Mechanics of Materials II:

Thin-Walled Pressure Vessels and Torsion

Dr. Wayne Whiteman
Senior Academic Professional and Director of the Office of Student Services
Woodruff School of Mechanical Engineering

Georgia Institute of Technology

Module 16 Learning Outcome

- Solve for the angle of twist for elastic torsion of a straight cylindrical shaft

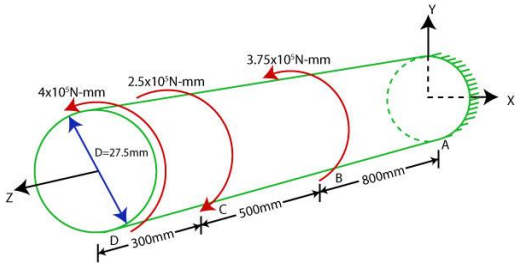
Elastic Torsion of Straight Cylindrical Shafts

Worksheet:

The steel bar to the right is subject to torques as shown.

a) Determine the maximum shear stress in the structure.

b) Determine the angle of twist if the free end with respect to the fixed end.



Angle of Twist, ϕ

$$\phi = \frac{T\,L}{G\,J}$$

$$T_{AB} = 5.25\,X\,10^5\ \ N-mm$$

$$T_{BC} = 1.5\,X\,10^5\ \ N-mm$$

$$T_{CD} = 4\,X\,10^5\ \ N-mm$$

$$J = 56150\ mm^4$$

Research a typical value for G for steel

$$G = 80\ GPa = 80000\ MPa$$

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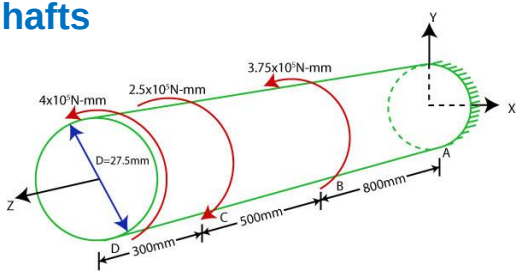

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$T_{BC} = 1.5\,X\,10^5\ \ N-mm$

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$$\phi_{BC} = \frac{1.5\,X\,10^5\ \ N\cdot mm(500\,mm)}{80000\,\frac{N}{mm^2}\left(56150\ mm^4\right)} = 0.0167\ rad$$

$$\phi_{CD} = \frac{4\,X\,10^5\ \ N\cdot mm(300\,mm)}{80000\,\frac{N}{mm^2}\left(56150\ mm^4\right)} = 0.0267\ rad$$

$$\phi_{TOTAL} = 0.1035\ rad$$

ANS