Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

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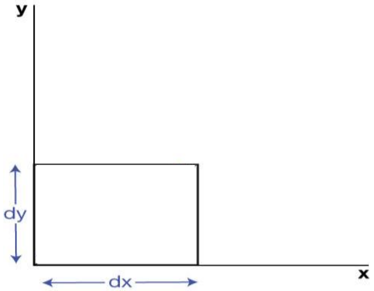
Module 34 Learning Outcome

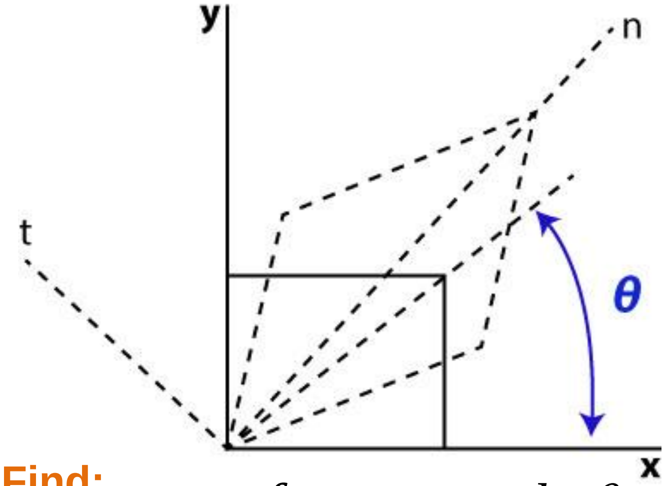
- For a given set of plane strain conditions, determine the strain on any given plane at a point using Mohr’s Circle

Plane Strain



$$\varepsilon_z = \gamma_{xz} = \gamma_{zx} = \gamma_{yz} = \gamma_{zy} = 0$$

In general, ε_x **,** ε_y **, and** $\gamma_{xy} = \gamma_{yx}$ **are known or can be found**



Find: $\varepsilon_n , \gamma_{nt}$ *for any angle* θ

Plane Strain
Mohr's Circle

Graphical tool for the depiction of the transformation equations for plane stress

$$\left(\varepsilon_n - \frac{\varepsilon_x + \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2} - 0\right)^2 = \left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2$$

Radius = $\sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$

Center: $\left(\frac{\varepsilon_x + \varepsilon_y}{2}, 0\right) = (\varepsilon_{AVG}, 0)$

The angle on Mohr's circle is 2 times the stress block angle

Mohr's circle is a circle where each point represents the stress ε **and** $\gamma / 2$ **on a particular plane through a single point**

Plane Strain
Mohr's Circle

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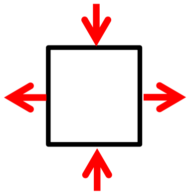
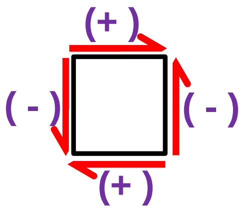
Mohr's Circle Sign Convention

Normal



(+) Tension
(-) Compression

Shear



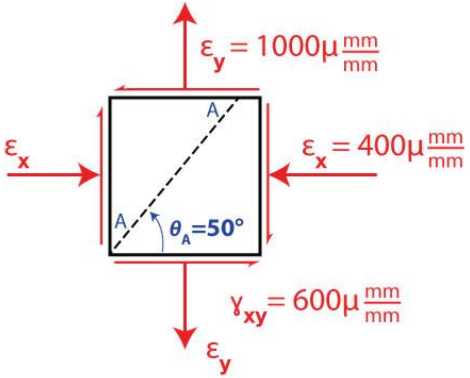
Clockwise (+)
Counterclockwise (-)

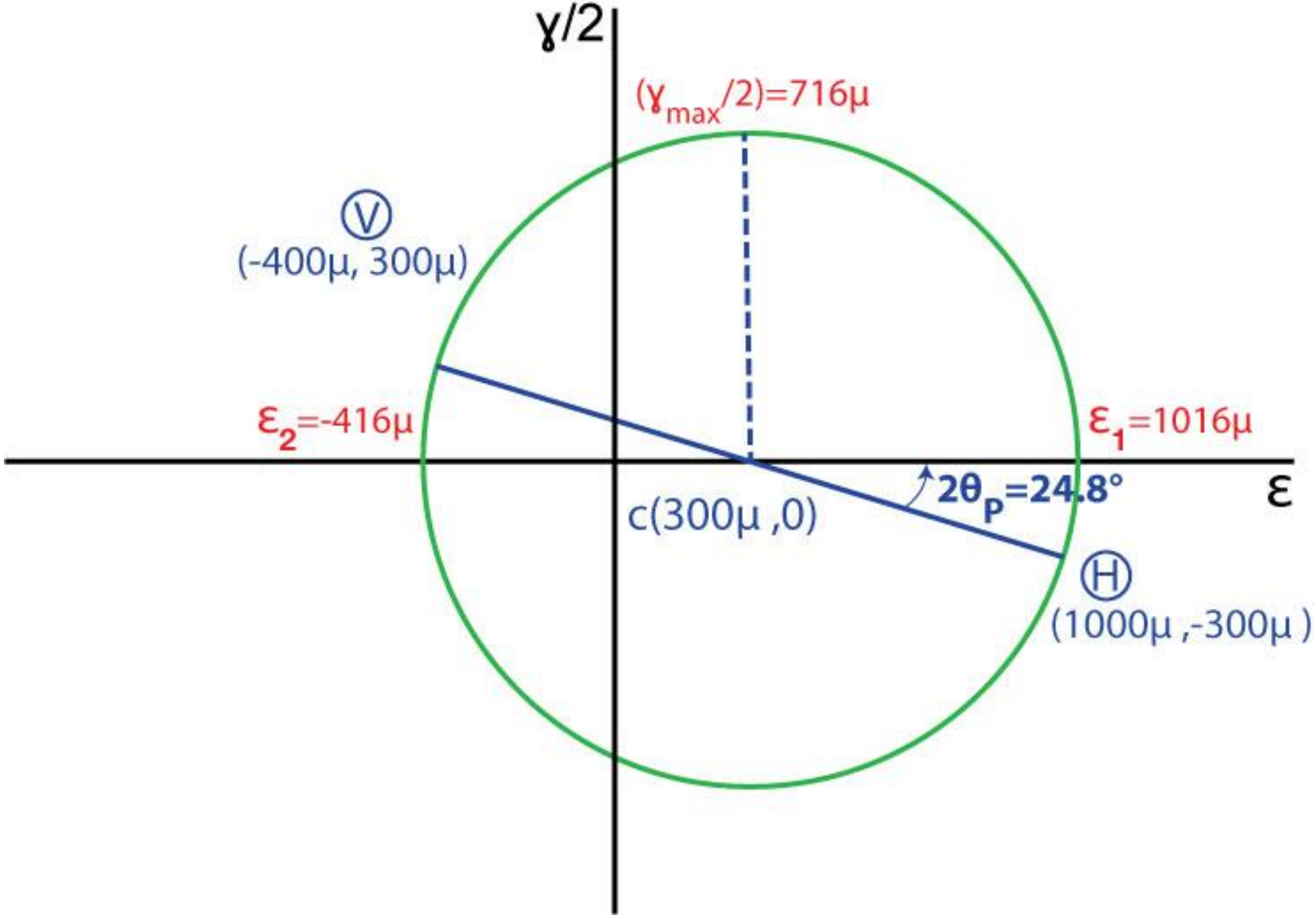
Example

The measured strain components at a point in a body under a state of plane strain are shown. Using Mohr's circle, find:

a) The principal strains and the maximum shear strain at that point, and find the orientation of the principal planes

b) The normal and shear strains on plane AA oriented as shown.





Do by hand on previous page

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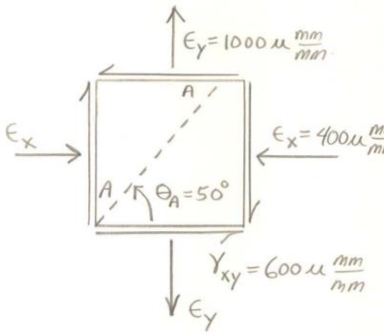

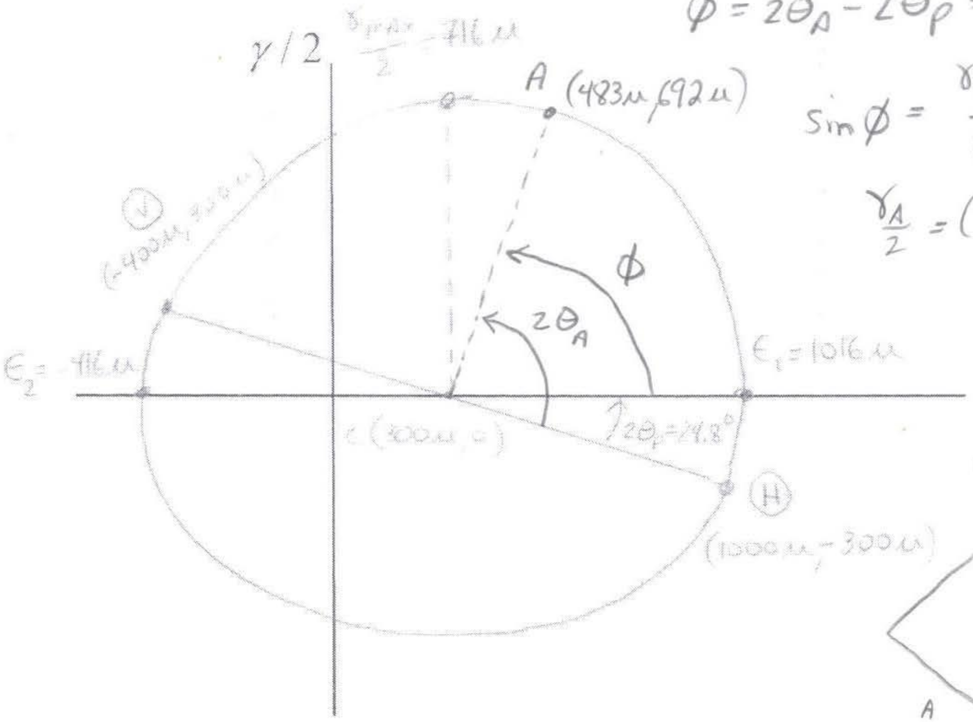

$\theta_A = 50°$ ON BLOCK

$2\theta_A = 100°$ ON MOHR'S CIRCLE

$\phi = 2\theta_A - 2\theta_p = 100° - 24.8° = 75.2°$

$\sin\phi = \frac{\gamma_A/2}{R}$

$\frac{\gamma_A}{2} = (716\mu)\sin 75.2° = \underline{\underline{692\mu\,rad}}$ ANS.

$\epsilon_A = (716\mu)\cos 75.2° + 300\mu = \underline{\underline{483\mu \frac{mm}{mm}\,(T)}}$ ANS.