EWCE 101

ANALYTICAL MECHANICS

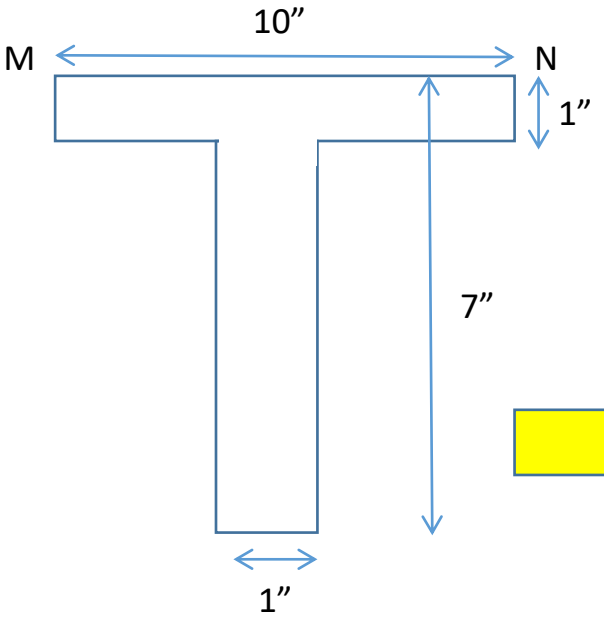
3 Credit Hour

Lecturer
Department of Environmental, Water Resources, and Coastal Engineering (EWCE)

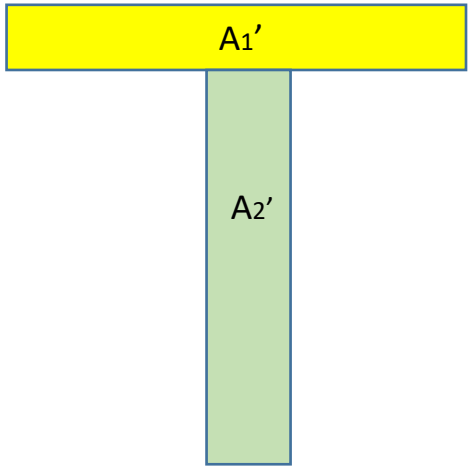


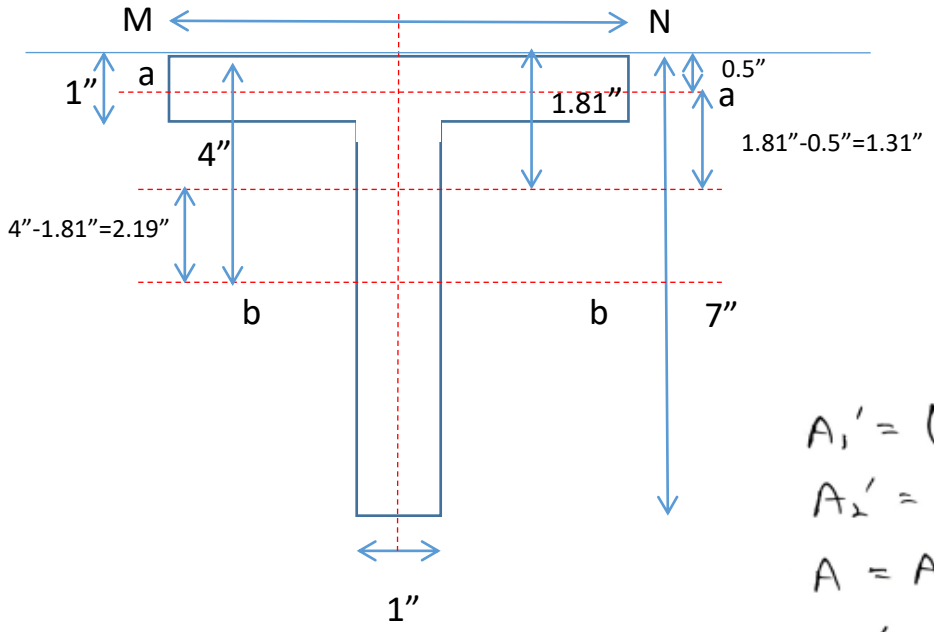
Military Institute of Science and Technology

Q: In designing a beam, the moment of inertia of a section of the beam about a centroidal axis is needed. Find the moment of inertia of the T-section shown in fig(1) about a centroidal axis parallel to MN.



fig(1)





$A_1' = (1 \times 10) = 10\ in^2$

$A_2' = (7-1) \times 1 = 6\ in^2$

$A = A_1' + A_2' = 16\ in^2$

$y_1' = \frac{1}{2} = 0.5\ in \quad ; \quad y_2' = 1 + \frac{7-1}{2} = 4''$

$\therefore A\bar{y} = A_1' y_1' + A_2' y_2'$

$\Rightarrow 16\bar{y} = (10 \times 0.5) + (6 \times 4)$

$\therefore \bar{y} = 1.81\ in$ (from the line MN)

Downward x direction is considered positive

Now, $I_{x_1} = \bar{I}_{a-a} + A_1' d^2$

$= \frac{bh^3}{12} + \{10 \times (1.81 - 0.5)^2\}$

$= \frac{10 \times 1^3}{12} + \{10 \times (1.31)^2\} = 17.99 \text{ in}^4$

$I_{x_2} = \bar{I}_{b-b} + A_2' d^2$

$= \frac{bh^3}{12} + A_2' d^2$

$= \frac{1 \times (7-1)^3}{12} + \{(1 \times 6) \times (4 - 1.81)^2\} = 46.78 \text{ in}^4$

$\therefore \bar{I}_x = I_{x_1} + I_{x_2} = 17.99 + 46.78 = 64.77 \text{ in}^4$

Q 801: In the following figure, find the centroidal moment of Inertia.

$A_1 = (1\times5) = 5\ in^2$; $A_2 = (1\times1) = 1\ in^2$

$x_1 = 0.5\ in$

$y_1 = \frac{5}{2} = 2.5\ in$

$x_2 = 1 + \frac{(2-1)}{2} = 1.5\ in$

$y_2 = \frac{1}{2} = 0.5\ in$

$\therefore A = A_1 + A_2$

$= 5 + 1 = 6\ in^2$

Now, $A\bar{x} = A_1x_1 + A_2x_2$

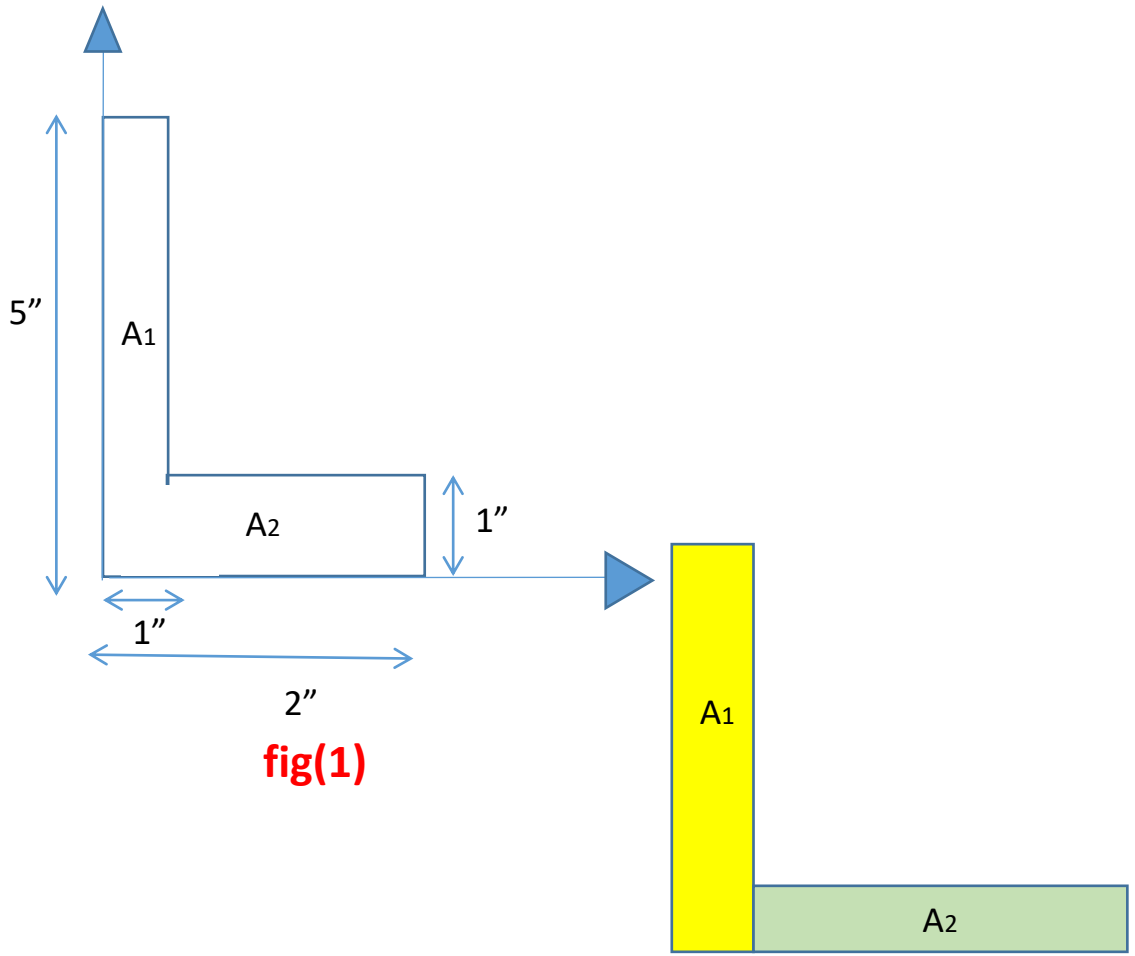
$$\Rightarrow \bar{x} = \frac{A_1x_1 + A_2x_2}{A} = \frac{(5\times0.5)+(1\times1.5)}{5+1}$$

$$= \frac{2}{3}\ in$$

$A\bar{y} = A_1y_1 + A_2y_2$

$$\Rightarrow \bar{y} = \frac{A_1y_1 + A_2y_2}{A} = \frac{(5\times2.5)+(1\times0.5)}{5+1}$$

$$= \frac{13}{6}\ in$$



fig(1)

$$I_{x_1} = \bar{I}_{x_1} + A_1 d^2$$

$$= \frac{1 \times 5^3}{12} + \left\{5 \times \left(2.5 - \frac{13}{6}\right)^2\right\}$$

$$= 10.97 \text{ in}^4$$

$$I_{x_2} = \bar{I}_{x_2} + A_2 d^2$$

$$= \frac{1 \times 1^3}{12} + \left\{1 \times \left(\frac{13}{6} - 0.5\right)^2\right\}$$

$$= 2.86 \text{ in}^4$$

$$\therefore \bar{I}_x = I_{x_1} + I_{x_2} = 13.83 \text{ in}^4$$

$$I_{y_1} = \bar{I}_{y_1} + A_1 d^2$$

$$= \frac{5 \times 1^3}{12} + \left\{5 \times \left(\frac{2}{3} - 0.5\right)^2\right\}$$

$$= 0.56 \text{ in}^4$$

$$I_{y_2} = \bar{I}_{y_2} + A_2 d^2$$

$$= \frac{1 \times 1^3}{12} + \left\{1 \times \left(1.5 - \frac{2}{3}\right)^2\right\}$$

$$= 0.78 \text{ in}^4$$

$$\therefore \bar{I}_y = I_{y_1} + I_{y_2} = 1.34 \text{ in}^4$$