

7.1 (Shigley)

AISI 1045 \rightarrow tensile strength 95 kpsi
yield \rightarrow 70 kpsi

(a) S_n endurance limit

(b) life $S_a = 55$ kpsi given stress

(c) 10^4 cycles, find load.

$$(a) S_n' \approx 0.5 S_{ut} = 0.5(95) = \underline{\underline{47.5 \text{ kpsi}}}$$

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

$$\Leftrightarrow S_f = a N^b$$

given S_f find N

given N find S_f

$$N = 10^3 \quad S_f = 0.9 S_{ut} \Rightarrow a 10^{3b} = 0.9 S_{ut} \quad (1)$$

$$N = 10^6 \quad S_f = 0.5 S_{ut} \Rightarrow a 10^{6b} = 0.5 S_{ut} \quad (2)$$

$$(1) \Rightarrow \log_{10}(0.9 S_{ut}) = \log_{10} a + 3b$$

$$(2) \Rightarrow \log_{10}(0.5 S_{ut}) = \log_{10} a + 6b$$

$$(2) - (1) \Rightarrow b = \frac{1}{3} \log_{10} \left[\frac{0.5 S_{ut}}{0.9 S_{ut}} \right] \quad (3)$$

subst (3) into (1) or into (2)

$$\Rightarrow a = \frac{(0.9 S_{ut})^2}{(0.5 S_{ut})}$$

$$(b) \quad N = 10^4$$

$$a = \left(\frac{0.9 S_{max}}{0.5 S_{max}} \right)^2 = \left[\frac{(0.9)(95)}{47.5} \right]^2 = \underline{153.9 \text{ kpsi}}$$

$$b = \frac{1}{3} \log_{10} \left(\frac{0.5}{0.9} \right) = -0.0851$$

$$S_f = a N^b = (153.9)(10^4)^{-0.0851}$$

$$= 70.3 \text{ kpsi}$$

$$(c) \quad S_f = a N^b$$

$$\log_{10} S_f \iff \log_{10} a + b \log_{10} N$$

$$\log_{10} N = \frac{\log_{10}(S_f) - \log_{10}(a)}{b}$$

$$\log_{10} N = x$$

$$\Leftrightarrow 10^x = N$$

$$N = 10^{\left(\frac{\log_{10}(S_f) - \log_{10}(a)}{b} \right)}$$

$$N = 10 \left(\frac{\log_{10}(55) - \log_{10}(153.9)}{-0.0851} \right)$$

$$\underline{N = 1.78 \times 10^5 \text{ cycles}}$$

$$S_f = \underbrace{a N^b}_{\substack{\uparrow \\ \text{kpsi}}}$$

$$N \uparrow \quad S_f \downarrow$$