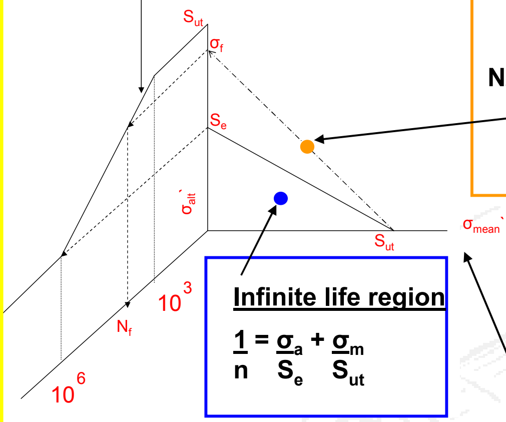
Combined Fatigue Loading Mode



Finite cycle life

$$N_f = \left(\frac{\sigma_f}{a}\right)^{1/b} \qquad a = \frac{(0.9 \cdot S_{ut})^2}{S_e} \qquad b = -\frac{1}{3}\log\left(\frac{0.9 \cdot Sut}{S_e}\right)$$

- Finite life found by plotting alternating and mean Von Mises stresses and drawing a line from the S_{ut} through the plotted point to find σ_f at the intersection of the σ_{alt} axis.
- From this point, the finite cycle life is found by intersection of σ_f and Basquin line

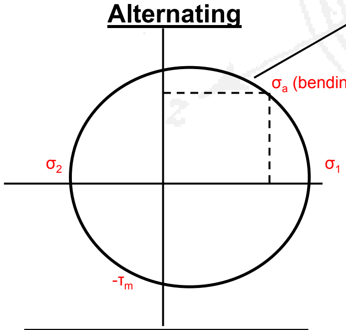
Infinite life region

$$\frac{1}{n} = \frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}}$$

Von Mises

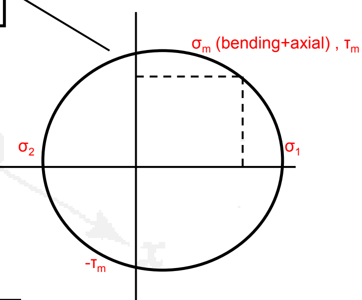
$$\sigma_{a/m}` = (\sigma_1^2 - \sigma_1 \sigma_2 + \sigma_2^2)^{1/2}$$

Alternating



Generic Mohr's Circle using calculated stresses

Mean



- Using the combined axial and bending stress and shear from torsion/shear, plot Mohr's circle
- Alternating and Mean stress have separate Mohr's circles, therefore each has separate principle stresses used to calculate Von Mises stresses

Axial

$$\frac{K_{f\_a} \cdot \sigma_{alt\_a}}{K_{c\_axial}} = \sigma_a \qquad \sigma_m$$

+

Bending

$$\frac{K_{f\_b} \cdot \sigma_{alt\_b}}{K_b} = \sigma_a \qquad \sigma_m$$

Torsion / Shear

$$\frac{K_{f\_t} \cdot \tau_{alt}}{K_b} = \tau_a \qquad \tau_m$$

Stress calculations done for each plane

Alternating

$$\sigma_{alt\_a/b} = (\sigma_{max} - \sigma_{min})/2$$

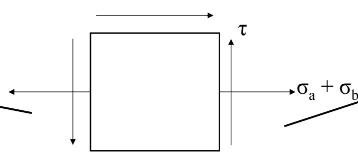
Mean

$$\sigma_m = (\sigma_{max} + \sigma_{min})/2$$

Axial/ Bending

σ_{max}

σ_{min}



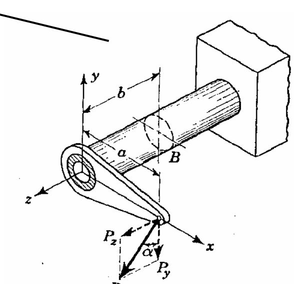
Uni-axial example of stress element

Torsion / Shear

τ_{max}

τ_{min}

Given Situation



- S_e should be calculated through the Marin equation. In this equation surface (K_a), temperature (K_d), and misc (K_e) factors are accounted for. Fatigue stress concentration (K_f) , load (K_c), size (K_b) are excluded in this modified endurance limit because there are different values for each loading mode. They are factored into the alternating and mean stresses for each mode.
- Stress concentration factor, K_t (table A-15,16), and the notch sensitivity factor, q (figure 5-16), are entered into $K_f = 1+q(K_t - 1)$
- Force transmission and stress analysis should be completed for the point of interest, giving you σ_{max} , σ_{min}, τ_{max}, and τ_{min}
- All equations and tables found in Mechanical Engineering Design 5th

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