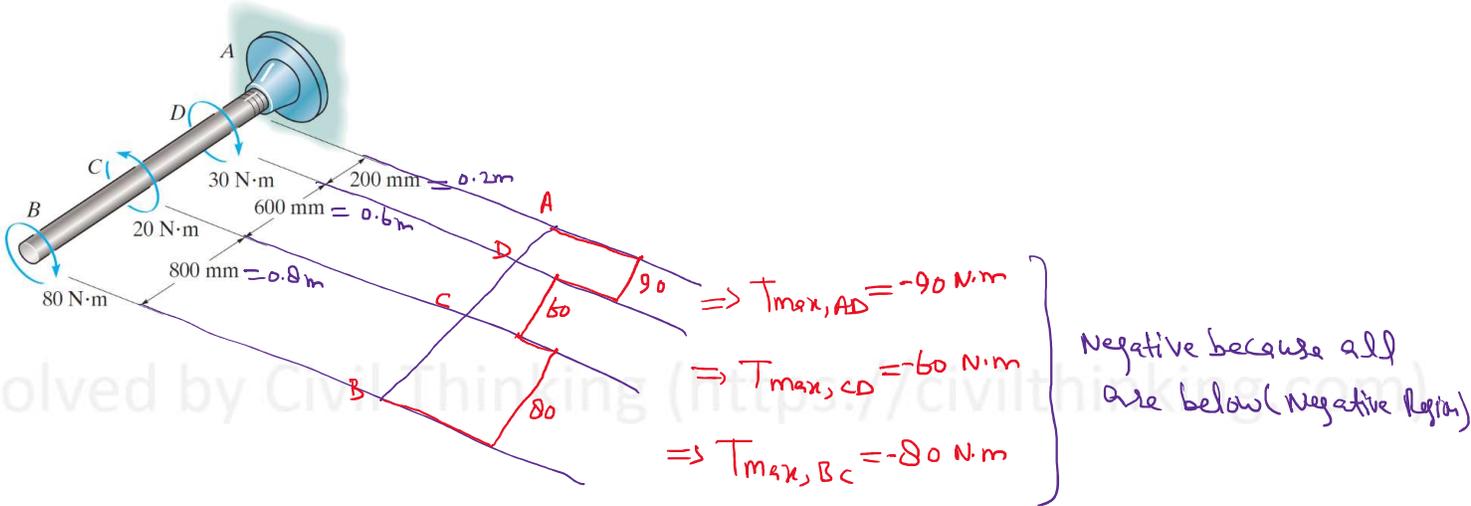


Torsion in Shafts. Question 5-53 Solution

Saturday, 15 March, 2025 07:18 AM

•5—53. The 20-mm-diameter A-36 steel shaft is subjected to the torques shown. Determine the angle of twist of the end B.

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$$\theta_{B/A} = \theta_{B/C} + \theta_{C/D} + \theta_{D/A}$$

We know:

$$\frac{G\theta}{L} = \frac{T}{J} \Rightarrow \theta = \frac{TL}{JG} \quad [\text{for single torque}]$$

we have multiple internal torques $\Rightarrow \theta = \sum \frac{TL}{JG}$

$J, G = \text{constant for all spans because its single, one type of shaft.}$

$$\Rightarrow \theta = \frac{1}{JG} \sum TL = \frac{1}{JG} \left[(TL)_{BC} + (TL)_{CD} + (TL)_{DA} \right]$$

$$J = \frac{\pi}{2} \left(\frac{d}{2} \right)^4 = \frac{\pi}{2} \left(\frac{0.02}{2} \right)^4 = 1.571 \times 10^{-8} \text{ m}^4$$

$$G = 75 \times 10^9 \text{ Pa} \quad [\text{for A-36 steel}]$$

$$\Rightarrow \theta = \frac{1}{1.571 \times 10^{-8} \times 75 \times 10^9} \left[(-80 \times 0.8) + (-60 \times 0.6) + (-90 \times 0.2) \right]$$

$$\Rightarrow \theta = -0.100149 \text{ radians} = |5.738^\circ| \quad \text{ANS.}$$

$$\Rightarrow \theta = -0.100149 \text{ radians} \approx |5.730^\circ| \text{ ANS.}$$

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