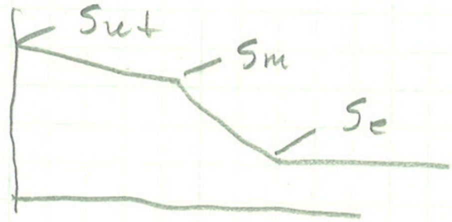
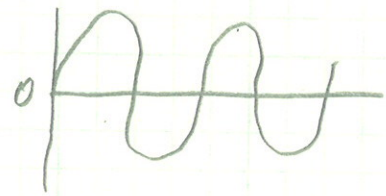
COMBINATIONS OF LOADING MODES

Todate we have looked at rather simple loading situations

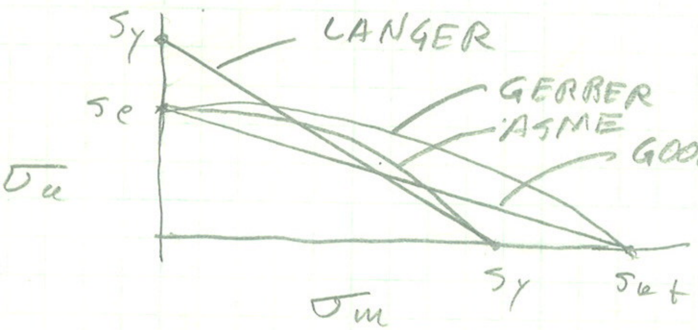
FULLY REVERSED LOADING

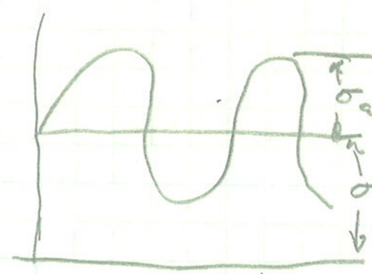




Can be solved with a simple S-N curve.

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 stresses, we must use a different method.

ENDURANCE LIMIT

There is one significant change to the correction factors for endurance limits.

Previously we had

$$C_{load} = k_c = \begin{cases} 1 & \text{bending} \\ .85 & \text{axial} \\ .59 & \text{Torsional} \end{cases}$$

If we have mixed loads then we let

$C_{LOAD} = 1$ for all Load cases.

LOCAL YIELDING CHECK

Let

$$\sigma_a = \sigma_{a_{bending}} + \sigma_{a_{axial}}$$

$$\sigma_m = \sigma_{m_{bending}} + \sigma_{m_{axial}}$$

$$\sigma_{max} = K_f \sigma_a + K_f \sigma_m$$

$$\tau_{max} = K_{fs} \tau_a + K_{fs} \tau_m$$

$$\sigma'_{max} = \sqrt{\sigma_{max}^2 + 3(\tau_{max})^2}$$

Now if

$$\sigma'_{max} < S_y$$

$$K_{fm} = K_f$$

$$K_{fsm} = K_{fs}$$

else

$$K_{fm} = \frac{S_y - K_f \sigma_a}{|\sigma_m|}$$

$$K_{fsm} = \frac{S_y - K_{fs} \tau_a}{|\tau_m|}$$

COMPUTE ALTERNATING AND MIDRANGE STRESSES

$$\sigma'_a = \sqrt{\left(K_f \sigma_{a_{bending}} + \frac{K_f \sigma_{a_{axial}}}{0.85}\right)^2 + 3\left(K_{fs} \tau_{a_{torsion}}\right)^2}$$

$$\sigma'_m = \sqrt{\left(K_{fm} \sigma_{m_{bending}} + K_{fm} \sigma_{m_{axial}}\right)^2 + 3\left(K_{fsm} \tau_{m_{torsion}}\right)^2}$$

1) Use σ_a' and σ_m' in the equations for Langer, Gerber, Goodman, and ASME safety factors.

2) Compare Langer (Static failure) to each of the others. If it is less than one of the others, it replaces that safety factor.