Mechanics of Materials II:

Thin-Walled Pressure Vessels and Torsion

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Module 18 Learning Outcome

- Solve for the angle of twist for elastic torsion of a straight cylindrical shaft that is non-prismatic

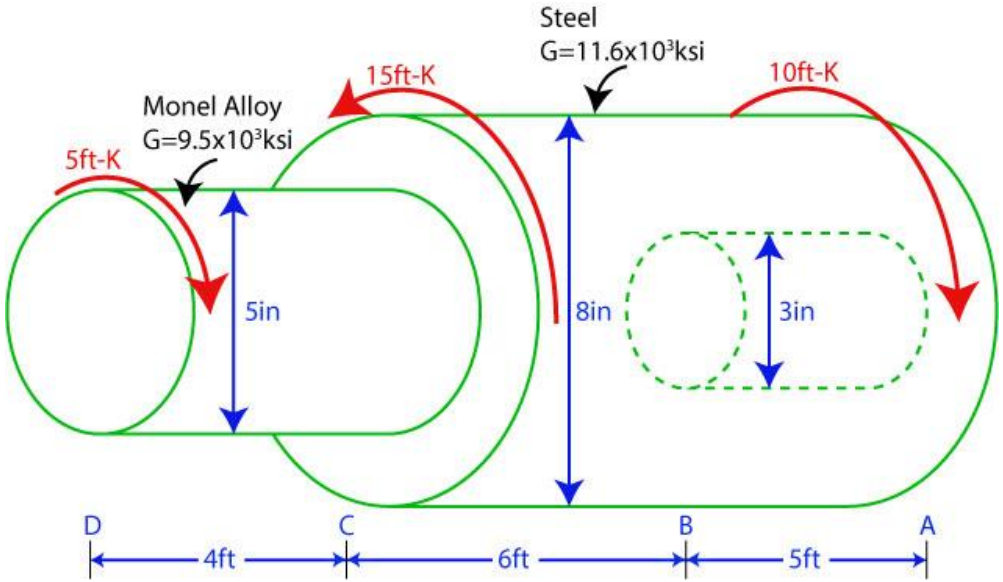
Elastic torsion of Straight Cylindrical Shafts that are non-prismatic

(prismatic is a straight engineering member with the same cross-section throughout its length)

Worksheet:

The non-prismatic cylindrical bar below is subject to torques as shown.
A portion of the steel section is hollow.

a) Determine the maximum shear stress in each section.
b) Determine the angle of twist of end D with respect to end A.



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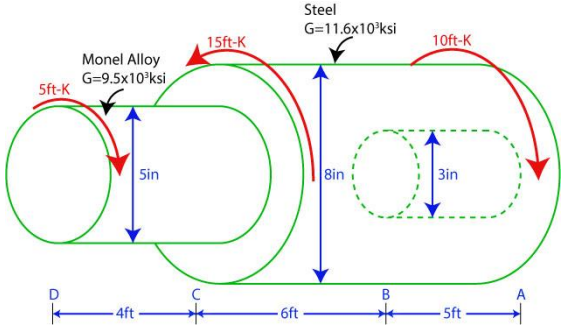

$$\vec{T}_{CD} = 5\ ft \cdot k\ \ \hat{k}$$

$$\vec{T}_{BC} = -10\ ft \cdot k\ \ \hat{k}$$

$$\vec{T}_{AB} = -10\ ft \cdot k\ \ \hat{k}$$

$$\phi_{BC} = \frac{10\ ft \cdot k\left(\frac{12\,in}{ft}\right)6\ ft\left(\frac{12\,in}{ft}\right)}{11.6\ X\ 10^3\ ksi\left[\frac{\pi(4\,in)^4}{2}\right]} = 1.85\ X\ 10^{-3}\ rad\ \ \hat{k}$$

(twist of C wrt B)

$$\phi_{AB} = \frac{10\ ft \cdot k\left(\frac{12\,in}{ft}\right)5\ ft\left(\frac{12\,in}{ft}\right)}{11.6\ X\ 10^3\ ksi\left[\frac{\pi(4\,in)^4}{2} - \frac{\pi(1.5\,in)^4}{2}\right]} = 1.575\ X\ 10^{-3}\ rad\ \ \hat{k}$$

(twist of B wrt A)