Machine Design Test 2

July 6, 2022

Gabe Morris

[1]:
```
# Notebook Preamble
import sympy as sp
import numpy as np
import matplotlib.pyplot as plt
from IPython.display import display

plt.style.use('maroon_ipynb.mplstyle')
```

Contents

1 Problem 6-4

1.1 Given

A steel rotating-beam test specimen has an ultimate strength of 1600 MPa.

1.2 Find

Estimate the life of the specimen if it is tested at a completely reversed stress amplitude of 900 MPa.

1.3 Solution

The first step is to find S_e'.

[2]:
```python
sig_ar, S_ut = sp.S(900), sp.S(1600)

# Eq. 6-10
S_e_prime = sp.S(700)
S_e_prime  # MPa
```

[2]:
```
700
```

The S_e' value will be used in place of S_e from Figure 6-23 description. We can use the following relationships to determine N.

$$N = \left(\frac{\sigma_{ar}}{a}\right)^{1/b}$$
$$a = \frac{(fS_{ut})^2}{S_e}$$
$$b = -\frac{1}{3}\log\left(\frac{fS_{ut}}{Se}\right)$$

The value of f is 0.77 from Figure 6-23 (estimated even though it is off the graph).

[3]:
```python
def log10(x_):
    return sp.log(x_)/sp.log(10)

f = sp.S('0.77')
a = (f*S_ut)**2/S_e_prime
b = -sp.Rational(1, 3)*log10(f*S_ut/S_e_prime)

display(sp.Eq(sp.Symbol('a'), a.n()),
        sp.Eq(sp.Symbol('b'), b.n()))

N = ((sig_ar/a)**(1/b)).n()
```

```
N  # cycles
```

$a = 2168.32$

$b = -0.0818375559380499$

```
[3]:
```

46379.6905856764

The life of the specimen is 46400 cycles.