

ME 423
Instructor: Ramesh Singh
HW#2

Assigned: August 26, 2024
Due: September 3, 2024

Please refer to Shigley's book for all the modifiers and stress concentration factors.

1. Derive the closed form solution for crack propagation from a_i to a_f after N_f cycles based on fracture toughness and Paris Law.
2. 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.
3. A solid round bar with diameter of 50 mm has a groove cut to a diameter of 45 mm, with a radius of 2.5 mm. The bar is not rotating. The bar is loaded with a repeated bending load that causes the bending moment at the groove to fluctuate between 0 and 2825 Nm. The bar is hot-rolled AISI 1095, but the groove has been machined. Determine the factor of safety for fatigue based on infinite life and the factor of safety for yielding (a) Using Modified Goodman; (b) ASME Elliptic.
4. A 40 mm-diameter bar has been machined from an AISI 1050 cold-drawn bar. This part is to withstand a fluctuating tensile load varying from 0 to 70 kN. Because of the ends, and the fillet radius, a fatigue stress-concentration factor K_f is 1.85 for 10^6 or larger life. Find S_a and S_m and the factor of safety guarding against fatigue and first-cycle yielding, using (a) the Gerber fatigue line; (b) the ASME-elliptic fatigue line; (c) Modified Goodman; (c) Soderberg. Also show the load line and critical line for the first three criteria in separate graphs.
5. The cold-drawn AISI 1040 steel bar shown in Figure 1 is subjected to a completely reversed axial load fluctuating between 28 kN in compression to 28 kN in tension. Estimate the fatigue factor of safety based on achieving infinite life, and the yielding factor of safety. If infinite life is not predicted, estimate the number of cycles to failure.

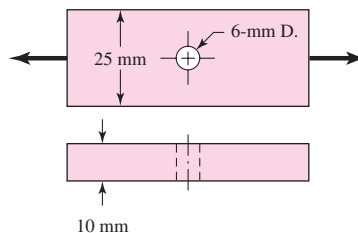


Fig. 1. Cold drawn steel bar under reversed axial loading

6. In Figure 2, shaft A, made of AISI 1020 hot-rolled steel, is welded to a fixed support and is subjected to loading by equal and opposite forces F via shaft B. A theoretical stress-concentration factor K_{ts} of 1.6 is induced by the 3 mm fillet. The length of shaft A from the fixed support to the connection at shaft B is 1 m. The load F cycles from 0.5 to 2 kN. Find

the factor of safety for infinite life using the modified Goodman and Gerber fatigue failure criteria.

