SOLUTION (1.13)

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

Substituting the given values

$$140^2 = \left(\frac{60+100}{2}\right)^2 + \tau_{xy}^2$$

or

$$\tau_{xy,max} = 114.19\ MPa$$

SOLUTION (1.40)

Direction cosines are:

$$l_1 = \sqrt{3}/2 \quad m_1 = 1/2 \quad n_1 = 0$$
$$l_2 = -1/2 \quad m_2 = \sqrt{3}/2 \quad n_2 = 0$$
$$l_3 = 0 \quad m_3 = 0 \quad n_3 = 1$$

Equation (1.24a) is thus

$$\sigma_{x'} = 20(\tfrac{3}{4}) + 0 + 0 + 2(12)(\tfrac{\sqrt{3}}{2})(\tfrac{1}{2}) + 0 + 0 = 25.392\ MPa$$

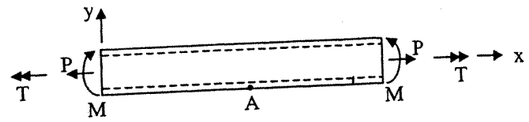
Similarly, applying Eqs. (1.24b) through (1.24e), we obtain $[\tau_{i'j'}]$:

$$\begin{bmatrix} 25.342 & -2.66 & -7.99 \\ -2.66 & -5.392 & 16.16 \\ -7.99 & 16.16 & 6 \end{bmatrix} MPa$$

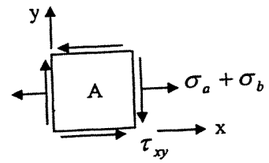
Then, Eqs. (1.29) result in

$$I_1 = I_1' = 26\ MPa \qquad I_2 = I_2' = -349\ (MPa)^2$$
$$I_3 = I_3' = -6464\ (MPa)^3$$

SOLUTION (1.23)



$$A = \pi(30^2 - 15^2) = 2.121(10^{-3})\ m^2$$
$$I = \tfrac{\pi}{4}(30^4 - 15^4) = 0.596(10^{-6})\ m^4 \qquad J = 2I$$



We have

$$\sigma_a = \frac{P}{A} = \frac{50(10^3)}{2.12(10^{-3})} = 23.58\ MPa$$
$$\sigma_b = \frac{Mr}{I} = \frac{200(0.03)}{0.596(10^{-6})} = 10.07\ MPa$$
$$\tau_{xy} = \frac{-Tr}{J} = \frac{-500(0.03)}{1.192(10^{-6})} = -12.58\ MPa$$

Thus,

$$\sigma_x = 23.58 + 10.07 = 33.65\ MPa \qquad \sigma' = 16.83\ MPa$$

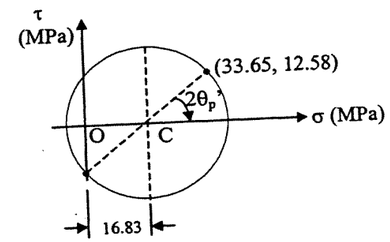


Figure (a)

From Mohr's circle (Fig. a):

$$r = \sqrt{12.58^2 + 16.83^2} = 21.01\ MPa \qquad \theta_p' = \tfrac{1}{2}\tan^{-1}\tfrac{12.58}{16.83} = 18.39^o$$
$$\sigma_1 = 16.83 + 21.01 = 37.84\ MPa$$
$$\sigma_2 = -4.18\ MPa$$

Results are shown in Fig. (b).

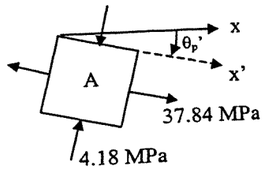


Figure (b)