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Final term Paper
(Summer)

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Subject : Mos 2

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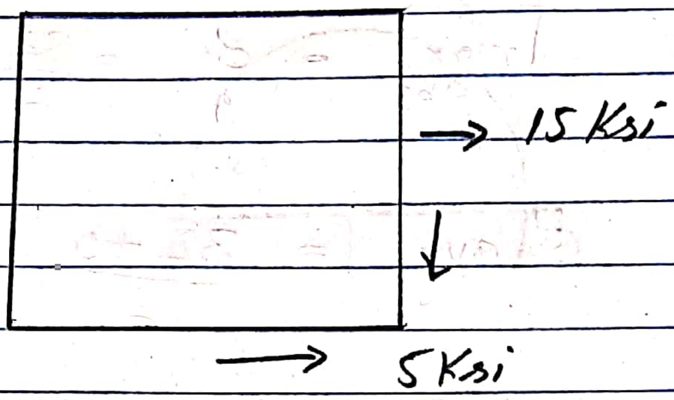
Q No 01



Given data

$\sigma_x = 15$ Ksi

$\sigma_y = 0$

$\tau_{xy} = -5$ Ksi

Required Data

a - Principal stress

b - Max - Plan shear stress

c - averag Normal stress

Sol:

a - Principal stress

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

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

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

$\sigma_{1} = 16.51$ Ksi

$\sigma_{2} = 7.5 - 9.01$

$\sigma_2 = -1.51$ Ksi

Now we find orientation
we Know that

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

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

$$\theta_2 = -0.33$$

Now we check which angles goes with which Principle stress
we Known that.

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

$$\tau_{xy} \sin 2\theta$$

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$$\sigma_{x_1} = \frac{15+0}{2} + \frac{15-0}{2}\cos 2(-0.33) + (-5)\sin 2(-0.33)$$

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

$$= 14.925 + 0.6$$

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

(b) Max plan shear stress:

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

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

$$\tau_{max} = 9.01 \text{ Ksi}$$

Now we find orientation
we known that

$$\tan 2\theta = \frac{-(\sigma_x \ \sigma_y)/2}{\tau_{xy}}$$

$$= \frac{(15-0)/2}{-5}$$

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$$\tan 2\theta = +1.5$$

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

$$2\theta = 56$$

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

$$\theta = 28$$

We Know that

$$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

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

$$= -7.5(0.82) - 2.8$$

$$\boxed{\tau_{x'y'} = -8.95}$$

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Q No 1

Part b

$\sigma_x = 15$ Ksi

$\tau_{xy} = -5$ Ksi

$\sigma_y = 0$

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

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

$C = 7.5$ Ksi

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

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

$$\boxed{R = 9.01}$$

Scale $\Rightarrow$

1 smal box $= 0.5$ Ksi

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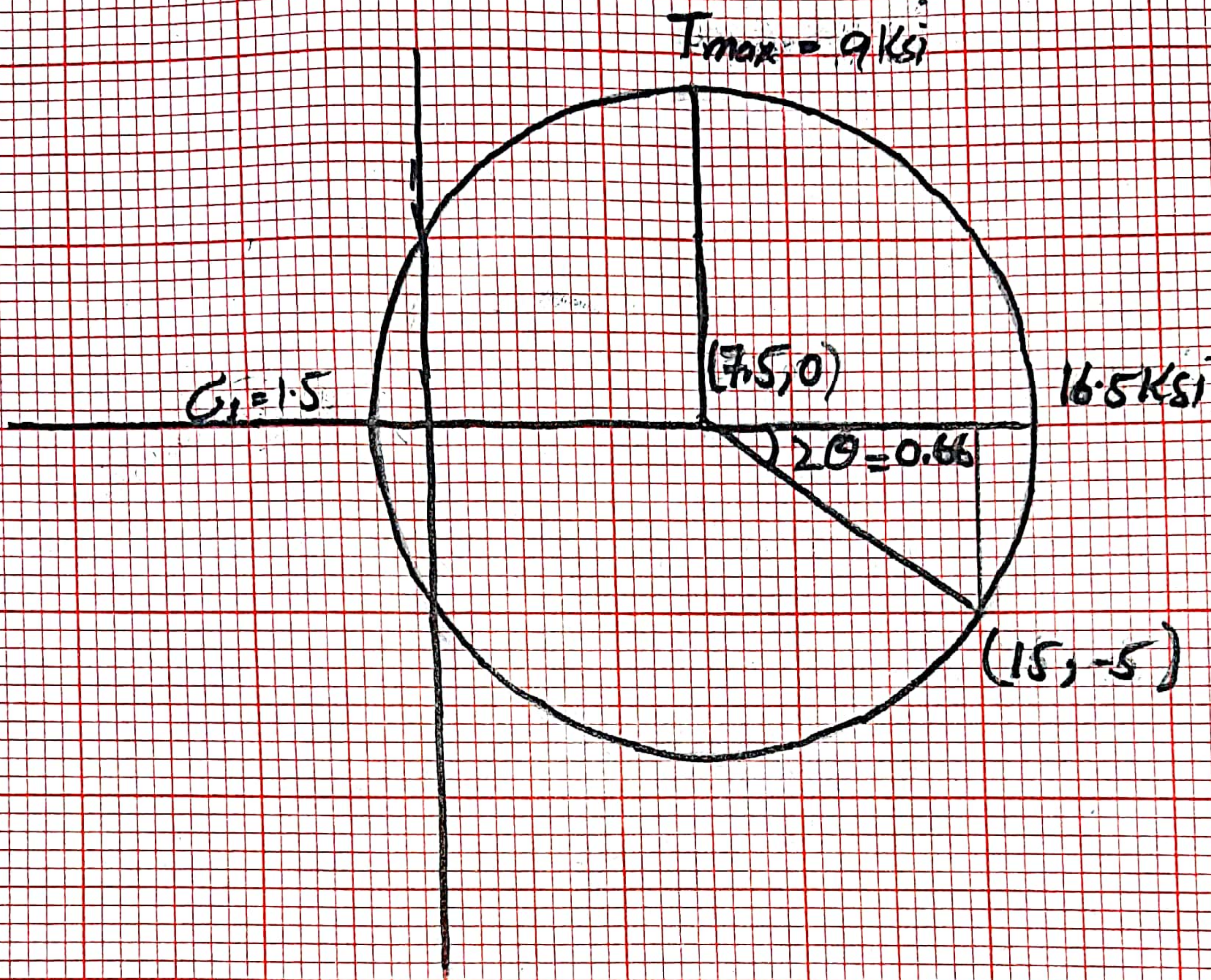

Scale = 1 small box = 0.5 Ksi

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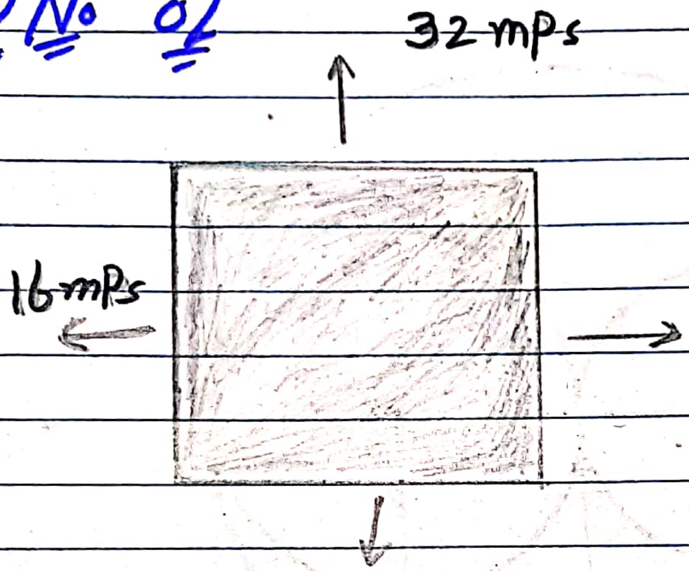
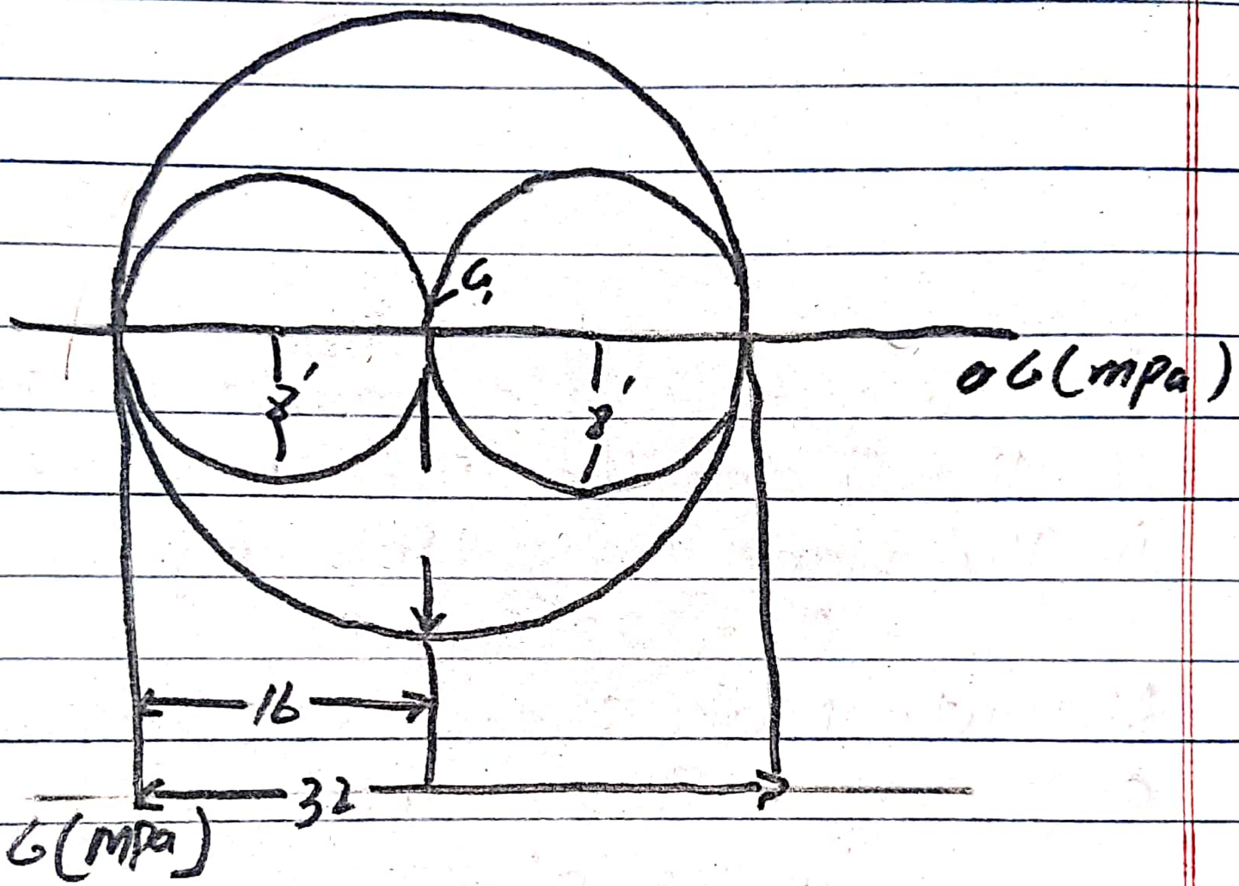
Q No 02



Sol

The Principal 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



G_1
8'
8'
σG(mpa)
16
32
G(mpa)

The largest circle has a radius of 16 MPa & describes the state of stress in the place only containing $\sigma = 32$ MPa

Absolute Max Shear stress & associated avg normal stress are

$$\tau_{abs_{max}} = 16 \text{ MPa}$$
$$\sigma_{avg} = 16 \text{ MPa}$$

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τ_{max} abs can be obtained from equation

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

$$\sigma_{avg} = \frac{32+0}{2}$$

$$\sigma_{avg} = 16\,MPa.$$

By comparsion the max in-plane shear stress can be determined from the Mohr's circle down between

$$\sigma_1 = 32\,MPa \;\&\; \sigma_2 = 16\,MPa$$

This give a value of

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

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

$$\sigma_{avg} = 24\,MPa$$

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Q No 3

Ans **Stresses Responsible for Failure of Ductile and Brittle materials:-**

* Ductile materials are limited by their shear strength usually fails because the shear stresses exceeds the strength of ductile materials.

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

Two Failure theories for Ducktile Materials.

(1) **Maximum shear stress Theory:-**
According to this theory "failure in ductile materials occurs when the maximum shear stress in the part exceeds the shear

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Stress in a tensile test specimen (of the same material) at yield. The maximum shear stress can be determined by drawing Moh's circle for the element. The result indicate that

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

This theory can be used to predict the failure stress of a ductile materials subject to any type of loading.

3 Maximum Distortion Energy Theory.

According to this theory failure occurs when the distortion strain energy in the material exceed the distortion strain energy in a tensile test specimen (of the same material) at yield.

The strain energy density can be considered as the sum of two parts, one part representing the energy needed to

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cause a volume change of the element with no change in shape, and the other part reopresanding the energy needed to distort the element.

Two Failure Theory for Brittle materials.

(1) Maximum Normal stress Theory:

According to this theory "A brittle materials will fail when the maximum tensile stress, σ_1 in the material reaches a value that is equal to ultmate normal stress the materials can sustain when it is subjected to simplo tension.

(2) Mohr's Failure Criterion

In some brittle materials tensions and compression properties are different. when this occurs a criterion based on the use of Mohr's circle may be used to predict failure. This method was developed by Otto Mohr and is sometimes referred to as Mohr's failure criterion. To apply it, one first perform three tests on the material. A uniaxial tensile test and uniaxial compressive test are used to determine the ultimate tensile and compressive stresses. Also a torsion test is performed to determine the material's ultimate shear stress. Mohr's circle for each of those stress conditions is then plotted. These three circle are contained in a "failure envelope" indicated by the extrapolated colored curve that is drawn tangent to all three circle. If a plane-stress condition at a point is represented by a circle that has a point of tangency with the envelope.

⇒ Maximum normal stress theory is applicable on concrete because tensile stresses are considered and as concrete is strong in compression and weak in tension also concrete is a brittle materials.

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

⇒ Streel is a ductile materials and due to maximum shear stress the stress bends which may cause the breaking of steel. Therefore maximum shear stress theory and maximum Distortion theory are applicable to ductile materials such as Streel.