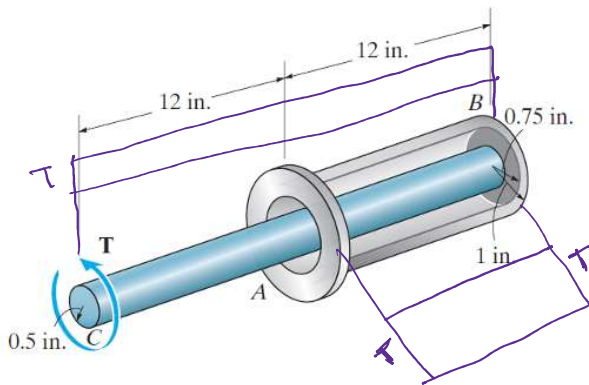


## Torsion in Shafts. Question 5-64 Solution

Sunday, 16 March, 2025 06:17 PM

\*5-64. The device serves as a compact torsion spring. It is made of A-36 steel and consists of a solid inner shaft CB which is surrounded by and attached to a tube AB using a rigid ring at B. The ring at A can also be assumed rigid and is fixed from rotating. If the allowable shear stress for the material is  $\tau_{\text{allow}} = 12 \text{ ksi}$  and the angle of twist at C is limited to  $3^\circ$ , determine the maximum torque  $T$  that can be applied at the end C.

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Shear stress check:

$$\frac{T_{AB}}{J_{AB}} = \frac{\tau_{AB}}{R_{AB}}$$

$$\Rightarrow \frac{T_{AB}}{\frac{\pi}{2} [1^4 - 0.75^4]} = \frac{12 \text{ ksi}}{1} \Rightarrow T_{AB} = 12 \times \frac{\pi}{2} [1 - 0.75^4]$$

$$\Rightarrow T_{AB} = 12.885 = T$$

$$\frac{T_{CB}}{J_{CB}} = \frac{\tau_{CB}}{R_{CB}}; \Rightarrow T_{CB} = 2.3562 = T$$

Twist check:

$$\phi_c = 3^\circ \times \frac{\pi}{180} = \phi_{CB} + \phi_{BA} = \frac{T \times 24}{11 \times 10^3 \times \frac{\pi}{2} \times 0.5^4} + \frac{T \times 12}{11 \times 10^3 \times \frac{\pi}{2} (1 - 0.75^4)}$$

$$\Rightarrow T = 2.253 \text{ kip.inch}$$

$$\text{Max Torque, } T = \min \{ 2.253 \text{ kip.inch}, 2.3562, 12.885 \} = 2.253 \text{ kip.inch ANS.}$$

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