

Laboratory IV: Fatigue

Objective of this Laboratory:

Observe fatigue test environment.

Location:

Wyman 163.

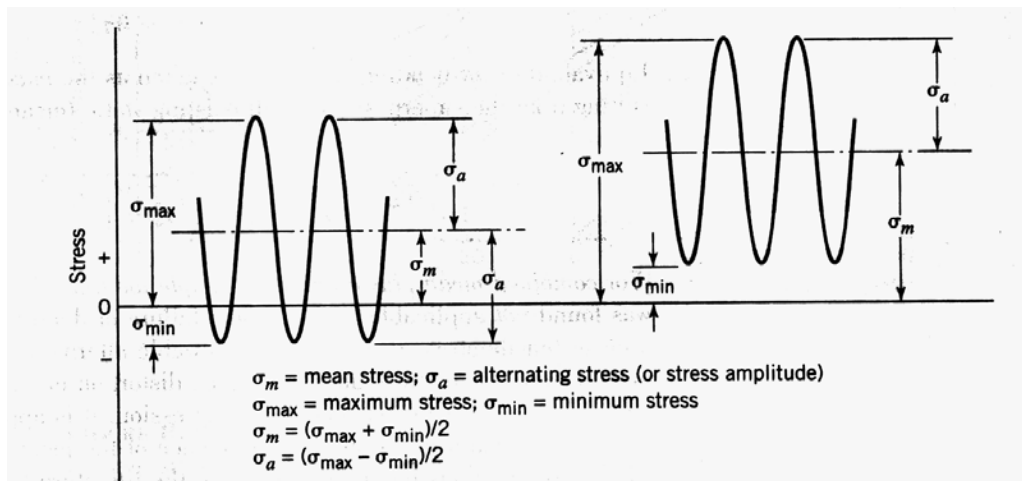
Procedure:

The machine will be run by the TA.

The specimen you have has a minimum cross-section of 0.125" by 0.238". The specimen material has an ultimate tensile strength of about 95 ksi. The force at which the specimen will break in uniaxial tension should therefore be 2800 lb.

Given the S_{ut} , we can calculate $S_n = 0.5S_{ut}$. This should be about 47 ksi. However, we are testing in tension, not reversed bending, so we have to use $S_n = S_n C_L C_G C_S$ to estimate the endurance limit for this case. We have $C_L = 1$, $C_G = 0.7$, $C_S = 0.75$ (the specimen is machined). This gives us $S_n = 24.7 \text{ ksi}$. The corresponding load (for the endurance limit in this loading arrangement) is 735 lb.

Since the specimens are cut from steel sheet, we cannot test in compression (because of buckling). Hence we cannot obtain the traditional fully reversed S-N curve directly. We test in tension-tension as shown in the sketch on the right side below.



The minimum stress will be set to nearly zero, i.e. the mean stress and the cyclic amplitude will be the same. When we set up the test machine, we set the mean stress and then adjust the cyclic stress to define the complete cycle (actually, we use forces). The effect of the mean stresses on the high-cycle (a million cycles) fatigue strength can be captured using the Modified Goodman equation:

530.215 MECHANICS-BASED DESIGN

$\frac{S_a}{S_n} + \frac{S_m}{S_{ut}} = 1$, where S_a and S_m are the amplitude and mean value of the strengths in the figure below (Figure 8.16; Juvinall). Since $S_a = S_m$ in this case and we know $S_n = 24.7 \text{ ksi}$ and S_{ut} , we can find the cyclic amplitude at which this should fail in high-cycle fatigue. This is about 19.8 ksi, corresponding to a load of 588 lbs. That is, for loads of this order, the specimen should survive for about a million cycles (although there will be variations from one test to another).

Since we would like to have these specimens break in class and we cannot afford to wait for a million cycles, we must set the mean and amplitude of the load to be greater than this. We will try a mean load of 1100 lbs, with minimum 0 lbs and a maximum of 2200 lbs.

Note the number of cycles at which failure actually occurs, and consider the reasons for this particular value.

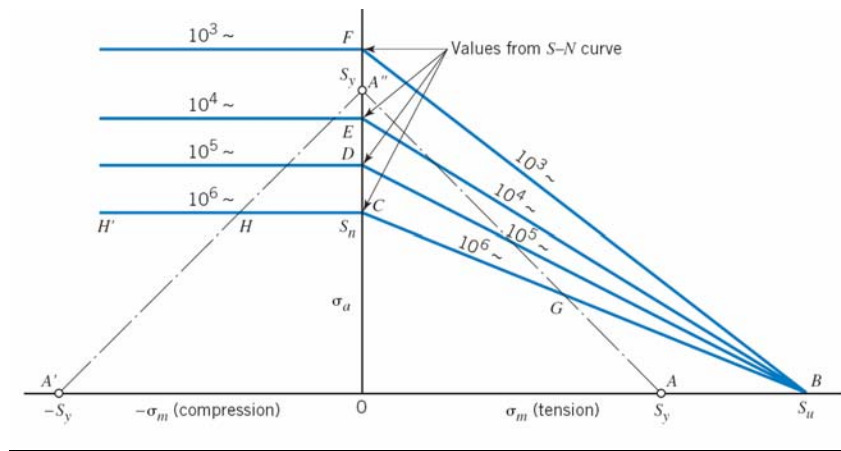


Figure 8.16 (p. 305, Juvinall)
Constant-life fatigue diagram – ductile materials.

No lab report is due for this lab.