The engine of the helicopter is delivering 600 hp (1 hp = 550 ft-lb/sec) to the rotor shaft AB when the blade is rotating at 1200 rpm. Determine the diameter of the shaft (a) if the allowable shear stress is $10.5 \times 10^3$ psi, (b) if the allowable angular twist is 0.05 radians. The shaft is 2 ft long and is made of L2 Steel ($G = 11 \times 10^6$ psi). Which of the two designs is conservative?

\[ p = T \cdot w \]
\[ w = \frac{2\pi N}{60} \]
\[ 600 \times 550 \times 12 = T \times \frac{2\pi (1200)}{60} \]
\[ T = 31513 \text{ lb-m} \]

(a) \[ \tau = \frac{TR}{J} \] \Rightarrow \[ 10.5 \times 10^3 = \frac{(31513)R}{\frac{\pi}{2} R^4} \] \Rightarrow \[ R = 1.24'' \text{ or } d = 2.48'' \]

(b) \[ \phi = \frac{TL}{GJ} \] \Rightarrow \[ 0.05 = \frac{31513 \times 2 \times 12}{11 \times 10^6 \times \frac{\pi}{2} R^4} \]
\[ R = 0.97'' \text{ or } d = 1.93'' \]

\( \circ \) (a) is a conservative design.