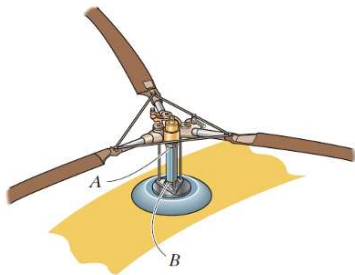


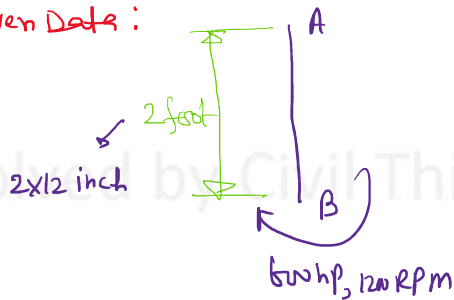
5-51. The engine of the helicopter is delivering 600 hp to the rotor shaft AB when the blade is rotating at 1200 rev/min. Determine to the nearest $\frac{1}{8}$ in. the diameter of the shaft AB if the allowable shear stress is $\tau_{\text{allow}} = 8$ ksi and the vibrations limit the angle of twist of the shaft to 0.05 rad. The shaft is 2 ft long and made from L2 steel.

5-51. The engine of the helicopter is delivering 600 hp to the rotor shaft AB when the blade is rotating at 1200 rev/min. Determine to the nearest $\frac{1}{8}$ in. the diameter of the shaft AB if the allowable shear stress is $\tau_{\text{allow}} = 8$ ksi and the vibrations limit the angle of twist of the shaft to 0.05 rad. The shaft is 2 ft long and made from L2 steel.



To find: Diameter of the shaft

Given Data:



$$\tau_{\text{max}} = \tau_{\text{all}} = 8 \text{ ksi}, \quad \theta = 0.05 \text{ rad}, \quad L = 2 \text{ feet} = \frac{2}{12} = \frac{1}{6} \text{ inch} \quad \text{L2 steel, } G = 11 \times 10^6 \text{ psi}$$

A shaft is designed based on τ_{max} and Angle of twist.

$$T = \frac{\text{Power}}{\text{Ang. Velocity}} = \frac{600 \text{ hp} \times 550 \text{ lb}\cdot\text{ft/s}}{2\pi \times 1200/60 \text{ rad/s}} = 2626.06 \text{ lb}\cdot\text{ft}$$

$$\Rightarrow T_{\text{max}} = 2626.06 \text{ lb}\cdot\text{ft}$$

$$\frac{\tau_{\text{max}}}{R} = \frac{T_{\text{max}}}{J} \Rightarrow \frac{8 \times 10^3 \text{ lb/in}^2}{d/2} = \frac{2626.06 \times 12 \text{ lb}\cdot\text{in}}{\frac{\pi}{2} (d/2)^4}$$

$$\frac{\tau_{max}}{R} = \frac{T_{max}}{J} \Rightarrow \frac{0.8 \times 10^{-6} \times 101''}{d/2} = \frac{2626.06 \times 12}{\frac{\pi}{2} (d/2)^4}$$

$$\Rightarrow \boxed{d = 2.72 \text{ inch.}} \text{--- (1)}$$

$$\frac{G\phi}{L} = \frac{T}{J}$$

$$\frac{11 \times 10^6 \times 0.05}{2 \times 12} = \frac{2626.06 \times 12}{\frac{\pi}{2} (d/2)^4}$$

$$\Rightarrow \boxed{d = 1.934 \text{ inch.}} \text{--- (2)}$$

From (1) & (2) $d_{max} = 2.72 \text{ inch}$ is the minimum required diameter

This problem was solved by Civil Thinking (<https://civilthinking.com>)

If you need solutions for **Strength of Materials** or any other **Civil Engineering** subject, contact us at:


solutions@civilthinking.com

Or submit your problem directly here:

<https://civilthinking.com/getproblemsolutions>

Other Subjects We Cover:

- ☒ Structural Analysis
- ☒ Fluid Mechanics
- ☒ Geotechnical Engineering
- ☒ Transportation Engineering
- ☒ Construction Management
- ☒ Finite Element Analysis (FEA)
- ☒ Engineering Software (ANSYS, ETABS, MATLAB, Revit)

Let us help you solve your engineering challenges! 

NOTE:

The solution provided in this document is the intellectual property of **Civil Thinking** and is protected by copyright. Any reproduction, distribution, or publication of this content, in whole or in part, is strictly prohibited without prior written permission from <https://civilthinking.com>.