ME 356 Fall 2001

Solutions to Homework #4

By: Nick Silverman

Questions, comments, gripes, and most importantly praise should be directed towards your loving TA during office hours MTF.

7.1) ESTIMATE FATIGUE STRENGTH OF A ROTATING-BEAM SPECIMEN MADE AISI 1020 ~~HOT~~ ROLLED STEEL. N = 12.5 K cycles

$S_e' = (.506)(S_{UT}) = .506(66.2) = 33.5$ kpsi

CHECK σ_0 (EQ (c) SEC 5-2):

$$\sigma_0 = S_{ut} \exp(m) m^{-m}$$
$$= 66.2 \exp(.22)(.22)^{-.22}$$
$$= 115.1 \text{ kpsi} \quad \text{(ok)}$$

FIND $\sigma_F' = S_{ut} + 50$ kpsi $= 66.2 + 50 = 116.2$ kpsi

FIND EXPONENT b (EQ (c) 7.5):

$$b = -\frac{\log(\sigma_F'/S_e')}{\log(2N_e)} = -\frac{\log[(116.2 \text{ kpsi})/33.5 \text{ kpsi}]}{\log(2 \times 10^6)}$$

$$= -.0857$$

NEXT FIND f:

$$f = \frac{\sigma_F'}{S_{ut}}(2 \cdot 10^3)^b = \frac{116.2}{66.2}(2 \times 10^3)^{-.0857} = .9151$$

NOW FIND a:

$$a = \frac{f^2 S_{ut}^2}{S_e'} = \frac{(.9151)^2(66.2)^2}{33.5} = 109.5$$

TO SOLVE FOR S_f USE EQUATION:

$$S_f = a N^b$$
$$= 109.5 (12\,500)^{-.0857}$$
$$= \boxed{48.8}$$

$$N = \left(\frac{\sigma_a}{a}\right)^{1/b} = \left(\frac{(36.)}{109.5}\right)^{1/-.0857} = \boxed{433\,752 \text{ cycles}}$$

7.2) DERIVE $S_f = S_{ut} N^{(\log f)/3}$ $\quad 1 \le N \le 10^3$

START WITH THE EQ:

$$S_f = a N^b$$

TAKE THE LOG

$$\log S_f = \log a + b \log N$$

SUBSTITUTE $(1, S_{ut})$

$$\log S_{ut} = \log a + b \log 1$$

$$\therefore \quad a = S_{ut}$$

SUBSTITUTE $(10^3, f S_{ut})$

$$\log f S_{ut} = \log S_{ut} + b \log 10^3$$

$$\therefore \quad b = \frac{1}{3} \log f \quad \text{and} \quad S_f = S_{ut} N^{(\log f)/3}$$

$$1 \le N \le 10^3$$

7.3) From the graph 7.6

$10^3 \Rightarrow 89$

$10^6 \Rightarrow 49$

$S = aN^b$

$\log S_1 = \log a + b \log N_1$

$\log S_2 = \log a + b \log N_2$

$$\log a = \frac{\log S_1 \log N_2 - \log S_2 \log N_1}{\log N_2/N_1}$$ Substitute for b

$$= \frac{\log 89 \log 10^6 - \log 49 \log 10^3}{\log 10^6/10^3}$$

$= 2.208583933$

$a = 10^{\log a} = 10^{2.208583933} = 161.65$

$$b = \frac{\log S_2 - \log a}{\log N_2} = -.0864$$

$$(S_f)_{AX} = aN^b = 161.65\, N^{-.0864} \qquad 10^3 \leq N \leq 10^6$$