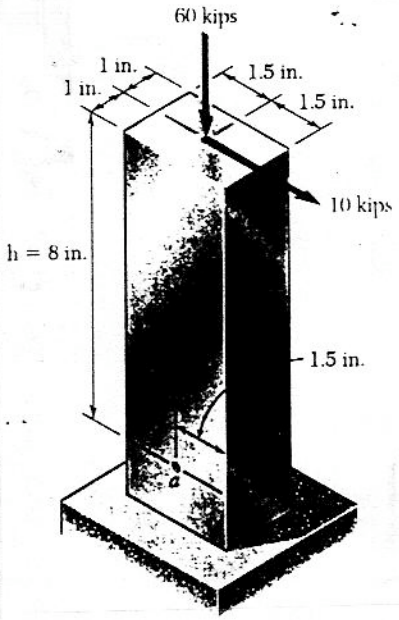
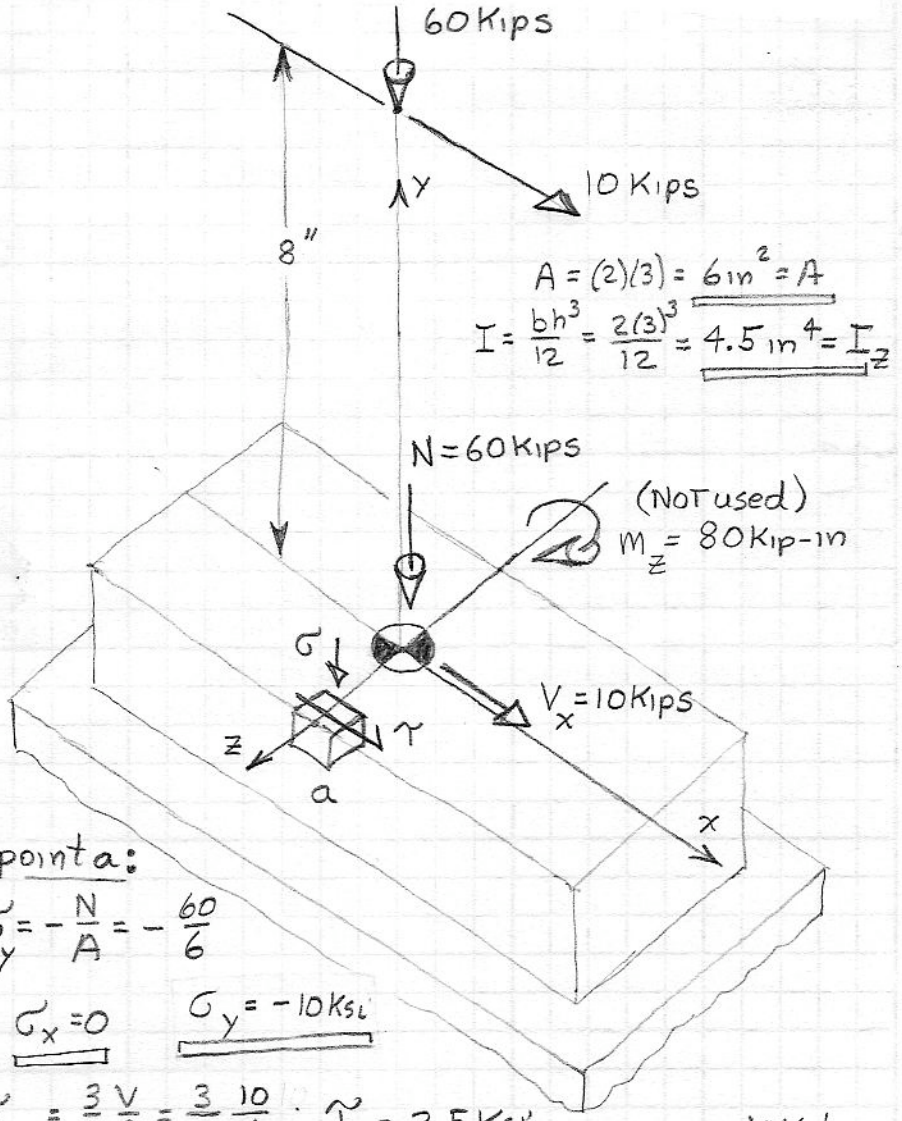
Problem 8.69

8.69 Two forces are applied to the bar shown. At point *a*, determine (*a*) the principal stresses and principal planes, (*b*) the maximum shearing stresses.





$A = (2)(3) = 6\,in^2 = A$

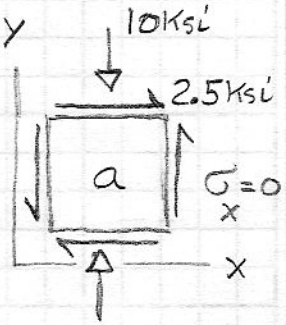
$I = \frac{bh^3}{12} = \frac{2(3)^3}{12} = 4.5\,in^4 = I_z$

Stress at point a:

$\sigma_y = -\frac{N}{A} = -\frac{60}{6}$

$\sigma_x = 0$ $\quad \sigma_y = -10\,Ksi$

$\tau_{xy} = \frac{3}{2}\frac{V}{A} = \frac{3}{2}\frac{10}{6}$ $\quad \tau_{xy} = 2.5\,Ksi$



Maximum Stresses

$\sigma_{avg} = -5\,Ksi$, $R = \sqrt{5^2 + 2.5^2}$, $R = 5.59\,Ksi$

$\tan 2\theta_p = \frac{2.5}{5} = 0.5$ $\quad \theta_p = 13.3°$

$\sigma_{max} = \sigma_{avg} + R$

$\sigma_{min} = \sigma_{avg} - R$

$\sigma_{max} = 0.590\,Ksi$

$\sigma_{min} = -10.59\,Ksi$

Because max(+) min(−) $\tau_{max}^{in\text{-}plane} = R$

$\tau_{max} = 5.59\,Ksi$