PhD Qualifying Exam
Jan. 2015

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Q.1 (25 pts.) –The round bar with the groove is subjected to tensile, torsional, and bending loads, as shown.

a) Determine the principal stresses at the location of stress concentration.

b) Calculate the safety factor with respect to yielding, given that the yield strength of the material is 100 Mpa.

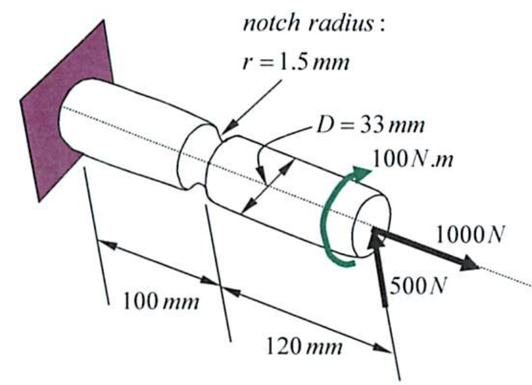


Table A-15

Charts of Theoretical Stress-Concentration Factors K_t^* *(Continued)*

Figure A-15-13

Grooved round bar in tension. $\sigma_0 = F/A$, where $A = \pi d^2/4$.

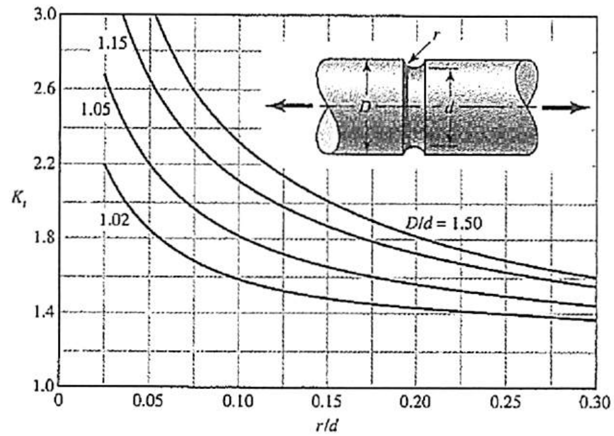


Figure A-15-14

Grooved round bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$ and $I = \pi d^4/64$.

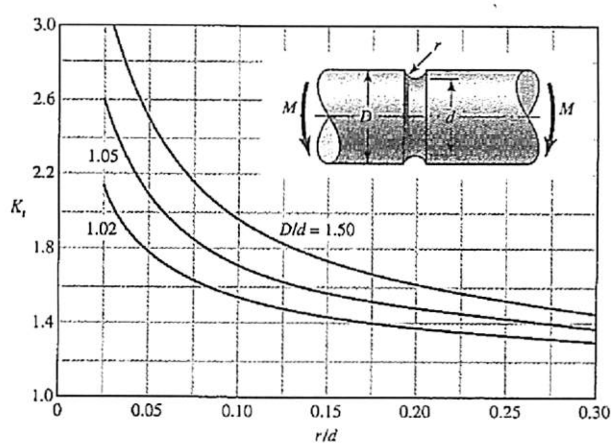
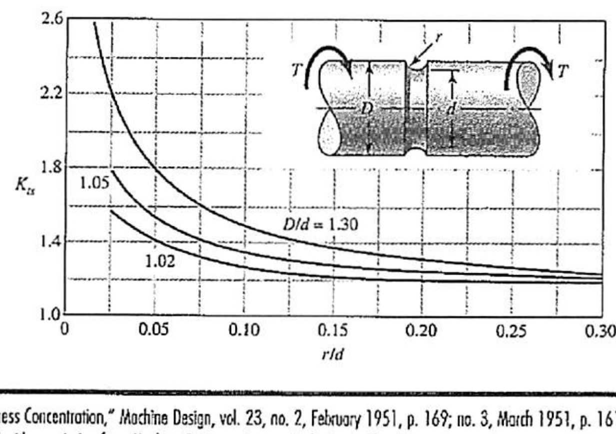


Figure A-15-15

Grooved round bar in torsion. $\tau_0 = Tc/J$, where $c = d/2$ and $J = \pi d^4/32$.



*Factors from R. E. Peterson, "Design Factors for Stress Concentration," Machine Design, vol. 23, no. 2, February 1951, p. 169; no. 3, March 1951, p. 161, no. 5, May 1951, p. 159; no. 6, June 1951, p. 173; no. 7, July 1951, p. 155. Reprinted with permission from Machine Design, a Penton Media Inc. publication.

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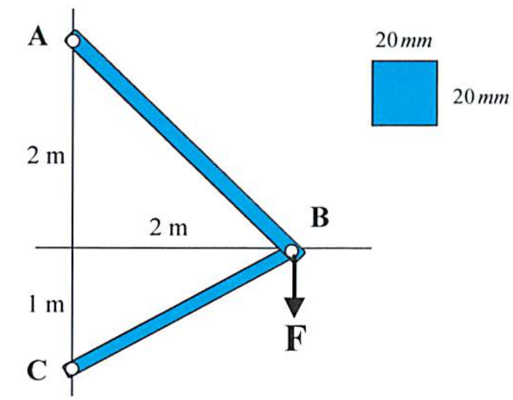
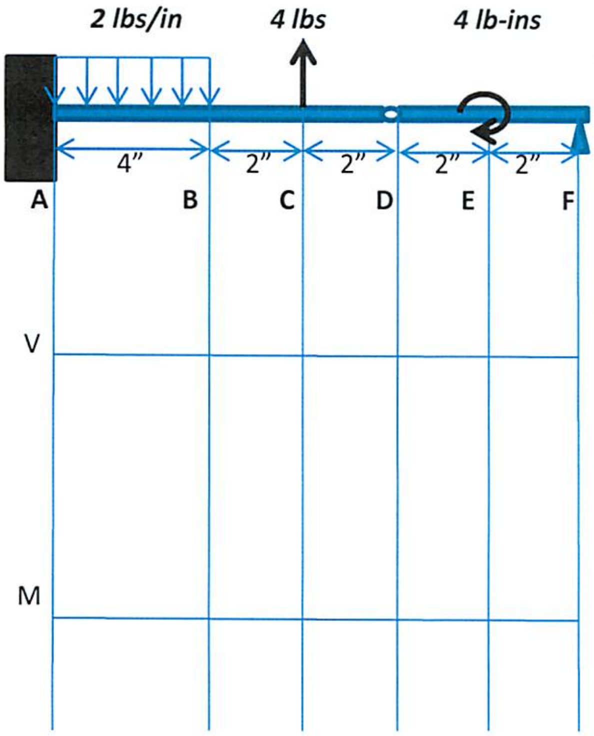
Q.2 (25 pts) – Using a safety factor of 3.5, calculate the maximum value for the load F that will prevents the following pin-jointed bracket from buckling. The members AB and BC of the bracket have a square cross section with each side equal to 20 mm, as shown. The material properties of the members are: $E = 1.0e9\ Pa$ $\sigma_y = 2.0e6\ pa$



3. Given the following beam under loading, draw the associated shear force and bending moment diagrams for the beam. Point A is a fixed end, point D is a hinge joint, and point F is a simply-supported end. Also identify V_{max} and M_{max} in the beam. (Mark maxima & minima on the diagrams)



(1) Draw *FBD* of section ABCD and find reaction forces at point A and D. (magnitude & direction)

Point A:____________________________

Point D:____________________________

(2) Draw *FBD* of section DF and find reaction forces at point D and F.

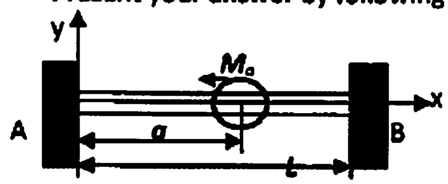
Point D: ____________________________

Point F:____________________________

V_{max}=__________ lbs

M_{max}=__________lb-in

4 Find the reaction forces at boundary B in the following beam AB which is fixed at both ends A and B. Present your answer by following the procedures given below. Beam AB has a bending rigidity *EI*.



a. Draw the free-body diagram of beam AB and identify the number of unknowns.

b. Present the non-trivial equilibrium equations and identify the number of the equations.

c. Identify the number of additional equation(s) required for finding the reaction forces.

d. Convert the SI problem into an SD problem by drawing diagrams based on the principle of superposition.

e. Identify the case number in Appendix D to be used in the principle of superposition.

f. Give the equations (as concluded of part f required for finding the unknowns in terms of boundary conditions.

g. Express the equations in part f in terms of *EI*, M_o, *L* and the reaction forces at point B.