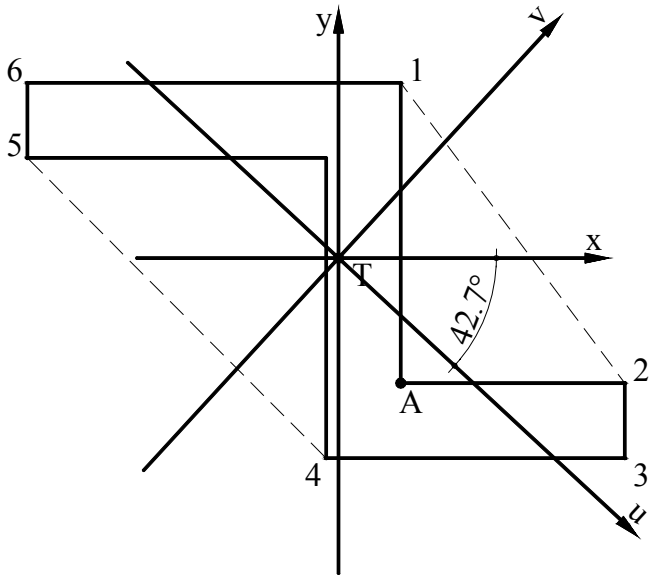
$$I_x = 6186666.72\text{cm}^4$$
$$I_y = 6986666.72\text{cm}^4$$
$$I_{xy} = -5013333.3\text{cm}^4$$

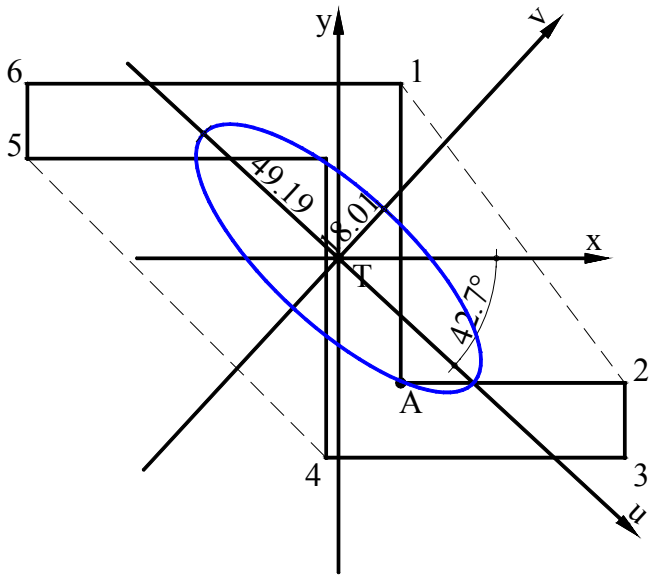
$$I_{u,v} = \frac{I_x + I_y}{2} \pm \frac{1}{2}\sqrt{(I_x - I_y)^2 + 4I_{xy}{}^2} =$$
$$= 6586666.72 \pm 5029265.43\text{cm}^4$$
$$I_u = 1557401.29\text{cm}^4$$
$$I_v = 11615932.15\text{cm}^4$$

$$I_u = 1557401.29\text{cm}^4$$
$$I_v = 11615932.15\text{cm}^4$$

$$i_u = \sqrt{\frac{I_u}{A}} = 18.01\text{cm}$$
$$i_v = \sqrt{\frac{I_v}{A}} = 49.19\text{cm}$$

$$\text{tg}2\alpha = -\frac{2I_{xy}}{I_x - I_y} = -12.53$$
$$\alpha = -42.7°$$





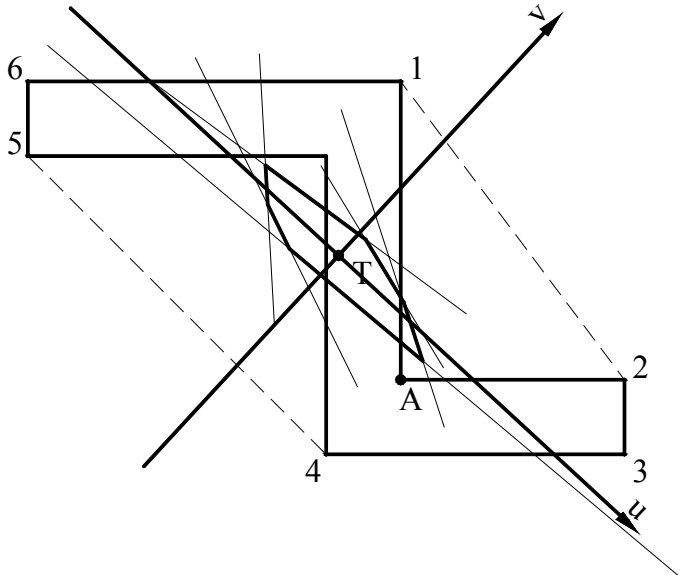
$$u = x \cdot \cos\alpha + y \cdot \sin\alpha$$

$$v = y \cdot \cos\alpha - x \cdot \sin\alpha$$

$$s = -\frac{i_v^{\,2}}{u} \qquad q = -\frac{i_u^{\,2}}{v}$$

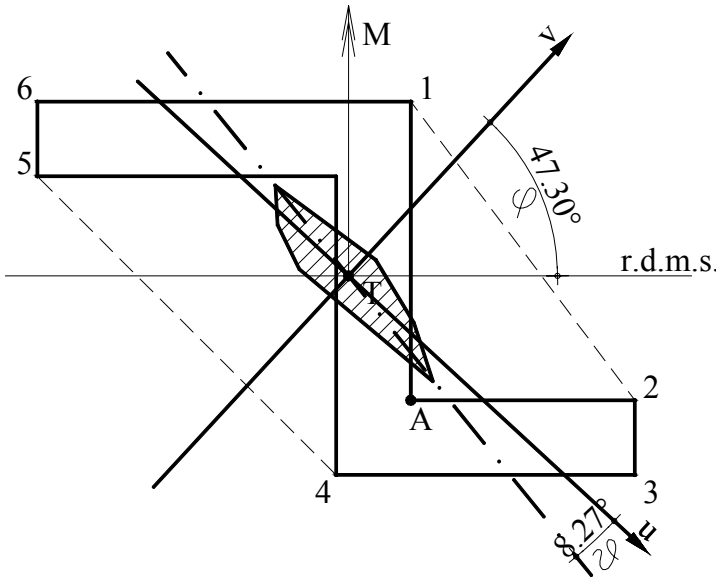
TOČKA	x	y	u	v
1	16.67	46.67	-19.39	45.60
2	76.67	-33.33	78.95	27.48
3	76.67	-53.33	92.51	12.78
4	-3.33	-53.33	33.71	-41.45
5	-83.33	26.67	-79.33	-36.89
6	-83.33	46.67	-92.89	-22.19

TOČKA	u	v	s	q
1	-19.39	45.60	**124.79**	**-7.11**
2	78.95	27.48	**-30.65**	**-11.80**
3	92.51	12.78	**-26.15**	**-25.38**
4	33.71	-41.45	**-71.78**	**7.82**
5	-79.33	-36.89	**30.50**	**8.79**
6	-92.89	-22.19	**26.05**	**14.22**



Naprezanja od momenta savijanja

$\varphi = -47.30°$ - otklon opterećenja od osi v

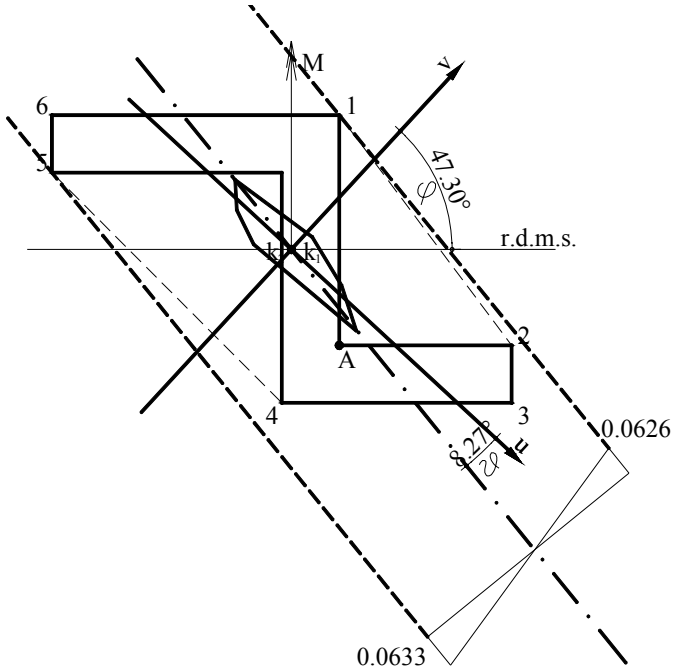


$$tg\vartheta = tg\varphi\frac{I_u}{I_v} \Rightarrow \vartheta = -8.27°$$

$$\sigma_{max} = \pm\frac{M_{max}}{k_{1,2}\cdot A}$$

$k_1 = 9.877\text{cm}$ $\qquad \sigma_{vlak} = \dfrac{M_{max}}{k_1\cdot A} = \dfrac{30\text{kNm}}{9.877\text{cm}\cdot 4800\text{cm}^2} = 0.063\dfrac{\text{kN}}{\text{cm}^2}$

$k_2 = 9.982\text{cm}$ $\qquad \sigma_{tlak} = \dfrac{M_{max}}{k_2\cdot A} = \dfrac{30\text{kNm}}{9.982\text{cm}\cdot 4800\text{cm}^2} = 0.0626\dfrac{\text{kN}}{\text{cm}^2}$


M
y
6
1
5
47.30°
φ
r.d.m.s.
K
K1
2
A
4
3
0.0626
0.0633

Naprezanja od ekscentične sile P

$$\sigma = \frac{P}{A} \pm \frac{P \cdot e}{A \cdot k_{1,2}} = \frac{P}{A}(1 \pm \frac{e}{k_{1,2}})$$

$$e = \sqrt{m^2 + n^2} = 37.26\text{cm}$$

$$k_1 = 16.0\text{cm} \qquad \sigma_{tlak} = \frac{P}{A}(1 + \frac{e}{k_1}) = \frac{50\text{kN}}{4800\text{cm}^2}(1 + \frac{37.26}{16.0}) = 0.03467\frac{\text{kN}}{\text{cm}^2}$$

$$k_2 = 17.0\text{cm} \qquad \sigma_{vlak} = \frac{P}{A}(1 - \frac{e}{k_2}) = \frac{50\text{kN}}{4800\text{cm}^2}(1 - \frac{37.26}{17.0}) = 0.01241\frac{\text{kN}}{\text{cm}^2}$$

Položaj neutralne osi možemo odrediti prema odsječcima s i q, ali kada uvrstimo koordinate djelovanja sile P.

$$s = -\frac{i_v^2}{u} = -\frac{49.19^2}{34.85} = -69.43\text{cm} \qquad q = -\frac{i_u^2}{v} = -\frac{18.01^2}{-13.19} = +24.59\text{cm}$$