Equation for Coulomb-Mohr Theory (4th Quadrant)

\[
\frac{1}{n} = \frac{\sigma_A}{S_{ut}} + \frac{\sigma_B}{S_{uc}} \quad \sigma_A \geq 0 \quad \sigma_B \leq 0
\]

Equation for Modified Mohr Theory (4th Quadrant)

\[
\frac{1}{n} = \sigma_A \left( \frac{1}{S_{ut}} + \frac{1}{S_{uc}} \right) + \frac{\sigma_B}{S_{uc}} \quad \sigma_A \geq 0 \quad \sigma_A \geq -\sigma_B
\]

\[
\frac{1}{n} = \sigma_A \left( \frac{1}{S_{ut}} + \frac{1}{S_{uc}} \right) + \frac{\sigma_B}{S_{uc}} \quad \sigma_A \geq 0 \quad \sigma_A \leq -\sigma_B
\]

Note: \(\sigma_B\) and \(S_{uc}\) are taken to be negative numbers in all of the above equations.

Example: Brittle Failure

The following shows the state of stress at a critical point in a part fabricated from Class 20 gray cast iron.

\[\tau_{xy} = 30 \text{ MPa}\]
\[\sigma_x = 50 \text{ MPa}\]

Determine the static factor of safety based on the state of stress at this point.

(Turn over for solution)
Solution:
From Appendix C-3a:
\[ S_{ut} = 152 \text{ MPa} \]
\[ S_{uc} = -572 \text{ MPa} \]
The principle stresses are first obtained using Mohr’s circle:

Then, using the Modified Mohr theory:
\[ \sigma_A = \sigma_1 \]
\[ \sigma_B = \sigma_3 \]
\[ \sigma_A \geq -\sigma_B \]
Therefore:
\[ n = \frac{S_{ut}}{\sigma_A} = \frac{152}{64.05} = 2.4 \]
Representing the solution graphically: