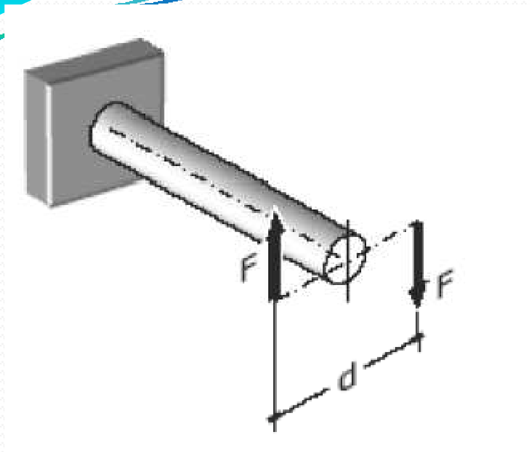
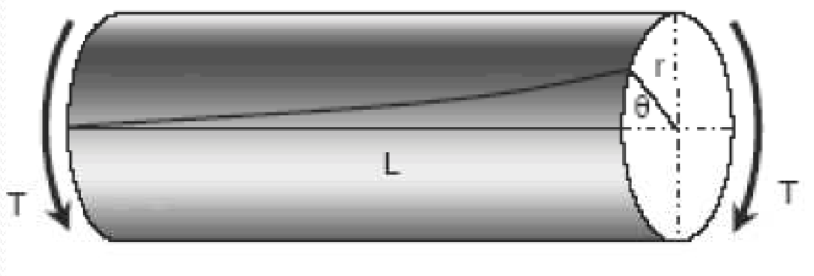
Strength of Material

Torsion

Dr. Attaullah Shah

Torsion





Torque or twisting moment T equivalent to F × d, which is applied perpendicular to the axis of the bar, as shown in the figure. Such a bar is said to be in torsion.

TORSIONAL SHEARING STRESS, τ

For a solid or hollow circular shaft subject to a twisting moment, the torsional shearing stress τ at a distance ρ from the center of the shaft is

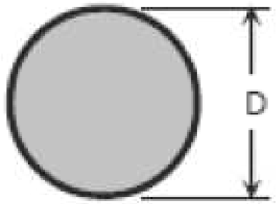
$$\tau = \frac{T\rho}{J} \text{ and } \tau_{max} = \frac{Tr}{J}$$

where J is the polar moment of inertia of the section ar radius.

For solid cylindrical shaft:

$$J = \frac{\pi}{32} D^4$$

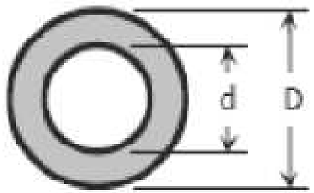
$$\tau_{max} = \frac{16T}{\pi D^3}$$



For hollow cylindrical shaft:

$$J = \frac{\pi}{32}(D^4 - d^4)$$

$$\tau_{max} = \frac{16TD}{\pi(D^4 - d^4)}$$



ANGLE OF TWIST

The angle θ through which the bar length L will twist is $\theta = \frac{TL}{JG}$ in radians

where T is the torque in N·mm, L is the length of shaft in mm, G is shear modulus in MPa, J is the polar moment of inertia in mm^4, D and d are diameter in mm, and r is the radius in mm.

- **POWER TRANSMITTED BY THE SHAFT**
  - A shaft rotating with a constant angular velocity ω (in radians per second) is being acted by a twisting moment T. The power transmitted by the shaft is

$$P = T\omega = 2\pi T f$$

  - where T is the torque in N·m, f is the number of revolutions per second, and P is the power in watts.