Torsion of Shafts

Mechanical Engineering

Shear stress and angle of twist in a circular shaft under torque.

In a circular shaft, shear stress grows linearly from the centre and twist grows with length.

$$\tau = T\,r \div J \cdot \theta = T\,L \div GJ \cdot J = \pi d^4 \div 32$$

Solid shaft, d = 50 mm — $J \approx 6.14\times10^5\ mm^4$

$\pi d^4 \div 32$.

T = 1 kN·m on it — $\tau_{max} \approx 40.7\ MPa$

T r ÷ J.

Hollow, same outside — **Nearly the same J**

Core does little.

THE COMMON MISTAKE

× Using $J = \pi d^4 \div 64$

✓ That is the bending I, not the polar J

For a circle the polar second moment is exactly twice the bending one. Using the bending value doubles the calculated shear stress.

Circular sections only. A non-circular shaft warps out of plane and needs a different torsion constant.