Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

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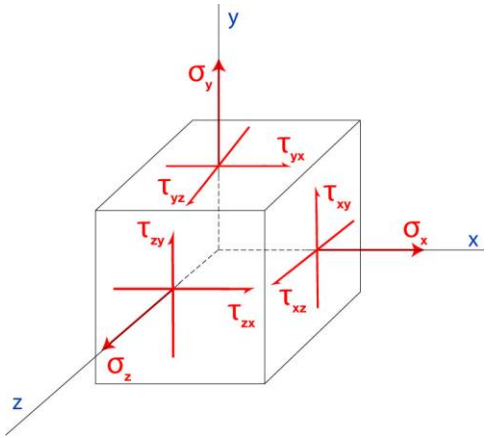
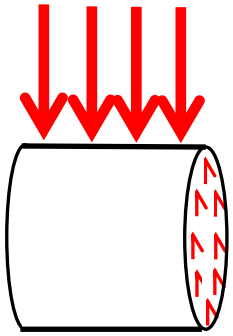
Module 15 Learning Outcomes

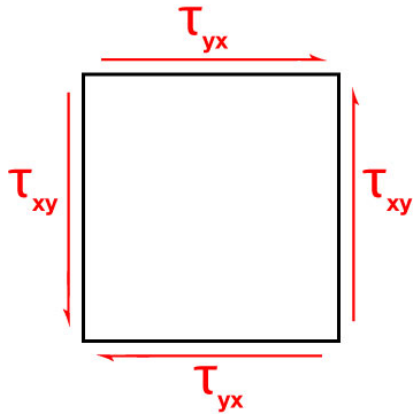
- Define/Discuss Shear Strain
- Define Hooke's Law for Shear
- Relate the Modulus of Elasticity (Young's Modulus) to the Modulus of Rigidity (Shear Modulus)

3D State of Stress at a Point
(shown in positive sign convention)





2D Pure Shear

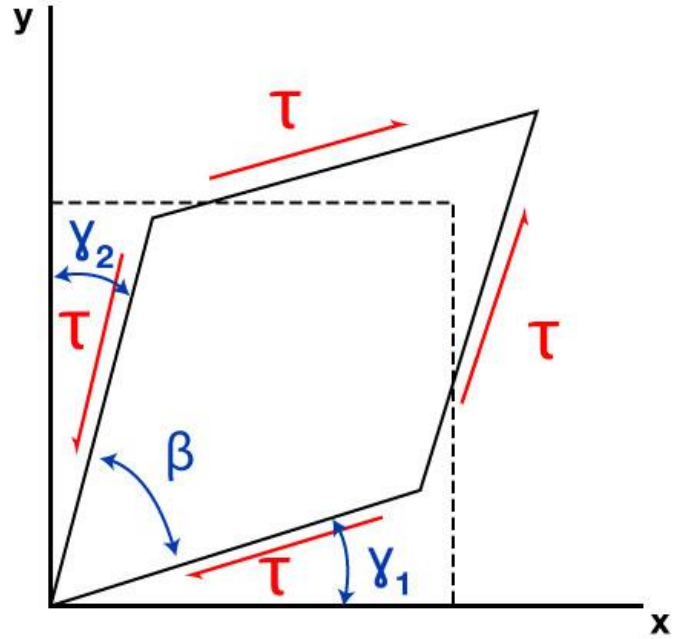


By Equilibrium:

$$\tau_{xy} = \tau_{yx} = \tau$$

Shear Strain, γ

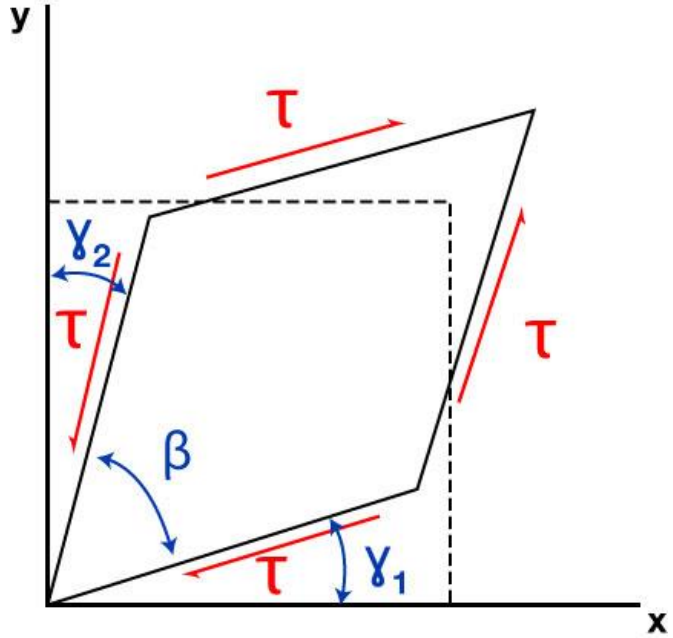
Change in the angle between perpendicular reference axes; Angular Distortion (Shear Distortion)



$\gamma \equiv Shear \quad Strain$ [dimensionless]

$$\gamma = \gamma_1 + \gamma_2 = \frac{\pi}{2} - \beta$$

Shear Strain, γ



Sign Convention

(+) Shear Stress causes (+) Shear Strain

Angle reduced on 2 positive (or 2 negative) faces

Hooke's Law in Shear

(valid for linear elastic region):

$$\tau = G\gamma$$

Analogous to:

$$\sigma = E\,\varepsilon$$

G = Modulus of Rigidity
(Shear Modulus)

Hooke's Laws

$$\sigma = E\,\varepsilon$$

$$\tau = G\gamma$$

Relationship between E and G

(They are not independent)

$$G = \frac{E}{2(1+\upsilon)}$$