1. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.

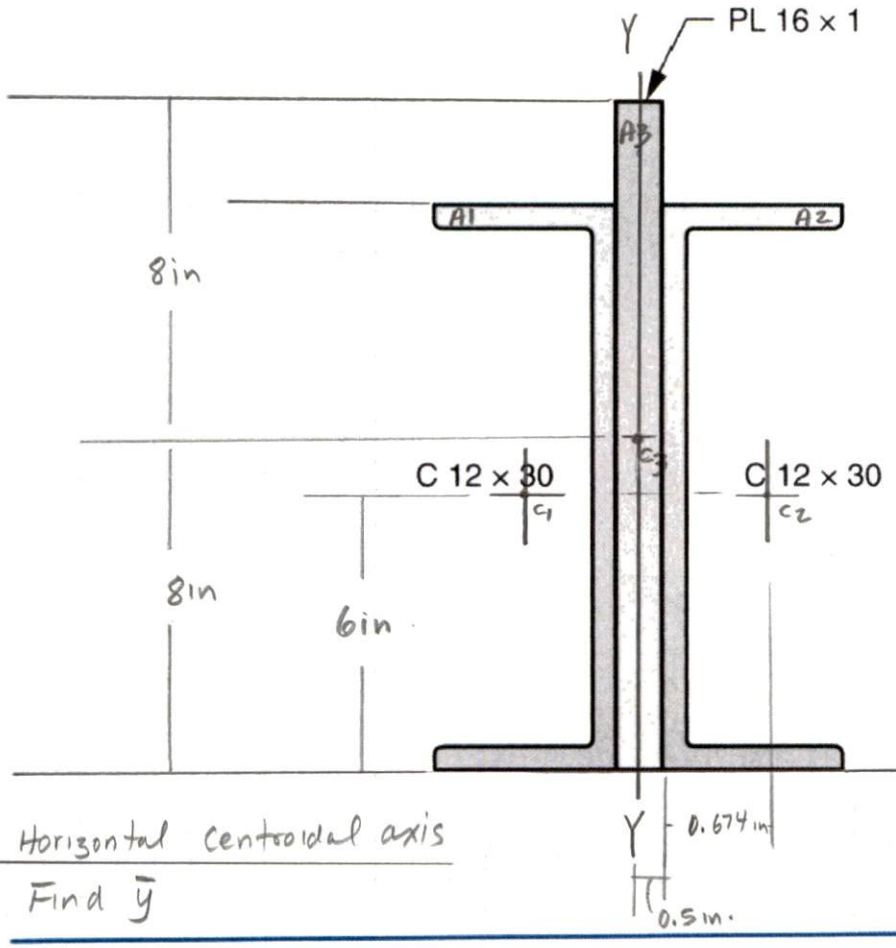


Table A-3(a)

C12×30

$A = 8.82\ in.^2$

$d = 12.00\ in.$

$b_f = 3.170\ in.$

$t_f = 0.501\ in.$

$\frac{X-X}{I = 162\ in.^4}$

$\frac{Y-Y}{I = 5.14\ in.^4}$

$\bar{x} = 0.674\ in.$

Horizontal centroidal axis

Find $\bar{y}$

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
C12×30	8.82	6	52.92	0.95	7.96	162
C12×30	8.82	6	52.92	0.95	7.96	162
PL 16×1	16	8	128	−1.05	17.64	$\frac{bh^3}{12} = \frac{1(16)^3}{12} = 341.33$
	Σ 33.64		Σ 233.84		Σ 33.56	Σ 665.33

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{233.84\ in.^3}{33.64\ in.^2} = 6.95\ in.$$

$$\bar{I}_x = \Sigma I + A(\bar{y}-y)^2 = 665.33\ in.^4 + 33.56\ in.^4$$

$$= 698.89\ in.^4$$

Vertical Centroidal axis
$\bar{x} = 0$

(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
C12×30	8.82	0.5+0.674 = 1.174	—	-1.174	12.16	5.14
C12×30	8.82	-1.174	—	1.174	12.16	5.14
PL 16×1	16	0	0		0	$\frac{bh^3}{12}$
					Σ 24.32	$\frac{16(1)^3}{12} = 1.33$
						11.61

$$\overline{I}_y = \Sigma I + A(\bar{x} - x)^2$$

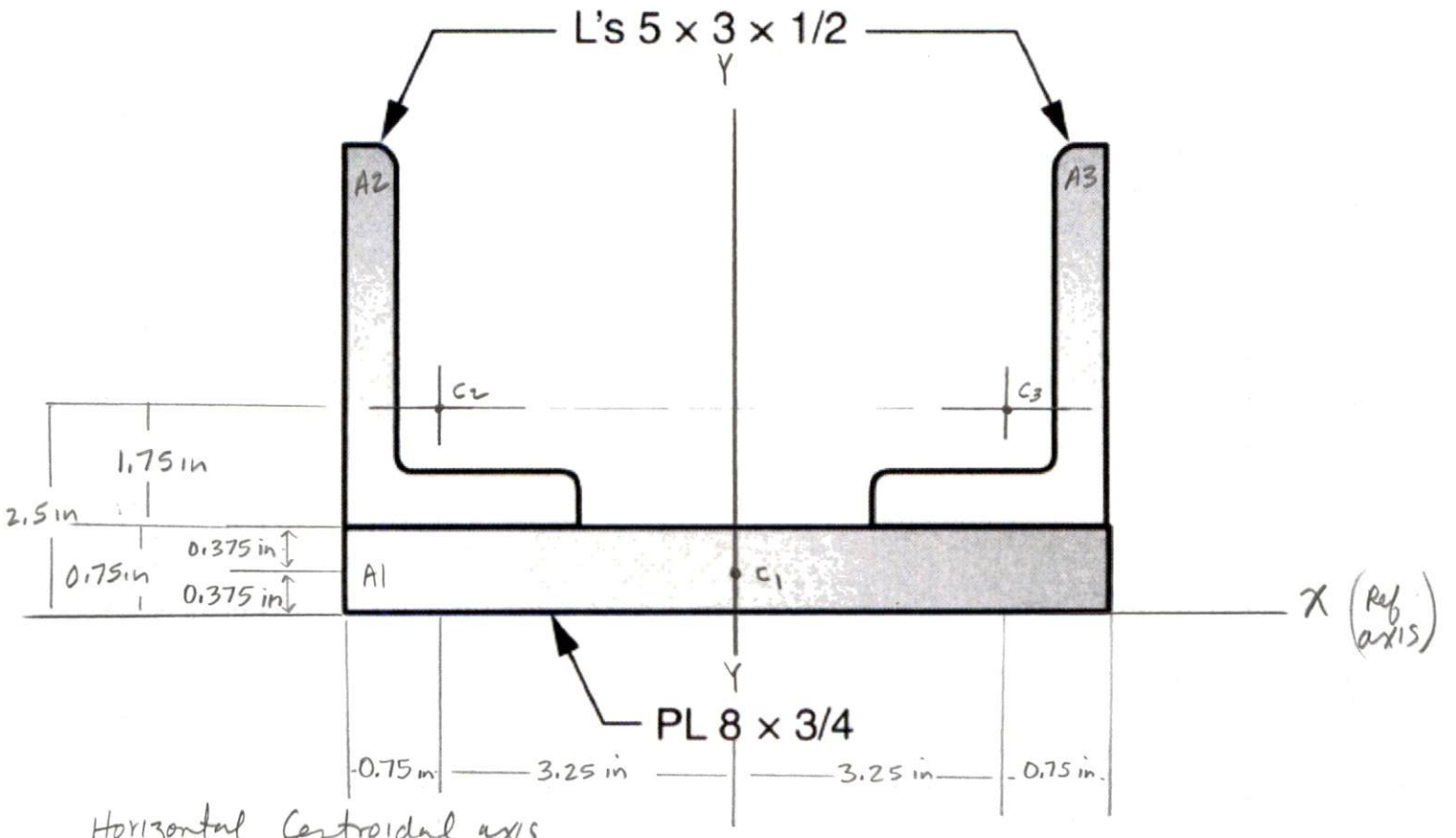
$$= 11.61 \text{ in}^4 + 24.32 \text{ in}^4$$

$$= 35.93 \text{ in}^4$$

Note.

The structures strong axis is the horizontal centroidal axis since the moment of inertia is larger about the $\overline{X}$-axis.

2. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.



Horizontal Centroidal axis
Find $\bar{y}$

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
PL 8×3/4	6	0.375	2.25	1.185	8.42535	$\frac{8(0.75)^3}{12} = 0.28125$
L 5×3×1/2	3.75	2.5	9.375	−0.94	3.3135	9.45
L 5×3×1/2	3.75	2.5	9.375	−0.94	3.3135	9.45
	Σ 13.5		Σ 21.00		15.05235	28.35

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{21.00\ in^3}{13.5\ in^2} = 1.56\ in$$

$$\bar{I}_x = \Sigma\left[I + A(\bar{y}-y)^2\right] = 28.35\ in^4 + 15.05235\ in^4$$

$$= 43.4\ in^4$$

Vertical Centroidal axis
$\bar{x} = 0$

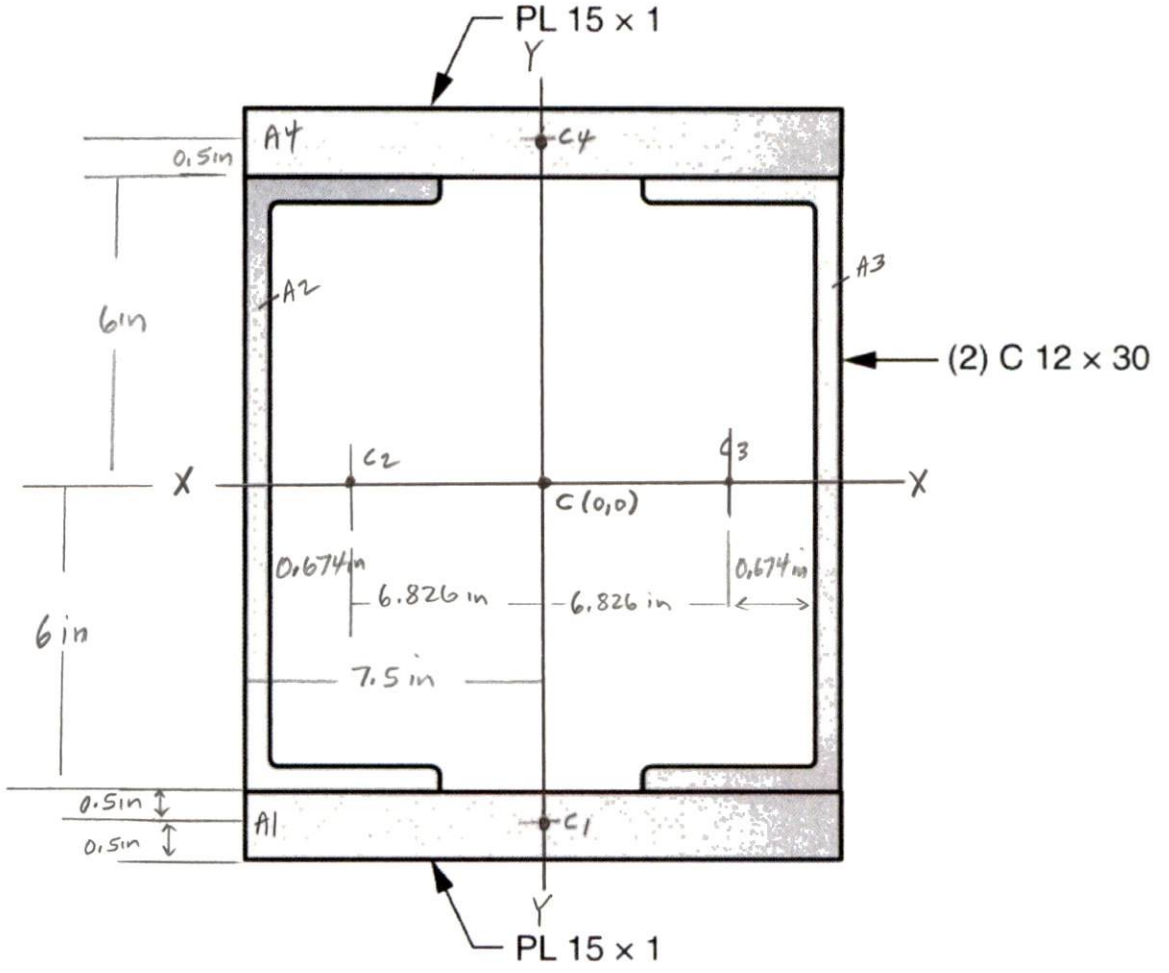
(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
PL 8×3/4	6	0	—	0	0	$\frac{0.75(8)^3}{12} = 32$
L 5×3×1/2	3.75	−3.25	—	3.25	39.6	2.58
L 5×3×1/2	3.75	3.25	—	−3.25	39.6	2.58
					79.2	37.16

$$\bar{I}_y = \Sigma\left[I + A(\bar{x} - x)^2\right]$$

$$= 37.16 \text{ in}^4 + 79.2 \text{ in}^4$$

$$= 116.36 \text{ in.}^4$$

3. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.



Horizontal Centroidal axis, $\bar{y} = 0$

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
PL 15x1	15	-6.5	—	6.5	633.75	$\frac{15(1)^3}{12} = 1.25$
C 12x30	8.82	0	—	0	0	162
C 12x30	8.82	0	—	0	0	162
PL 15x1	15	6.5	—	6.5	633.75	1.25
					1267.5	326.5

$$\bar{I}_x = \Sigma [I + A(\bar{y} - y)^2]$$

$$= 326.5 \text{ in}^4 + 1267.5 \text{ in}^4 = \underline{1594 \text{ in.}^4}$$

Vertical Centroidal axis, $\bar{x} = 0$

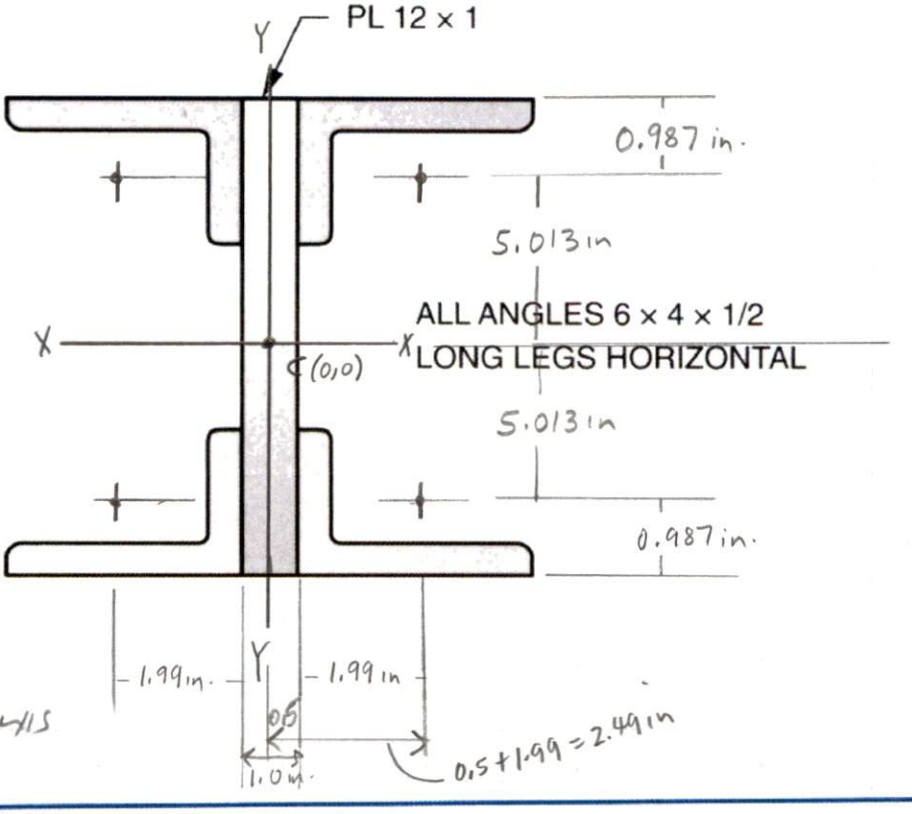
(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
PL 15×1	15	0	—	0	0	$\frac{1(15)^3}{12} = 281.25$
C 12×30	8.82	−6.826	—	−6.826	410.96	5.14
C 12×30	8.82	6.826	—	6.826	410.96	5.14
PL 15×1	15	0	—	0	0	281.25
					821.92	572.78

$$\bar{I}_y = \Sigma [I + A(\bar{x} - x)^2]$$

$$= 572.78 \text{ in.}^4 + 821.92 \text{ in.}^4$$

$$= \underline{1394} \text{ in.}^4$$

4. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.



Horizontal Centroidal axis
$\bar{y} = 0$ (symmetry)

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
PL 12×1	12	0	—	0	0	$\frac{1(12)^3}{12} = 144$
(×4) L 6×4×½	4.75	5.013 in		5.013 in	119.37	6.27
					477.47	169

$$\overline{I}_x = \Sigma [I + A(\bar{y} - y)^2]$$

$$= 169 \text{ in.}^4 + 477.47 \text{ in}^4$$

$$= 646.5 \text{ in.}^4$$

Vertical Centroidal axis, $\bar{x} = 0$ (Symmetry)

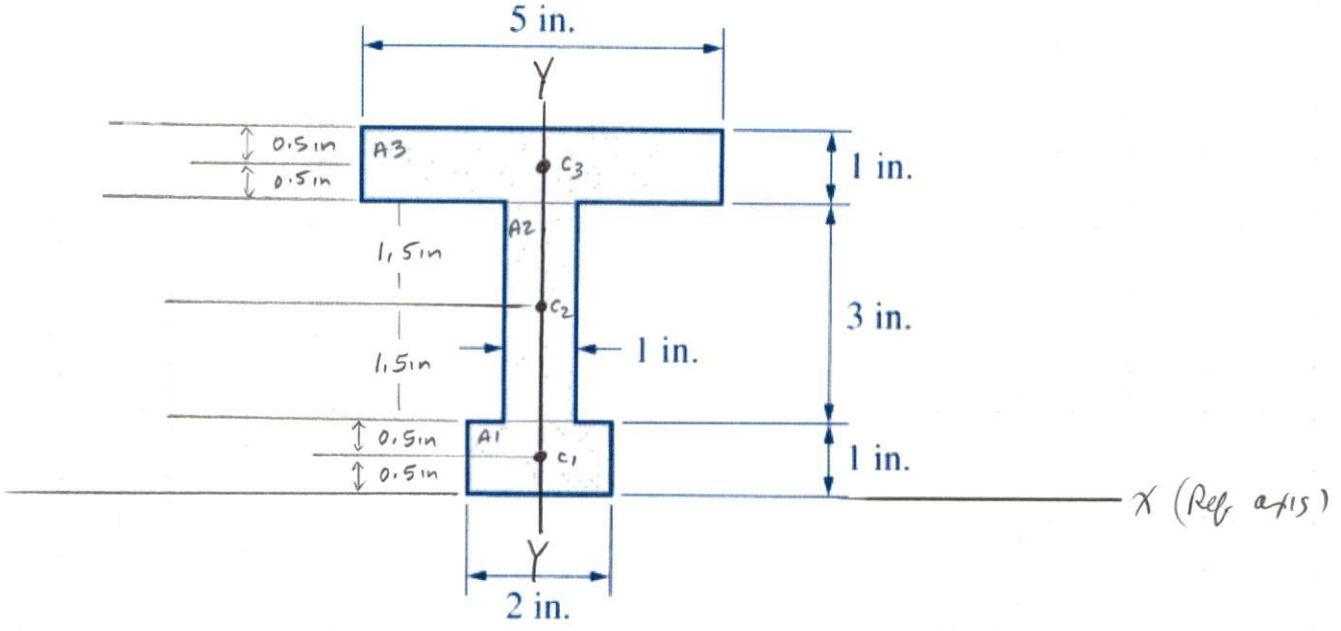
(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
PL 12×1	12	0	—	0	0	$\frac{12(1)^3}{12} = 1.0$
(×4) L 6×4×½	4.75	1.99 + 0.5 = 2.49	—	2.49	29.45	17.4
					117.8	70.6

$$\bar{I}_y = \Sigma[I + A(\bar{x} - x)^2]$$

$$= 70.6 \text{ in.}^4 + 117.8 \text{ in.}^4$$

$$= 188.4 \text{ in.}^4$$

5. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.



Horizontal Centroidal axis

Find $\bar{y}$

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
A1 2×1	2	0.5	1.0	2.6	13.52	$\frac{2(1)^3}{12} = 0.167$
A2 1×3	3	2.5	7.5	0.6	1.08	$\frac{1(3)^3}{12} = 2.25$
A3 5×1	5	4.5	22.5	−1.4	9.8	$\frac{5(1)^3}{12} = 0.4167$
	10		31.0		24.4	2.83

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{31.0\ in^3}{10\ in^2} = 3.1\ in.$$

$$\bar{I}_x = \Sigma[I + A(\bar{y}-y)^2] = 2.83\ in^4 + 24.4\ in^4 = 27.23\ in^4$$

Vertical Centroidal axis, $\bar{x} = 0$ (by Symmetry)

(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
A1 2×1	2	0	—	—	—	$\frac{1(2)^3}{12} = 0.67$
A2 1×3	3	0	—	—	—	$\frac{3(1)^3}{12} = 0.25$
A3 5×1	5	0	—	—	—	$\frac{1(5)^3}{12} = 10.4167$
						11,33

$\bar{I}_y = 11.33 \text{ in.}^4$

6. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.

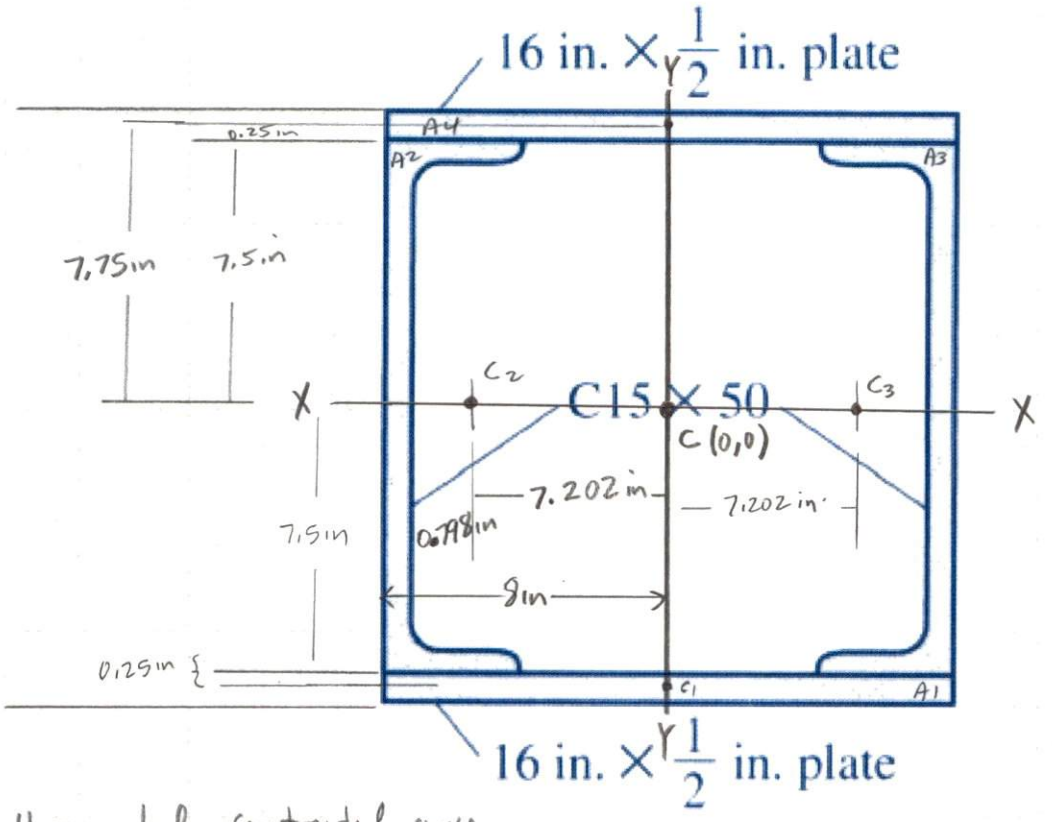


Table A-3(a)

C15×50

A = 14.7

$I_x = 404\ in.^4$

Horizontal centroidal axis

$\bar{y} = 0$ (by Symmetry)

(1) Part	(2) A (in.²)	(3) y (in.)	(4) Ay (in.³)	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.⁴)	(7) I (in.⁴)
PL 16×0.5	8	7.75	—	7.75	480.5	$\frac{16(0.5)^3}{12} = 0.167$
C 15×50	14.7	0	—	0	0	404
C15×50	14.7	0	—	0	0	404
PL 16×0.5	8	7.75	—	7.75	480.5	0.167
					961	808.334

$$\overline{I}_x = \Sigma I + A(\bar{y}-y)^2$$

$$= 808.334\ in.^4 + 961\ in^4$$

$$= \underline{1769\ in.^4}$$

Vertical Centroidal axis
$\bar{x} = 0$ (by symmetry)

(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
PL 16×0.5	8	0	—	—	—	$\frac{0.5(16)^3}{12} = 170.67$
C15×50	14.7	7.202	—	7.202	762.47	11.0
C15×50	14.7	7.202	—	7.202	762.47	11.0
PL 16×0.5	8	0	—	—	—	170.67
					1524.94	363.33

$$\overline{I}_y = \Sigma\left[I + A(\bar{x} - x)^2\right]$$

$$= 363.33 \text{ in}^4 + 1524.94 \text{ in}^4$$

$$= \underline{\underline{1888 \text{ in}^4}}$$

7. Determine the moment of inertia about the centroidal x- and the centroidal y-axes for the shape shown.

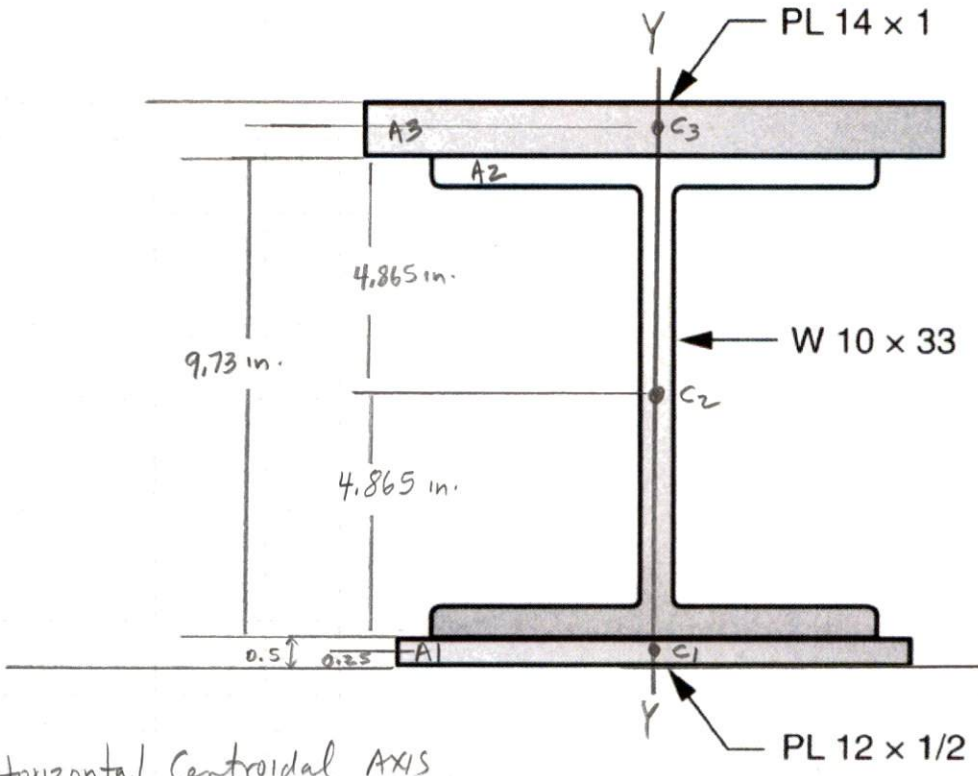


Table A-1(a)

W10x33

$A = 9.71 \text{ in.}^2$

$d = 9.73 \text{ in.}$

$\bar{I}_x = 170 \text{ in}^4$

$\bar{I}_y = 36.6 \text{ in}^4$

Horizontal Centroidal AXIS

Find $\bar{y}$

(1) Part	(2) A (in.^{2})	(3) y (in.)	(4) Ay (in.^{3})	(5) $\bar{y} - y$ (in.)	(6) $A(\bar{y} - y)^2$ (in.^{4})	(7) I (in.^{4})
PL 12x½	6	0.25	1.5	6.61	262.1526	$\frac{12(0.5)^3}{12} = 0.125$
W10x33	9.71	5.365	52.09415	1.495	21.7	170
PL 14x1	14	10.73	150.22	-3.87	209.67	$\frac{14(1)^3}{12} = 1.167$
	29.71		203.81415		493.5226	171.29

$$\bar{y} = \frac{\Sigma Ay}{\Sigma A} = \frac{203.81415 \text{ in.}^3}{29.71 \text{ in}^2} = 6.86 \text{ in.}$$

$$\bar{I}_x = \Sigma I + A(\bar{y} - y)^2$$

$$= 171.29 \text{ in.}^4 + 493.5226 \text{ in}^4$$

$$= 664.8 \text{ in.}^4$$

Vertical Centroidal axis
$\bar{x} = 0$ (by Symmetry)

(1) Part	(2) A (in.^{2})	(3) x (in.)	(4) Ax (in.^{3})	(5) $\bar{x} - x$ (in.)	(6) $A(\bar{x} - x)^2$ (in.^{4})	(7) I (in.^{4})
PL 12×0.5	6	0	—	—	—	$\frac{0.5(12^3)}{12} = 72$
W10×33	9.71	0	—	—	—	36.6
PL 4×1	14	0	—	—	—	$\frac{1(14)^3}{12} = 228.6$
						337.27

$\overline{\overline{I_y}} = 337.27 \text{ in}^4$