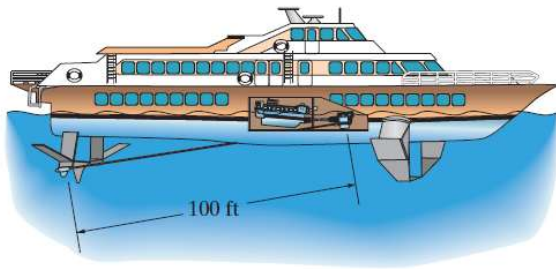
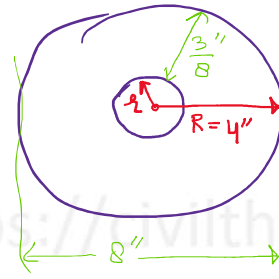
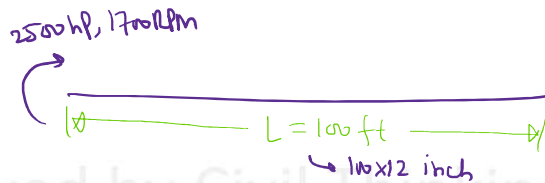


5-50. The hydrofoil boat has an A-36 steel propeller shaft that is 100 ft long. It is connected to an in-line diesel engine that delivers a maximum power of 2500 hp and causes the shaft to rotate at 1700 rpm. If the outer diameter of the shaft is 8 in. and the wall thickness is $\frac{3}{8}$ in., determine the maximum shear stress developed in the shaft. Also, what is the "wind up," or angle of twist in the shaft at full power?

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Given Data:



$$\begin{aligned} r &= 4 - \frac{3}{8} = 3.5'' \\ &= \frac{3.5}{12} = \frac{7}{24} \text{ feet} \\ R &= \frac{4}{12} = \frac{1}{3} \text{ feet} \end{aligned}$$

To find: τ_{\max} , Angle of twist, θ at full power.

We know:

$$\frac{\tau_{\max}}{R} = \frac{T_{\max}}{J} \quad \left[\text{Torsion Equation} \right] \quad \left[\text{To convert hp to Ib}\cdot\text{ft/s} \right]$$

$$T_{\max} = \frac{\text{Power}}{\omega} = \frac{2500 \text{ hp} \times (550 \text{ Ib}\cdot\text{ft/s})}{2\pi \times \frac{1700}{60} \text{ rad/s}} = \frac{412500}{17\pi} \text{ Ib}\cdot\text{ft}$$

$$R = \frac{1}{3} \text{ feet}$$

$$J = \frac{\pi}{2} [R^4 - r^4] = \frac{\pi}{2} \left[\left(\frac{1}{3} \right)^4 - \left(\frac{7}{24} \right)^4 \right] = \frac{565\pi}{221184}$$

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$$\Rightarrow \frac{\tau_{max}}{\frac{1}{3}} = \frac{412500/17\pi}{565\pi/221184} \Rightarrow \tau_{max} = 320818.42 \text{ lb/ft}^2 = 2.83 \text{ ksi}$$

lets find angle of twist, θ :

We know :

$$\frac{G\theta}{L} = \frac{T}{J} \quad [\text{Torsion Equation - Part 2}]$$

$$\frac{1656214934.7 \times \theta}{100 \text{ ft} \times 144} = \frac{\frac{412500}{17\pi} \text{ lb ft}}{\frac{565\pi}{221184} \text{ ft}^4}$$

$$\Rightarrow \theta = 0.058 \text{ rad} = 3.32^\circ$$

G of A36 steel = 79.3 GPa
↓ conversion to lb/ft²

From: gigapascal
To: pound-force/square foot

Result: 79.3 gigapascal = 1656214934.7 pound-force/square foot

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