Fatigue of Structures - Assignment 6

Problem 1

A 28 mm diameter smooth solid shaft is made from a material with σ_o = 650 MPa and axial SN curve with the equation $\sigma_a = 590 \cdot N_f^{-0.065}$. The shaft is subjected to in-phase bending and torsion. The bending varies from 0 to 500 Nm and the torque varies from -140 to 420 Nm.

a) Calculate the safety factor against static yielding of the outer surface of the shaft.

b) Can the shaft withstand 10 million of these combined cycles?

c) What is the minimum allowed diameter of shaft if the shaft should withstand 2.0 million cycles?

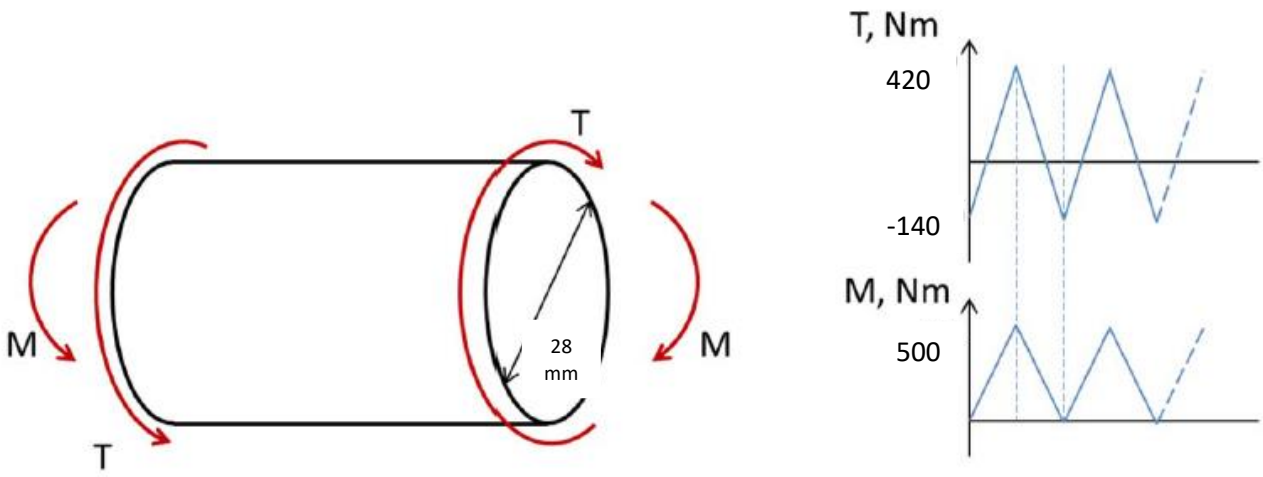

Figure 1 A solid shaft subjected to in-phase bending and torsion

Problem 2

The rotating bending fatigue tests are carried out for a component. The test is done with three different stress amplitude (σ_a=500 MPa, 350 MPa, 200 MPa) and the test data is given in Table 1.

a) Calculate the mean, standard deviation and coefficient of variation for the fatigue lives at different stress amplitudes. Use both normal and log-normal distributions assumptions i.e. x=Nf or x=Log(Nf). Does normal or log-normal distribution fit better on the test data?

b) Calculate the fatigue life Nf at failure probability level on 97.7%, 50% and 2.3%. for different stress levels using log-normal distribution. Compare the statistical variation ($[Nf_{2.3\%} - Nf_{97.7\%}]/Nf_{50\%}$) at different stress levels. What is the reason for difference in variation?

Table 1 The fatigue test result

sa=500 MPa							
Samples failed n	2	7	6	9	7	5	2
Fatigue life Nf	8300	13700	22700	25000	27500	45300	74800
sa=300 MPa							
Samples failed n	1	5	8	10	7	5	2
Fatigue life Nf	28300	55200	107600	140000	182000	354900	692000
sa=200 MPa							
Samples failed n	1	4	8	10	9	5	1
Fatigue life Nf	65800	148100	333000	500000	750000	1687500	3796800