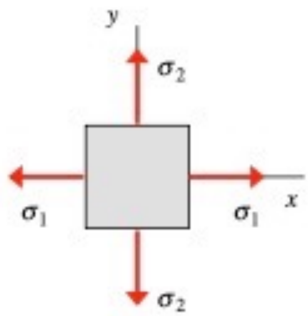
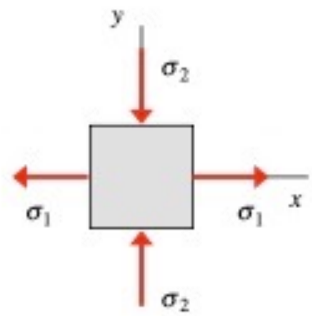
Q1

Conceptual question 13.3



stress state (a)



stress state (b)

Consider stress states (a) and (b) shown above, with $|\sigma_1| > |\sigma_2|$. Let $\left(|\tau|_{max,abs}\right)_a$ and $\left(|\tau|_{max,abs}\right)_b$ represent the absolute maximum shear stress corresponding to stress states (a) and (b), respectively. Circle the response below that describes the relative sizes of these stresses:

i) $\left(|\tau|_{max,abs}\right)_a > \left(|\tau|_{max,abs}\right)_b$

ii) $\left(|\tau|_{max,abs}\right)_a = \left(|\tau|_{max,abs}\right)_b$

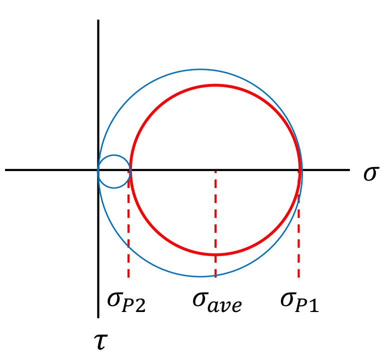
iii) $\left(|\tau|_{max,abs}\right)_a < \left(|\tau|_{max,abs}\right)_b$

iv) more information about the stress states is needed in order to answer this question

Stress state "a"

$\sigma_{ave} = (\sigma_1 + \sigma_2)\ /\ 2$
$R = (\sigma_1 - \sigma_2)\ /\ 2$

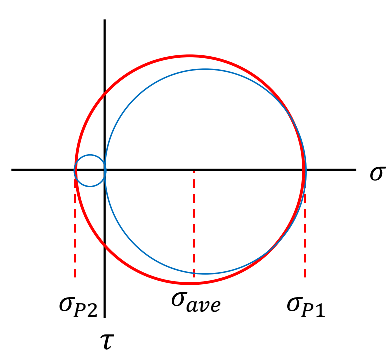
Therefore $\sigma_{ave} > R$. From this we see that both σ_{P1} and σ_{P2} are positive. Because of this, the radius of the larger of the two out-of-plane Mohr's circles is maximum shear stress: $\tau_{max,abs} = \sigma_{P1}/2 = \sigma_1\ /\ 2$.



Stress state "b"

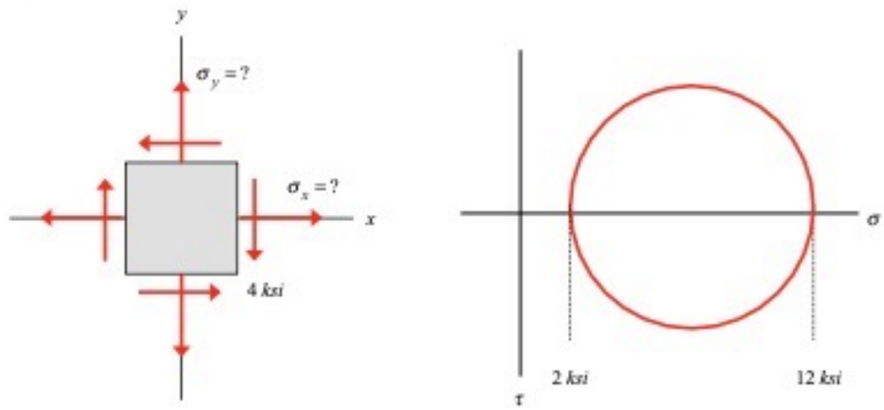
$\sigma_{ave} = (\sigma_1 - \sigma_2)\ /\ 2$
$R = (\sigma_1 + \sigma_2)\ /\ 2$

Therefore $\sigma_{ave} < R$. From this we see that σ_{P1} and σ_{P2} are of opposite signs. Because of this, the radius of in-plane circle is maximum shear stress: $\tau_{max,abs} = (\sigma_1 + \sigma_2)\ /\ 2$.



Q2

Conceptual question 13.6



Consider the state of plane stress shown above left where the two normal components of stress, σ_x and σ_y, are unknown. The Mohr's circle for this state of stress is provided in the figure above right. Determine numerical values for the two normal components of stress σ_x and σ_y. There may be more than one set of answers; you need only find one set.

$$\sigma_{ave} = (\sigma_x + \sigma_y)/2 = 7 \quad \Rightarrow \quad \sigma_x = 14 - \sigma_y$$

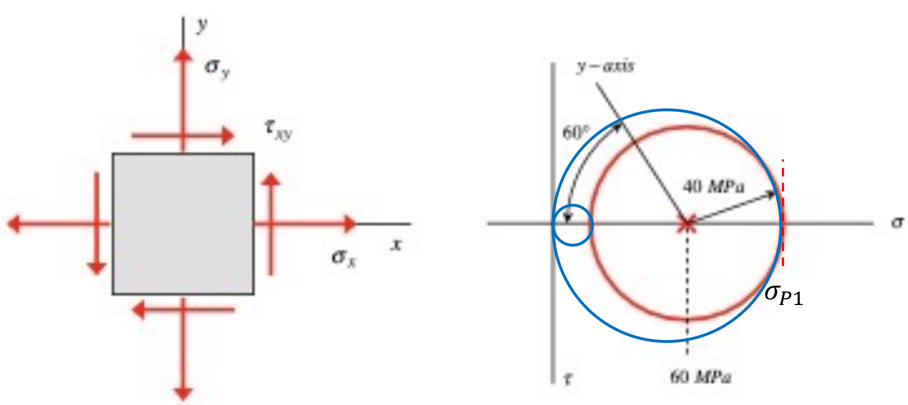
$$R^2 = (\sigma_x - \sigma_y)^2/4 + \tau_{xy}^2 = (14 - 2\sigma_y)^2/4 + \tau_{xy}^2 \Rightarrow$$

$$\sigma_y = \frac{1}{2}\left[14 - 2\sqrt{R^2 - \tau_{xy}^2}\right] = \frac{1}{2}\left[14 - 2\sqrt{5^2 - 4^2}\right] = 4\ ksi$$

$$\sigma_x = 14 - \sigma_y = 10\ ksi$$

Q3

Conceptual question 13.7



The Mohr's circle for a stress state is presented above.

a) Determine the values of σ_x, σ_y and τ_{xy} for this stress state.

b) What is the maximum absolute shear stress for the stress state?

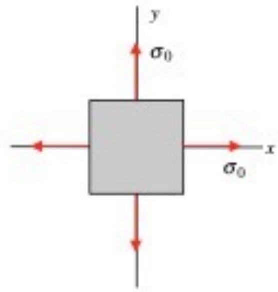
c) What is the smallest counter-clockwise rotation of the stress element above that will show the principal stresses on its faces?

$$\sigma_{P1} = 60 + 40 = 100MPa$$

Based on the larger of the two out-of-plane Mohr's circle: $\tau_{max,abs} = \sigma_{p1} / 2 = 50MPa$

Q4

Conceptual question 13.9



The stress element for a particular state of stress is shown above. Let $|\tau|_{max,in-plane}$ and $|\tau|_{max,abs}$ represent the maximum in-plane shear stress and the absolute maximum shear stress, respectively, that corresponds to this state of stress. Circle the answer below that most accurately represents the relative sizes of $|\tau|_{max,in-plane}$ and $|\tau|_{max,abs}$:

a) $0 < |\tau|_{max,in-plane} < |\tau|_{max,abs}$

b) $0 = |\tau|_{max,in-plane} < |\tau|_{max,abs}$

c) $0 < |\tau|_{max,abs} < |\tau|_{max,in-plane}$

d) $0 = |\tau|_{max,abs} < |\tau|_{max,in-plane}$

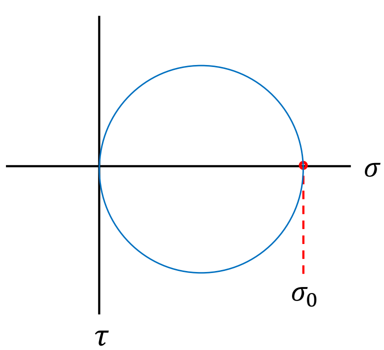
e) $0 < |\tau|_{max,in-plane} = |\tau|_{max,abs}$

f) $0 = |\tau|_{max,in-plane} = |\tau|_{max,abs}$

g) More information is needed about the state of stress in order to answer this question.

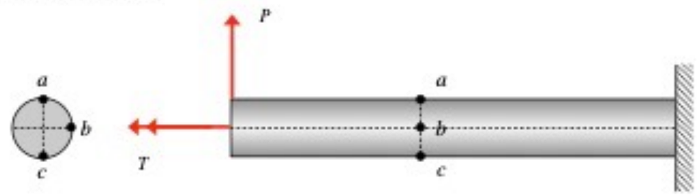
$\sigma_{ave} = (\sigma_0+\sigma_0)\ /\ 2 = \sigma_0$
$R = (\sigma_0-\sigma_0)\ /\ 2 = 0 = \tau_{max,in-plane}$

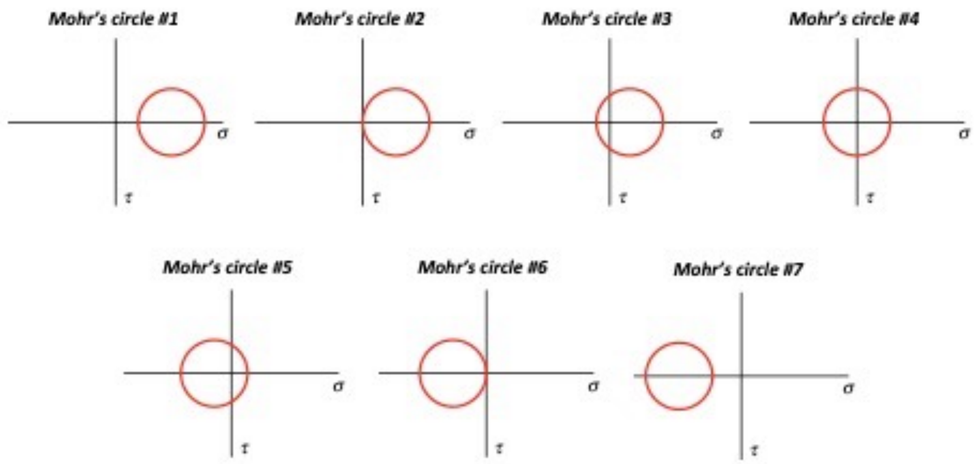
Therefore the in-plane Mohr's circle is a point. The radii of the out-of-plane Mohr's circles represent the absolute maximum shear stress: $\tau_{max,abs} = \sigma_{ave} = \sigma_0$.



Q5

Conceptual question 14.1





A cantilevered beam is loaded with a transverse force P and an axial torque T at its left end. Consider points "a", "b" and "c" on a cross section of the beam. In this problem, you are asked to match the stress state at each point with a Mohr's circle (Mohr's circles #1-#7). For this, circle the Mohr's circle below that matches each cross section point:

- *Point "a":* Mohr's circle *#1* *#2* *#3* *#4* *#5* *#6* *#7*
- *Point "b":* Mohr's circle *#1* *#2* *#3* *#4* *#5* *#6* *#7*
- *Point "c":* Mohr's circle *#1* *#2* *#3* *#4* *#5* *#6* *#7*

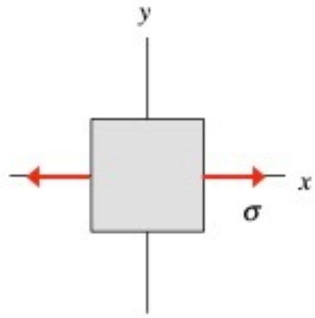
Point "a": $\sigma_x < 0$ and $\tau_{xz} \neq 0$. Therefore: $\sigma_{ave} < 0$ and $|\sigma_{ave}| < R$

Point "b": $\sigma_x = 0$ and $\tau_{xy} \neq 0$. Therefore: $\sigma_{ave} = 0$

Point "c": $\sigma_x > 0$ and $\tau_{xz} \neq 0$. Therefore: $\sigma_{ave} > 0$ and $|\sigma_{ave}| < R$

Q6

Conceptual question 15.1



Consider the state of stress shown above in a *ductile* material. Let σ_{MSS} and σ_{MDE} be the values of the normal stress σ above that correspond to failure of the material using the maximum shear stress and maximum distortional energy theories, respectively. Circle the answer below the best describes the relative sizes of σ_{MSS} and σ_{MDE}. Provide a written explanation for your answer.

a) $\sigma_{MSS} < \sigma_{MDE}$

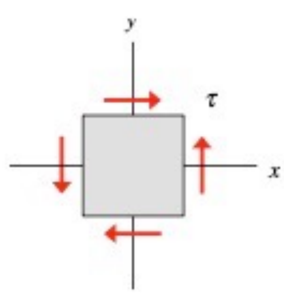
b) $\sigma_{MSS} = \sigma_{MDE}$

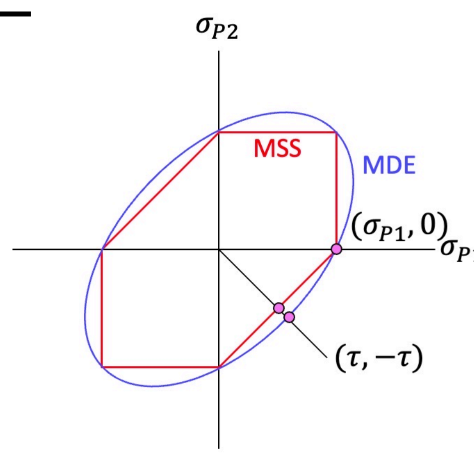
c) $\sigma_{MSS} > \sigma_{MDE}$

$\sigma_{ave} = \sigma / 2$ and $R = \sigma/2 \;\Rightarrow\; \sigma_{P1} = \sigma$ and $\sigma_{P2} = 0$

Q7

Conceptual question 15.2





Consider the state of stress shown above in a *ductile* material. Let τ_{MSS} and τ_{MDE} be the values of the shear stress τ above that correspond to failure of the material using the maximum shear stress and maximum distortional energy theories, respectively. Circle the answer below the best describes the relative sizes of τ_{MSS} and τ_{MDE}. Provide a written explanation for your answer.

a) $\tau_{MSS} < \tau_{MDE}$

b) $\tau_{MSS} = \tau_{MDE}$

c) $\tau_{MSS} > \tau_{MDE}$

$\sigma_{ave} = 0$ and $R = \tau \;\Rightarrow\; \sigma_{P1} = \tau$ and $\sigma_{P2} = -\tau$