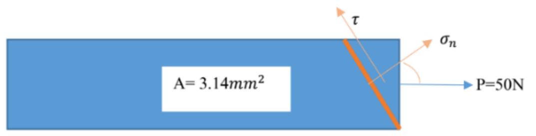
1.



The normal stress on the cross-section(pq) is given by,

$$\sigma = \frac{Force}{Area} = \frac{Pcos\phi}{A/cos\phi} = \sigma_x(cos\phi)^2$$

$$= (50/(3.14x10^{-6}))\cos^2 20°$$

$$= 14.0608MPa$$

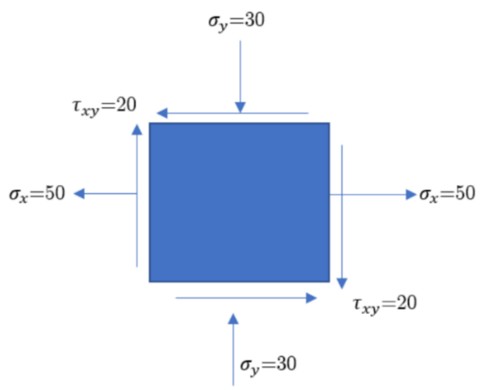
There the shear stress is given by

$$\tau = \frac{Psin\phi}{A/cos\phi} = \sigma_x sin\phi cos\phi$$

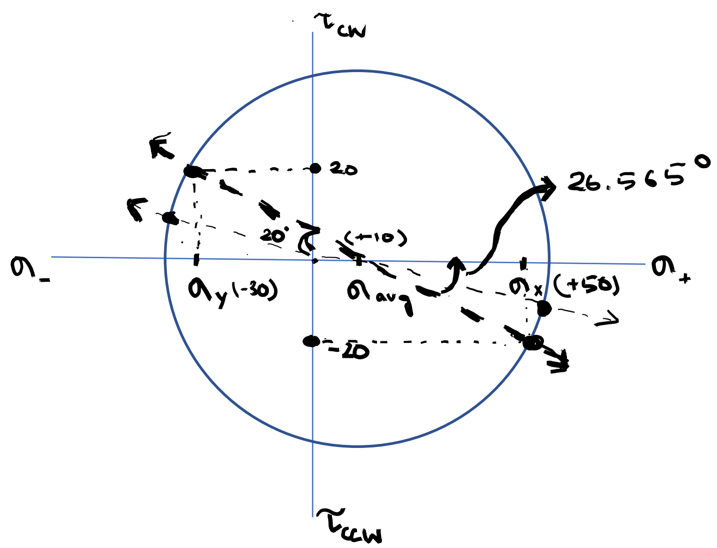
$$= (50/(3.14x10^{-4}))cos20sin20$$

$$= 5.11773MPa$$

2.



(a)



(b) Maximum principal stress $\sigma_{a=}\frac{\sigma_x+\sigma_y}{2}+\sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2+\tau_{xy}^2}$

= ((50-30)/2) + (√((50+30)/2)^2 + 20^2)

= 10+44.721 = **54.721**

Minimum principal $\sigma_{b=}\frac{\sigma_x+\sigma_y}{2}-\sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2+\tau_{xy}^2}$ stress

= 10 - 44.721 = **-34.721**

Maximum shear stress = Radius of circle = **44.721**

Also, tan2θ = 20/40 = 0.5

∴θ = tan^{-1}0.5/2

= 26.565/2

= 13.2825°

(c)At Φ=10° , $\sigma_{X'}$ = σ_{avg} + Rcos(26.565-20)[From Mohrs Circle]

= 10 + 44.4278

= **54.4278**

$\sigma_{Y'}$ = σ_{avg} - Rcos(26.565-20)

= **-34.4278**

τ = Rsin(26.565-20)

= 44.721x0.11433

= **5.113**

3.

$$\sigma=\begin{bmatrix}10 & 20 & -50\\ -30 & 44 & 0\\ 72 & 28.8 & -5\end{bmatrix}$$

We know $\sigma_{hyd}=\frac{\sigma_{xx}+\sigma_{yy}+\sigma_{zz}}{3}$

= (10+44-5)/3

$= 16.333$

Which can be written as $\sigma_{hyd} = \begin{pmatrix} 16.33 & 0 & 0 \\ 0 & 16.33 & 0 \\ 0 & 0 & 16.33 \end{pmatrix}$

$\sigma_{ij} = \sigma_{hyd} + \sigma_{\text{dev}}$ Also,

$$\sigma_{\text{dev}} = \begin{pmatrix} 10 & 20 & -50 \\ -30 & 44 & 0 \\ 72 & 22.8 & -5 \end{pmatrix} - \begin{pmatrix} 16.33 & 0 & 0 \\ 0 & 16.33 & 0 \\ 0 & 0 & 16.33 \end{pmatrix} = \begin{pmatrix} \frac{-633}{100} & 20 & -50 \\ -30 & \frac{2767}{100} & 0 \\ 72 & \frac{114}{5} & \frac{-2133}{100} \end{pmatrix}$$

4.

Isotropic Materials: Since $C_{ij} = C_{ji}$, the stiffness tensor becomes a symmetric matrix, hence reducing the number of independent components required in the C matrix from 4 to **2**.

Anisotropic Materials: $C_{anisotropic}$ has **3** independent elements. (Less symmetry than isotropic materials)

Orthotropic Materials: $C_{orthotropic}$ has **9** independent elements. (Less symmetry than anisotropic materials)

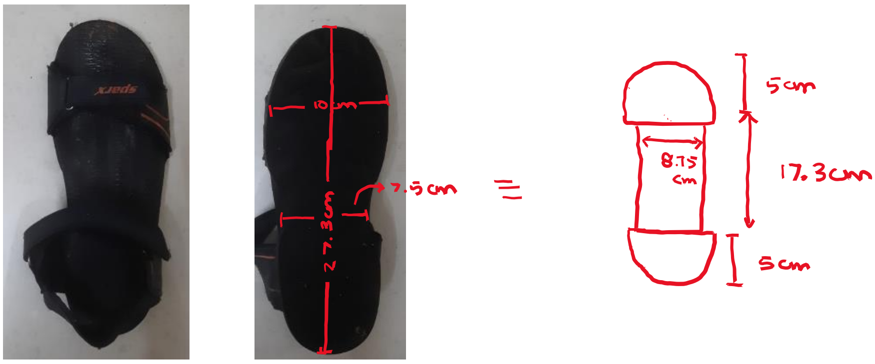
5.

(a) My weight = 54 kgwt. = 529.2N (Assuming g = 9.8 ms^{-2})

(b) The weight experienced by each slipper = 529.2/2

= 264.6N

(c)



Approximate area of slipper = $(\pi x 5^2 + 8.75 x 17.3) cm^2$

$= 229.9\ cm^2 = 0.02299\ m^2$

(d) The approximate Youngs Modulus of the material we assume it to be made of (tanned leather) = **51MPa**

(e) Stress in the slippers = (Weight per slipper)/(Area of slipper)

= 264.6/0.02299

= **11.5094kPa**