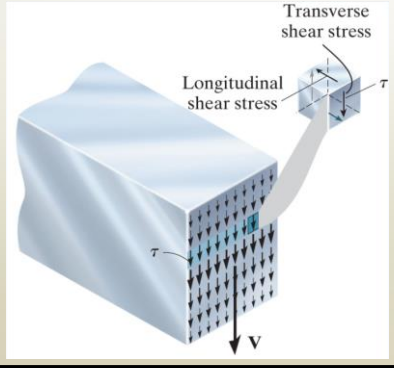
MECE 3321 Mechanics of Solids Chapter 7

Samantha Ramirez

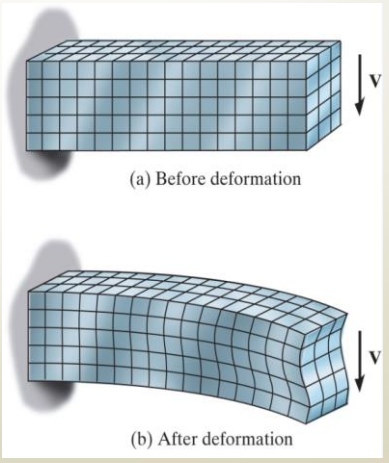
Shear in Straight Members

- A beam will support both shear forces and bending moments. Due to the complementary property of shear, this stress will create corresponding longitudinal shear stresses which will act along longitudinal planes of the beam.



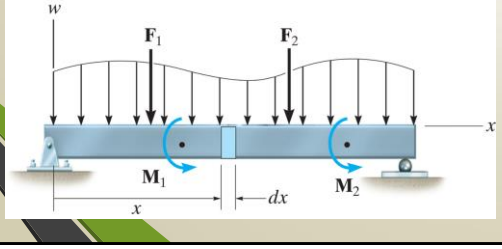
Shear in Straight Members

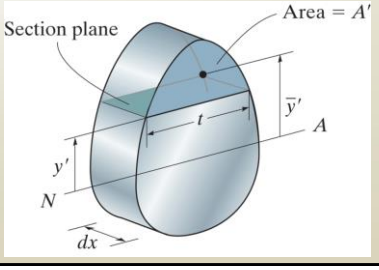
- Transverse loadings will generate both bending moments and shear forces along the beam.
- When a beam is subjected to both bending and shear, the cross section will not remain plane.
  - Assuming small cross-sectional warping allows it to be neglected.



The Shear Formula

- The shear formula was derived by horizontal force equilibrium of the longitudinal shear stress and bending stress distributions acting on a portion of a differential segment of a beam.
- The shear formula is valid for homogeneous materials and the internal resultant shear force is directed along an axis of symmetry.





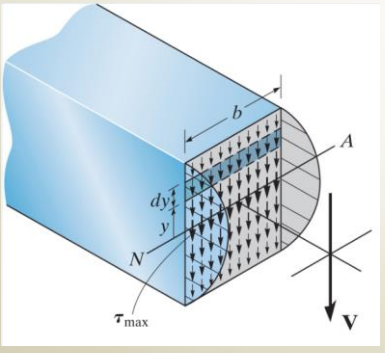
The Shear Formula

$$\tau = \frac{VQ}{It}$$

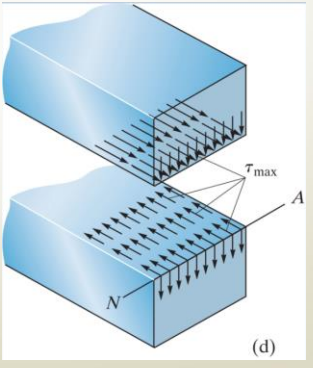
- τ: the shear stress in the member at the point located a distance y′ from the neutral axis
- V: the internal resultant shear force
- Q: $\bar{y}'A'$, where A′ is the area of the top (or bottom) portion of the member's cross-sectional area, above (or below) the section plane where t is measured, and $\bar{y}'$ is the distance from the neutral axis to the centroid of A′
- I: the moment of inertia of the entire cross-sectional area calculated about the neutral axis
- t: the width of the member's cross-sectional area, measured at the point where τ is to be determined

Shear Stress Distribution

Shear Stress Distribution

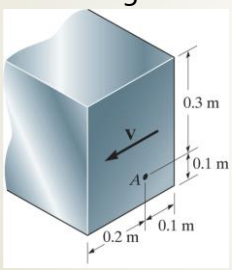


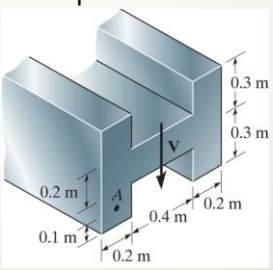
Shear Stress on a Volume Element

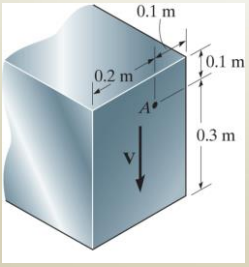


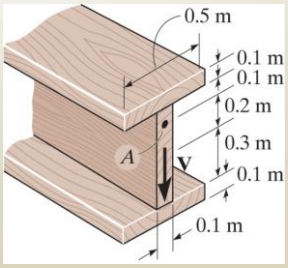
Solving for Q and t

- Calculate the value of Q and t that are used in the shear formula for finding the shear stress at point A.



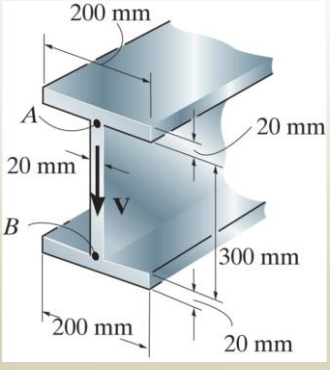






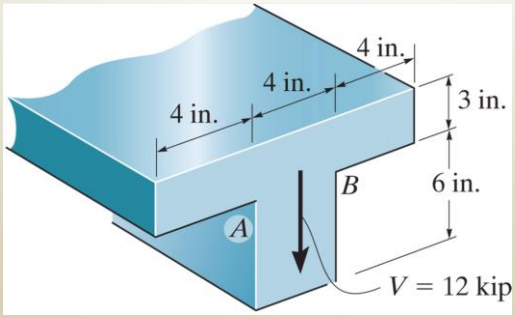
Problem 7-1

- If the wide-flange beam is subjected to a shear of V=20 kN, determine the shear stress on the web at A. Indicate the shear-stress components on a volume element located at this point.



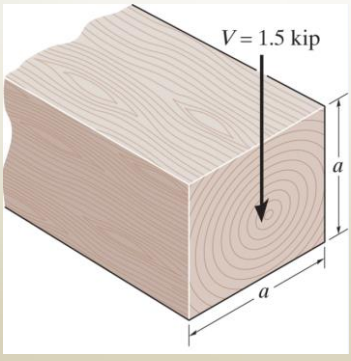
Problem 7-4

- If the T-beam is subjected to a vertical shear of V = 12 kip, determine the maximum shear stress in the beam. Also, compute the shear-stress jump at the flange-web junction AB. Sketch the variation of the shear-stress intensity over the entire cross section.



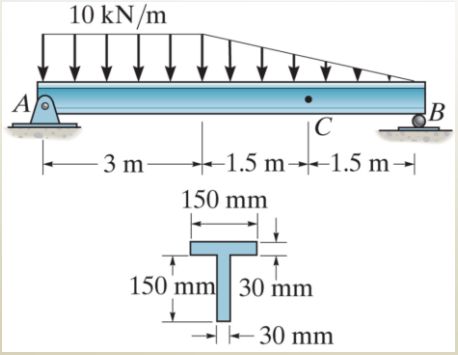
Problem 7-26

- The beam has a square cross-section and is made of wood having an allowable shear stress of 1.4 ksi. If it is subjected to a shear force of 1.5 kip, determine the smallest dimension a of its sides.



Problem 7-24

- Determine the maximum shear stress in the T-beam at the critical section where the internal shear force is maximum.



Example 4

- The member shown has a rectangular cross section. Determine the state of stress that the loading produces at C and D.