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Subject	Mechanics of Solid-II
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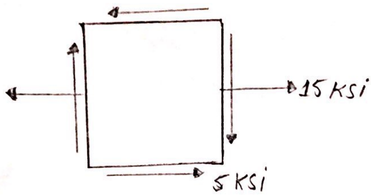
Q No 1



Given data

$\sigma_x = 15$ ksi

$\sigma_y = 0$

$\tau_{xy} = -5$ ksi

Required Data.

(a) principal stress

(b) Max-plan Shear stress

(c) average Normal Stress

Solution:.

(a) principal Stresses

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

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

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

$$\sigma_1 = 16.51 \text{ ksi}$$

$\sigma_2 = 7.5 - 9.01$

$\sigma_2 = -1.51$ ksi

Now we find orientation we know That

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

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

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

Now we check which angle goes with which principle stress

We know that

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

$$= \frac{15+0}{2} + \frac{15+0}{2} \cos_2 (0.33) + (-5)$$

$$\sin 2(-0.33)$$

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

$$= 14.925 + 0.6$$

$$\sigma_{x_1} = 15.525$$

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(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 know that

$$\tan 2\theta = \frac{-\left(\frac{\sigma_x - \sigma_y}{2}\right)/2}{2}$$

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

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

$$2\theta = 56$$

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

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

we know That

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

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

$= -7.5 (0.82) - 28$

$= -8.95$

<u>Q1) part b</u>

$\sigma_x = 15 ksi$

$\tau_{xy} = -5 ksi$

$\sigma_y = 0$

$h @ = \frac{\sigma_x + \sigma_y}{2} = \frac{15-0}{2}$

$h = 7.5 ksi$

<u>Radius</u>

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

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

$R = 9.01$

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Scale

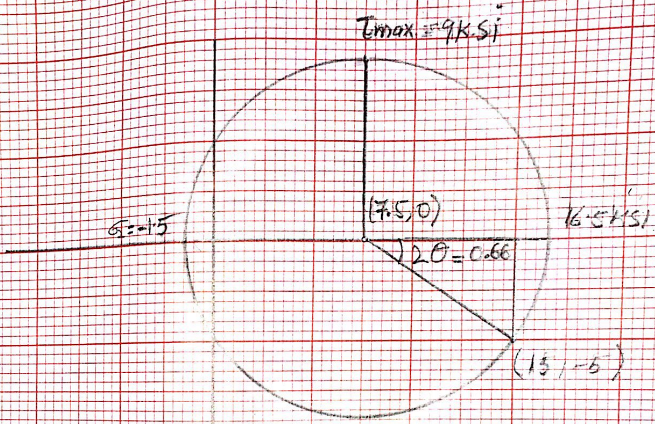
1 small box = 0.5 ksi

3 ksi = 1cm

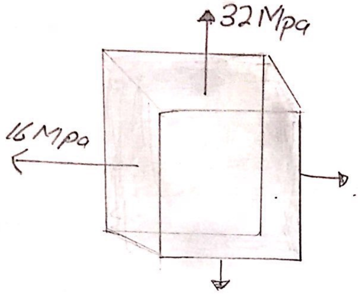
$h = 75$ ksi = 2.5cm

$2x = 15$ ksi = 5cm

Scale = 1 Small box = 0.5 ksi



Q No2



Given data

$\sigma_1 = 32 Mpa$

$\sigma_2 = 16 Mpa$

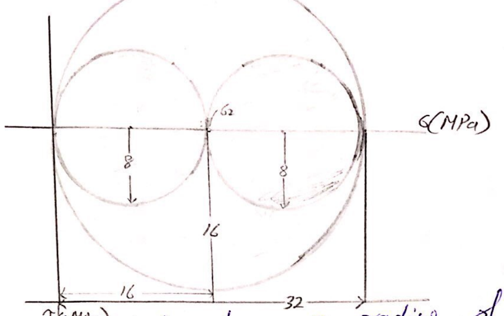
Required

Maximum shear stresses at point using Mohr's circle = ?

Solution

An orientation of an element 45° within this plane yeilds the state of absolute maximum shear stresses and the associated average normal stress namely.

- These stresses are ploted along the σ axis three Mohr's circle are constructed, stresses are shown.



The largest circle has a radius of 16 Mpa and describes the state of stress in the plane only containing $\sigma_1 = 32$ Mpa

Absolute Max. Shear stress and associated avg normal stress are

$$\tau_{abs\,max} = 16 \text{Mpa}$$

$$\sigma_{avg} = 16 \text{Mpa}$$

· $\tau_{abs\,max}$ can be obtained from ~~d~~ equation

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

$$\sigma_{avg} = \frac{32+0}{2} = 16 \text{Mpa}$$

By comparison the maximum in-plan shear ~~plan~~ Stress can be determined from the Mohr's circle

draw b/w $\sigma_1 = 32Mpa$ and $\sigma_2 = 16Mpa$

This gives a value of

$$\tau_{\substack{max \\ Inplan}} = \frac{32-16}{2} = 8 \text{ Mpa}$$

$$\sigma_{avg} = \frac{32+16}{2} = 24 \text{Mpa}$$

QNo 3

Ans

Main Stresses responsible for failure of ductile and brittle Mat

Stress responsible for failure of ductile and brittle material are shear strength and tensile strength.

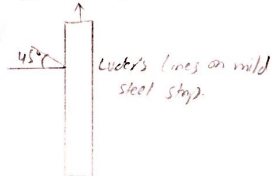
⇒ Ductile materials are limited by their shear strength. Ductile material usually fails because the shear stresses exceeds the strength of ductile materials.

⇒ Brittle materials are limited by their tensile strength. Brittle materials 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 occure when the maximum shear stress in the part exceeds in shear stress in a part exceeds the shear stress in tensile test specimen (of same material at yeild) The slipping that occure is caused by shear stress.

The edge of planes slipping as They appear on the Surface of the strip are refered as Lüder's line These lines are clearly Indicate the slip plane in the strip which occure at approximatly 45° with the axis of the strip. The maximum sheare stresse can be determined by drawing Mohr's circle for the element The result Indicate that



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

This theory can be used to predict the faliure stress of ductile material subjected to any type of loading.

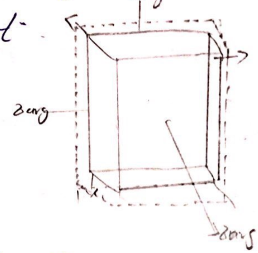
② Maximum Distortion Energy Theory

According to This Theory "faliure occurs when ~~the~~ an external loading will deform a material causing it to store energy Internally Througout its volume. The energy per unit volume of material ~~subjected~~ is called strain density energy.

$$U = \frac{1}{2}\sigma\epsilon$$

The strain energy density can be consided as the sum of two parts, one part represting the

the energy needed to cause a volume ch energy. of the element with no change in shape and The othere part representing the energy needed to distort the element.



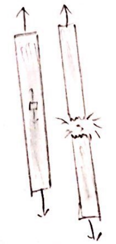
Theories of Falive for Brittle M.

① **Maximum-Normal Stress Theory:**

According to This Theory " A brittle material will fail when the maximum tensile stresses σ_1 in the material reaches a value That is equal to ultimate normal va stress the material can sustain when it is subject to simple tension.

$$|\sigma_1| = \sigma_{ult}$$

$$|\sigma_2| = \sigma_{ult}$$



② **Mohr's failure Criterion.** In some brittle materials tension and compression property are different when this occure a criterion based on use of Mohr circle may be used to predict failure.

This method was develop by otto Mohr and is sometime reffered to as Mohr's failure criterion

A uniaxial tensile test and uniaxial compressive test are used to determine the ultimate tensile and compressive stresses (ZuHk and material ultimat shear) stress TuH. Mohr's circle for each of these stress conditions is then plotted in diagram..

→ Which failure is more applicable on fllwing material why?

(a) Steel.
(b) Concrete.

<u>Concret</u> Maximum normal stress Theory is applicable on concret because tensile stresses are considerd and as concrete is strong in compression and weak in tension. also concrete is brittle material.

→ Mohr's failure criteria theory is applicable to predict the failure of brittle material as concrete is brittle material.

<u>Steel</u> Steel is a ductile material and due to maximum shear stess stéel bends which may cause the breaking of streel therfor maximum shear stress theory and maximum b. distortion Theory are applicable to ductile material such as steel.