Problem Solution

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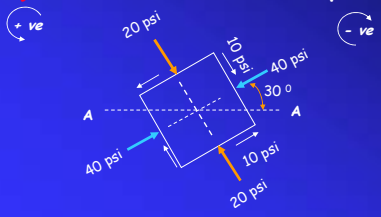
Mohr's Circle Problem

- For the element shown below, and using Mohr's Circle Method, Determine the following:
  - a) The Magnitude of principal stress.
  - b) The direction of principal stress.
  - c) Stresses on the horizontal plane A-A.



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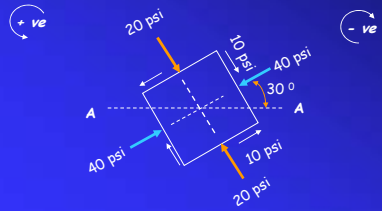

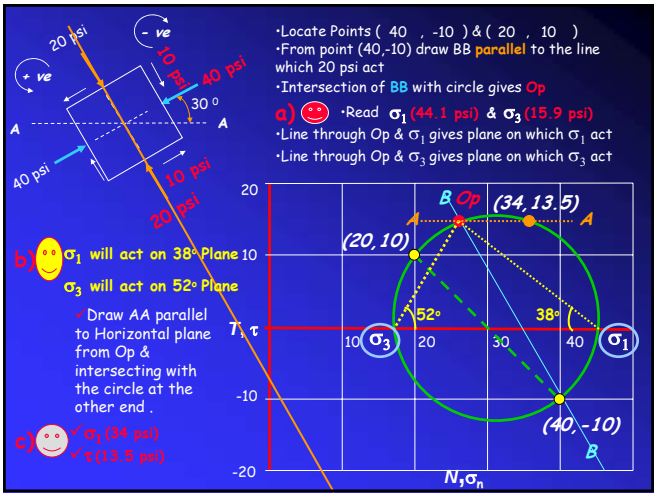

Mohr's Circle on the Web

To learn How to solve Mohr's Circle check the following web pages

Draw Mhor http ://ce.ecn.purdue.edu/~berney/CE597N/project/Index

Draw Mhor http://www.aoe.vt.edu/~jing/MohrCircle.html

Learn about the Theory
http://www.aoe.vt.edu/~jing/java/nsfapplets/MohrCircles2-3D/Theory/theory.htm

http://physics.uwstout.edu/strength/special/spec85.htm

Center of Circle

- The circle center is determined from the following calculation:

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

- The radius can also be found by the following relation:

$$Radius = \sqrt{\left[\frac{\sigma_y + \sigma_x}{2}\right]^2 + \tau^2_{xy}}$$

Principal Stresses

- The principal stresses represent the largest normal stresses developed on the element. This will occur when the shear stresses are 0. From the following formulation the principal stresses can be determined given the initial coordinates:

$$\sigma_{1,3} = \frac{\sigma_y + \sigma_x}{2} \pm \sqrt{\left[\frac{\sigma_y - \sigma_x}{2}\right]^2 + \tau^2_{xy}}$$

- On the Mohr's circle one merely needs to draw a circle with the radius shown (the distance from the center to one of the initial coordinates) and read off the values where the circle intersects the sigma (horizontal) axis. This axis represents the stresses on the element where tau (shear stress) is equal to 0.

Rotated Points

- In order to determine the stresses acting on the element for any given plane, the following equation can be used knowing the principal stresses and the angle of rotation from the horizontal axis:

$$\sigma_\theta = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2}\cos 2\theta \quad \textit{and} \quad \tau_\theta = \frac{\sigma_1 - \sigma_3}{2}\sin 2\theta$$

- As you can see it is much simpler to use the graphical method as it allows you to quickly visualize not only the plane of interest but where certain critical stress points exist, such as
  - What is the rotation of the element to reach the principal stress state?
  - What is the rotation to reach a shear state (normal stresses = 0)?
  - What are the stresses for any value of rotation?

Pole Point

- The pole point is determined from drawing a line parallel to the face of the elment which the stresses are acting. To determine your pole point follow these steps:
- find the coordinate point (sigmaX, tauX) and draw a line vertically until it touches the Mohr's circle.
- find the coordinate point (sigmaY, tauY) and draw a line horizontally until it touches the Mohr's circle. Done properly, this line should intersect the previous line at the intersection with the Mohr's circle. This is now the pole point.
- It was mentioned earlier that all angles measured on the element must be multiplied by 2 when determining values from the Mohr's circle. The advantage of the pole point is that the true angle can be used to determine the stresses lying on a given plane of rotation. This is not shown on the graph, but the angle made by the intersection of a line drawn from the Pole Point to the point F on the graph and the horizontal will be equal to half the angle ACF or equal to your input orientation.