

EXAMPLE 10.4

Determine the moment of inertia of the area shown in Fig. 10-8a about the x axis.

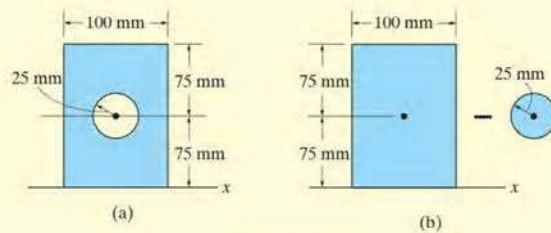


Fig. 10-8

SOLUTION

Composite Parts. The area can be obtained by *subtracting* the circle from the rectangle shown in Fig. 10-8b. The centroid of each area is located in the figure.

Parallel-Axis Theorem. The moments of inertia about the x axis are determined using the parallel-axis theorem and the data in the table on the inside back cover.

Circle

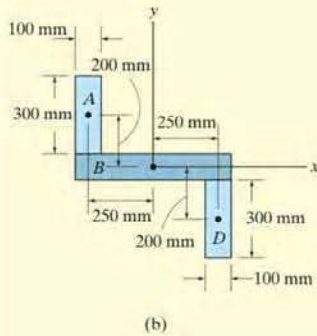
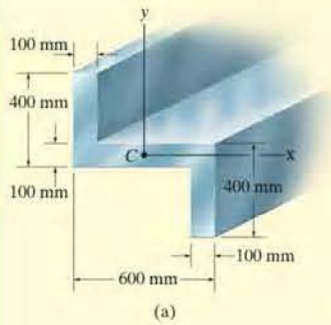
$$\begin{aligned} I_x &= \bar{I}_{x'} + Ad_y^2 \\ &= \frac{1}{4}\pi(25)^4 + \pi(25)^2(75)^2 = 11.4(10^6) \text{ mm}^4 \end{aligned}$$

Rectangle

$$\begin{aligned} I_x &= \bar{I}_{x'} + Ad_y^2 \\ &= \frac{1}{12}(100)(150)^3 + (100)(150)(75)^2 = 112.5(10^6) \text{ mm}^4 \end{aligned}$$

Summation. The moment of inertia for the area is therefore

$$\begin{aligned} I_x &= -11.4(10^6) + 112.5(10^6) \\ &= 101(10^6) \text{ mm}^4 \end{aligned} \quad \text{Ans.}$$

EXAMPLE 10.5**Fig. 10-9**

Determine the moments of inertia for the cross-sectional area of the member shown in Fig. 10-9a about the x and y centroidal axes.

SOLUTION

Composite Parts. The cross section can be subdivided into the three rectangular areas A , B , and D shown in Fig. 10-9b. For the calculation, the centroid of each of these rectangles is located in the figure.

Parallel-Axis Theorem. From the table on the inside back cover, or Example 10.1, the moment of inertia of a rectangle about its centroidal axis is $\bar{I} = \frac{1}{12}bh^3$. Hence, using the parallel-axis theorem for rectangles A and D , the calculations are as follows:

Rectangles A and D

$$I_x = \bar{I}_x + Ad_y^2 = \frac{1}{12}(100)(300)^3 + (100)(300)(200)^2 = 1.425(10^9) \text{ mm}^4$$

$$I_y = \bar{I}_y + Ad_x^2 = \frac{1}{12}(300)(100)^3 + (100)(300)(250)^2 = 1.90(10^9) \text{ mm}^4$$

Rectangle B

$$I_x = \frac{1}{12}(600)(100)^3 = 0.05(10^9) \text{ mm}^4$$

$$I_y = \frac{1}{12}(100)(600)^3 = 1.80(10^9) \text{ mm}^4$$

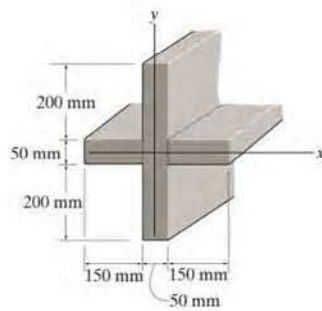
Summation. The moments of inertia for the entire cross section are thus

$$I_x = 2[1.425(10^9)] + 0.05(10^9) = 2.90(10^9) \text{ mm}^4 \quad \text{Ans.}$$

$$I_y = 2[1.90(10^9)] + 1.80(10^9) = 5.60(10^9) \text{ mm}^4 \quad \text{Ans.}$$

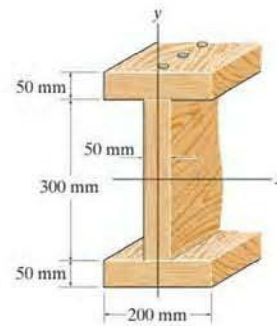
FUNDAMENTAL PROBLEMS

F10-5. Determine the moment of inertia of the beam's cross-sectional area about the centroidal x and y axes.



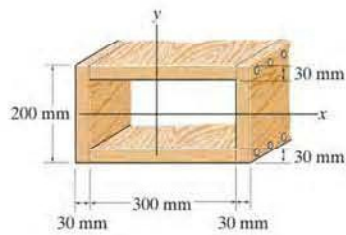
F10-5

F10-7. Determine the moment of inertia of the cross-sectional area of the channel with respect to the y axis.



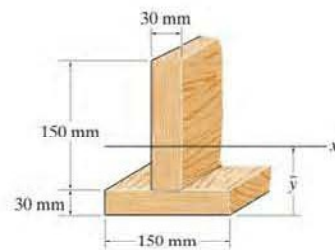
F10-7

F10-6. Determine the moment of inertia of the beam's cross-sectional area about the centroidal x and y axes.



F10-6

F10-8. Determine the moment of inertia of the cross-sectional area of the T-beam with respect to the x' axis passing through the centroid of the cross section.



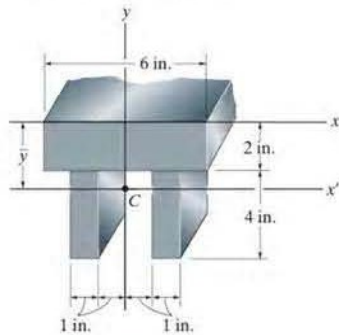
F10-8

PROBLEMS

10-27. Determine the distance \bar{y} to the centroid of the beam's cross-sectional area; then find the moment of inertia about the x' axis.

***10-28.** Determine the moment of inertia of the beam's cross-sectional area about the x axis.

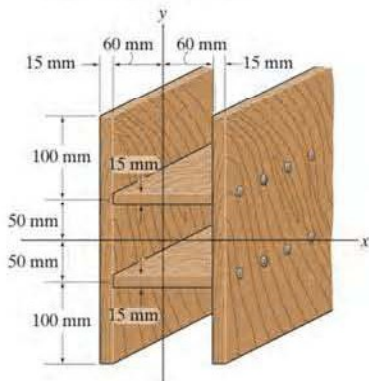
•10-29. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-27/28/29

10-30. Determine the moment of inertia of the beam's cross-sectional area about the x axis.

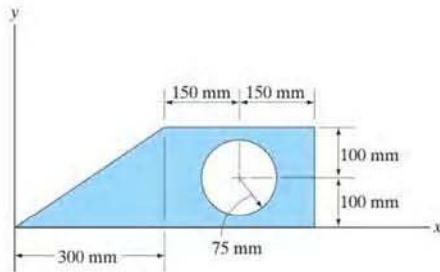
10-31. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-30/31

***10-32.** Determine the moment of inertia of the composite area about the x axis.

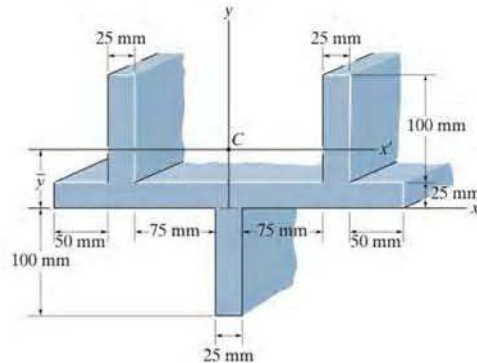
•10-33. Determine the moment of inertia of the composite area about the y axis.



Probs. 10-32/33

10-34. Determine the distance \bar{y} to the centroid of the beam's cross-sectional area; then determine the moment of inertia about the x' axis.

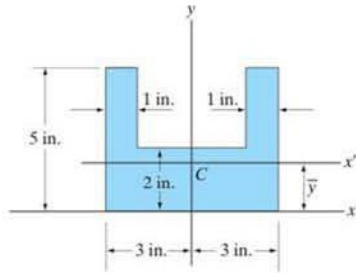
10-35. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-34/35

*10-36. Locate the centroid \bar{y} of the composite area, then determine the moment of inertia of this area about the centroidal x' axis.

•10-37. Determine the moment of inertia of the composite area about the centroidal y axis.

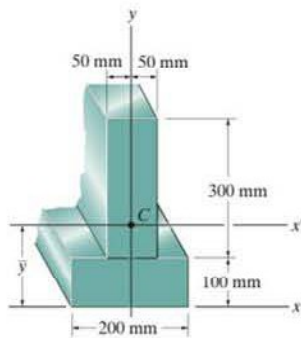


Probs. 10-36/37

10-38. Determine the distance \bar{y} to the centroid of the beam's cross-sectional area; then find the moment of inertia about the x' axis.

10-39. Determine the moment of inertia of the beam's cross-sectional area about the x axis.

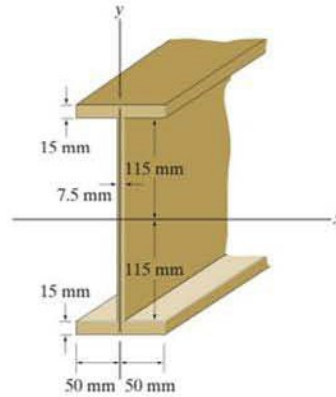
*10-40. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-38/39/40

•10-41. Determine the moment of inertia of the beam's cross-sectional area about the x axis.

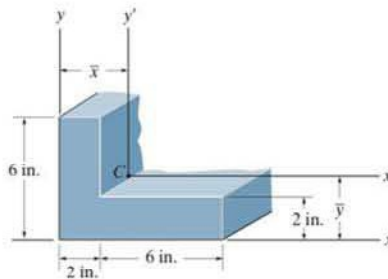
10-42. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-41/42

10-43. Locate the centroid \bar{y} of the cross-sectional area for the angle. Then find the moment of inertia $I_{x'}$ about the x' centroidal axis.

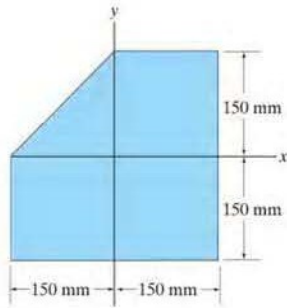
*10-44. Locate the centroid \bar{x} of the cross-sectional area for the angle. Then find the moment of inertia $I_{y'}$ about the y' centroidal axis.



Probs. 10-43/44

•10-45. Determine the moment of inertia of the composite area about the x axis.

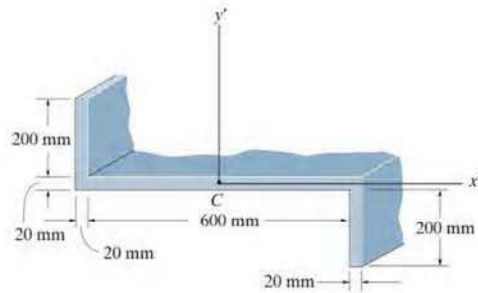
10-46. Determine the moment of inertia of the composite area about the y axis.



Probs. 10-45/46

•10-49. Determine the moment of inertia $I_{y'}$ of the section. The origin of coordinates is at the centroid C .

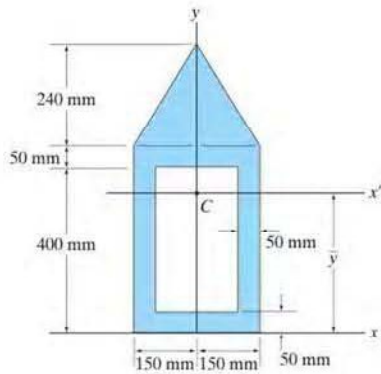
10-50. Determine the moment of inertia $I_{y'}$ of the section. The origin of coordinates is at the centroid C .



Probs. 10-49/50

10-47. Determine the moment of inertia of the composite area about the centroidal y axis.

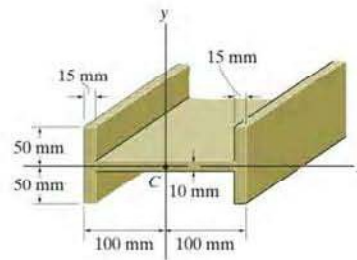
*10-48. Locate the centroid \bar{y} of the composite area, then determine the moment of inertia of this area about the x' axis.



Probs. 10-47/48

10-51. Determine the beam's moment of inertia I_x about the centroidal x axis.

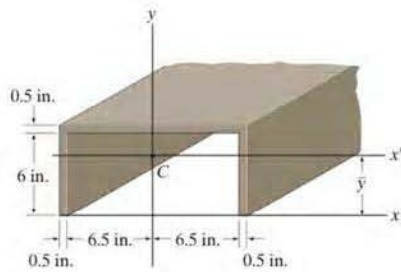
*10-52. Determine the beam's moment of inertia I_y about the centroidal y axis.



Probs. 10-51/52

•10-53. Locate the centroid \bar{y} of the channel's cross-sectional area, then determine the moment of inertia of the area about the centroidal x' axis.

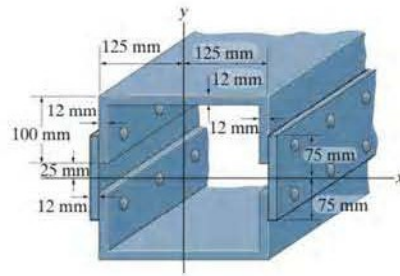
10-54. Determine the moment of inertia of the area of the channel about the y axis.



Probs. 10-53/54

•10-57. Determine the moment of inertia of the beam's cross-sectional area about the x axis.

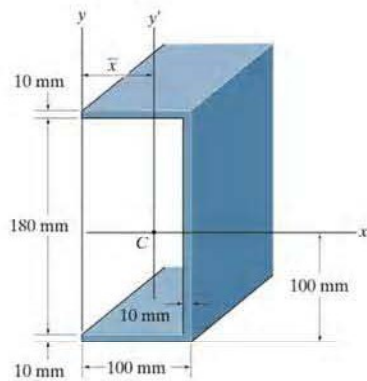
10-58. Determine the moment of inertia of the beam's cross-sectional area about the y axis.



Probs. 10-57/58

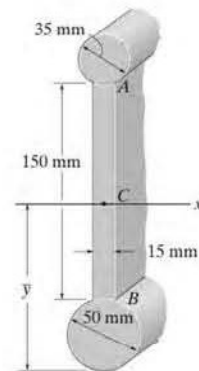
10-55. Determine the moment of inertia of the cross-sectional area about the x axis.

*10-56. Locate the centroid \bar{x} of the beam's cross-sectional area, and then determine the moment of inertia of the area about the centroidal y' axis.



Probs. 10-55/56

10-59. Determine the moment of inertia of the beam's cross-sectional area with respect to the x' axis passing through the centroid C of the cross section. $\bar{y} = 104.3$ mm.



Prob. 10-59

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