What is Torsion in Shafts?

Worksheet

Torsion is the twisting of a shaft under torque. Shear stress and angle of twist are calculated using = Tr/J and = TL/GJ.

= Tr/J and = TL/GJ

Questions

1. Shear stress is proportional to

A) torque only
B) radius only
C) torque radius
D) torque / (radius J)

2. Polar moment J for solid circular shaft?

A) r/4
B) r/4
C) r/32
D) 2r

3. Larger shear modulus G means

A) more twist
B) less twist
C) same twist
D) no effect

4. Unit of polar moment J?

A) m
B) m
C) m
D) m

5. Solid shaft radius 0.05 m, polar moment J = 4.910 m, torque 500 Nm. Max shear stress?

6. Steel shaft 2 m long (G = 80 GPa, J = 110 m), torque 300 Nm. Angle of twist?

7. Hollow shaft inner 0.04 m, outer 0.06 m, torque 800 Nm. J = (r_or_i)/32. _max?

8. Define: What is torsion in a shaft?

9. Define: Shear stress formula?

10. Define: Angle of twist formula?

Answer Key

1. C) torque radius - = Tr/J - increases with both torque and distance from center.
2. C) r/32 - J = r/32 for solid shaft, or d/32 using diameter.
3. B) less twist - = TL/(GJ) - larger G decreases angle of twist.
4. C) m - Polar moment has units m (similar to second moment in bending).
5. _max = Tr/J _max = (500 0.05)/(4.910) _max = 25/(4.910) = 510,204 Pa 51 MPa
6. = TL/(GJ) = (300 2)/(8010 110) = 600/(810) = 7.510 rad 0.0043
7. J = (0.060.04)/32 1.1610 m _max = (800 0.06)/(1.1610) 4.14 MPa
8. Twisting deformation caused by torque, causing shear stress and angle of twist.
9. = Tr/J, where T is torque, r is radius, J is polar moment of inertia.
10. = TL/(GJ), where L is length and G is shear modulus.