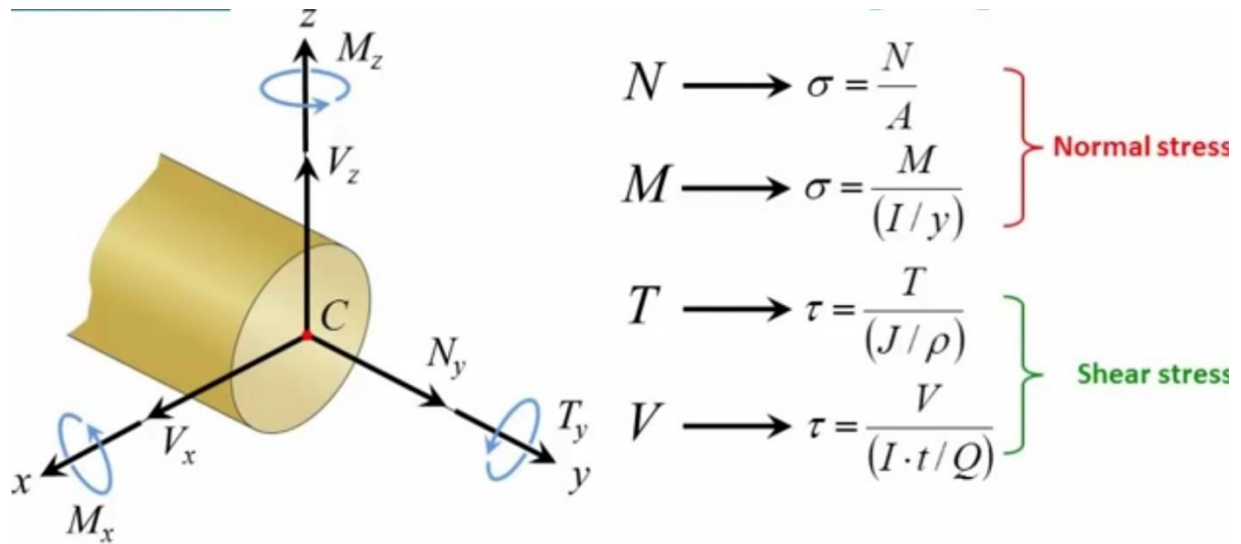
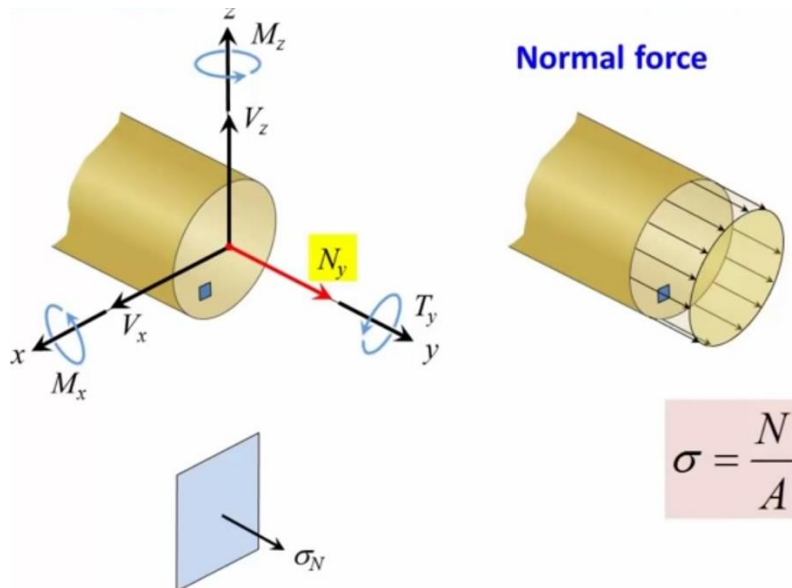
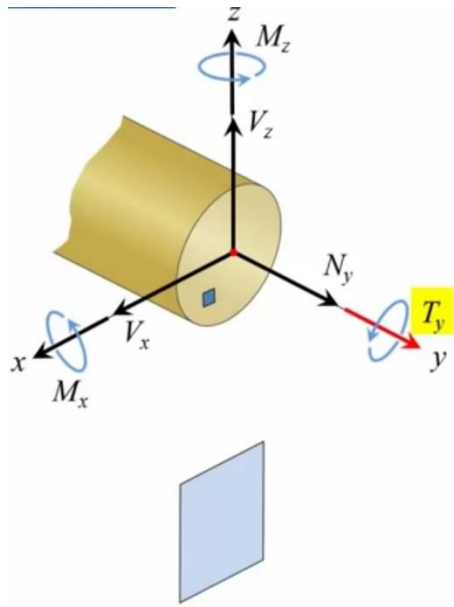


## COMBINED LOADING AT A SPECIFIC POINT OF BEAM CROSS SECTION

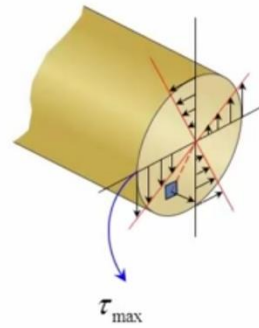


Normal Stress Distribution



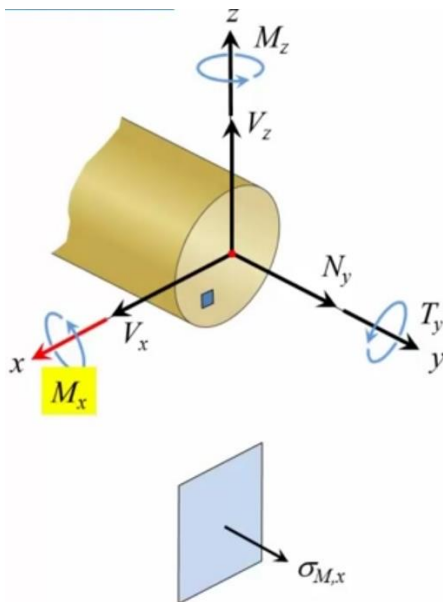


### Torsional moment

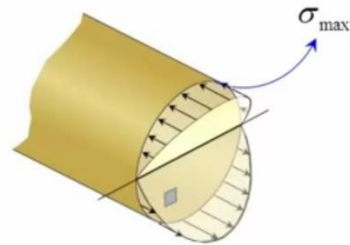


$$\tau = \frac{T\rho}{J}$$

the **torsion** formula

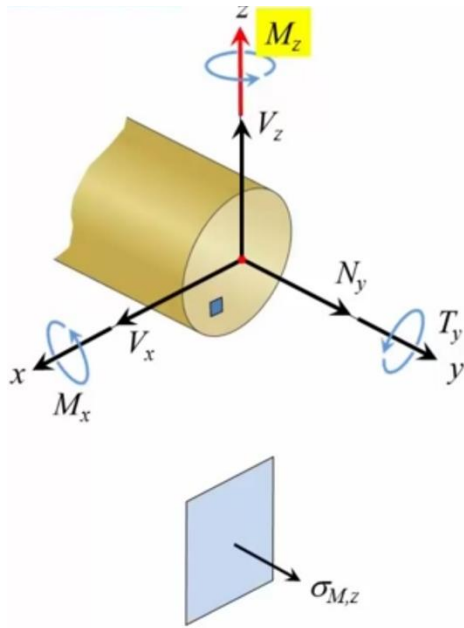


### Bending moment

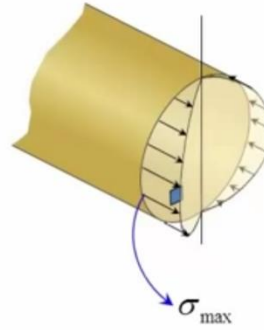


$$\sigma = \frac{M_x z}{I_x}$$

the **flexure** formula

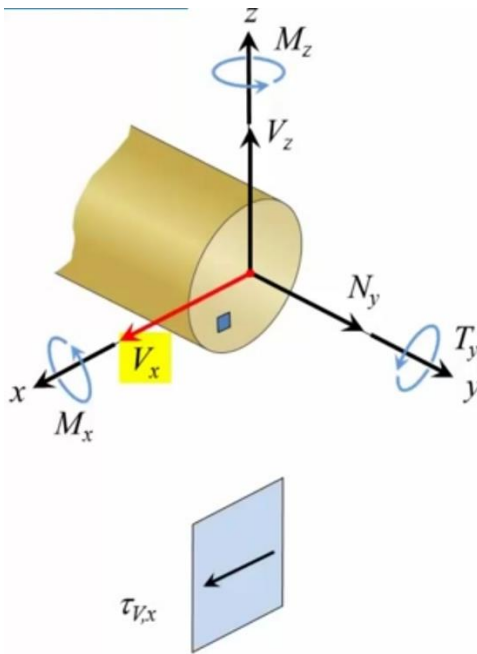


### Bending moment

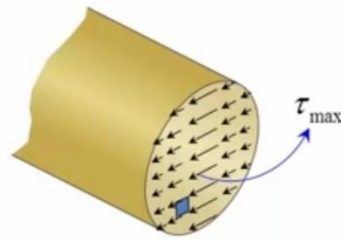


$$\sigma = \frac{M_z x}{I_z}$$

the flexure formula

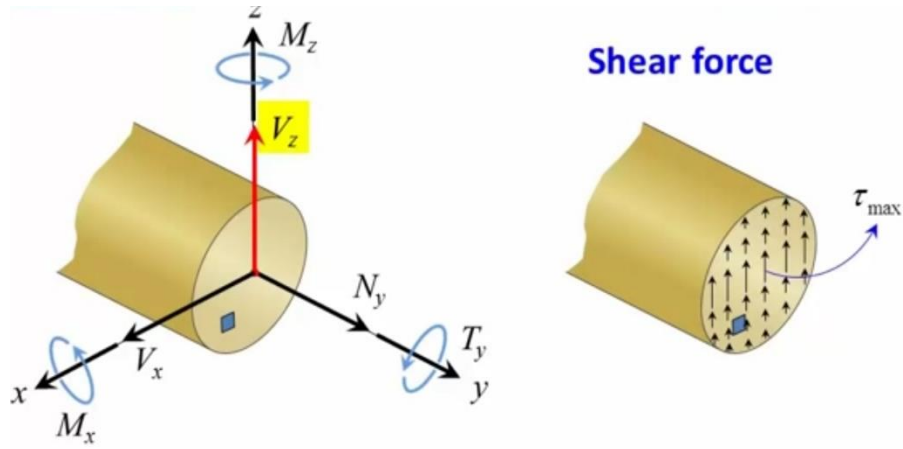


### Shear force

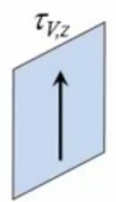
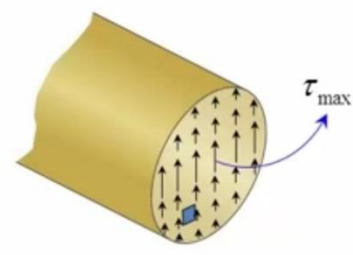


$$\tau = \frac{V_x Q_z}{I_z t}$$

the shear formula

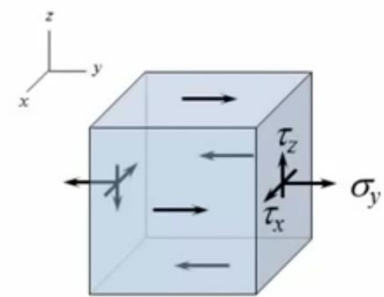
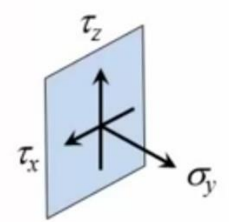
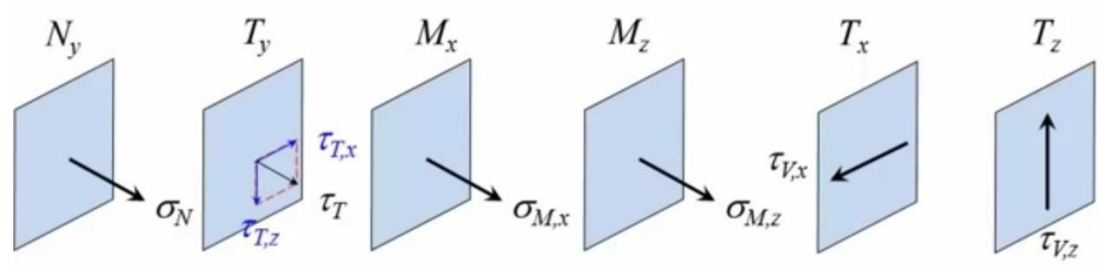


**Shear force**

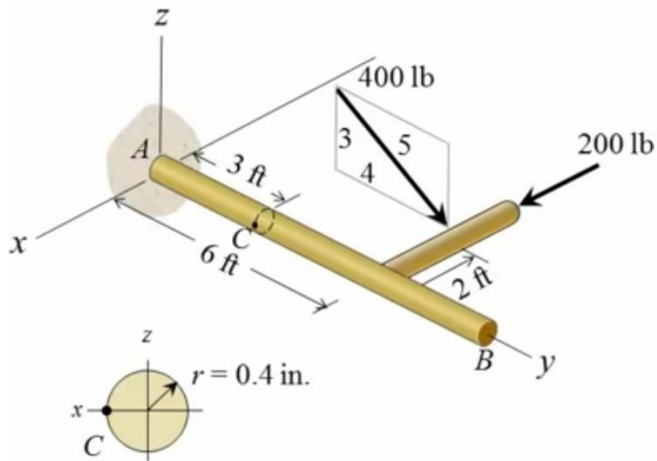


$$\tau = \frac{V_z Q_x}{I_x t}$$

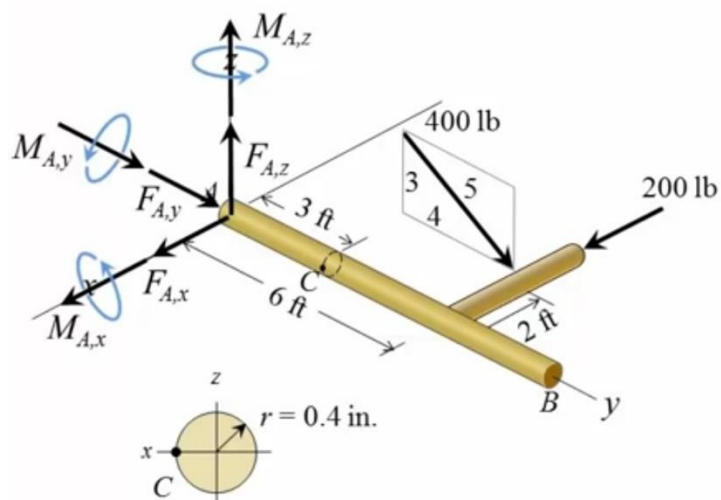
**the shear formula**

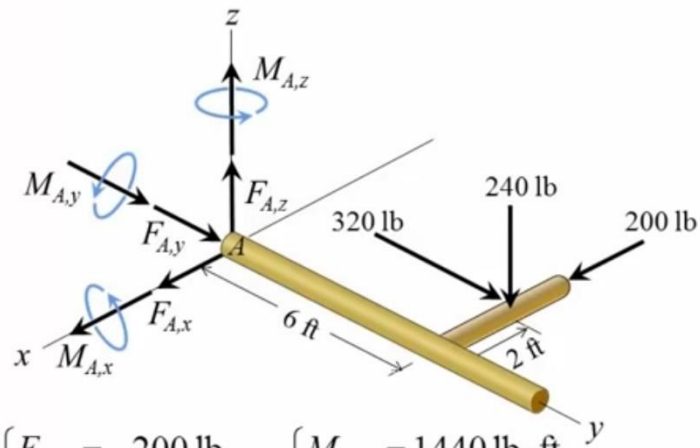


**Example 1:** For the composite beam subjected to the loadings shown, determine the state of stress at point C and show the result on a **planar element** at point C.



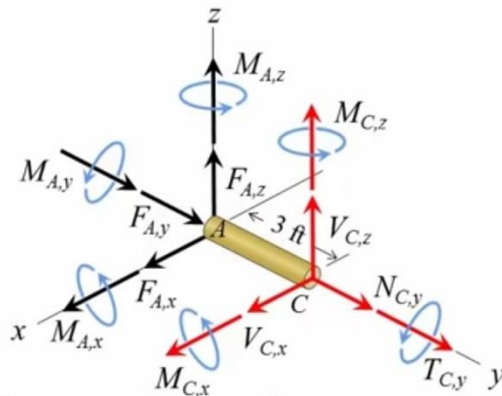
① FBD and solve for all **external** support reactions.





$$\begin{cases} F_{A,x} = -200 \text{ lb} \\ F_{A,y} = -320 \text{ lb} \\ F_{A,z} = 240 \text{ lb} \end{cases} \quad \begin{cases} M_{A,x} = 1440 \text{ lb}\cdot\text{ft} \\ M_{A,y} = 480 \text{ lb}\cdot\text{ft} \\ M_{A,z} = 1840 \text{ lb}\cdot\text{ft} \end{cases}$$

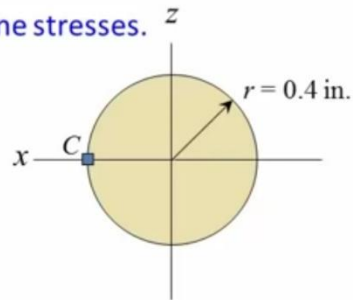
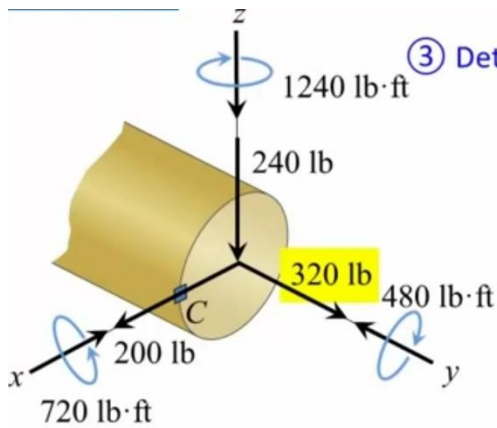
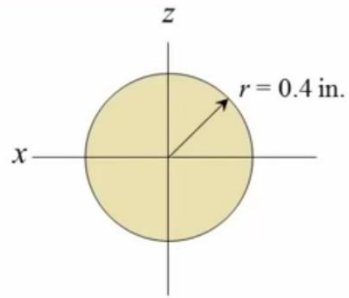
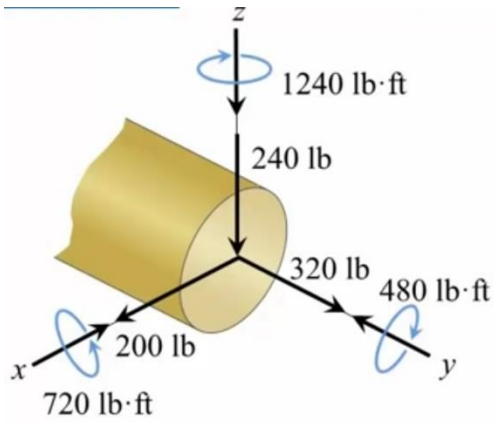
② Method of section and solve for **internal** reactions.



$$\begin{cases} F_{A,x} = -200 \text{ lb} \\ F_{A,y} = -320 \text{ lb} \\ F_{A,z} = 240 \text{ lb} \end{cases} \quad \begin{cases} M_{A,x} = 1440 \text{ lb}\cdot\text{ft} \\ M_{A,y} = 480 \text{ lb}\cdot\text{ft} \\ M_{A,z} = 1840 \text{ lb}\cdot\text{ft} \end{cases}$$

$$\begin{cases} V_{C,x} = 200 \text{ lb} \\ N_{C,y} = 320 \text{ lb} \\ V_{C,z} = -240 \text{ lb} \end{cases}$$

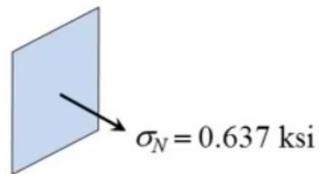
$$\begin{cases} M_{C,x} = -720 \text{ lb}\cdot\text{ft} \\ T_{C,y} = -480 \text{ lb}\cdot\text{ft} \\ M_{C,z} = -1240 \text{ lb}\cdot\text{ft} \end{cases}$$

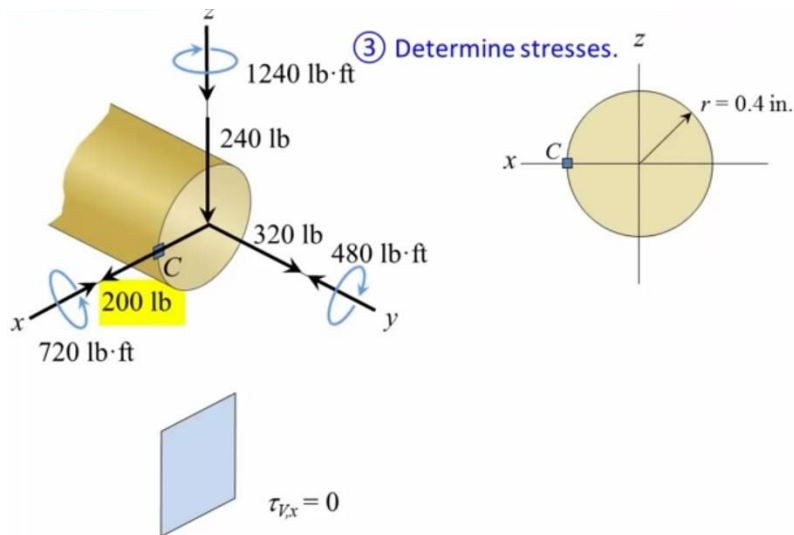
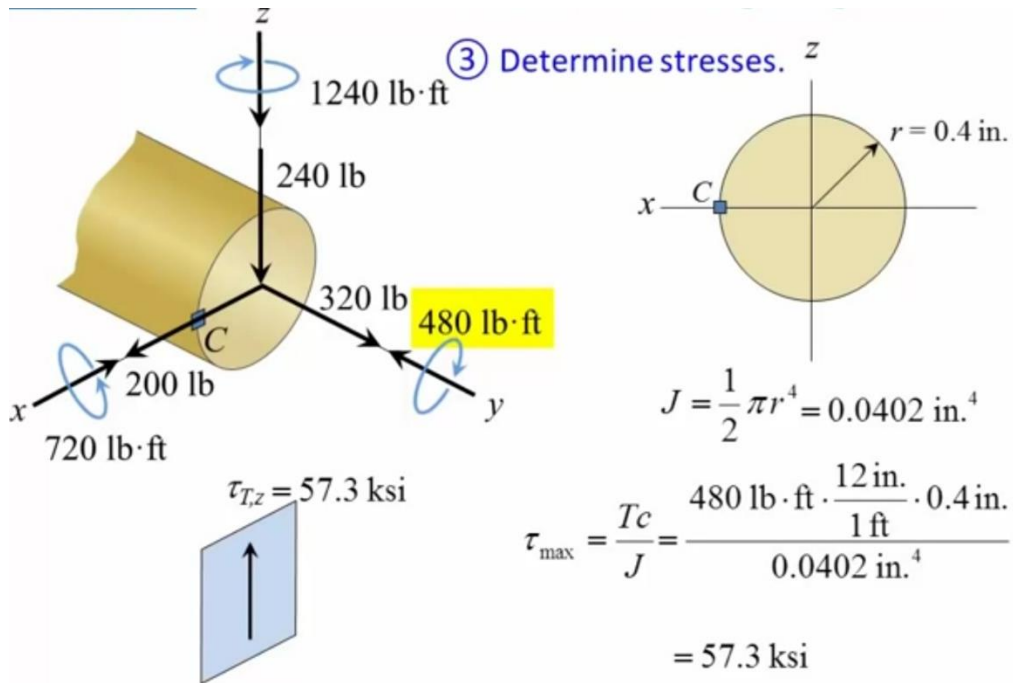


$$A = \pi r^2 = 0.503 \text{ in.}^2$$

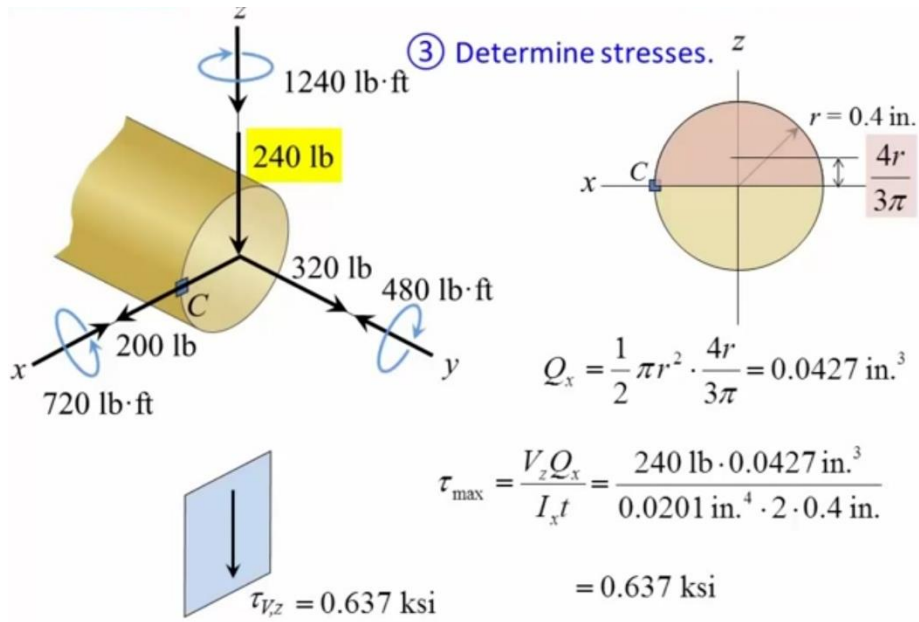
$$\sigma = \frac{N}{A} = \frac{320 \text{ lb}}{0.503 \text{ in.}^2}$$

$$= 0.637 \text{ ksi}$$

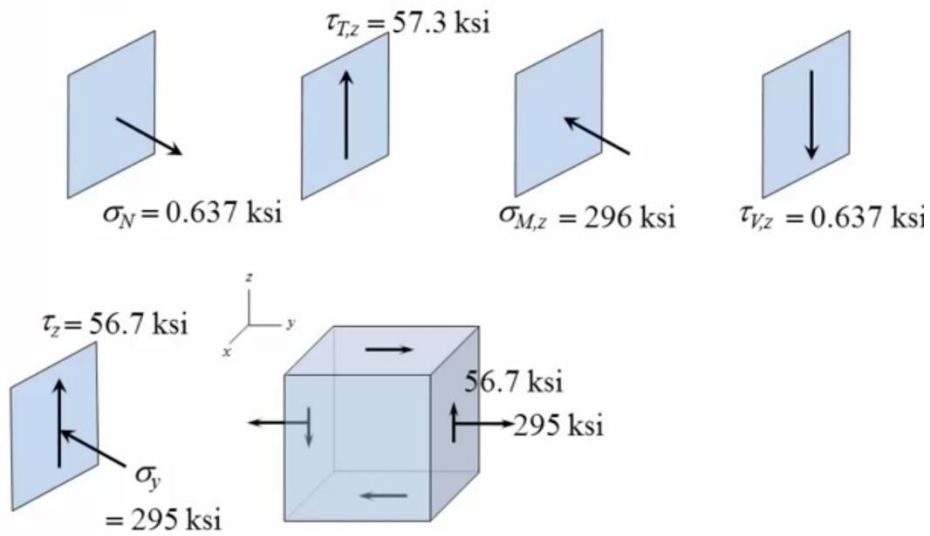




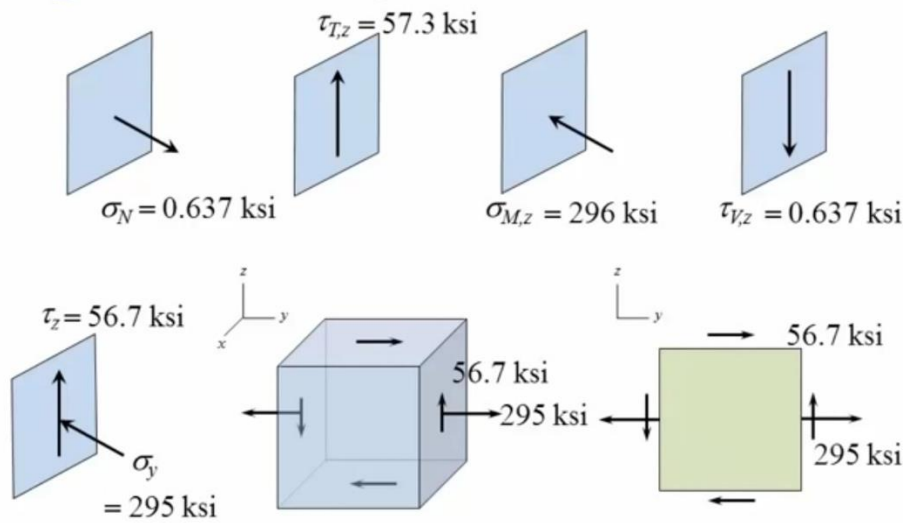




④ Combine stresses and present the result.



④ Combine stresses and present the result.



EGR 246 MECHANICS OF MATERIALS  
Instructor: Dr. Yiheng Wang

Stated of stress caused by  
**combined** loadings

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