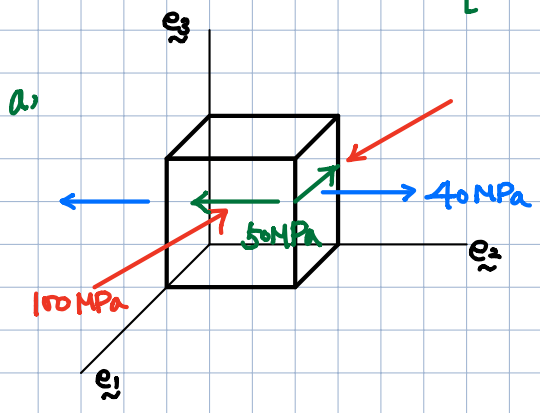
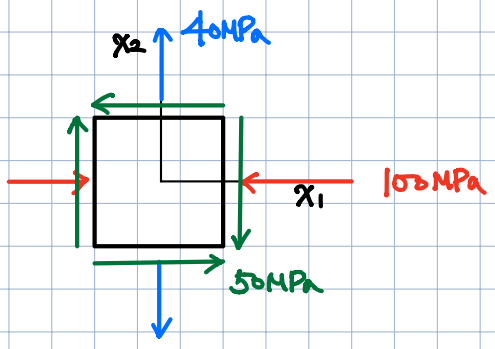
AISI 1020 steel
$\sigma_y = 260\ MPa$

$$\underset{\sim}{\sigma} = \begin{bmatrix} -100 & -50 & 0 \\ -50 & 40 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$\sigma_{11} = -100$
$\sigma_{12} = -50$
$\sigma_{22} = 40$

a)



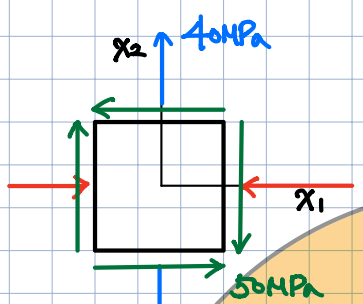

b) What is the effective stress (von-Mises, Tresca)

Tresca $\longrightarrow$ $\tau_{max} = \sigma_{y/2} \sim$ Max $\left\{ \frac{\sigma_I - \sigma_{II}}{2}, \frac{\sigma_{II} - \sigma_{III}}{2}, \frac{\sigma_{III} - \sigma_I}{2} \right\}$

Von-Mises $\longrightarrow$ $\sigma_y \sim \sigma_{eff} = \bar{\sigma} = \frac{1}{\sqrt{2}} \sqrt{(\sigma_I - \sigma_{II})^2 + (\sigma_{II} - \sigma_{III})^2 + (\sigma_{III} - \sigma_I)^2}$

$$= \frac{1}{\sqrt{2}} \cdot \sqrt{(\sigma_{11} - \sigma_{22})^2 + (\sigma_{22} - \sigma_{33})^2 + (\sigma_{33} - \sigma_{11})^2 + 6(\sigma_{12}^2 + \sigma_{23}^2 + \sigma_{31}^2)}$$

$\sigma_{11} = -100$
$\sigma_{12} = -50$
$\sigma_{22} = 40$

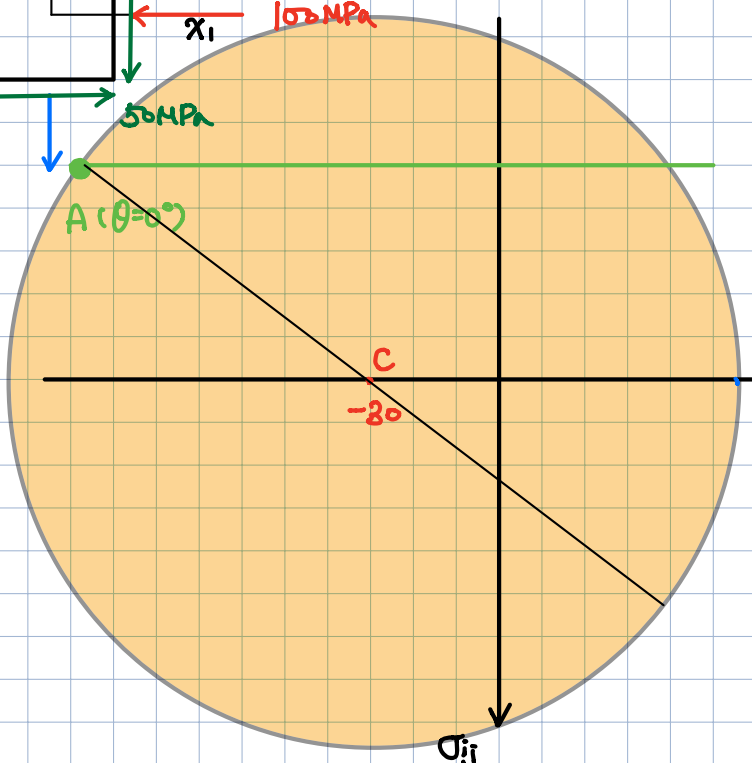



$$C = \frac{\sigma_{11} + \sigma_{22}}{2} = \frac{-100 + 40}{2} = -30$$

$$R = \sqrt{\left(\frac{\sigma_{11} - \sigma_{22}}{2}\right)^2 + \sigma_{12}^2} = \sqrt{\left(\frac{-100 - 40}{2}\right)^2 + 50^2}$$

$$= \sqrt{70^2 + 50^2}$$

$$= 86.02$$




$$\sigma_{p,1} = C - R = -30 - 86.02$$

$$= -116.02 \quad \text{Ans.}$$

$$\sigma_{p,2} = C + R = -30 + 86.02$$

$$= 56.02 \quad \text{Ans.}$$

$$\underset{\sim}{\sigma} = \begin{bmatrix} -100 & -50 & 0 \\ -50 & 40 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\begin{vmatrix} -100-\lambda & -50 \\ -50 & 40-\lambda \end{vmatrix} = 0$$

$$(\lambda+100)\cdot(40-\lambda) - 2500 = 0$$

$$\lambda^2 + 60\lambda - 6500 = 0$$

$$\lambda_{1,2} = -116.0233 \;,\; 56.0233 \quad \text{Ans.}$$

$$\sigma_{p,1} = C - R = -30 - 86.02 = -116.02 \quad \text{Ans.}$$

$$\sigma_{p,2} = C + R = -30 + 86.02 = 56.02 \quad \text{Ans.}$$

Tresca $\longrightarrow$ $\tau_{max} = \sigma_y/2 \sim \text{Max}\left\{\frac{\sigma_I-\sigma_{II}}{2}, \frac{\sigma_{II}-\sigma_{III}}{2}, \frac{\sigma_{III}-\sigma_I}{2}\right\}$

$= 260/2$

$= 130 \text{MPa}$

$$\sigma_{eff,Tresca} = \text{Max}\left\{\left|\frac{-116-56}{2}\right|, \left|\frac{56-0}{2}\right|, \left|\frac{0+116}{2}\right|\right\}$$

$= 172/2 = 86$ Ans.

Von-Mises $\longrightarrow$ $\sigma_y \sim \sigma_{eff} = \bar{\sigma} = \frac{1}{\sqrt{2}}\sqrt{(\sigma_I-\sigma_{II})^2+(\sigma_{II}-\sigma_{III})^2+(\sigma_{III}-\sigma_I)^2}$

$= 260 \text{MPa}$

$$= \frac{1}{\sqrt{2}}\cdot\sqrt{(\sigma_{11}-\sigma_{22})^2+(\sigma_{22}-\sigma_{33})^2+(\sigma_{33}-\sigma_{11})^2 + 6(\sigma_{12}^2+\sigma_{23}^2+\sigma_{31}^2)}$$

$$= \frac{1}{\sqrt{2}}\cdot\sqrt{(-116-56)^2+(56-0)^2+(0+116)^2}$$

$$= 151.9$$

(c) SF? (Von-Mises)

$$SF = \frac{260}{151.9} = 1.71 \quad \text{Ans.}$$

$$\underset{\sim}{\sigma} = \begin{bmatrix} -100 & -50 & 0 \\ -50 & 40 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$