Torsion   in   fatigue   6-13

$S_{su} = 0.67 \, S_{ut}$ shear ultimate strength

$S_{sy} = 0.577 \, S_{yt}$ distortion energy theory

$k_c = 0.59$

Problem 3

2024 T3 AL

2" OD

fully reversed torsion

k_a, k_b, k_c

   $\rightarrow 0.59$

$S_{su} = 0.67 \, S_{ut} = 46.9 \, Kpsi$

$S_{\ell c} = f \, S_{su} \approx 43 \, Kpsi$

$N = (10^3) \quad \rightarrow fig \; 6\text{-}18 \qquad f = 0.9$

Table A-24

$(S'_e)_{50 \times 10^7} = 20 \, Kpsi$

$S_{ut} = 70 \, Kpsi$

$(S_e)_{50 \times 10^7} = k_a \cdot k_b \cdot k_c \, (S'_e)_{50 \times 10^7}$
$= 5.6 \, Kpsi$

S-N
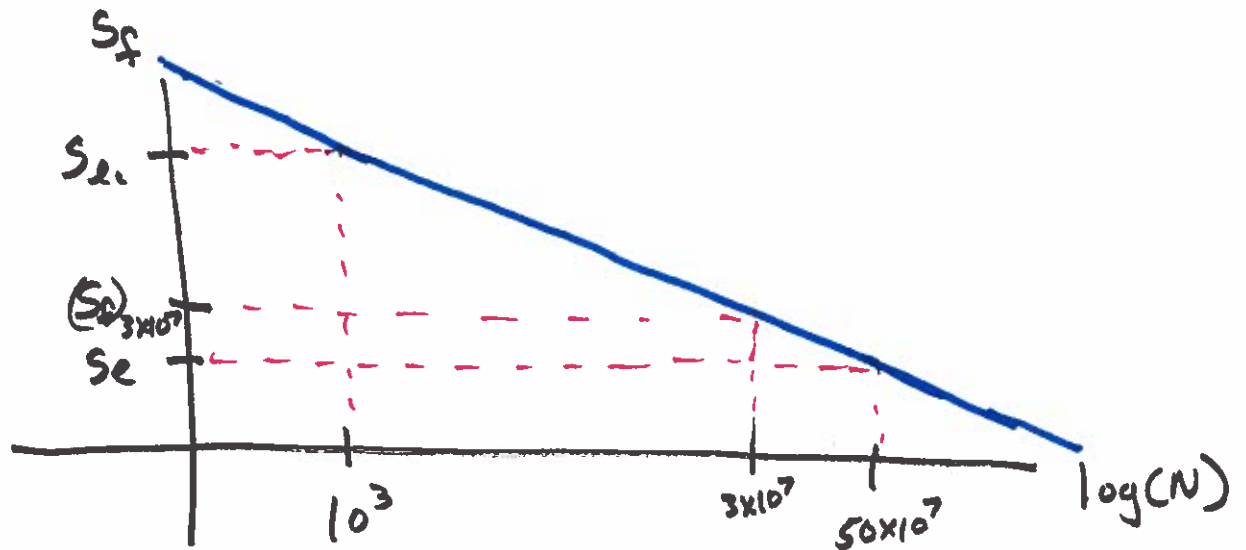
$$\left(S_f\right)_{3\times10^7} = ?$$

$$\frac{S_e - S_{kc}}{\log(50E7) - \log(1E3)} = \frac{\left(S_f\right)_{3\times10^7} - S_{kc}}{\log(3E7) - \log(1E3)}$$

Solve for $\left(S_f\right)_{3\times10^7}$

$$b = -\frac{1}{3}\log\left(\frac{fS_{ut}}{S_e}\right) \implies \text{valid only for } N = 10^6$$

Compound Loading

  1. fully reversed stresses $\Big\}$ based on a single
  2. fluctuating stresses $\Big\}$ loading type
  3. Compound loading $\Rightarrow$ what happens when you
          have multiple loading
           types

Fatigue data is collected for case 1.
Failure theories are developed for case 2

Case 3 strategy:

1. consider σ_a and σ_m seperately (two stress elements)

2. apply fatigue stress concentration factors
  independently: $(K_f)_{bending}$, $(K_f)_{torsion}$, $(K_f)_{axial}$

3. determine von mises stress for σ_a^I and σ_m^I

4. use fluctuating failure theory with σ_a', σ_m'

5. use $\sigma_{max}' = \sigma_a' + \sigma_m'$ for yield check

eqn 6-55/56

$$\sigma_i' = \left\{ \left[(K_f)_{bend}\,(\sigma_i)_{bend} + (K_f)_{axial}\,(\sigma_i)_{axial} \right]^2 + 3\left[(K_f)_{torsn}(\sigma_i)_{torsn} \right]^2 \right\}^{1/2}$$

$i = a$ or m

     [* Don't use k_c for torsion
     [becaus von mises already accounts for it

- HW #8 Due Monday

- Dynamic Loading Memo due Wednesday
  - Where are the largest stresses seen from dynamic loads?
  - How did you estimate σ_m and σ_a (or σ_a' and σ_m')?
  - What static and fatigue material properties did you obtain for your material choices?
  - What type of fatigue stresses are seen?

- Lightning talks on Friday
  - Can use visuals: doc camera, board, projector
  - <u>5 minutes</u> to pitch and explain your design
    └ strict!
  - Probably should pick one team member that has best PR skills. They should practice for rest of team.
  - Potential method: 10 slides at 30 seconds each
    Each member makes ~2 slides with scripts
  - Look up PechaKucha for ideas.

  - Judged by instructors plus reviewers (Andy Wyly, etc)
  - Best talk will get a prize.