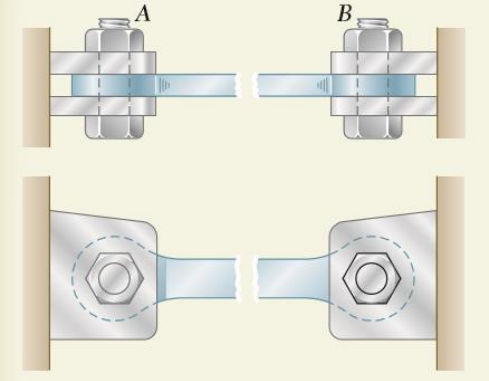
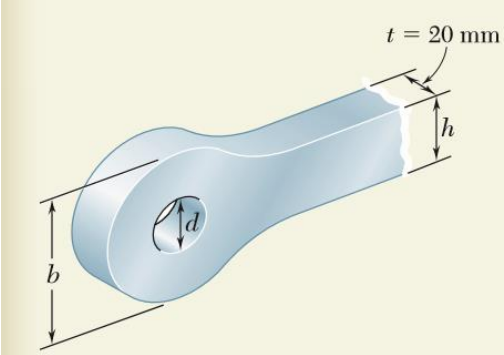
Simple Stresses and Strains-Sheet 1

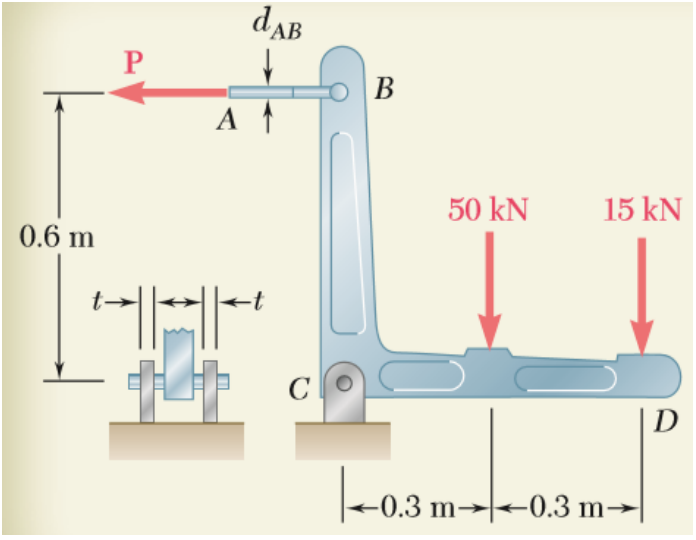
Q1. The steel tie bar is to be designed to carry a tension force of magnitude P = 120 kN when bolted between double brackets at A and B. The bar will be fabricated from 20 mm thick plate stock. For the grade of steel to be used, the maximum allowable stresses are $\sigma = 175\ MPa, \tau = 100\ MPa, \sigma_b = 350\ MPa$. Design the tie bar determining the required values of (a) the diameter 'd' of the bolt, (b) the dimension 'b' at each end of the bar, (c) the dimension 'h' of the bar.





Ans: (a) 28 mm, (b) 62.3 mm, (c) 35 mm

Q2. Two forces are applied to the bracket BCD as shown. (a) Knowing that the control rod AB is to be made of a steel having an ultimate normal stress of 600 MPa, determine the diameter of the rod for which the factor of safety with respect to failure will be 3.3. (b) The pin at C is to be made of a steel having an ultimate shearing stress of 350 MPa. Determine the diameter of the pin C for which the factor of safety with respect to shear will also be 3.3. (c) Determine the required thickness of the bracket supports at C knowing that the allowable bearing stress of the steel used is 300 MPa



Ans: (a) 16.74 mm, (b) 22 mm, (c) 6 mm

Q3. A straight, uniform rod of length L rotates at uniform angular speed ω about an axis through one end and perpendicular to its length. Estimate the maximum tensile stress generated in the rod and the elongation of the rod at this speed. The density of the material is ρ and the Young's Modulus is E.

Q4. A circular, metal rod of diameter 1 cm is loaded in tension. When the tensile load is 5 kN, the extension of a 25 cm length is measured accurately and found to be 0.0227 cm. Estimate the value of Young's Modulus, E of the metal.

Ans: 70 GPa

Q5. A bar of steel, having a rectangular cross section 7.5 cm by 2.5 cm, carries an axial tensile load of 180 kN. Estimate the decrease in the length of each side of the cross section if Youngs's Modulus E is 200 GPa and Poisson's ratio is 0.3.

Ans: 0.00108 cm and 0.00036 cm

Q6. A 2.5 cm diameter steel bolt passes through a steel tube 5 cm internal diameter, 6.25 cm external diameter, and 40 cm long. The bolt is then tightened up onto the tube through rigid end blocks until the tensile force in the bolts is 40 kN. The distance between the head of the bolt and the nut is 50 cm. If an external force of 30 kN is applied to the end blocks, tending to pull them apart, estimate the resulting tensile force in the bolt.

Ans: 47.89 kN

Q7. A concrete column, 50 cm square, is reinforced with four steel rods, each 2.5 cm in diameter, embedded in the concrete near the comers of the square. If Young's modulus for steel is 200 GN/m^2 and that for concrete is 14 GN/m^2, estimate the compressive stresses in the steel and concrete when the total thrust on the column is 1 MN.

Ans: Compressive stress = 3.62 MPa, 51.76 MPa

Q8. An aluminium rod 2.2 cm diameter is screwed at the ends, and passes through a steel tube 2.5 cm internal diameter and 0.3 cm thick. Both are heated to a temperature of 140°C, when the nuts on the rod are screwed lightly on to the ends of the tube. Estimate the stress in the rod when the common temperature has fallen to 20°C. For steel, E = 200 GN/m^2 and $\alpha = 1.2 \times 10^{-5}\ per\ ^oC$, and for aluminium, E = 70 GN/m^2 and $\alpha = 2.3 \times 10^{-5} per\ ^oC$, where E is Young's modulus and a is the coefficient of linear expansion.

Ans: 61.4 MPa