COMBINATIONS OF LOADING MODES

To date we have looked at rather simple loading situations.

FULLY REVERSED LOADING

Can be solved with a simple S-N curve.

SIMPLE LOADING WHERE MIDRANGE STRESSES ARE NOT ZERO

Here we separated the alternating and the midrange curves and looked at Langer, Gerber, ASME, and Goodman curves for solving these problems.

COMPLEX LOADING

If we have complex loading where there is bending, axial, and torsional stress, we must choose a different method.

ENDURANCE LIMIT

There is one significant change to the correction factors for endurance limit. Previously we had:

\[ C_{load} = k_c = \begin{cases} 3 & \text{bending} \\ 1.85 & \text{axial} \\ 1.5 & \text{torsional} \end{cases} \]
If we have mixed loads then we let

\[ C_{\text{load}} = 1 \]  For all load cases.

**LOCAL YIELDING CHECK**

\[
\sigma_a = \sigma_{a \text{ bending}} + \sigma_{a \text{ axial}}
\]

\[
\sigma_{\text{max}} = K_f \sigma_a + K_f \sigma_m \quad \sigma_m = \sigma_{m \text{ bending}}
\]

\[
T_m = K_f s \sigma_a + K_f t \sigma_m
\]

\[
\sigma_m' = \sqrt{\sigma_{\text{max}}^2 + 3 (T_m) ^2}
\]

Now if

\[ \sigma_{\text{max}} < S_y \]

\[ K_f m = K_f \]

\[ K_f s m = K_f t \]

Else

\[ K_f m = \frac{S_y - K_f \sigma_a}{1 \sigma_m} \]

\[ K_f s m = \frac{S_y - K_f s T_a}{1 T_m} \]

**COMPUTE ALTERNATING AND MIDRANGE STRESSES**

\[
\sigma_a' = \sqrt{(K_f \sigma_a \text{ bending})^2 + \left(\frac{K_f \sigma_a \text{ axial}}{0.185}\right)^2 + 3 \left( K_f s T_a \text{ torsion} \right)^2}
\]

\[
\sigma_m' = \sqrt{(K_f m \sigma_m \text{ bending} + K_f m \sigma_m \text{ axial})^2 + 3 \left( K_f s m T_m \text{ torsion} \right)^2}
\]
1) Use $S_a$ and $S_m$ in the equations for Long-Term, Goodman, and ASME safety factors.

2) Compare Long-Term (Static Failure) to each of the others. If it is less than one of the others, it replaces that safety factor.