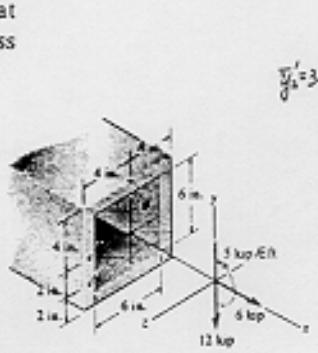
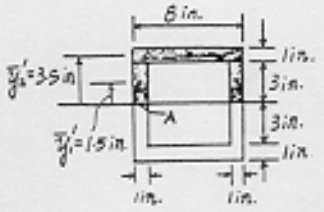
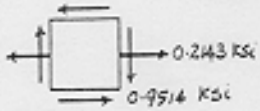
9–38. The internal loadings at a section of the beam consist of an axial force of 6 kip, a shear force of 12 kip, and a moment of 500 lb · ft. Determine the principal stresses at point A. Also compute the maximum in-plane shear stress at this point.







Section Properties :

$$A = 8(8) - 6(6) = 28.0\ \text{in}^2$$

$$I_z = \frac{1}{12}(8)\left(8^3\right) - \frac{1}{12}(6)\left(6^3\right) = 233.33\ \text{in}^4$$

$$(Q_A)_y = \Sigma \tilde{y}' A' = 1.5(3)(2) + 3.5(1)(8) = 37.0\ \text{in}^3$$

Normal Stress :

$$\sigma = \frac{N}{A} - \frac{M_z y}{I_z}$$

$$\sigma_A = \frac{6}{28.0} - \frac{5(12)(0)}{233.33}$$

$$= 0.2143\ \text{ksi}$$

Shear Stress : Applying the shear formula.

$$\tau_A = \frac{V_y (Q_A)_y}{I_z t} = \frac{12(37.0)}{233.33(2)} = 0.9514\ \text{ksi}$$

In - Plane Principal Stress : $\sigma_x = 0.2143$ ksi, $\sigma_y = 0$ and $\tau_{xy} = -0.9514$ ksi for point A. Applying Eq. 9 – 5.

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \frac{0.2143 + 0}{2} \pm \sqrt{\left(\frac{0.2143 - 0}{2}\right)^2 + (-0.9514)^2}$$

$$= -2.619 \pm 57.203$$

$$\sigma_1 = 1.06\ \text{ksi} \qquad \sigma_2 = -0.850\ \text{ksi} \qquad \text{Ans}$$

Maximum In - Plane Shear Stress : Applying Eq. 9 – 7.

$$\tau_{\substack{\max \\ \text{in-plane}}} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= \sqrt{\left(\frac{0.2143 - 0}{2}\right)^2 + (-0.9514)^2}$$

$$= 0.957\ \text{ksi} \qquad \text{Ans}$$