

PROBLEM STATEMENT A STEEL ROTATING-BEAM TEST SPECIMEN HAS AN ULTIMATE STRENGTH OF 1600 MPa. ESTIMATE THE LIFE OF THE SPECIMEN IF IT IS TESTED AT A COMPLETELY REVERSED STRESS AMPLITUDE OF 900 MPa

GIVEN:

1. STANDARD ROTATING-BEAM SPECIMEN
2. MATERIAL: STEEL, $S_{UT} = 1600 \text{ MPa}$

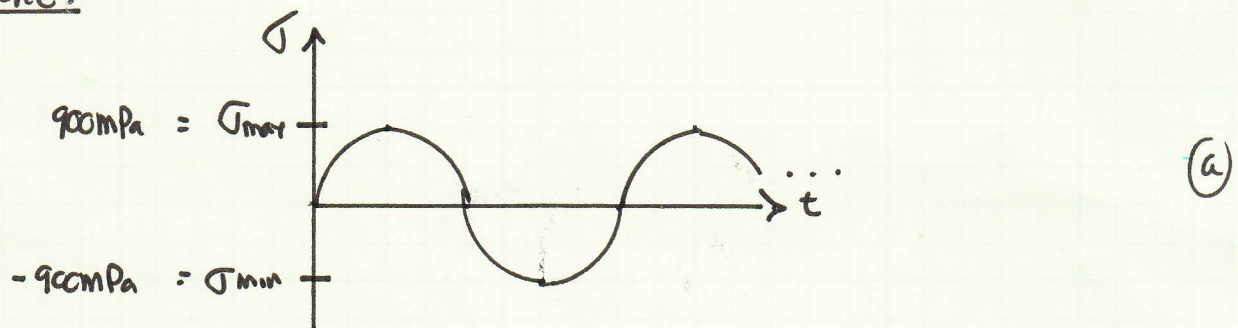
ASSUMPTIONS:

1. LINEAR-ELASTIC MATERIAL
2. COMPLETELY REVERSED LOADING
3. ONLY BENDING LOADS

FIND:

1. DETERMINE THE FATIGUE LIFE

FIGURE:



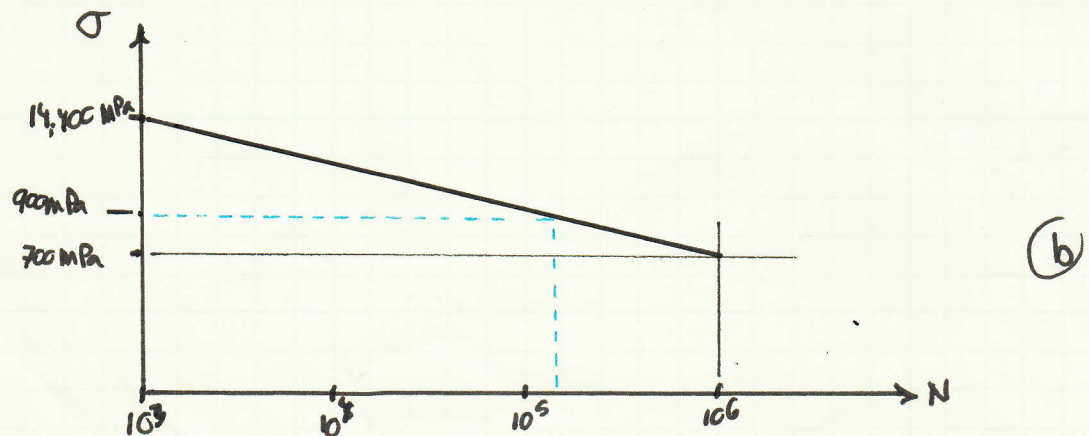
SOLUTION:

THE ENDURANCE LIMIT FOR STEEL NEEDS TO BE ESTIMATED. SINCE

$$S_{UT} > 1400 \text{ MPa} \Rightarrow S'_e = 700 \text{ MPa} \quad (1)$$

$$0.9 S_{UT} = 0.9 (1600 \text{ MPa}) = 1440 \text{ MPa} \quad (2)$$

THE S-N DIAGRAM CAN NOW BE CONSTRUCTED



GIVEN THE LOG-LOG EQUATION FOR THE LINE IN (b)

$$\log S_f' = -m \cdot \log N + b$$

WHERE

$$m = \frac{1}{3} \log \frac{0.9 \cdot S_{UT}}{S_f'} = \frac{1}{3} \log \frac{0.9 \cdot (1600 \text{ MPa})}{700 \text{ MPa}} = 0.1044 \quad (3)$$

$$b = \log \frac{(0.9 \cdot S_{UT})^2}{S_f'^2} = \log \frac{[0.9 \cdot (1600 \text{ MPa})]^2}{700^2} = 3.472 \quad (4)$$

THE FATIGUE LIFE AT 900 MPa CAN NOW BE CALCULATED

$$N = \frac{10^{b/m}}{S_f'^{1/m}} = \frac{10^{3.472/0.1044}}{(900 \text{ MPa})^{1/0.1044}} = \boxed{91.1 (10^3) \text{ CYCLES}}$$

Summary:

THE PARAMETERS FOR THE S-N CURVE BETWEEN 10^3 cycles AND 10^6 cycles ARE CALCULATED MAKING THE FATIGUE LIFE CALCULATION AT 900 MPa POSSIBLE.