Moments of Inertia

- 2nd moment area
  - math concept
  - area \times (distance)^2
- need for behavior of
  - beams
  - columns

Moment of Inertia

- about any reference axis
- can be negative

\[
I_y = \int x^2 \, dA
\]
\[
I_x = \int y^2 \, dA
\]

- resistance to bending and buckling
Polar Moment of Inertia

- for round-ish shapes
- uses polar coordinates ($r$ and $\theta$)
- resistance to twisting

\[ J_o = \int r^2 dA \]

Radius of Gyration

- measure of inertia with respect to area

\[ r_x = \sqrt{\frac{I_x}{A}} \]

Parallel Axis Theorem

- can find composite $I$ once composite centroid is known (basic shapes)

\[ I_x = I_{cx} + Ad_y^2 = \bar{I}_x + Ad_y^2 \]

Basic Procedure

1. Draw reference origin (if not given)
2. Divide into basic shapes (+/-)
3. Label shapes
4. Draw table with $A$, $\bar{x}$, $\bar{xA}$, $\bar{y}$, $\bar{yA}$, $\bar{I}$'s, $d$'s, and $Ad^2$'s
5. Fill in table and get $\hat{x}$ and $\hat{y}$ for composite
6. Sum necessary columns
7. Sum $\bar{I}$'s and $Ad^2$'s

\( (d_x = \hat{x} - \bar{x}) \)
\( (d_y = \hat{y} - \bar{y}) \)
Area Moments of Inertia

- Table 7.2 – pg. 252 (bars refer to centroid)
  - x, y
  - x’, y’
  - C