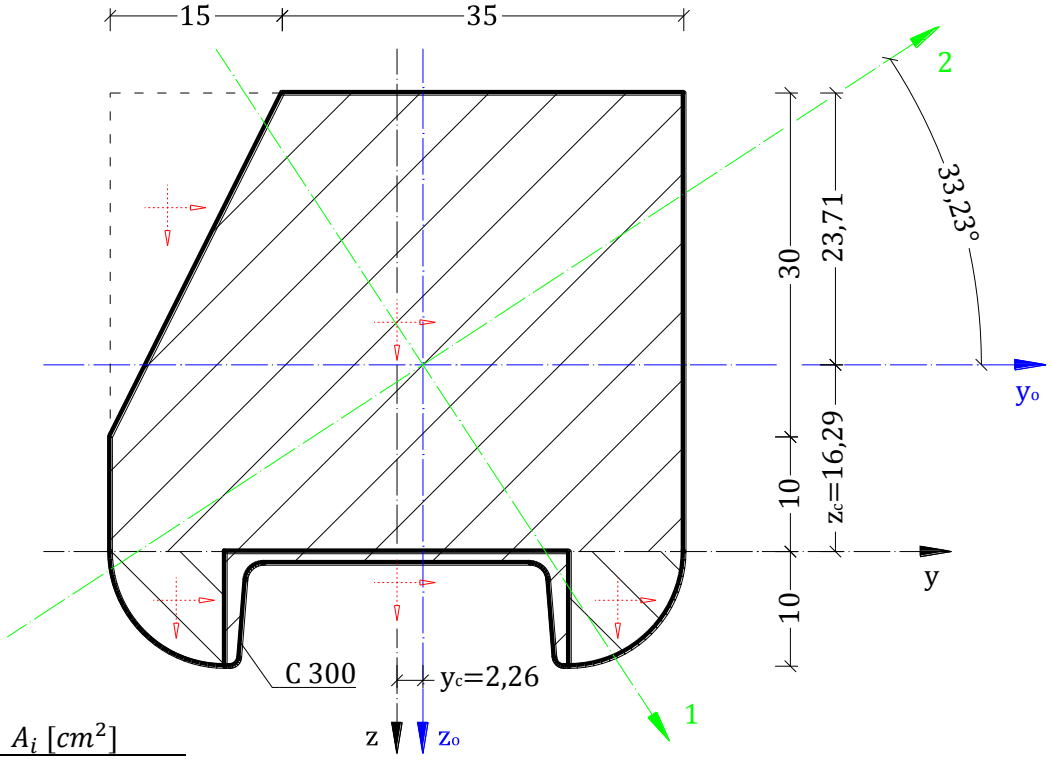
Zadanie 3. Wyznaczyć położenie osi głównych centralnych i policzyć momenty bezwładności względem tych osi.

C 300
$A =$ 58,8 cm^2
$b_f =$ 100 mm
$t_f =$ 16 mm
$t_w =$ 10 mm
$I_x =$ 8030 cm^4
$I_y =$ 495 cm^4
$e =$ 2,7 cm



	ELEMENT		A_i $[cm^2]$
1	$50x40$	+	2000
2	$15x30$	-	225
3	$R = 10$	+	78,54
4	$R = 10$	+	78,54
5	C 300	+	58,8
	$A =$		1990,9 cm^2

$$y_C = \frac{2000 \cdot 0 - 225 \cdot (-20) + 78{,}54 \cdot \left(-15 - \frac{4 \cdot 10}{3\pi}\right) + 78{,}54 \cdot \left(15 + \frac{4 \cdot 10}{3\pi}\right) + 58{,}8 \cdot 0}{1990{,}9} = \frac{4500}{1990{,}9} =$$

$$= 2{,}26\ cm$$

$$z_C = \frac{2000 \cdot (-20) - 225 \cdot (-30) + 78{,}54 \cdot \frac{4 \cdot 10}{3\pi} \cdot 2 + 58{,}8 \cdot 2{,}7}{1990{,}9} = \frac{-32424{,}6}{1990{,}9} = -16{,}29\ cm$$

$$\mathrm{I}_{y_0} = \left[\frac{50 \cdot 40^3}{12} + 2000 \cdot \left(\overbrace{16{,}29 - 20}^{-3{,}71}\right)^2\right] - \left[\frac{15 \cdot 30^3}{36} + 225 \cdot \left(\overbrace{-23{,}71 + 10}^{-13{,}71}\right)^2\right] +$$

$$+ \left[0{,}055 \cdot 10^4 + 78{,}54 \cdot \left(\overbrace{16{,}29 + \frac{4 \cdot 10}{3\pi}}^{20{,}53}\right)^2\right] \cdot 2 + \left[495 + 58{,}8 \cdot \left(\overbrace{16{,}29 + 2{,}7}^{18{,}99}\right)^2\right] =$$

$$= 294194{,}9 - 53541{,}9 + 33666{,}4 \cdot 2 + 21699{,}5 = 329685\ cm^4$$

$$\mathrm{I}_{z_0} = \left[\frac{40 \cdot 50^3}{12} + 2000 \cdot (-2{,}26)^2\right] - \left[\frac{30 \cdot 15^3}{36} + 225 \cdot \left(\overbrace{-2{,}26 - 20}^{-22{,}26}\right)^2\right] +$$

$$+\left[0{,}055\cdot 10^4+78{,}54\cdot\left(\overbrace{-2{,}26-15-\frac{4\cdot 10}{3\pi}}^{-21{,}50}\right)^2\right]+\left[0{,}055\cdot 10^4+78{,}54\cdot\left(\overbrace{-2{,}26+15+\frac{4\cdot 10}{3\pi}}^{16{,}98}\right)^2\right]+$$

$$+[8030+58{,}8\cdot(-2{,}26)^2]=426881{,}9-114301{,}7+36869{,}1+23205{,}7+8330{,}3=380985\ cm^4$$

$$\mathrm{I}_{y_0z_0}=[0+2000\cdot(-3{,}71)\cdot(-2{,}26)]-\left[-\frac{15^2\cdot 30^2}{72}+225\cdot(-13{,}71)\cdot(-22{,}26)\right]+$$

$$+[0{,}0165\cdot 10^4+78{,}54\cdot(20{,}53)\cdot(-21{,}50)]+[-0{,}0165\cdot 10^4+78{,}54\cdot(20{,}53)\cdot(16{,}98)]+$$

$$+[0+58{,}8\cdot(18{,}99)\cdot(-2{,}26)]=16769{,}2-65854{,}0-34502{,}2+27214{,}0-2523{,}5=$$

$$=-58896{,}5\ cm^4$$

$$\mathrm{tg}2\varphi_0=\frac{-2\mathrm{I}_{y_0z_0}}{\mathrm{I}_{y_0}-\mathrm{I}_{z_0}}=\frac{-2\cdot(-58896{,}5)}{329685-380985}=-2{,}296$$

$$2\varphi_0=arctg(-2{,}296)=-66{,}46°$$

$\varphi_0=-33{,}23°\ \rightarrow$ *minus oznacze że należy obrócić osie przeciwnie do ruchu wskazówek zegara*

$$I_{1,2}=\frac{1}{2}(\mathrm{I}_{y_0}+\mathrm{I}_{z_0})\pm\frac{1}{2}\sqrt{(\mathrm{I}_{y_0}-\mathrm{I}_{z_0})^2+4\mathrm{I}_{y_0z_0}{}^2}$$

$$I_{1,2}=\frac{1}{2}(329685+380985)\pm\frac{1}{2}\sqrt{(329685-380985)^2+4(-58896{,}5)^2}$$

$I_1=355335+64239{,}6=419574{,}6\ cm^4$

$I_2=355335-64239{,}6=291095{,}4\ cm^4$

$\mathrm{I}_{y_0}<\mathrm{I}_{z_0}$ *więc oś* z_0 *przechodzi w oś* 1