## Torsion in Shafts. Question 5-63 Solution

Sunday, 16 March, 2025 04:35 PM

5-63. The device serves as a compact torsional 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 a torque of T 2 kip • in. is applied to the shaft, determine the angle of twist at the end C and the maximum shear stress in the tube and shaft.

**5-63.** The device serves as a compact torsional 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 a torque of  $T = 2 \text{ kip} \cdot \text{in.}$  is applied to the shaft, determine the angle of twist at the end *C* and the maximum shear stress in the tube and shaft.



Griven elate: A-36 steel =>  $C_n = 11 \times 10^3$  Kips Shaft: -2 = 0.5 in., T = 2 Kipsin Tube: R = 1 in., -2 = 0.75 in.

To find :  $e_{B}$ ,  $T_{Max-tube}$ ,  $T_{Max-shaft}$ 



$$\frac{V_{\text{max},AB}}{R_{AB}} = \frac{T_{AB}}{J_{AB}} \left[ \text{Totalon } G_{\text{testion}} \right] \qquad \frac{V_{\text{max},Bc}}{R_{Bc}} = \frac{T_{Bc}}{R_{Bc}}$$

$$=) \frac{V_{\text{max},AB}}{1 \text{ incl.}} = \frac{2 \times i\beta_{3} \cdot in}{\pi^{2} \left[ \left( 1 \right)^{\frac{d}{2}} \left( 0 \cdot 75 \right)^{\frac{d}{2}} \right]} = \frac{18623 \, \text{Ki}}{\text{HANS.}} \left| = \right) \frac{V_{\text{max},Bc}}{P_{B}} = \frac{2 \times i\beta_{3} \cdot in}{\pi^{2} \times 0.5^{\frac{d}{3}} \cdot 3} = \frac{10 \cdot 10^{1} \, \text{Kd}}{\text{HANS.}} \right| \\
=) \frac{V_{\text{max},AB}}{P_{B}} = \frac{2 \times i\beta_{3} \cdot in}{\pi^{2} \times 0.5^{\frac{d}{3}} \cdot 3} = \frac{10 \cdot 10^{1} \, \text{Kd}}{\text{HANS.}}$$

$$\varphi_{c} = \varphi_{c,B} + \varphi_{B,A} = \left(\frac{TL}{C_{0}T}\right)_{cB} + \left(\frac{TL}{C_{0}T}\right)_{BA} = \frac{2 \times 2 \cdot 4}{11 \times 10^{3} \times \frac{T}{a} \times 0.5^{\frac{d}{3}} + \frac{2 \times 12}{11 \times 10^{\frac{1}{3}} \times \frac{T}{a} \times 0.5^{\frac{d}{3}}} + \frac{2 \times 12}{11 \times 10^{\frac{1}{3}} \times \frac{T}{a} \times 0.5^{\frac{d}{3}}}$$

$$=) \varphi_{c} = 0 \cdot 0.46 \, \text{KB} \, \text{Radians} \times \frac{180}{\sqrt{T}} \simeq 2.66^{\circ} \, \text{ANS.}$$

$$\text{Converts} \, \text{Radian to dayten}$$

This problem was solved by Civil Thinking ( <u>https://civilthinking.com</u> )	NOTE:
If you need solutions for Strength of Materials or any other Civil Engineering	The solution provided in this document
subject, contact us at:	is the intellectual property of Civil
solutions@civilthinking.com	Thinking and is protected by copyright.
Or submit your problem directly here:	Any reproduction, distribution, or
<u>https://civilthinking.com/getproblemsolutions</u>	publication of this content, in whole or
Other Subjects We Cover:	in part, is strictly prohibited without
Structural Analysis	prior written permission from
✓ Fluid Mechanics	https://civilthinking.com
🗹 Geotechnical Engineering	
✓ Transportation Engineering	
Construction Management	

Finite Element Analysis (FEA)
 Engineering Software (ANSYS, ETABS, MATLAB, Revit, SAP2000, etc.)
 Let us help you solve your engineering challenges!