Mechanics of Materials II:

Thin-Walled Pressure Vessels and Torsion

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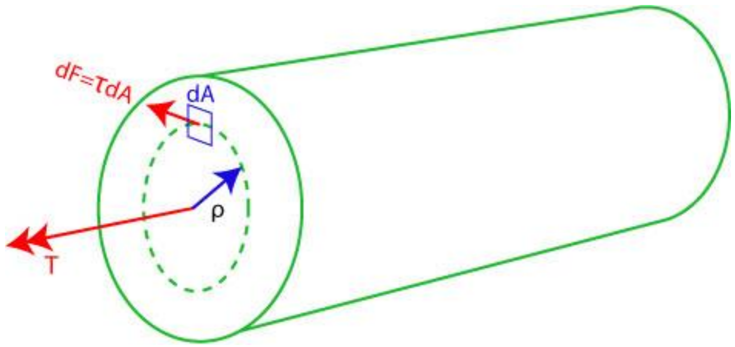
Module 13 Learning Outcome

- Calculate the Polar Moment of Inertia for circular cross-sections



$$T = \int_A dT = \frac{\tau_{MAX}}{r} \underbrace{\int_A \rho^2 \, dA}$$

$$J \equiv Polar \;\; Moment \;\; of \;\; Inertia$$

$$J = \int_A \rho^2 \, dA$$

Elastic Torsion Formula

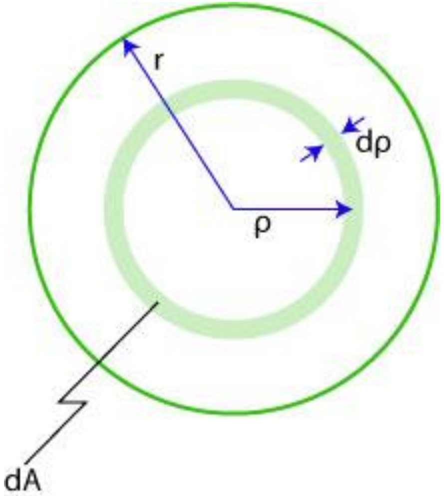
$$\tau = \frac{T\rho}{J}$$

Polar Moment of Inertia, J

$$J \equiv Polar\ \ Moment\ \ of\ \ Inertia$$

$$J = \int_A \rho^2\, dA$$

$$dA = 2\pi\,\rho\, d\rho$$

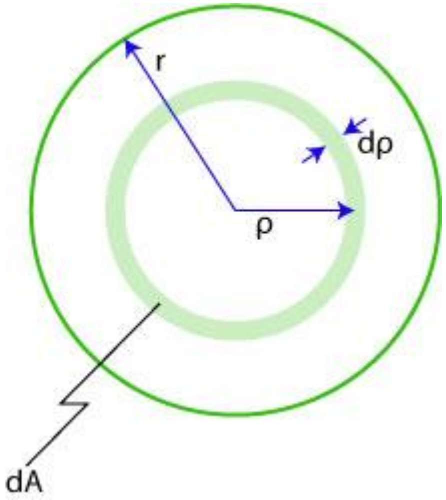


$$J = \int_0^r \rho^2\, 2\pi\,\rho\, d\rho = 2\pi \int_0^r \rho^3\, d\rho = \frac{\pi\, r^4}{2}$$

Polar Moment of Inertia, J

$$J \equiv Polar\ \ Moment\ \ of\ \ Inertia$$

$$J = \int_A \rho^2\, dA$$



Solid Circular Cross Section

$$J = \frac{\pi\, r^4}{2} = \frac{\pi \left(\frac{D}{2}\right)^4}{2} = \frac{\pi\, D^4}{32}$$

Hollow Circular Cross Section

Often more efficient for torsion

$$J = \frac{\pi}{2}\left(r_{outside}^4 - r_{inside}^4\right) = \frac{\pi}{32}\left(D_{outside}^4 - D_{inside}^4\right)$$