Mohr's Circle: Example Problem

\[ 22.1 \text{ ksi} = \sigma_y \]

\[ 9.3 \text{ ksi} = \sigma_x \]

\[ 4.8 \text{ ksi} = \tau_{xy} \]

Redraw in positive directions:

\[ \sigma_y = -22.1 \text{ ksi} \]

\[ \tau_{xy} = -4.8 \text{ ksi} \]

\[ \sigma_x = 9.3 \text{ ksi} \]

1. Find Center of Circle

\[ C = \sigma_{ave} = \frac{\sigma_x + \sigma_y}{2} = \frac{9.3 - 22.1}{2} = -6.4 \]

2. Plot Points:

\[ (\sigma_{ave}, 0) = (-6.4, 0) \]

\[ (\sigma_x, \tau_{xy}) = (9.3, -4.8) \]

\[ (\sigma_y, -\tau_{xy}) = (-22.1, 4.8) \]

3. Draw Circle Around Center (over)

4. Find radius of circle (see figure)

\[ R^2 = h^2 + b^2 = [9.3 - (-6.4)]^2 + [4.8]^2 \Rightarrow R = 16.42 \]

5. Use Table. To find answers to question like:

- Find maximum & minimum principal stresses, \( \theta_p \) (principal angle)
- Draw Principal Stress State
- Find maximum shear stress state
- Draw max shear stress state
- Rotate block \( \theta = 25^\circ \) to find new components
All units Ksi.

\[(\sigma_{p1}, \sigma_{p2}) = (-6.4, 16.4)\]

\[(\sigma_{x}, \sigma_{y}) = (9.3, -4.8)\]

\[\theta_{p} = 17^\circ\]

\[\theta_{p} = 8.5^\circ\]

**Original Stress State**

-22.1 Ksi

\[\sigma_{p1} = \sigma_{max} + R = -6.4 + 16.42\]

\[\sigma_{p1} = 10.02\text{ Ksi}\]

\[\sigma_{p2} = \sigma_{min} - R = -6.4 - 16.42\]

\[\sigma_{p2} = -22.82\text{ Ksi}\]

**Principal Stress State**

Notice that \((\sigma_{x}, \sigma_{y})\) was rotated to \((\sigma_{p1}, 0)\).
(c) Max shear stress in at top & bottom of circle
   rotate \( \theta_s = 90° \) from principal stress state \( \sigma_x \) on circle.

-22.8 ksi

Notice that \( (\sigma_p, 0) \) was rotated to \( (\sigma_{xy}, \theta_p) \).

(e) \( 25° \) on block \( \Rightarrow 50° \) on circle

New location of \( \sigma_x' \):

\[
\begin{align*}
\sigma_x' &= \sigma_{xy} + l = -6.4 + 13.8 = 7.35 \text{ ksi} \\
\tau_x'y' &= h = 8.9 \text{ ksi}
\end{align*}
\]
Also \( \sigma_y' = \sigma_{xx} - P = -6.4 - 13.8 = -20.2 \text{ ksi} \)

\[ \sigma_y = 22.1 \text{ ksi} \]

\[ T_{xy} = -4.8 \text{ ksi} \]

\( \sigma_x = 9.3 \text{ ksi} \)

\( T_{xy}' = 8.9 \text{ ksi} \)

\( \sigma_x' = 7.35 \text{ ksi} \)

\[ 25^\circ \]

Notice that \((\sigma_x, T_{xy})\) rotated to \((\sigma_x', T_{xy}')\) of Part (c)

The old \( \sigma_x \) component rotates to the new \( \sigma_x' \) component.

The old \( \sigma_y \) component rotates to the new \( \sigma_y' \) component.

The shear stress direction (sign) is determined by where the new pt. \((\sigma_x', T_{xy}')\) end up:

\( T_{xy}' \) is positive below the \( \sigma \) axis,

\( T_{xy}' \) is negative above the \( \sigma \) axis

when looking at \((\sigma_x', T_{xy}')\)