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METHODS OF PROBLEM SOLVING IN THEORETICAL MECHANICS COURSES

Abduxakim Nigmatovich Abdullayev
Tashkent State Pedagogical University, Department of "Technological Education Methodology",assistant professor,Tashkent city.
abdullayeva.abduhakim.1967@gmail.com
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ANNOTATION: Presented in the article The problem is presented in order to prevent errors that may occur during course work, and there is a sequence in it. First, a graph is drawn based on the scale of the problem condition, and then the following calculation is made according to the books.

KEY WORDS: Shveller, assortment, moment of inertia, static moment, Principal axes, moment of resistance, radius of inertia, Plane shapes, Center of gravity, Moment of inertia of an arbitrary plane shape.

RESULTS

Determination of static moments of the general surface in relation to the x-axis, calculation of the coordinates of the general center of gravity.

DISCUSSION

In the article, for the cross-section of the given flat shapes, the channelizers were selected, and based on this, the values were obtained according to the assortment, the ratio of channelizers to the auxiliary axes passed through the centers of gravity, and the guidelines for calculating the static, centrifugal inertia and central head moments of inertia with respect to the axes of the general surface are shown.

CONCLUSION

At the end of the issue, the results were checked. Showing the method of solving the problem serves to prevent the mistakes that the students may make in graphic work.

Given flat forms section for channel No. 12 and on the basis of the channel No. 14 assortment according to values taken from table-1 issue let's solve

Table-1

Nº	Dimensions, mm				Cut surface, sm²	J_x sm⁴	W_x sm³	i_x sm	S_x sm³	J_y sm⁴	W_y sm³	i_y sm	z_0 cm
	h	b	d	t									
12	120	52	4.8	7.8	13.3	304	50.6	4.78	29.6	31.2	8.52	1.53	1.54
14	140	58	4.9	8.1	15.6	491	70.2	5.60	40.8	45.4	11.0	1.70	1.67

Rolled steel channel picture-1

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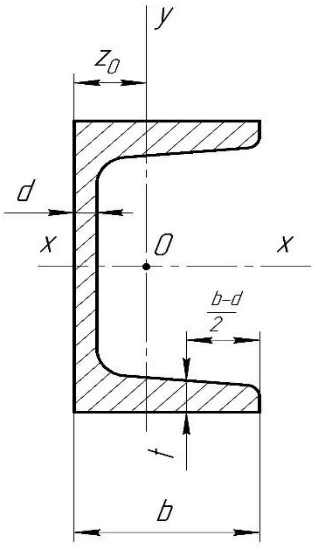	**Channels (GOST 8240-72)** h-the height of the beam b- the width of the hammer d-hammer wall thickness The middle thickness of the t-shelf I-moment of inertia W-moment of resistance i-radius of inertia; S-static moment

Solution: 1). First of all, we draw the chevellers based on the scale and place auxiliary axes xu on them (Fig. 1). The general surface is xu we determine the static moments relative to the axes. Then, finding the center of gravity from the symmetry centers of the shapes, by calculating the coordinates of the common center of gravity, we mark the point S on the drawing. X_C , Y_C.

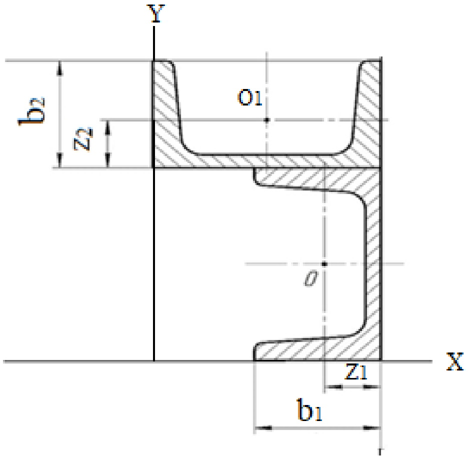

Figure 1

1) We find the common surface. $\sum F = F_1^{шв} + F_2^{шв} = 13{,}6 + 15{,}6 = 28{,}9 sm^2$ total surface area.Static moments about the X axis. When finding the static moments of flat shapes, the distance from the surface of the flat shape to the coordinate axis is understood (Fig. 2). Static moment about the X axis Static moment

$S_x = \int ydA$ .about the U axis

$$S_y = \int xdA.$$

$$S_X^{шв1} = F_1^{шв} \cdot \frac{h_1}{2} = 13{,}6 \cdot \frac{120}{2} = 816 \text{ sm}^3$$

$$S_X^{шв2} = F_2^{шв} \cdot (h_1 + z_2) = 15{,}6 \cdot (120 + 1{,}67) = 1898{,}052 \text{ sm}^3$$

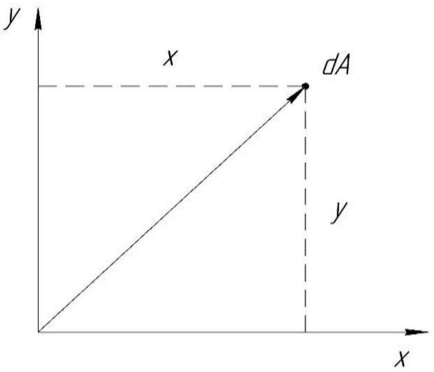

Figure 2

X The total static moment about the axis is equal to:

$S_x = S_X^{шв1} + S_X^{шв2} = 816 + 1898{,}052 = 2714{,}052\ sm^3$

U are static moments about the axis

$$S_y^{шв1} = F_1^{шв1} \cdot \frac{h_1}{2} = 13{,}6 \cdot 60 = 73{,}6\ sm^3$$

$$S_y^{шв2} = F_2^{шв2} \cdot (h_1 + Z_2) = 15{,}6 \cdot (120 + 1{,}67) = 1898{,}052\ sm^3$$

Y The total static moment about the axis is equal to:

$S_y = S_y^{шв1} + S_y^{шв2} = 73{,}6 + 1898{,}052 = 1971{,}652 sm^3$

2) We find the center of gravity relative to the auxiliary XU axes passed through the centers of gravity of the sleepers: $S_X = Y_C(F_1^{шв} + F_2^{шв})$,from here Y_C the coordinate of the center of gravity for the section of general flat shapes $Y_C = \frac{S_X}{(F_1^{шв}+F_2^{шв})} = \frac{2714{,}052}{13{,}6+15{,}6} = 92{,}9469 sm$

$S_y = X_C(F_1^{шв} + F_2^{шв})$where is $X_C$the coordinate of the center of gravity

$X_C = \frac{S_y}{(F_1^{шв}+F_2^{шв})} = \frac{1971{,}652}{13{,}6+15{,}6} = 67{,}5223\ sm$

3) $X_C$and $Y_C$calculate the moments of inertia relative to the axes (Fig. 3) . $J_x = \int y^2 dA$and relative to the Y axis$J_y = \int x^2 dA$

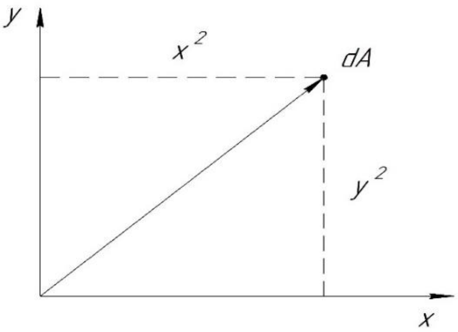

Figure 3

$I_x = I_{x1}^{шв} + \left(\frac{h_1}{2}\right)^2 \cdot F_1^{шв} + I_{x2}^{шв} + (h_1 + Z_2)^2 \cdot F_2^{шв} = 304 + (60)^2 \cdot 13{,}3 + 491 + (120 + 1{,}67)^2 \cdot 15{,}6 = 280690{,}98684\ sm^4$

$$I_y = I_y^{шв1} + (h_2 - Z_1)^2 \cdot F_1^{шв} + I_y^{шв2} + \left(\frac{h_2}{2}\right)^2 \cdot F_2^{шв}$$

$$= 31{,}2 + (140 - 1{,}54)^2 \cdot 13{,}3 + 491 + (70)^2 \cdot 15{,}6 = 331938{,}78228\ sm^4$$

Here: h_1, b_2, b_1, h_2 s are taken from table-1 for channels.

4) Centrifugal moments of inertia. Centripetal moment of inertia of a flat shape is obtained in the form of mutual values of XY coordinate axes and surface product. This is reflected below.

$$I_{xy} = I_{x_1y_1} + F_1^{шв} \cdot a_1 \cdot a_3 + I_{x_1y_1} + F_2^{шв} \cdot a_2 \cdot a_4$$
$$= 13{,}3 \cdot \frac{h_1}{2} \cdot (h_2 - Z_1) + 15{,}6 \cdot (h_1 + Z_2) \cdot (\frac{h_2}{2}) = 243354{,}72\ sm^4$$

Here: To simplify the calculation $(h_2 - Z_1) = a_3$; $\frac{h_1}{2} = a_1$;

$$(h_1 + Z_2) = a_2;\ \frac{h_2}{2} = a_4$$

confusion in the calculation won't be. a_1 and a_2 (Fig. 4), a_3 and a_4 (Fig. 5)

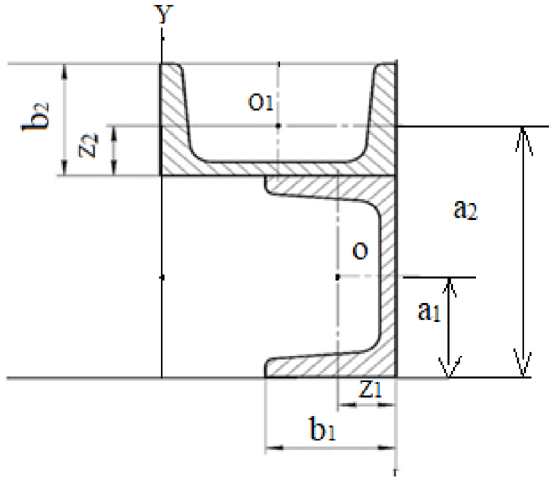

Figure 4

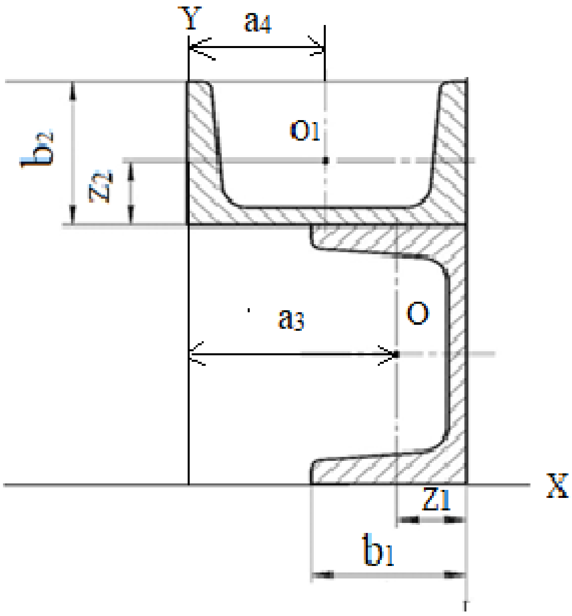

Figure 5

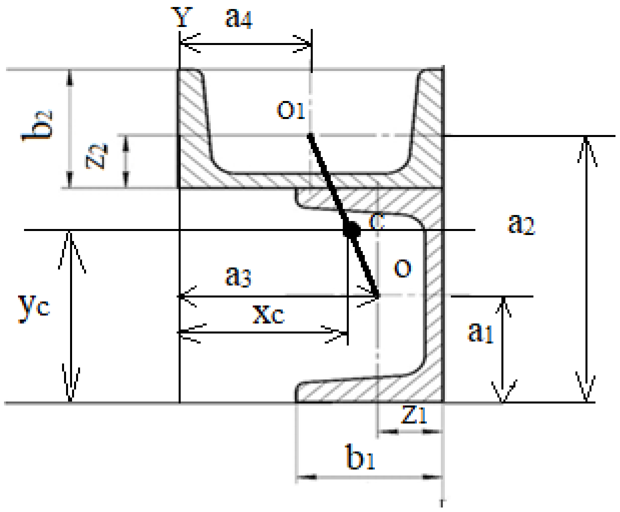

Figure 6.

In Fig. 6, we mark the point S where the common center of gravity Xc and Yc coordinate dimensions are united.

5) We determine the position of the central main axes of inertia and ∝ бурчакнитransfer the central main axes y and в (Fig. 7). we set the angle $X_C$from the axis ∝in the anti-clockwise direction. Because

$\propto = -\mathrm{arctg}4{,}7$ the value is negative.

$$\mathrm{tg}\ 2\propto = \frac{2I_{xy}}{I_x - I_y} = \frac{2\cdot 243354{,}72}{280690{,}98684 - 331938{,}78228} = -9{,}49717808973521;$$

$\mathrm{tg}\ 2\propto = 9{,}49717808973521$from here$\propto = -\mathrm{arctg}4{,}7$

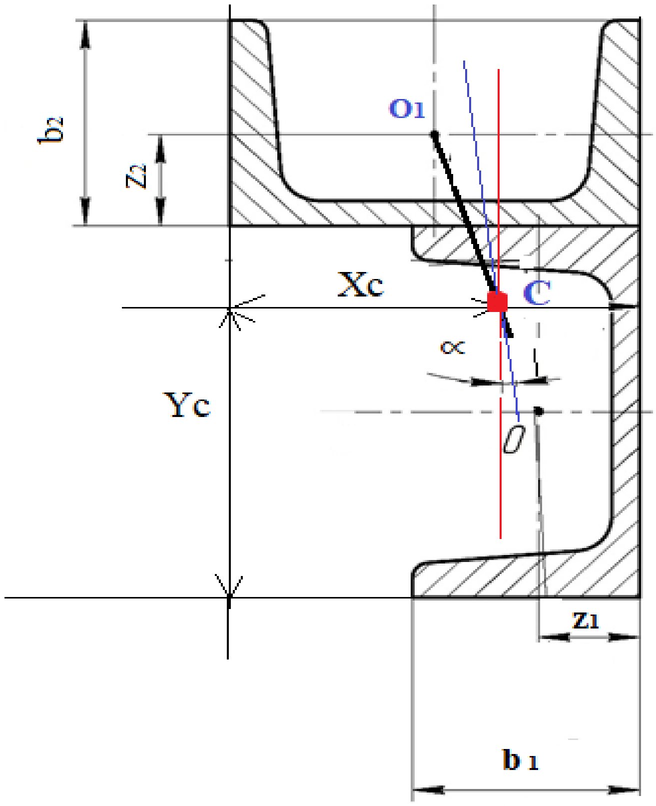

Figure 7

6) We calculate the moments of inertia of the central head:

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$I_{min}^{max} = \frac{I_x+I_y}{2} \pm \frac{1}{2}\sqrt{(I_x - I_y)^2 + 4I_{xy}}$ We take the values from the above calculation results and replace them in the formula . The following expression is derived

$I_{min}^{max} = \frac{280690,98684+331938,78228}{2} \pm \frac{1}{2}\sqrt{(-51247,79544)^2 + 4 \cdot 243354,72}$

We find the final result by simplifying the expression.

$$I_{min}^{max} = 306314,88456 \pm \frac{1}{2} \cdot 51257,2917\ sm^4$$

$I_{min}^{max} = 306314,88456 \pm 25628,64585\ sm^4$

$I_{max} = 306314,88456 + 25628,64585 = 331943,53041;sm^4$

$I_{min} = 306314,88456 - 25628,64585 = 280686,23871 sm^4$

From here$I_{max} = 331943,53041$ см^4; $I_{min} = 280686,23871\ sm^4$

General graphic view (Fig. 7):

7) Check: $I_x + I_y = I_{max} + I_{min}$We put the above values into the equation. On the left side of the equation$I_x + I_y = 612629,76912\ sm^4$; and on the right side of Eq $I_{max} + I_{min} =$ 612629,76912 см^4;In general, we compare the left and right sides of the equation: 612629,76912 = 612629,76912 So the issue is resolved correctly.

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