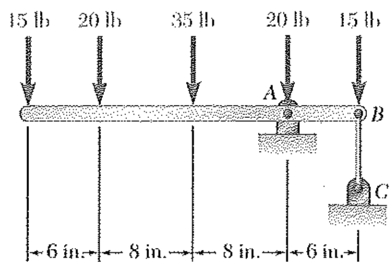
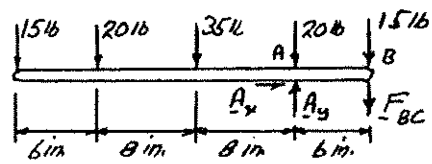


PROBLEM 4.4

For the beam and loading shown, determine (*a*) the reaction at *A*, (*b*) the tension in cable *BC*.

SOLUTION

Free-Body Diagram:



(*a*) Reaction at *A*: $\Sigma F_x = 0$: $A_x = 0$

$+\circlearrowleft \Sigma M_B = 0$: $(15 \text{ lb})(28 \text{ in.}) + (20 \text{ lb})(22 \text{ in.}) + (35 \text{ lb})(14 \text{ in.}) + (20 \text{ lb})(6 \text{ in.}) - A_y(6 \text{ in.}) = 0$

$A_y = +245 \text{ lb}$ $\qquad$ $\mathbf{A} = 245 \text{ lb}\uparrow$ ◀

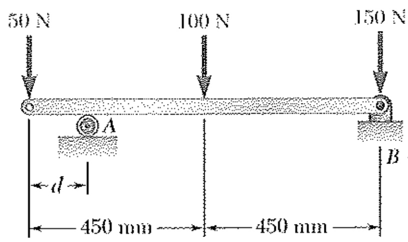
(*b*) Tension in *BC* $\quad +\circlearrowleft \Sigma M_A = 0$: $(15 \text{ lb})(22 \text{ in.}) + (20 \text{ lb})(16 \text{ in.}) + (35 \text{ lb})(8 \text{ in.}) - (15 \text{ lb})(6 \text{ in.}) - F_{BC}(6 \text{ in.}) = 0$

$F_{BC} = +140.0 \text{ lb}$ $\qquad$ $F_{BC} = 140.0 \text{ lb}$ ◀

Check: $+\uparrow \Sigma F_y = 0$: $-15 \text{ lb} - 20 \text{ lb} = 35 \text{ lb} - 20 \text{ lb} + A - F_{BC} = 0$

$-105 \text{ lb} + 245 \text{ lb} - 140.0 = 0$

$0 = 0$ (Checks)

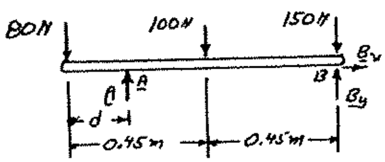


PROBLEM 4.10

Solve Problem 4.9 if the 50-N load is replaced by an 80-N load.

PROBLEM 4.9 The maximum allowable value of each of the reactions is 180 N. Neglecting the weight of the beam, determine the range of the distance *d* for which the beam is safe.

SOLUTION



$$\Sigma F_x = 0: \quad B_x = 0$$

$$B = B_y$$

$$+\circlearrowleft \Sigma M_A = 0: \quad (80 \text{ N})d - (100 \text{ N})(0.45 \text{ m} - d) - (150 \text{ N})(0.9 \text{ m} - d) + B(0.9 \text{ m} - d) = 0$$

$$80d - 45 + 100d - 135 + 150d + 0.9B - Bd = 0$$

$$d = \frac{180 \text{ N}\cdot\text{m} - 0.9B}{330\text{N} - B} \qquad (1)$$

$$+\circlearrowleft \Sigma M_B = 0: \quad (80 \text{ N})(0.9 \text{ m}) - A(0.9 \text{ m} - d) + (100 \text{ N})(0.45 \text{ m}) = 0$$

$$d = \frac{0.9A - 117}{A} \qquad (2)$$

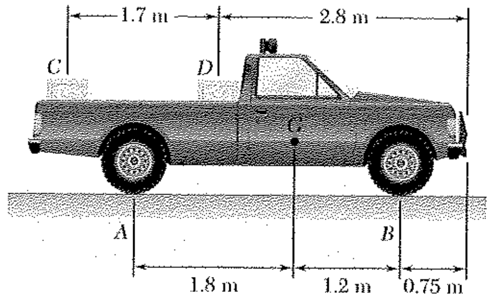
Since $B \leq 180$ N, Eq. (1) yields.

$$d \geq (180 - 0.9 \times 180)/(330 - 180) = \frac{18}{150} = 0.12 \text{ m} \qquad d = 120.0 \text{ mm} \;\triangleleft$$

Since $A \leq 180$ N, Eq. (2) yields.

$$d \leq (0.9 \times 180 - 112)/180 = \frac{45}{180} = 0.25 \text{ m} \qquad d = 250 \text{ mm} \;\triangleleft$$

Range: $120.0 \text{ mm} \leq d \leq 250 \text{ mm}$ ◀

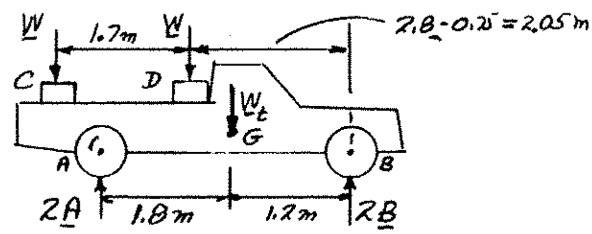


PROBLEM 4.5

Two crates, each of mass 350 kg, are placed as shown in the bed of a 1400-kg pickup truck. Determine the reactions at each of the two (*a*) rear wheels *A*, (*b*) front wheels *B*.

SOLUTION

Free-Body Diagram:



$$W = (350 \text{ kg})(9.81 \text{ m/s}^2) = 3.434 \text{ kN}$$

$$W_t = (1400 \text{ kg})(9.81 \text{ m/s}^2) = 13.734 \text{ kN}$$

(*a*) Rear wheels

$$+\circlearrowleft \Sigma M_B = 0: \quad W(1.7 \text{ m} + 2.05 \text{ m}) + W(2.05 \text{ m}) + W_t(1.2 \text{ m}) - 2A(3 \text{ m}) = 0$$

$$(3.434 \text{ kN})(3.75 \text{ m}) + (3.434 \text{ kN})(2.05 \text{ m}) + (13.734 \text{ kN})(1.2 \text{ m}) - 2A(3 \text{ m}) = 0$$

$$A = +6.0663 \text{ kN}$$

$\mathbf{A} = 6.07 \text{ kN}\uparrow$ ◀

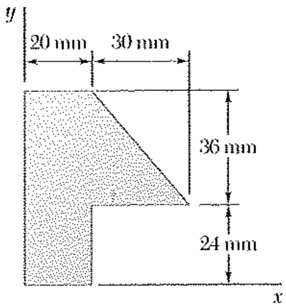
(*b*) Front wheels

$$+\uparrow \Sigma F_y = 0: \quad -W - W - W_t + 2A + 2B = 0$$

$$-3.434 \text{ kN} - 3.434 \text{ kN} - 13.734 \text{ kN} + 2(6.0663 \text{ kN}) + 2B = 0$$

$$B = +4.2347 \text{ kN}$$

$\mathbf{B} = 4.23 \text{ kN}\uparrow$ ◀

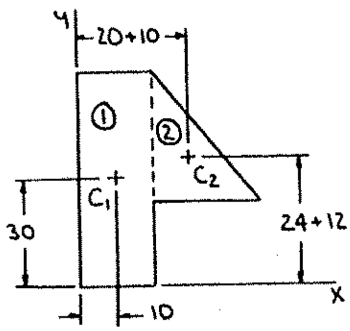


PROBLEM 5.2

Locate the centroid of the plane area shown.

SOLUTION

Dimensions in mm

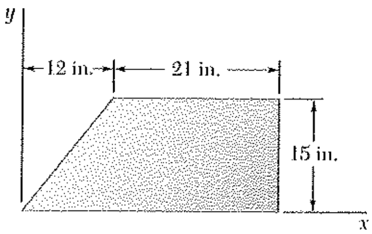


	A, mm^2	$\bar{x}$, mm	$\bar{y}$, mm	$\bar{x}A$, mm^3	$\bar{y}A$, mm^3
1	1200	10	30	12000	36000
2	540	30	36	16200	19440
Σ	1740			28200	55440

Then

$$\bar{X} = \frac{\Sigma \bar{x} A}{\Sigma A} = \frac{28200}{1740}$$ $\bar{X} = 16.21$ mm ◀

$$\bar{Y} = \frac{\Sigma \bar{y} A}{\Sigma A} = \frac{55440}{1740}$$ $\bar{Y} = 31.9$ mm ◀

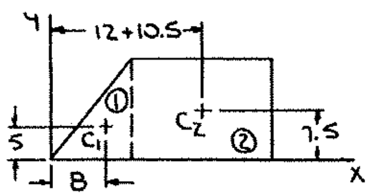


PROBLEM 5.3

Locate the centroid of the plane area shown.

SOLUTION

Dimensions in in.

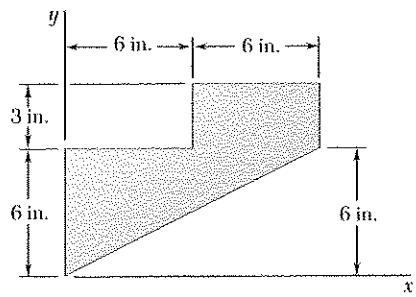


	A, in.^{2}	$\bar{x}$, in.	$\bar{y}$, in.	$\bar{x}A$, in.^{3}	$\bar{y}A$, in.^{3}
1	$\frac{1}{2}\times 12\times 15=90$	8	5	720	450
2	$21\times 15=315$	22.5	7.5	7087.5	2362.5
Σ	405.00			7807.5	2812.5

Then
$$\bar{X}=\frac{\Sigma\bar{x}A}{\Sigma A}=\frac{7807.5}{405.00}$$ $\bar{X}=19.28$ in. ◀

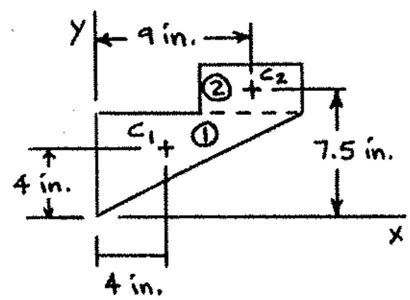
$$\bar{Y}=\frac{\Sigma\bar{y}A}{\Sigma A}=\frac{2812.5}{405.00}$$ $\bar{Y}=6.94$ in. ◀

PROBLEM 5.4



Locate the centroid of the plane area shown.

SOLUTION



	A, in.^{2}	$\bar{x}$, in.	$\bar{y}$, in.	$\bar{x}A$, in.^{3}	$\bar{y}A$, in.^{3}
1	$\frac{1}{2}(12)(6) = 36$	4	4	144	144
2	$(6)(3) = 18$	9	7.5	162	135
Σ	54			306	279

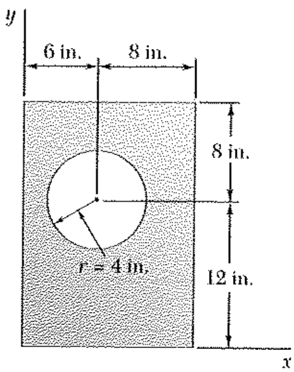
Then

$$\bar{X}A = \Sigma\bar{x}A$$

$$\bar{X}(54) = 306 \qquad \bar{X} = 5.67 \text{ in.} \blacktriangleleft$$

$$\bar{Y}A = \Sigma\bar{y}A$$

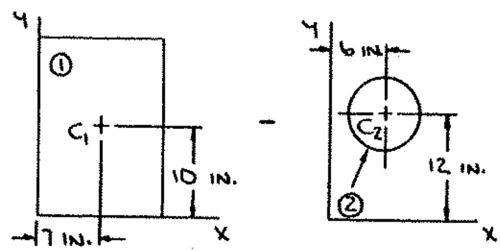
$$\bar{Y}(54) = 279 \qquad \bar{Y} = 5.17 \text{ in.} \blacktriangleleft$$



PROBLEM 5.5

Locate the centroid of the plane area shown.

SOLUTION



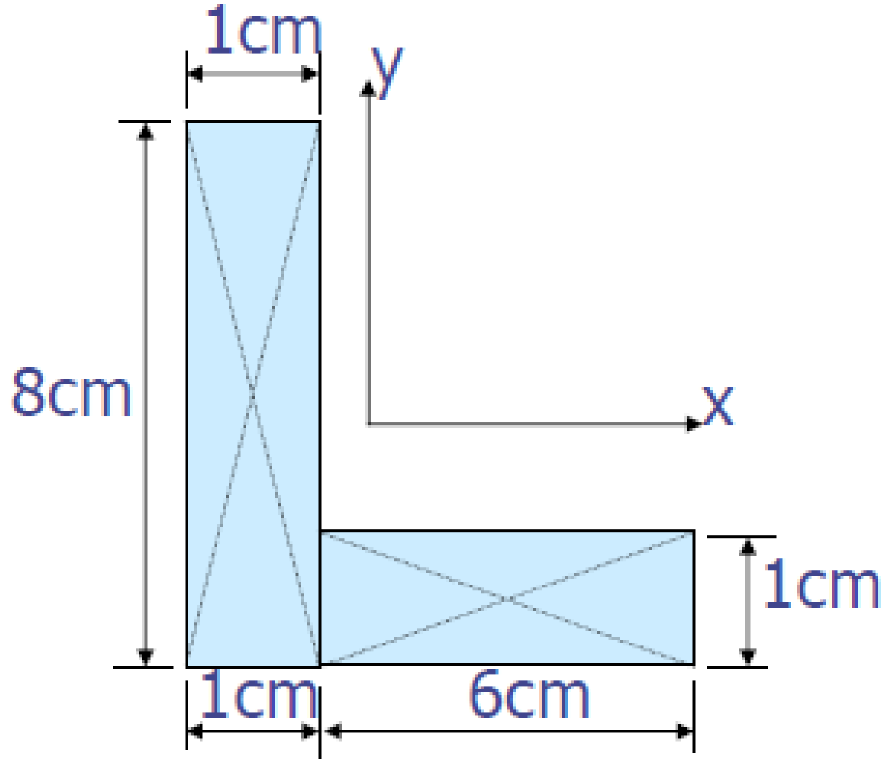
	A, in.^{2}	$\bar{x}$, in.	$\bar{y}$, in.	$\bar{x}A$, in.^{3}	$\bar{y}A$, in.^{3}
1	$14 \times 20 = 280$	7	10	1960	2800
2	$-\pi(4)^2 = -16\pi$	6	12	–301.59	–603.19
Σ	229.73			1658.41	2196.8

Then

$$\bar{X} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{1658.41}{229.73} \qquad \bar{X} = 7.22 \text{ in.} \blacktriangleleft$$

$$\bar{Y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{2196.8}{229.73} \qquad \bar{Y} = 9.56 \text{ in.} \blacktriangleleft$$

Aşağıdaki şekilde I_x, I_y hesaplayın



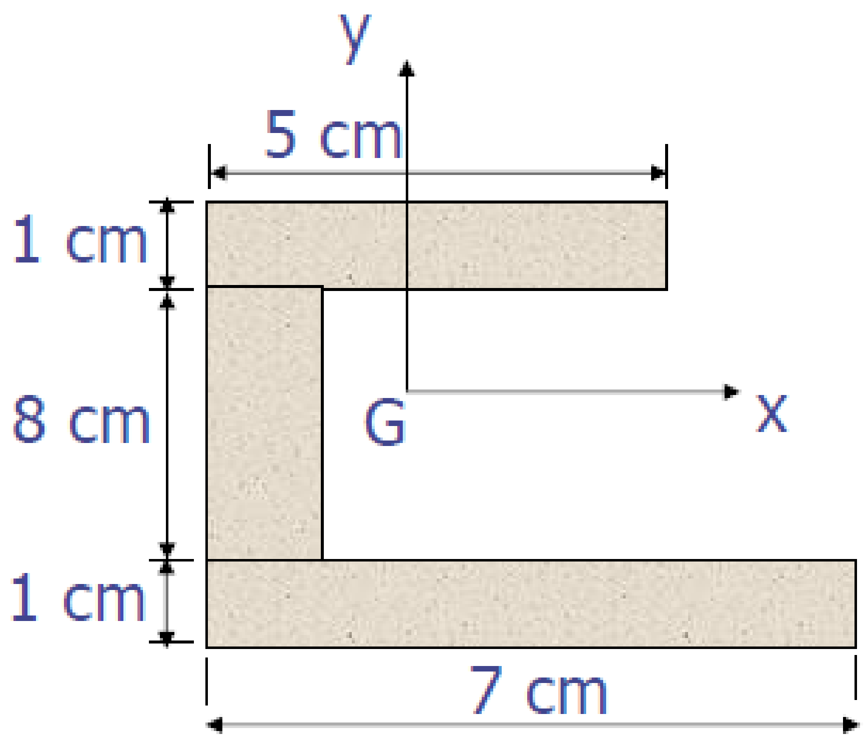
$$x_g = \frac{x_1 A_1 + x_2 A_2}{A_1 + A_2} = \frac{0{,}5.8 + 4.6}{8+6} = 2\,cm$$

$$y_g = \frac{y_1 A_1 + y_2 A_2}{A_1 + A_2} = \frac{4.8 + 0{,}5.6}{8+6} = 2{,}5\,cm$$

$$I_x = \frac{1.8^3}{12} + (4 - 2{,}5)^2.8 + \frac{6.1^3}{12} + (0{,}5 - 2{,}5)^2.6 = 85{,}16\,cm^4$$

$$I_y = \frac{8.1^3}{12} + (0{,}5 - 2)^2.8 + \frac{1.6^3}{12} + (4 - 2{,}5)^2.6 = 50{,}16\,cm^4$$

Verilen profil kesitte ağırlık merkezinden geçen x, y eksen takımına göre atalet momentlerini hesaplayınız.



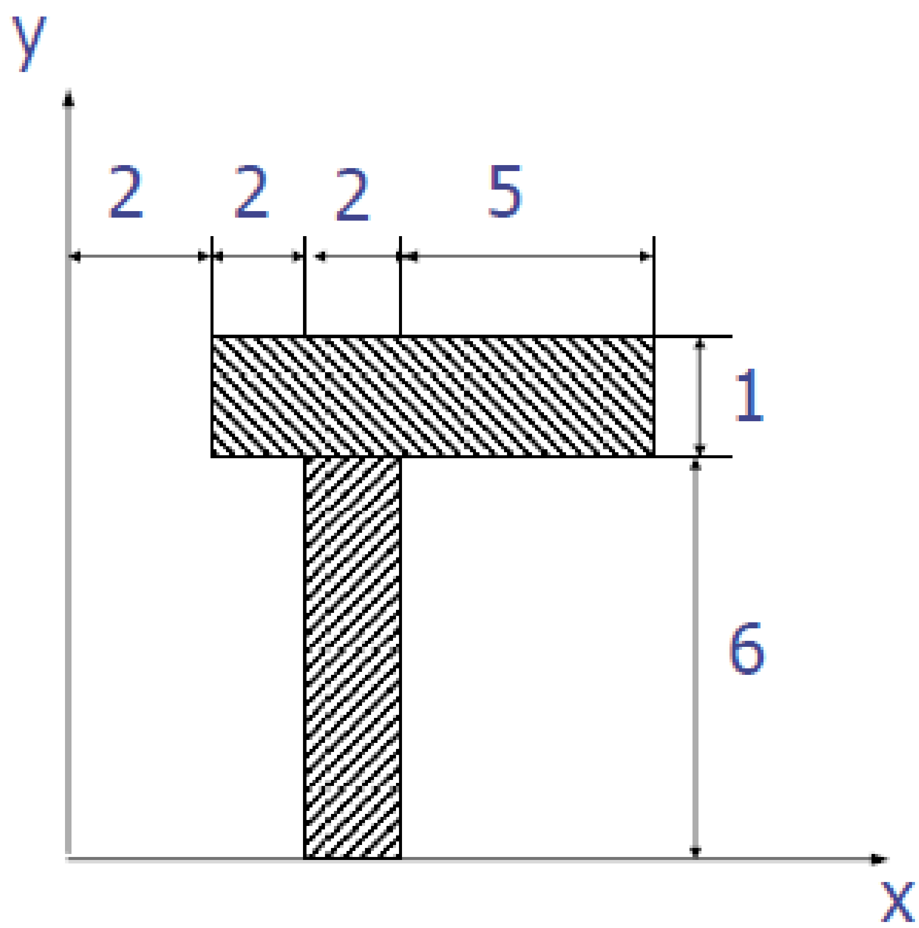
$$x = \frac{x_1 A_1 + x_2 A_2 + x_3 A_3}{A_1 + A_2 + A_3} = \frac{2{,}5.5 + 0{,}5.8 + 3{,}5.7}{20} = 2{,}0 \text{ cm}$$

$$y = \frac{y_1 A_1 + y_2 A_2 + y_3 A_3}{A_1 + A_2 + A_3} = \frac{9{,}5.5 + 5.8 + 0{,}5.7}{20} = 4{,}5 \text{ cm}$$

$$\mathbf{I_x} = \frac{5.1^3}{12} + 5^2.5 + \frac{1.8^3}{12} + (0{,}5)^2.8 + \frac{1^3.7}{12} + 4^2.7 = 282{,}6\ cm^4$$

$$I_y = \frac{1.5^3}{12} + 10{,}55^2.5 + \frac{8.1^3}{12} + (1{,}5)^2.8 + \frac{1.7^3}{12} + (1{,}5)^2.7 = 74{,}6\ cm^4$$

Problem 1)



a) Ağırlık merkezini bulunuz.

b) Ağırlık merkezinder geçen eksene göre atalet momentlerini hesaplayınız.

Not: Ölçüler cm'dir.

$$x = \frac{9x6{,}5 + 12x5}{9 + 12} = \frac{118{,}5}{21} = 5{,}64cm$$

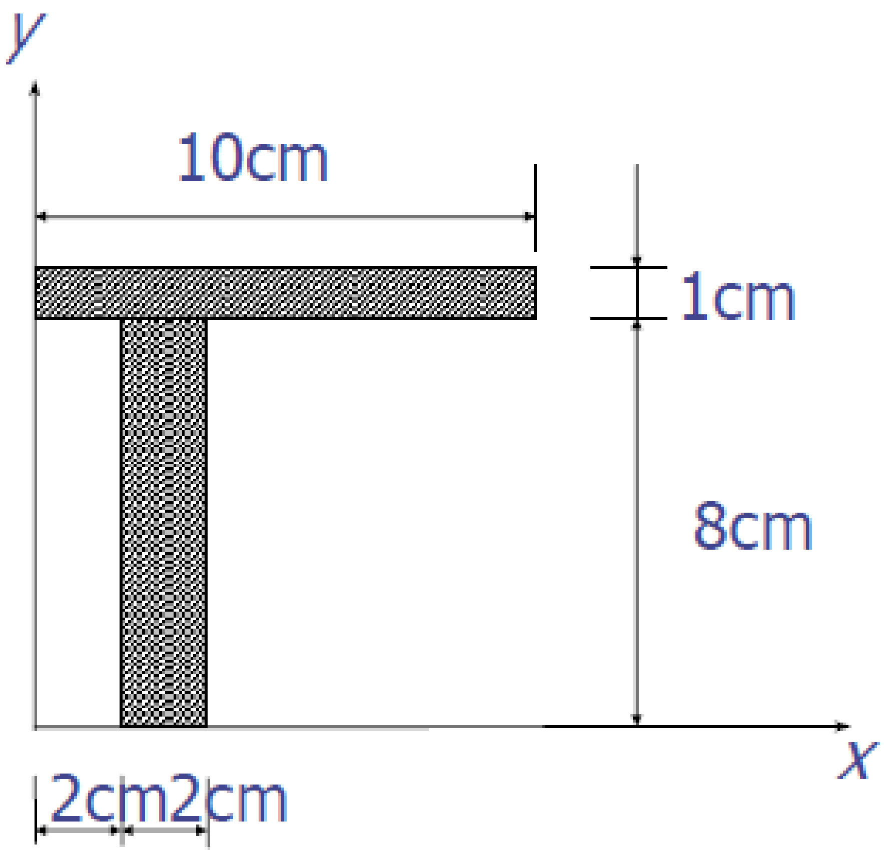
$$y = \frac{9x6{,}5 + 12x3}{21} = 4{,}5cm$$

$$I_x = \frac{9x1^3}{12} + (9)(6{,}5 - 4{,}5)^2 + \frac{6^3 x2}{12} + (12)(3 - 4{,}5)^2$$

$$I_x = 0{,}75 + 36 + 36 + 27 = 99{,}75cm^4$$

$$I_y = \frac{1x9^3}{12} + (9)(6{,}5 - 5{,}64)^2 + \frac{2^3 x6}{12} + (12)(5 - 5{,}64)^2$$

$$I_y = 60{,}75 + 6{,}65 + 4 + 4{,}91 = 76{,}31cm^4$$

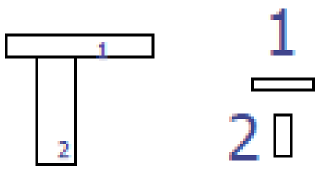


Verilen kesitin;

Ağırlık merkezinin koordinatlarını hesaplayınız.

Ağırlık merkezinden geçen koordinat eksenine göre atalet momentlerini hesaplayınız.

Asal atalet momentlerini hesaplayınız.



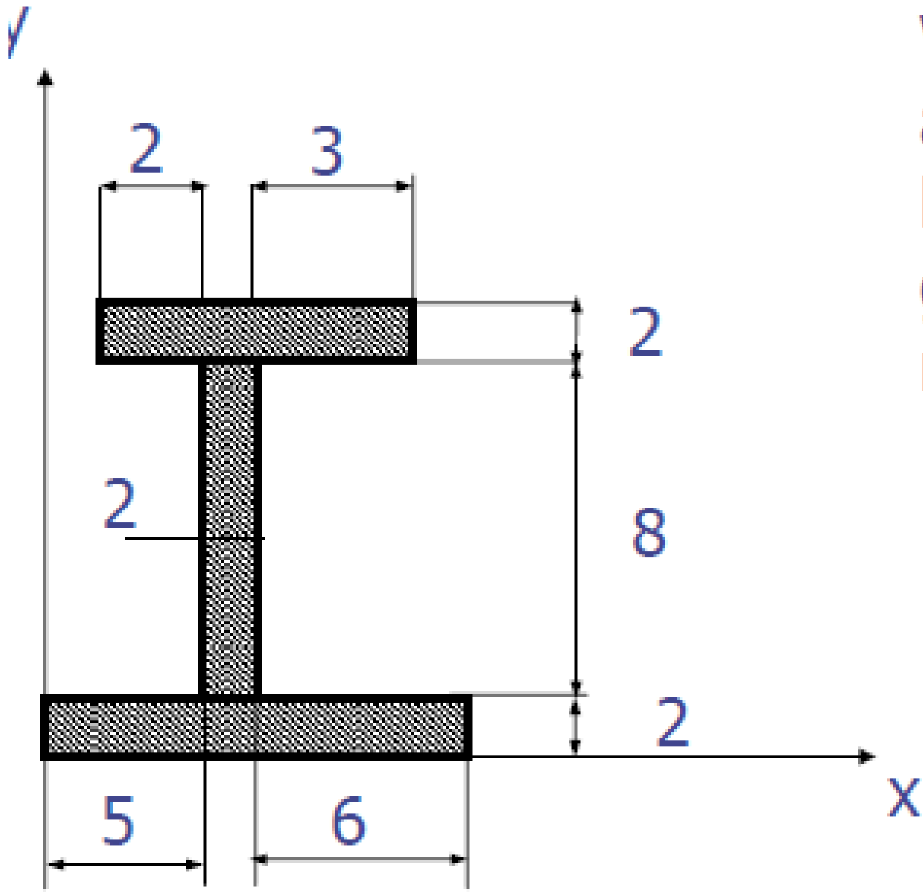
	x	y	A	A_x	A_y
1	5	8,5	10	50	85
2	3	4	16	48	64
Toplam			26	98	149

a) $\bar{x} = \dfrac{\Sigma xA}{\Sigma A} = \dfrac{98}{26} = 3{,}77\ cm$ $\qquad$ $\bar{y} = \dfrac{\Sigma yA}{\Sigma A} = \dfrac{149}{26} = 5{,}73\ cm$

b)

$$I_x = \frac{10.1^3}{12} + (8,5 - 5,73)^2.10 + \frac{2.8^3}{12} + (4 - 5,73)^2.16 = 210,78\ cm^4$$

$$I_y = \frac{1.10^3}{12} + (5 - 3,77)^2.10 + \frac{8.2^3}{12} + (3 - 3,77)^2.16 = 113,28\ cm^4$$



Verilen profil kesitte;

a) Ağırlık merkezini,

b) Ağırlık merkezinden geçen eksene göre atalet momentini,

	A	x	y	A_x	A_y
1	14	6,5	11	91	154
2	16	6	6	96	96
3	26	6,5	1	169	26
T	56			356	276

$$\bar{x} = \frac{356}{56} = 6{,}35 \text{ cm} \quad \bar{y} = \frac{276}{56} = 4{,}92 \text{ cm}$$

b)

$$I_x = \frac{7.2^3}{12} + (6,08)^2.14 + \frac{2.8^3}{12} + (1,08)^2.16 + \frac{13.2^3}{12} + (-3,92)^2.26 = 1034,1\ cm^4$$

$$I_y = \frac{2.7^3}{12} + (0,15)^2.14 + \frac{8.2^3}{12} + (-0,35)^2.16 + \frac{2.13^3}{12} + (0,15)^2.26 = 431,1\ cm^4$$