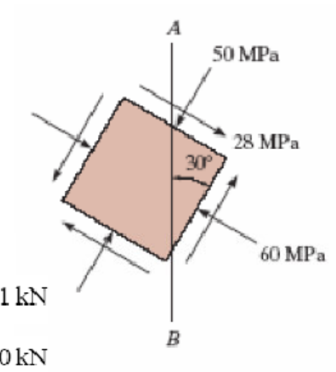
Problem 9-5

The state of stress at a point in a member is shown on the element. Determine the stress components acting on the inclined plane *AB*. Solve the problem using the method of equilibrium described in Sec. 9.1.



Given: $\sigma_x := -60\text{MPa}$ $\quad \sigma_y := -50\text{MPa}$

$\phi := 30\text{deg}$ $\quad \tau_{xy} := 28\text{MPa}$

Solution: Set $\Delta_A := m^2$ $\quad \theta := 180\text{deg} + \phi$

Force Equilibrium: For the sectioned element,

$\Delta_{Ax} := \Delta_A \cdot \cos(\phi)$ $\quad \Delta_{Ay} := \Delta_A \cdot \sin(\phi)$

$F_{xx} := \sigma_x \cdot \Delta_{Ax}$ $\quad F_{xy} := \tau_{xy} \cdot \Delta_{Ax}$ $\quad F_{xy} = 24248.71\,\text{kN}$

$F_{yy} := \sigma_y \cdot \Delta_{Ay}$ $\quad F_{yx} := \tau_{xy} \cdot \Delta_{Ay}$ $\quad F_{yx} = 14000.00\,\text{kN}$

Given

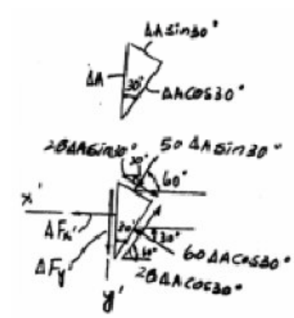
$\overset{+}{\leftarrow}$ $\Sigma F_{x'}=0;$ $\quad \Delta_{Fx'} + F_{xy} \cdot \sin(\theta) + F_{xx} \cdot \cos(\theta) + F_{yx} \cdot \cos(\theta) + F_{yy} \cdot \sin(\theta) = 0$

$+\downarrow$ $\Sigma F_{y'}=0;$ $\quad \Delta_{Fy'} + F_{xy} \cdot \cos(\theta) - F_{xx} \cdot \sin(\theta) - F_{yx} \cdot \sin(\theta) + F_{yy} \cdot \cos(\theta) = 0$

Guess $\quad \Delta_{Fx'} := 1\text{kN}$ $\quad \Delta_{Fy'} := 1\text{kN}$

$$\begin{pmatrix} \Delta_{Fx'} \\ \Delta_{Fy'} \end{pmatrix} := \text{Find}(\Delta_{Fx'}, \Delta_{Fy'}) \qquad \begin{pmatrix} \Delta_{Fx'} \\ \Delta_{Fy'} \end{pmatrix} = \begin{pmatrix} -33251.29 \\ 18330.13 \end{pmatrix} \text{kN}$$

Normal and Shear Stress: $\quad \sigma = \lim_{A \to 0} \left(\dfrac{F}{A} \right)$



$\sigma_{x'} := \dfrac{\Delta_{Fx'}}{\Delta_A}$ $\qquad \sigma_{x'} = -33.251\,\text{MPa}$ $\quad$ **Ans**

$\tau_{x'y'} := \dfrac{\Delta_{Fy'}}{\Delta_A}$ $\qquad \tau_{x'y'} = 18.330\,\text{MPa}$ $\quad$ **Ans**

The negative signs indicate that the sense of $\sigma_{x'}$ is opposite to that shown in FBD.