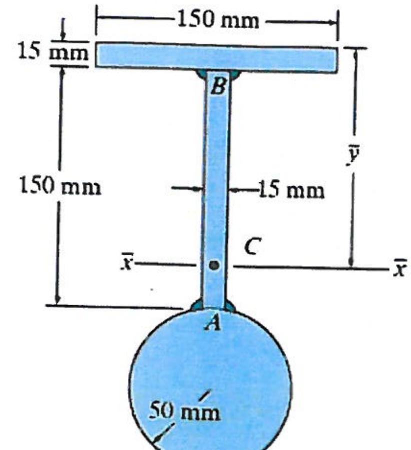
9–58.

Determine the location $\bar{y}$ of the centroidal axis $\bar{x}-\bar{x}$ of the beam's cross-sectional area. Neglect the size of the corner welds at A and B for the calculation.



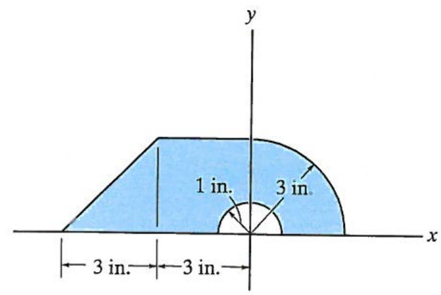
Shape	$\tilde{y}$	A	$\tilde{y}A$
	$(15/2)\,mm = 7.5\,mm$	$15(150)\,mm^2 = 2250\,mm^2$	$16875\,mm^3$
	$(15+150/2)\,mm = 90\,mm$	$150(15)\,mm^2 = 2250\,mm^2$	$202500\,mm^3$
	$(15+150+50)\,mm = 215\,mm$	$\pi(50)^2\,mm^2 = 7853\,mm^2$	$1688606\,mm^3$
Σ	–	$12353\,mm^2$	$1907981\,mm^3$

$$\bar{y} = \frac{\Sigma \tilde{y}A}{\Sigma A} = \frac{1907981\,mm^3}{12353\,mm^2} = 154.45\,mm$$

$$\bar{y} = \underline{154.5\,mm}$$

***9–64.**

Locate the centroid $(\bar{x}, \bar{y})$ of the shaded area.



SOLUTION

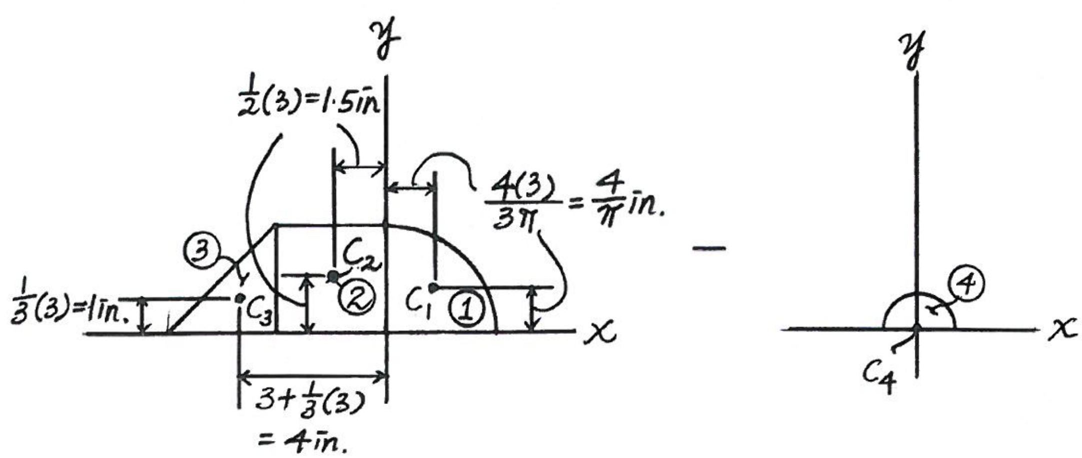
Centroid. Referring to Fig. *a*, the areas of the segments and the locations of their respective centroids are tabulated below

Segment	A (in.^{2})	$\tilde{x}$ (in.)	$\tilde{y}$ (in.)	$\tilde{x}A$ (in.^{3})	$\tilde{y}A$ (in.^{3})
1	$\frac{\pi}{4}(3^2)$	$\frac{4}{\pi}$	$\frac{4}{\pi}$	9.00	9.00
2	3(3)	−1.5	1.5	−13.50	13.50
3	$\frac{1}{2}(3)(3)$	−4	1	−18.00	4.50
4	$-\frac{\pi}{2}(1^2)$	0	$\frac{4}{3\pi}$	0	−0.67
Σ	18.9978			−22.50	26.33

Thus,

$$\bar{x} = \frac{\Sigma\tilde{x}A}{\Sigma A} = \frac{-22.50 \text{ in.}^3}{18.9978 \text{ in.}^2} = -1.1843 \text{ in.} = -1.18 \text{ in.} \qquad \textbf{Ans.}$$

$$\bar{y} = \frac{\Sigma\tilde{y}A}{\Sigma A} = \frac{26.33 \text{ in.}^3}{18.9978 \text{ in.}^2} = 1.3861 \text{ in.} = 1.39 \text{ in.} \qquad \textbf{Ans.}$$

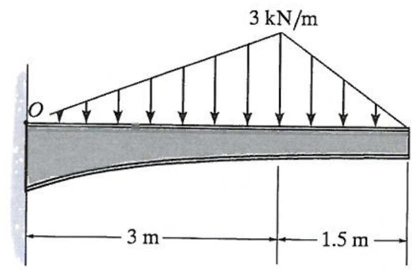


(a)

Ans:
$\bar{x} = -1.18$ in.
$\bar{y} = 1.39$ in.

4–139.

Replace the distributed loading with an equivalent resultant force, and specify its location on the beam measured from point O.



SOLUTION

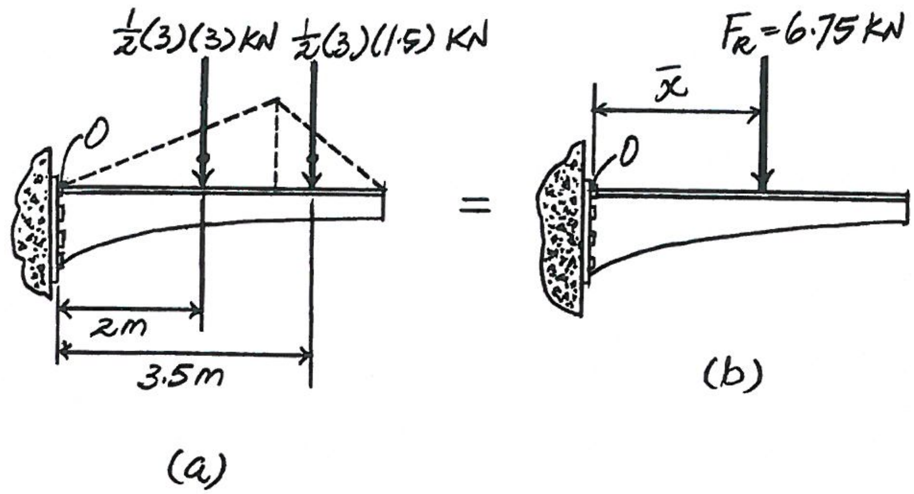
Loading: The distributed loading can be divided into two parts as shown in Fig. *a*.
Equations of Equilibrium: Equating the forces along the y axis of Figs. *a* and *b*, we have

$+\downarrow F_R = \Sigma F;$ $\qquad F_R = \frac{1}{2}(3)(3) + \frac{1}{2}(3)(1.5) = 6.75 \text{ kN} \downarrow$ **Ans.**

If we equate the moment of F_R, Fig. *b*, to the sum of the moment of the forces in Fig. *a* about point O, we have

$\circlearrowleft + (M_R)_O = \Sigma M_O;$ $\qquad -6.75(\bar{x}) = -\frac{1}{2}(3)(3)(2) - \frac{1}{2}(3)(1.5)(3.5)$

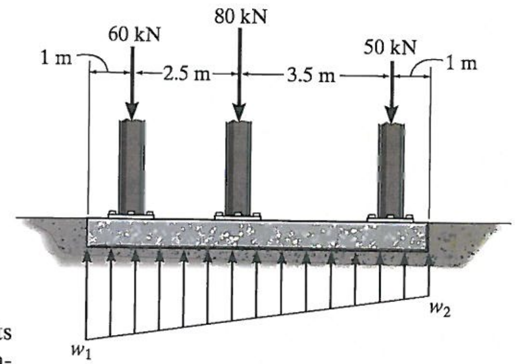
$\bar{x} = 2.5 \text{ m}$ **Ans.**



Ans:
$F_R = 6.75$ kN
$\bar{x} = 2.5$ m

4–149.

If the soil exerts a trapezoidal distribution of load on the bottom of the footing, determine the intensities w_1 and w_2 of this distribution needed to support the column loadings.



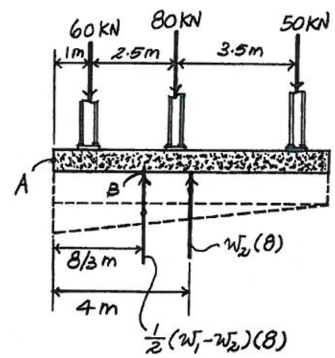
SOLUTION

Loading: The trapezoidal reactive distributed load can be divided into two parts as shown on the free-body diagram of the footing, Fig. *a*. The magnitude and location measured from point *A* of the resultant force of each part are also indicated in Fig. *a*.

Equations of Equilibrium: Writing the moment equation of equilibrium about point *B*, we have

$$\circlearrowleft + \Sigma M_B = 0; \quad w_2(8)\left(4 - \frac{8}{3}\right) + 60\left(\frac{8}{3} - 1\right) - 80\left(3.5 - \frac{8}{3}\right) - 50\left(7 - \frac{8}{3}\right) = 0$$

$$w_2 = 17.1875 \text{ kN/m} = 17.2 \text{ kN/m} \qquad \textbf{Ans.}$$



(a)

Using the result of w_2 and writing the force equation of equilibrium along the *y* axis, we obtain

$$+\uparrow \Sigma F_y = 0; \quad \frac{1}{2}(w_1 - 17.1875)8 + 17.1875(8) - 60 - 80 - 50 = 0$$

$$w_1 = 30.3125 \text{ kN/m} = 30.3 \text{ kN/m} \qquad \textbf{Ans.}$$

Ans:
$w_2 = 17.2 \text{ kN/m}$
$w_1 = 30.3 \text{ kN/m}$