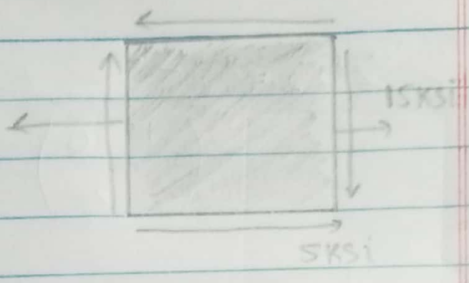
Q#01



Given Data:

$\sigma_x = 15KSi$

$\sigma_y = 0$

$\tau_{xy} = -5KSi$

Required Data:

(a) Principle Stress

(b) Max-Plan Shear Stress

(c) Average Normal Stress

Solution:-

1) Principle Stress:

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

$$\sigma_{1,2} = \frac{15+0}{2} \pm \sqrt{\left(\frac{15-0}{2}\right)^2 + (-5)^2}$$

$$\sigma_{1,2} = 7.5 \pm 9.01$$

$$\boxed{\sigma_1 = 16.51 \text{ KSi}}$$

$$\sigma_2 = 7.5 - 9.01$$

$$\boxed{\sigma_2 = -1.51 \text{ KSi}}$$

Now we find orientation

We know that

$$2\theta_2 = \frac{\tau_{xy}}{\left(\frac{\sigma_x-\sigma_y}{2}\right)}$$

$$2\theta_2 = \frac{-5}{\left(\frac{15-0}{2}\right)}$$

$$\boxed{\theta_2 = -0.33^\circ}$$

Now we check which angles goes with which principle stress

$$\sigma_{x_1} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$= \frac{15+0}{2} + \frac{15-0}{2} \cos 2(-0.33) + (-5) \sin 2(-0.33)$$

$$= \frac{15}{2} + \frac{15}{2}(0.99) + (-5)(-0.12)$$

$$= 14.925 + 0.6$$

$$\boxed{\sigma_{x_1} = 15.525}$$

b- Max: Plan Shear Stress:

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

$$\tau_{max} = \sqrt{\left(\frac{15-0}{2}\right)^2 + (-5)^2}$$

$$\boxed{\tau_{max} = 9.01\ ksi}$$

Now we find orientation

$$\tan 2\theta = \frac{-\frac{(\sigma x - \sigma y)}{2}}{\tau xy}$$

$$= \frac{\frac{(15-0)}{2}}{15}$$

$\tan 2\theta = +1.5$

$2\theta = \tan^{-1}(1.5)$

$2\theta = 56$

$\theta = \frac{56}{2}$

$$\boxed{\theta = 28^\circ}$$

Also we have

$$\tau x'y' = -\frac{\sigma x - \sigma y}{2} \sin 2\theta + \tau xy \cos 2\theta$$

$$= \frac{-15-0}{2} \sin 2(28) + (5) \cos 2(28)$$

$$= -7.5(0.82) \cancel{\ \ } -28$$

$\tau x'y' = -8.95$

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Q#1
Part B

$\sigma_x = 15 ksi$
$\tau_{xy} = -5 ksi$
$\sigma_y = 0$

$$C = \frac{\sigma_x + \sigma_y}{2} = \frac{15+0}{2}$$

$$C = 7.5 ksi$$

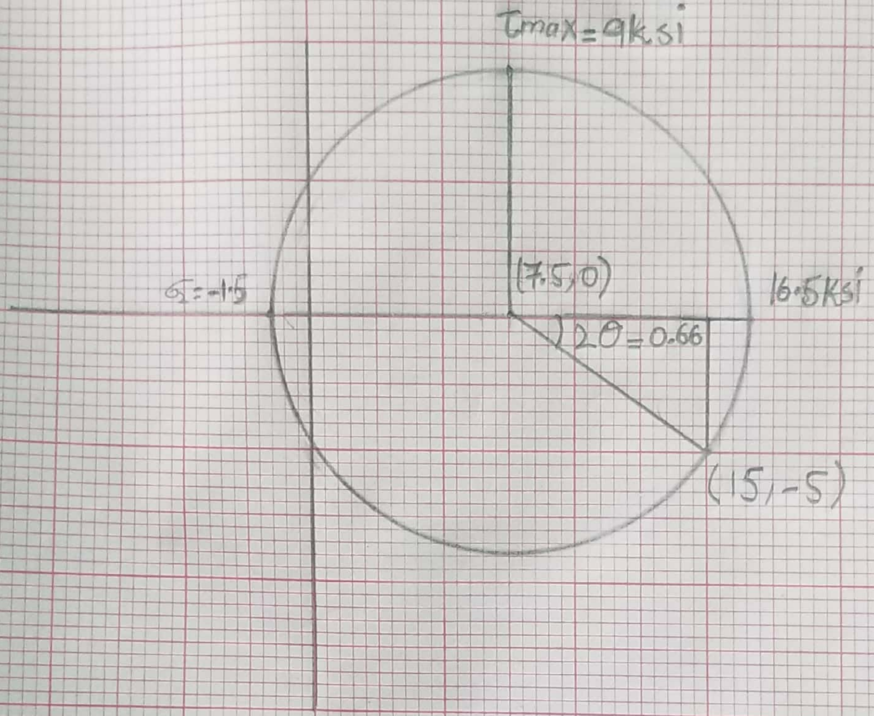
$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$R = \sqrt{\left(\frac{15-0}{2}\right)^2 + (-5)^2}$$

$$\boxed{R = 9.01}$$

Note
1 Small box = 0.5ksi in graph papar.

Scanned with CamScanner

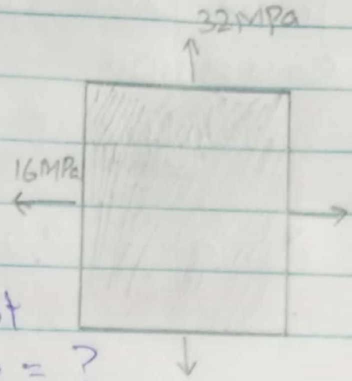


Scale
1 small box = 0.5ksi

Q#02 Given Data:

$\sigma_1 = 32$ MPa

$\sigma_2 = 16$ MPa



Required Data:

Max: Shear Stress at point Using Mohr's Circle = ?

Sol: Principle Shear Stress are $\sigma_1 = 32$ MPa

$\sigma_2 = 16$ MPa

These Stresses are ploted along the σ axis, three Mohr's circle are Constructed, Stresses are Shown

Circle diagram at last of Question

The largest circle has a radius of 16 MPa & describes the state of stress in the plane only containing

$\sigma_1 = 32$ MPa

Absolute Max: Shear Stress & associated avg: normal Stress are

$\tau_{abs\,max} = 16$ MPa

$\sigma_{avg} = 16$ MPa

τ_{max} abs can be obtained from equation

$$\tau_{max\,abs} = \frac{\sigma_1}{2} = \frac{32}{2} = 16\,MPa$$

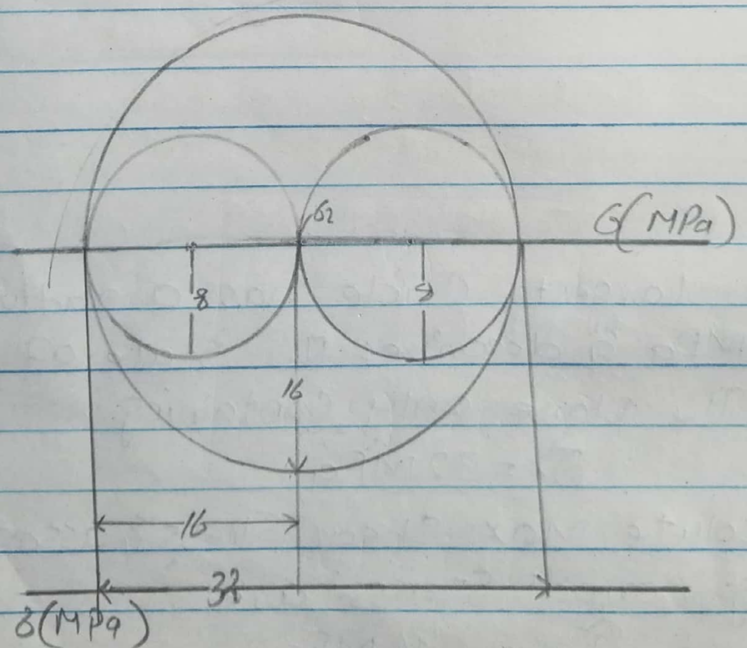
$$\sigma_{Avg} = \frac{32+0}{2} = 16\,MPa$$

By comparison, the max in-plane shear stress can be determined from the Mohr's circle drawn b/w $\sigma_1 = 32\,MPa$ & $\sigma_2 = 16\,MPa$

This gives a value of

$$\tau_{max\,in\,plane} = \frac{32-16}{2} = 8\,MPa$$

$$\sigma_{Avg} = \frac{32+16}{2} = 24\,MPa.$$



Q#03

Ans: Stresses Responsible for failure of Ductile & Brittle material:

Ductile materials are limited by Their Shear strength. Ductile material usually fails because the shear stresses exceeds the strength of ductile materials

→ Brittle materials are limited by their tensile strengths. Brittle material fails when the tensile stresses exceeds the strength of materials

Two Failure theories for Ductile Material

1) Maximum Shear Stress Theory:

According to this Theory "Failure in ductile material occurs when the maximum shear stress in the part exceeds the shear stress in a tensile test Speciman (of the same material) at yield. The max: shear stress can be determined by drawing Mohr's circle for the element. The result indicate that

$$\tau_{max} = \sigma_Y/2$$

This Theory Can be used to predict the failure Stresses of a ductile material Subjected to any type of loading

(2) Maximum Distortion Energy Theory:

According to This Theory "Failure" occurs when the distortion Strain energy in the materials exceeds the distortion Strain energy in tensile test Speciman (of the Same materials) at yield.

The Strain energy density Can be Considered as The Sum of Two parts one part representing the energy needed to Cause a volume Change of the element with no Change in Shape, and the other part representing the energy needed to distort the element

⟹ Two Failure Theory For Brittle Material

(1) Max: Normal Stress Theory:

According to this Theory

" A brittle material will fail when the maximum tensile Stress, σ_1

in the material reaches a value that is equal to ultimate normal stress the material can sustain when it is subjected to simple tension

⇒ Maximum normal stress theory is applicable on concrete because tensile stresses are consider and concrete is strong in compression and weak in tension a concrete is brittle material

⇒ Mohr's failure criterion theory applicable to predict the failure of brittle materials as concrete is a brittle material

⇒ Steel is a ductile material and due to max: shear stress the steel bends which may cause the breaking of steel therefore max: shear stress theory and minimum distortion theory are applicable to ductile material such as steel.