ME423 – Tutorial 2/ HW 2 – Due 2nd Sept 2024 – 11.00 pm

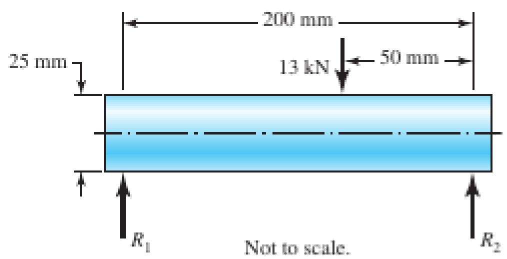
I will be discussing/solving a few of these problems during the tutorial hour. You have to submit all the problems by 11.00 pm, 2/9/2024 [Moodle].

1. Estimate σ'_e in MPa for the following materials:
(a) AISI 1035 CD steel.
(b) AISI 1050 HR steel.
(c) 2024 T4 aluminum.
(d) AISI 4130 steel heat-treated to a tensile strength of 1620 MPa.

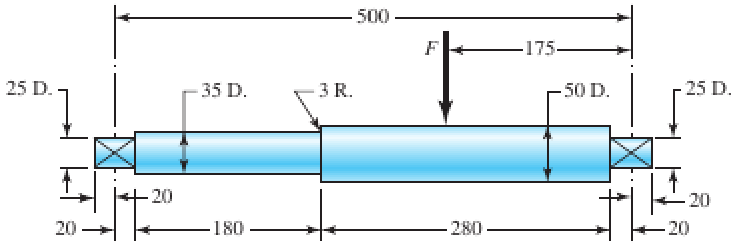
2. A steel rotating-beam test specimen has an ultimate strength of 830 MPa. Estimate the life of the specimen if it is tested at a completely reversed stress amplitude of 480 MPa.

3. A steel rotating-beam test specimen has an ultimate strength of 1030 MPa and a yield strength of 930 MPa. It is desired to test low-cycle fatigue at approximately 500 cycles. Check if this is possible without yielding by determining the necessary reversed stress amplitude.

4. A rotating shaft of 25-mm diameter is simply supported by bearing reaction forces R_1 and R_2. The shaft is loaded with a transverse load of 13 kN as shown in the figure. The shaft is made from AISI 1045 hot-rolled steel. The surface has been machined. Determine
(a) the minimum static factor of safety based on yielding.
(b) the endurance limit, adjusted as necessary with correction (Marin) factors.
(c) the minimum fatigue factor of safety based on achieving infinite life.
(d) If the fatigue factor of safety is less than 1, then estimate the life of the part in number of rotations of rotations.



5. The rotating shaft shown in the figure is machined from AISI 1020 CD (cold rolled) steel. It is subjected to a force of F = 6 kN. Find the minimum factor of safety for fatigue based on infinite life. If the life is not infinite, estimate the number of cycles. Be sure to check for yielding. All the dimensions are in mm.



6. A steel part is loaded with a combination of bending, axial, and torsion such that the following stresses are created at a particular location:
Bending: Completely reversed, with a maximum stress of 60 MPa
Axial: Constant stress of 20 MPa
Torsion: Repeated load, varying from 0 MPa to 70 MPa
Assume the varying stresses are in phase with each other. The part contains a notch such that $(K_f)_{\text{bending}} = 1.4$, $(K_f)_{\text{axial}} = 1.1$, and $(K_f)_{\text{torsion}} = 2.0$. The material properties are $\sigma_y =$ 300 MPa and $\sigma_{ult} = 400$ MPa. The completely adjusted (corrected) endurance limit is found to be $\sigma_e = 160$ MPa. Find the factor of safety for fatigue based on infinite life, using the Goodman criterion (assume proportional loading). If the life is not infinite, estimate the number of cycles, using the SWT criterion to find the equivalent completely reversed stress. Be sure to check for yielding.

7. A machine part will be cycled at ± 350 MPa for $5\text{x}10^3$ cycles. Then the loading will be changed to ± 260 MPa for $5\text{x}10^4$ cycles. Finally, the load will be changed to ± 225 MPa. Using the Miner's rule, estimate the of cycles of operation that can be expected at this stress level before the part fails? For the part, $\sigma_{ult} = 530$ MPa, $f = 0.9$, and has a fully corrected endurance strength of $\sigma_e = 210$ MPa.

8. The figure shows a formed round-wire cantilever spring subjected to a varying force. The inner radius of the bend is 20 mm. The hardness tests made on 50 springs gave a minimum hardness of 400 Brinell. A visual inspection of the springs indicates that the surface finish corresponds closely to a hot-rolled finish. Estimate the number of cycles to likely to cause failure using the Goodman criterion.
1. If the curvature effects on the bending stress are ignored.
2. If the curvature effects on the bending stress are not ignored