**Goodman and Soderberg Failure Criteria**

### Soderberg

- \( m \sigma_m + b = \sigma_a \)
- \( m(0) + b = S_f \)
- \( m(S_y) + b = 0 \)
- \( b = S_f \)
- \( m = -\frac{S_f}{S_y} \)
- \( -\frac{S_f}{S_y} \sigma_m + S_f = \sigma_a \)
- \( S_f \left( 1 - \frac{\sigma_m}{S_y} \right) = \sigma_a \)

### Goodman

- \( m \sigma_m + b = \sigma_a \)
- \( m(0) + b = S_f \)
- \( m(S_{ut}) + b = 0 \)
- \( b = S_f \)
- \( m = -\frac{S_f}{S_{ut}} \)
- \( -\frac{S_f}{S_{ut}} \sigma_m + S_f = \sigma_a \)
- \( S_f \left( 1 - \frac{\sigma_m}{S_{ut}} \right) = \sigma_a \)
What happens if the alternating stress is low and constant, but the mean stress continues to increase?

![Graph showing Goodman Failure Line and Load Line]

The ratio of \(-\sigma_m + S_y\) to \(\sigma'_a\) is the factor of safety

\[-\sigma_m + S_y = \sigma'_a\]

(equation of yield line)

\[\sigma_m = -\sigma'_a + S_y\]

\[n = \frac{\sigma_m}{\sigma'_m}\]
Vary alternating stress and hold mean stress constant

\[ S_f \left( 1 - \frac{\sigma_m'}{S_{ut}} \right) = \sigma_a \]

\[ n = \frac{\sigma_a}{\sigma_a'} \]

ratio of \( \sigma_a' \) to \( \sigma_a \) is the factor of safety
maintain load line ratio, increase alternating and mean stresses

\[
\frac{\sigma_a'}{\sigma_m'} = S_f \left(1 - \frac{\sigma_m}{S_{ul}}\right)
\]

\[
\sigma_m \left(\frac{\sigma_a'}{\sigma_m'} + \frac{S_f}{S_{ul}}\right) = S_f
\]

\[
\sigma_m = \frac{S_f}{\left(\frac{\sigma_a'}{\sigma_m'} + \frac{S_f}{S_{ul}}\right)}
\]

\[
n = \frac{\sigma_m}{\sigma_m'}
\]
Given the following information, construct a Goodman Failure Diagram and determine factors of safety considering constant alternating stress and increasing mean stress, constant mean stress and increasing alternating stress, and increasing mean and alternating stress with a constant load line slope.

\[ \sigma_a' = 8.72 \text{ ksi} \]
\[ \sigma_m' = 10.5 \text{ ksi} \]
\[ \text{Sut} = 80 \text{ ksi} \]
\[ \text{Sy} = 60 \text{ ksi} \]
\[ \text{Sf} = 21.8 \text{ ksi} \]