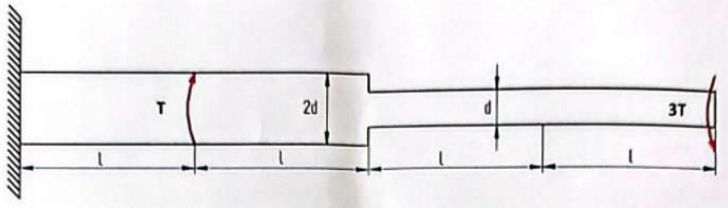


Torsion in Shafts problem Solution

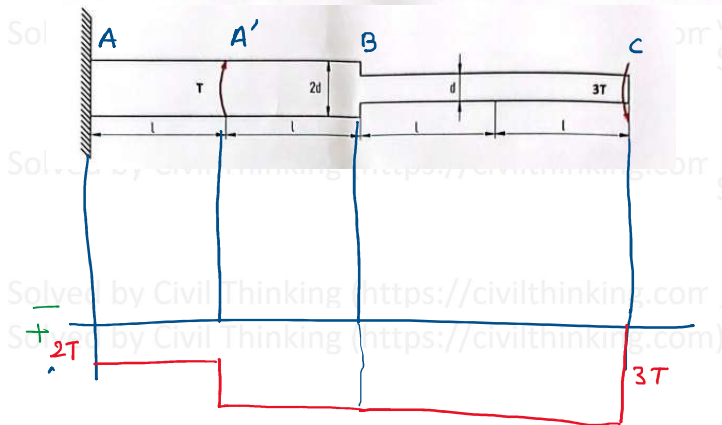
Calculate the maximum value of the torque T which can be applied to the shafts shown in the figures below and the following data:

diameter $d = 50$ mm, max permitted shear stress $k_s = 80$ MPa, length $l = 500$ mm, Kirchhoff's module $G = 85$ GPa, also calculate the total twist angle for each shaft.



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$$\frac{\gamma}{r} = \frac{T}{J} = \frac{G \phi}{L} \Rightarrow \frac{\gamma}{r} = \frac{T}{J}$$

$$\frac{\gamma_{max}}{R} = \frac{T_{max}}{J}$$

B-C:

$$\frac{80 \times 10^6}{\frac{0.05}{2}} = \frac{3T}{\frac{\pi \times (\frac{0.05}{2})^4}{2}}$$

$$\Rightarrow T = 654.5 \text{ N.m} \quad \text{--- (1)}$$

For A-B:

$$\frac{80 \times 10^6}{\frac{0.05}{2}} = \frac{3T}{\frac{\pi \times (\frac{0.05}{2})^4}{2}}$$

$$\Rightarrow T = 523.6 \text{ N.m} \quad \text{--- (2)}$$

$$T_{max} = \min(1, 2) = 523.6 \text{ N.m}$$

Ans. 1

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$$\phi_{AB} = \phi_{AA'} + \phi_{A'B} = \left(\frac{TL}{GJ} \right)_{AA'} + \left(\frac{TL}{GJ} \right)_{A'B}$$

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Superposition

$$\phi_{AB} = \frac{L}{GJ} (T_{AA'} + T_{A'B}) = \frac{0.5}{85 \times 10^9 \times \pi \times 0.05^4} (27 + 37)$$

Solved by Civil Thinking (<https://civilthinking.com>)

57
654.5

$$\phi_{AB} = 0.00196 \text{ radian.}$$

Solved by Civil Thinking (<https://civilthinking.com>)

$$\frac{\tau}{2} = \frac{T}{J} = \frac{G\phi}{L} \Rightarrow \phi = \frac{TL}{GJ}$$

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$$\phi_{BC} = \frac{T_{BC} L_{BC}}{G_{BC} J_{BC}} = \frac{3T \times 2l}{85 \times 10^9 \times \pi R^4 / 2}$$

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$$\phi_{BC} = \frac{3T \times 2 \times 0.5 \text{ m} \times 2}{85 \times 10^9 \times \pi \times 0.025^4} = 0.03765 \text{ rad}$$

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