ME 354 Fall 2022: Quiz 3a Name: Solution

INSTRUCTIONS:

This quiz is open-book, open-note, and you may work with your classmates.

GIVEN:

A 1.5-in-diameter rod has a tensile strength of 110 kpsi and is loaded in rotating bending. The surface is ground.

FIND:

a) The fully corrected endurance limit for the rod, S_e.

b) Sketch and label the S-N diagram. Use the axes provided.

c) The life of the rod if the rod is loaded in completely reversed bending with a maximum stress of 70 kpsi. If infinite life is predicted, what is the factor of safety?

d) The life of the rod if the rod is loaded in completely reversed bending with a maximum stress of 30 kpsi. If infinite life is predicted, what is the factor of safety?

e) How would the rod's life change if the surface was machined instead of ground? Briefly justify your choice.

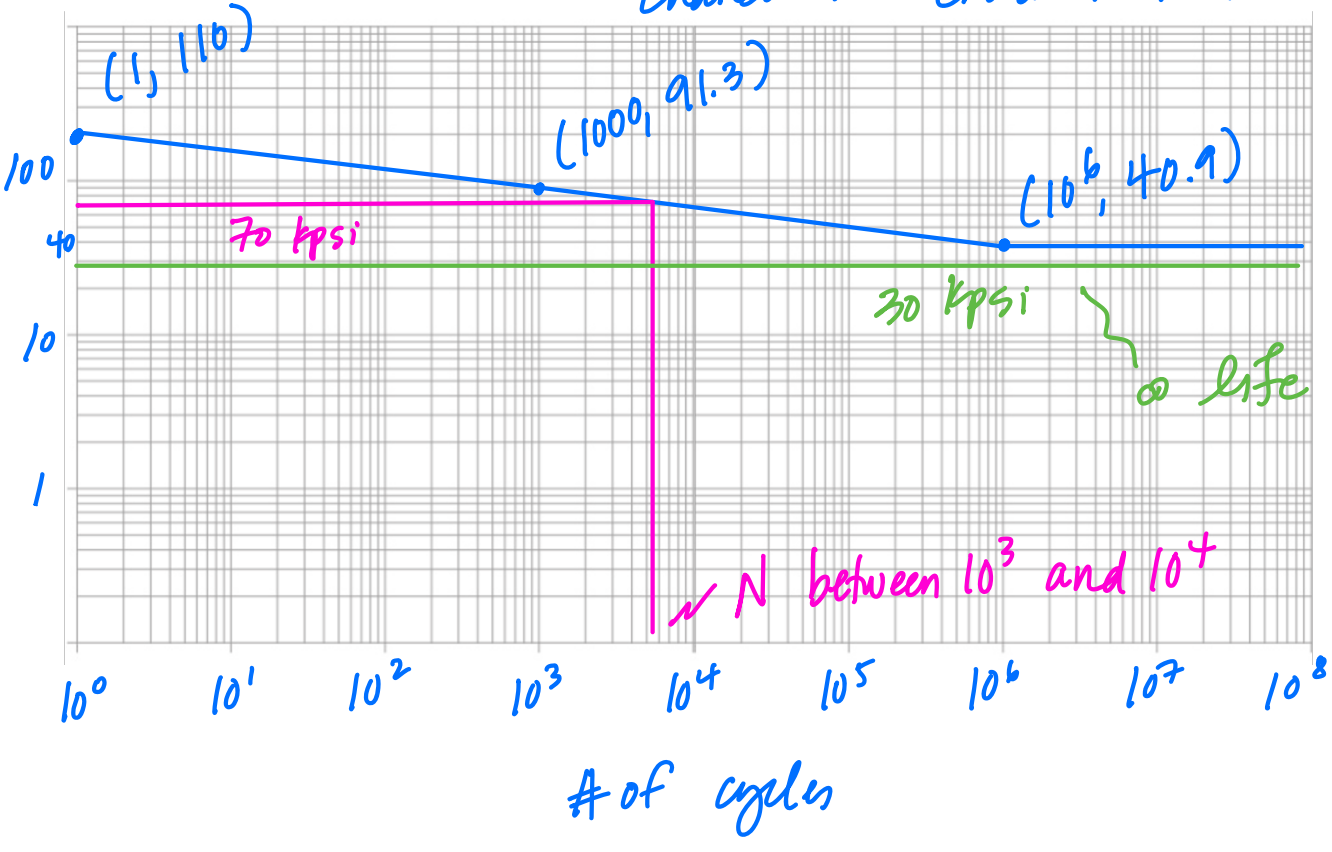
- (●) The rod's life would decrease.
- ( ) The rod's life would remain the same.
- ( ) The rod's life would increase.

rougher surface would decrease life (more chances for crack to initiate)

f) How would the rod's life change if the diameter was decreased to 1 inch? Briefly justify your choice.

- ( ) The rod's life would decrease.
- ( ) The rod's life would remain the same.
- (●) The rod's life would increase.

smaller volume would increase life due to less voids (less chances for crack to initiate)



a) $S_e = k_a k_b k_c k_d k_e S_e' = 40.9$ kpsi

$S_e' = 0.5 S_{ut} = 55$ kpsi

$k_a = a S_{ut}^b = 1.21 (110)^{-0.067} = 0.883$

$k_b = 0.879 (1.5)^{-0.107} = 0.942$

$k_c = 1$ for bending

$k_d = 1$ assume room temp

$k_e = 1$ assume 50% reliability

b) $f = 0.83$ for $S_{ut} = 110$ kpsi (Fig 6-23)

$f S_{ut} = 91.3$ kpsi

c) $N = \left(\frac{\sigma}{a}\right)^{1/b} = \left(\frac{70}{203.8}\right)^{1/-0.116} = 9825$ cycles

$a = \frac{(f S_{ut})^2}{S_e} = \frac{91.3^2}{40.9} = 203.8$

$b = -\frac{1}{3} \log\left(\frac{f S_{ut}}{S_e}\right) = -\frac{1}{3} \log\left(\frac{91.3}{40.9}\right) = -0.116$

d) 30 kpsi $< S_e \rightarrow \infty$ life is predicted.

$n = \frac{S_e}{\sigma_a} = \frac{40.9 \text{ kpsi}}{30 \text{ kpsi}} = 1.4$ (or 1.3)