6.2 Torsion

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS torsion • angle of twist

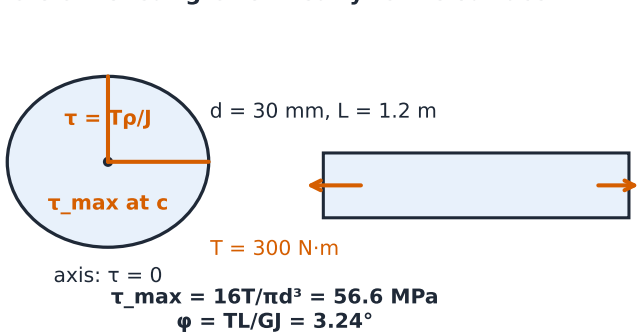
Objective

Price a shaft in torsion: surface shear, angle of twist, transmitted power and the diameter a stress limit demands.

1 Key knowledge and worked examples

■ **Circular-shaft torsion**

$\tau_{max} = 16T/\pi d^3$, $\phi = TL/GJ$, $J = \pi d^4/32$, $P = T\omega$; steel $G = 80$ GPa.



*Shear grows linearly from the axis

■ **Worked example. The 30 mm drive shaft**

$T = 300$ N · m: $\tau = 56.6$ MPa, $\phi = 3.24°$ over 1.2 m ✓; at 180 rpm it transmits 5.65 kW.

2 Practice

Solid steel shafts, $G = 80$ GPa.

2.1 A shaft of $d = 40$ mm, $L = 2.0$ m carries $T = 600$ N m (steel, $G = 80$ GPa): the maximum shear stress (one decimal, MPa) and the angle of twist (two decimals, degrees). [5]

2.2 The same torque at 240 rpm: the transmitted power (one decimal, kW). [3]

2.3 A shaft for $T = 800$ N m at $\tau_{allow} = 75$ MPa: the required diameter (one decimal, mm). [3]

2.4 One sentence each: where is torsional shear zero and where is it worst, and why does a longer shaft twist more? [3]