Force Equilibrium in Two and Three D. $\sum F_x = 0 \quad \sum F_y = 0 \quad \sum F_z = 0$

Normal / Shear Stress $\sigma = \dfrac{N}{A_n}$ $\tau = \dfrac{V}{A_n}$

Stress on an Oblique Plane $\sigma = \dfrac{P}{A_o}\cos^2\theta$ $\tau = \dfrac{P}{A_o}\cos\theta\sin\theta$

Unit vector $\bar{e} = \dfrac{\bar{R}}{R} = \dfrac{R_x\hat{i} + R_y\hat{j} + R_z\hat{k}}{\sqrt{R_x^2 + R_y^2 + R_z^2}}$

Dot product of vectors $\bar{A}\cdot\bar{B} = AB\cos(\theta) = A_xB_x + A_yB_y + A_zB_z$

$$\text{Factor of Safety} = \frac{\text{Failure Load}}{\text{Allowable Load}} = \frac{\text{Ultimate Stress}}{\text{Design Stress}} = \frac{\text{Strength}}{\text{Stress}}$$

Normal Strain in Axial Loading $\varepsilon = \dfrac{\delta}{L}$

Hooke's Law for Axial Loading $\sigma = E\varepsilon$

Mechanical Deflection for Axial Loading $\delta = \dfrac{PL}{AE}$

Thermal Deflection $\delta_{th} = \alpha(\Delta T)L$

Moment of a force acting at P about point O

$$\bar{M} = \bar{r}_{OP} \times \bar{F}$$

$$\bar{M} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} = (r_yF_z - r_zF_y)\hat{i} - (r_xF_z - r_zF_x)\hat{j} + (r_xF_y - r_yF_x)\hat{k}$$

Moment of a force acting at P about axis in direction $\bar{e}$ passing through O.

$$M_{axis} = \bar{e}\cdot\left(\bar{r}_{OP} \times \bar{F}\right)$$

Moment Equilibrium in Two and Three D. $\sum M_x = 0 \quad \sum M_y = 0 \quad \sum M_z = 0$

Centroids of Areas. $\bar{x} = \dfrac{1}{A}\int x\,dA \qquad \bar{y} = \dfrac{1}{A}\int y\,dA$

Centroids of Composite Bodies. $A = \sum_i A_i \qquad \bar{x} = \dfrac{1}{A}\sum_i \bar{x}_iA_i \qquad \bar{y} = \dfrac{1}{A}\sum_i \bar{y}_iA_i$

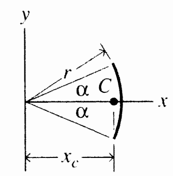
TABLE 5-1 Centroid Locations For A Few Common Line Segments And Areas

Circular arc

$L = 2r\alpha$

$x_C = \dfrac{r \sin \alpha}{\alpha}$

$y_C = 0$

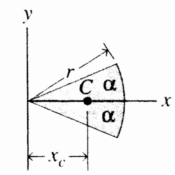


Circular sector

$A = r^2\alpha$

$x_C = \dfrac{2r \sin \alpha}{3\alpha}$

$y_C = 0$

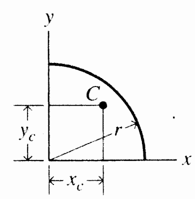


Quarter circular arc

$L = \dfrac{\pi r}{2}$

$x_C = \dfrac{2r}{\pi}$

$y_C = \dfrac{2r}{\pi}$

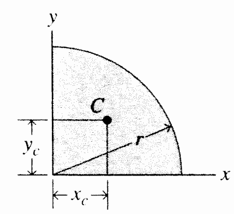


Quadrant of a circle

$A = \dfrac{\pi r^2}{4}$

$x_C = \dfrac{4r}{3\pi}$

$y_C = \dfrac{4r}{3\pi}$

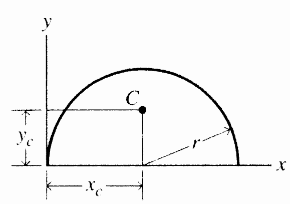


Semicircular arc

$L = \pi r$

$x_C = r$

$y_C = \dfrac{2r}{\pi}$

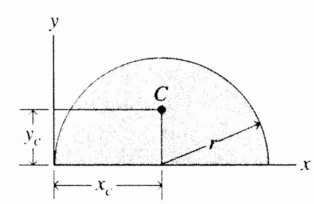


Semicircular area

$A = \dfrac{\pi r^2}{2}$

$x_C = r$

$y_C = \dfrac{4r}{3\pi}$

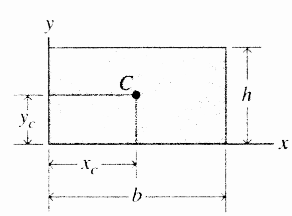


Rectangular area

$A = bh$

$x_C = \dfrac{b}{2}$

$y_C = \dfrac{h}{2}$



Quadrant of an ellipse

$A = \dfrac{\pi ab}{4}$

$x_C = \dfrac{4a}{3\pi}$

$y_C = \dfrac{4b}{3\pi}$

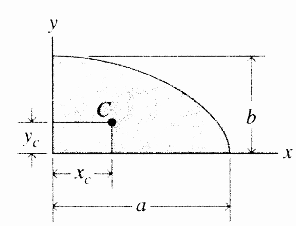


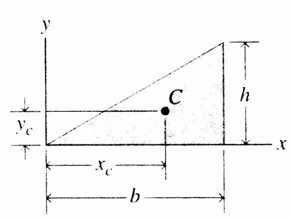
TABLE 5-1 (Continued)

Triangular area

$A = \dfrac{bh}{2}$

$x_C = \dfrac{2b}{3}$

$y_C = \dfrac{h}{3}$

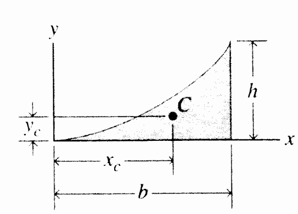


Parabolic spandrel

$A = \dfrac{bh}{3}$

$x_C = \dfrac{3b}{4}$

$y_C = \dfrac{3h}{10}$

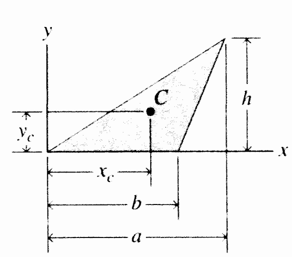


Triangular area

$A = \dfrac{bh}{2}$

$x_C = \dfrac{a + b}{3}$

$y_C = \dfrac{h}{3}$



Quadrant of a parabola

$A = \dfrac{2bh}{3}$

$x_C = \dfrac{5b}{8}$

$y_C = \dfrac{2h}{5}$