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Subject:- MOS II

Department:- BE (civil)

Exam:- Final term

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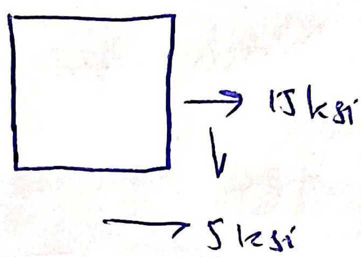
Q1:-

Given data:-

$\sigma_x = 15\,ksi$

$\sigma_y = 0$

$\sigma_{xy} = -5\,ksi$



Required data:-

a) Principle stress

b) Max- Plan shear stress

c) - average Normal stress.

Solution:-

a) Principle stress:-

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

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

$$\boxed{\sigma_{1,2} = 16.51\ ksi}$$

$$S_2 = 7.5 - 9.01$$

$$S_2 = -1.51 \text{ ksi}$$

Now we find orientation we know that

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

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

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

Now we check which angles goes with which principles stress:

we know that.

$$S_{x_1} = \frac{S_x + S_y}{2} + \frac{S_x - S_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

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

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

b) **Max-Plan shear stress:-**

$$t_{max} = \sqrt{\left(\frac{\delta x - \delta y}{2}\right)^2 + t_{xy}^2}$$

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

$$\boxed{t_{max} = 9.01 \text{ ksi}}$$

Now we find Orientation we know that:

$$\tan 2\theta_3 = -\frac{(\delta x - \delta y)/2}{\tau_{xy}}$$

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

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

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

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

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

We know that

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

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

$$= -8.95$$

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=~~

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

$R = 9.01$

Scale ⇒

1 smal box = 0.5 ksi

Graph:

$f_x = 15$ ksi

$\tau_{xy} = -5$ ksi

$f_y = 0$

$$C = \frac{f_x + f_y}{2}$$

$$C = \frac{15-0}{2} = 7.5 \text{ ksi}$$

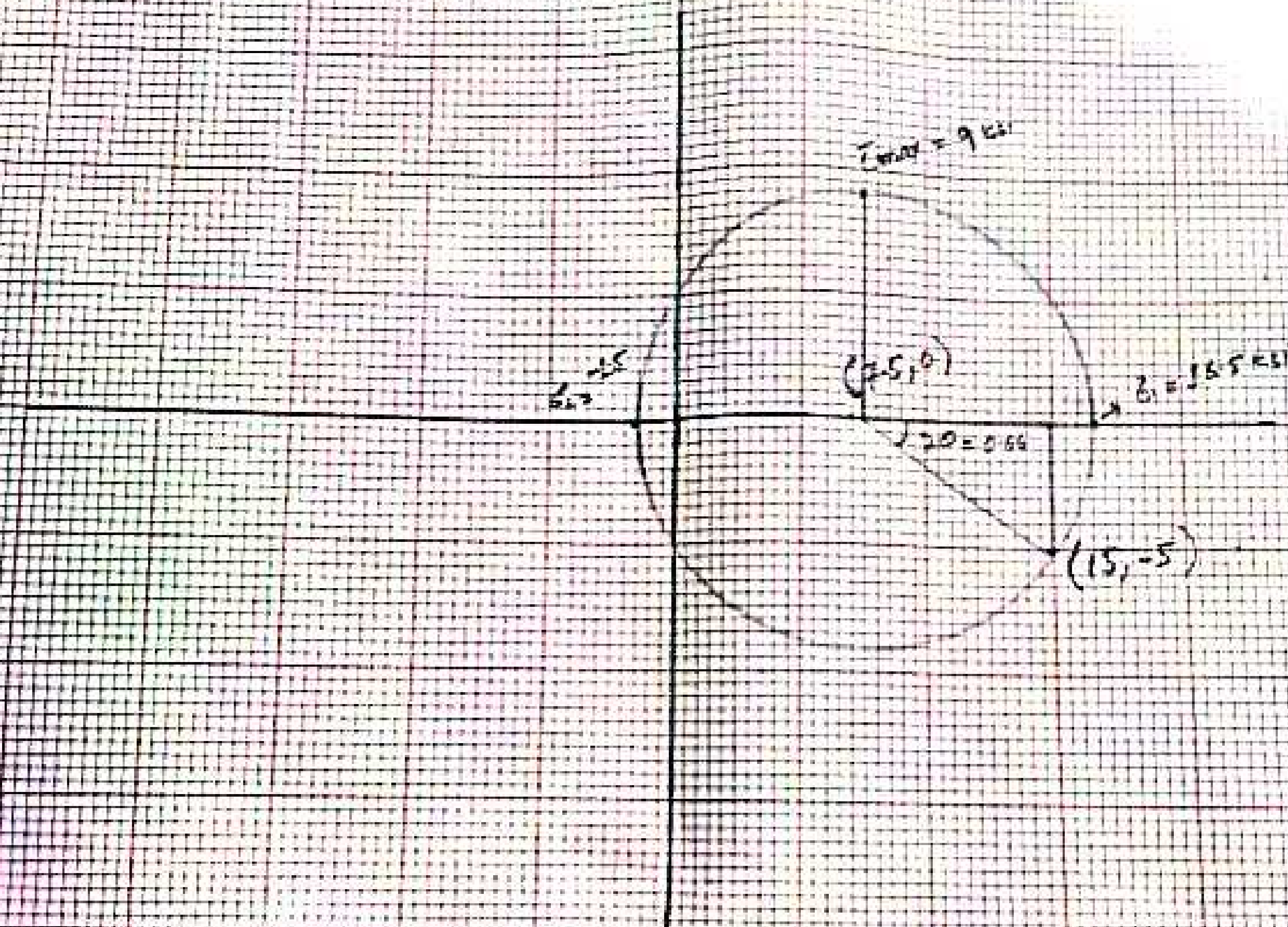
$\sigma_x = 15$ ksi

$\tau_{xy} = 5$ ksi

$\sigma_y = 0$

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

σ_a



Q2
=

Given data:.

$\delta_1 = 32$ mpa

$\delta_2 = 16$ mpa

Required data:.

Absolute Maximum shear stress.

Solution:.

The Principle stresses are

$\delta_1 = 32$ mpa

$\delta_2 = 16$ mpa

If δ_1 and δ_2 are plotted along δaxis, the Mohr's circle are obtained.

The large circle was radius of 16mpa. ~~and~~ The small circle was both have Radius of 8mpa and 1^{st} small has center of 8 and 2nd one have center of 24 on δaxis.

An orientation of 45° in plane, show that as shown in graph

$\tau_{abs\text{-}max} = 16$ mpa

$\tau_{ave} = 16$ mpa

Check:

$\tau_{abs\text{-}max} = \frac{\sigma_1}{2}$

$= \frac{32}{2} = 16$ mpa

$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2}$

$\sigma_{ave} = \frac{32 - 0}{2}$

$\sigma_{ave} = 16$ mpa

By compression, the maximum in plane shear stress can be determined from the Mohr's circle shown in graph.

$\tau_{max\text{-}in\ plan} = 8$ mpa

$\sigma_{ave} = 24$ mpa

Check:

$$\tau_{max-in\,plan} = \frac{\delta_1 - \delta_2}{2}$$

$$= \frac{32-16}{2}$$

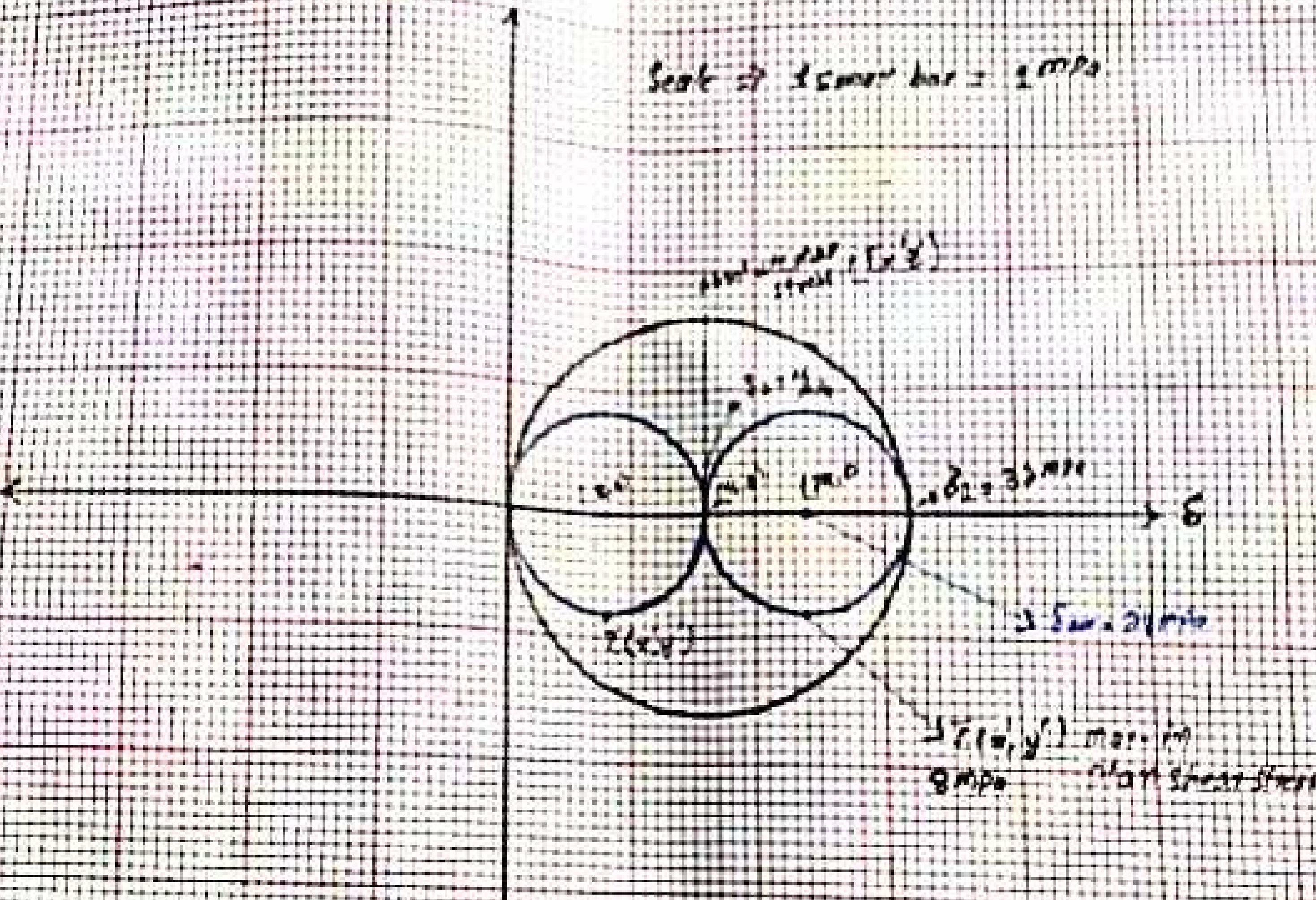
$$\boxed{\tau_{max-in\,plan} = 8\ mpa}$$

$$\delta_{ave} = \delta_1 + \delta_2$$

$$= \frac{32+16}{2}$$

$$\boxed{\delta_{ave} = 24\ mpa}$$

Scale ⇒ 1 small box ⇒ 1 MPa



Q3

Ans:- Stresses responsible for failure of ductile and brittle material:

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

→ Brittle materials are limitted 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 materials occure when the maximum shear stress in the part exceeds the shear stress in a tensile test Specimen (of the same material) at yield. The maximum shear stress can be determine by drawing Mohr's circle for the element. The result indicate that

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

This theory can ~~by~~ be used to predict the failure stress 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 a tensile test specimen (of the same material) at yield.

The strain energy density can be considered as the sum of two part, one part representing ~~experimently~~ two energy needed to cause a volume change in shape, and the other part representing the energy needed to distort the element.

⇒ Two Failure theory for Brittle Materials:-

1) Maximum Normal stress theory:-

According to this theory " A brittle material with fail when the maximum tensile stress in the material reaches a value that is equal to ultimate normal stress the material can sustain when it is subjected to simple tension.

2) Mohr's Failure Criterion:-

In Some brittle material tension and compression properties are different. When this occurs a criterion based on the use of Mohr's circle may be used to predict a failure. This mathod was developed by Otto Mohr and is sometime referred to as Mohr's failure Criterion. To apply it, one first Perform three test on the material. A ~~uste~~ uniaxial ~~test~~ tensile test and uniaxial compressive test are used to determine the ultimate tensile and compressive stresses(S_{ult})and (S_{ult})$_c$, respectively. Also a torsion test is performed to determine the materials ultimate shear stress. Mohr's Circle for each of these stress conditions is then plotted. These three circles are contained in a "failure envelope". indicated by the extrapolated colored curve that is drawn tangent to all three circles. If a plan-stress condition at a point is represented by a circle that has a point of tangency with the envelope, or if it extends beyond the envelope's boundry, then failure is said to occur.