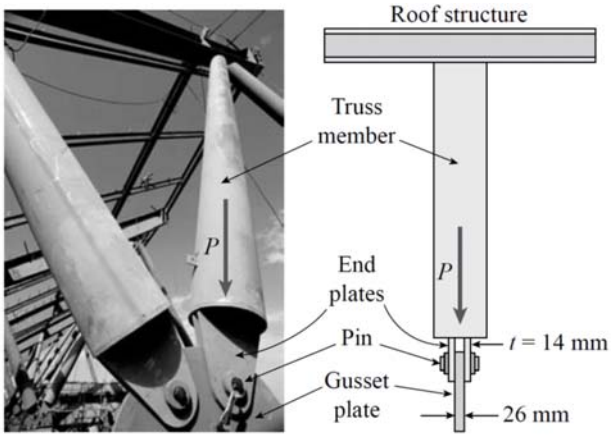
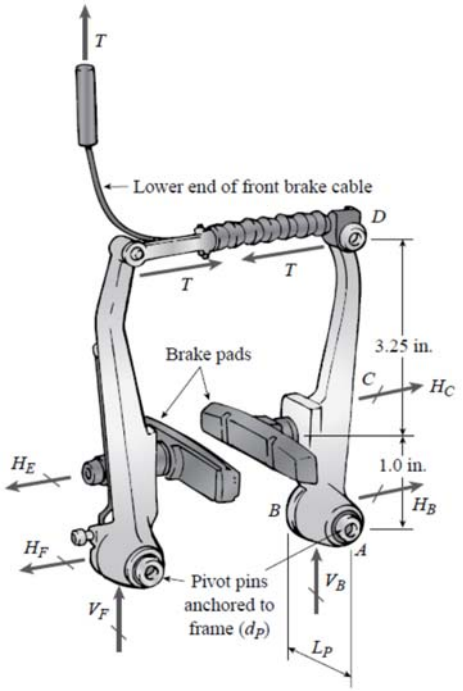
Mechanics of Materials I
Homework assignment # 1

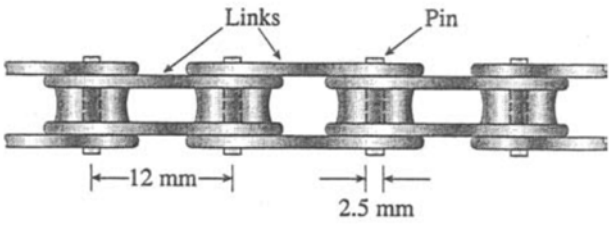
Problem 1. Truss members supporting a roof are connected to a 26-mm-thick gusset plate by a 22 mm diameter pin as shown in the figure and photo. The two end plates on the truss members are each 14 mm thick.
(a) If the load P = 80 kN, what is the largest bearing stress acting on the pin?
(b) If the ultimate shear stress for the pin is 190 MPa, what force P_{ult} is required to cause the pin to fail in shear?
(Disregard friction between the plates.)

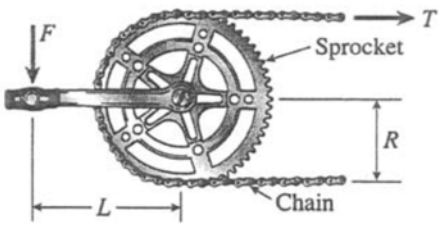


Problem 2. The force in the brake cable of the V-brake system shown in the figure is T = 45 lb. The pivot pin at A has diameter $d_p = 0.25$ in and length $L_p = 5/8$ in. Use dimensions shown in the figure. Neglect the weight of the brake system.
(a) Find the average shear stress τ_{ave} in the pivot pin where it is anchored to the bicycle frame at B.
(b) Find the average bearing stress $\sigma_{b,ave}$ in the pivot pin over
segment AB.

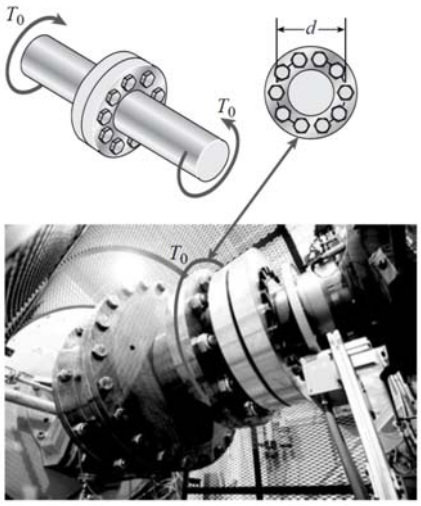


Problem 3. A bicycle chain consists of a series of small links, each 12 mm long between the centers of the pins (see figure). You might wish to examine a bicycle chain and observe its construction. Note particularly the pins, which we will assume to have a diameter of 2.5 mm. In order to solve this problem, you must now make two measurements on a bicycle (see figure): (1) the length L of the crank arm from main axle to pedal axle, and (2) the radius R of the sprocket (the toothed wheel, sometimes called the chainring). Suppose L=162 mm and R=90 mm.
(a) Calculate the tensile force T in the chain due to a force F=800 N applied to one of the pedals.
(b) Calculate the average shear stress τ_{ave} in the pins.

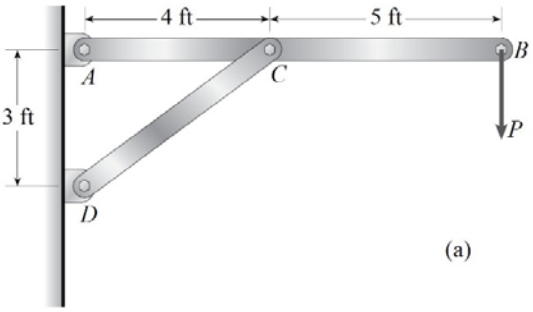


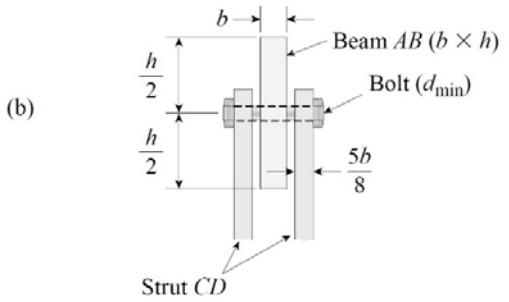


Problem 4. A torque T_0 is transmitted between two flanged shafts by means of ten 20-mm bolts (see figure and photo). The diameter of the bolt circle is d=250 mm. If the allowable shear stress in the bolts is 90 MPa, what is the maximum permissible torque?
(Disregard friction between the flanges.)

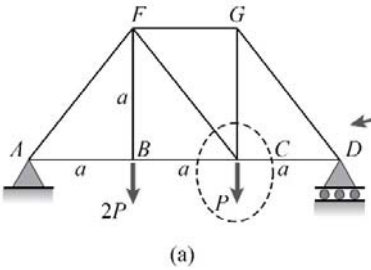


Problem 5. A horizontal beam AB with cross-sectional dimensions (b=0.75 in) and (h=8.0 in.) is supported by an inclined strut CD and carries a load P=2700 lb at joint B [see figure part (a)]. The strut, which consists of two bars each of thickness 5b/8, is connected to the beam by a bolt passing through the three bars meeting at joint C [see figure part (b)].
(a) If the allowable shear stress in the bolt is 13,000 psi, what is the minimum required diameter d_{min} of the bolt at C?
(b) If the allowable bearing stress in the bolt is 19,000 psi, what is the minimum required diameter d_{min} of the bolt at C?

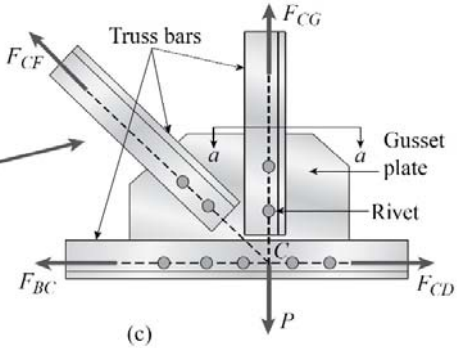




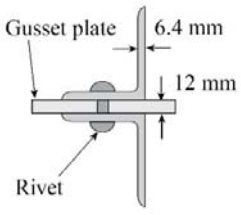
Problem 6. A plane truss is subjected to loads 2P and P at joints B and C, respectively, as shown in the figure part (a). The truss bars are made of two steel angles [cross sectional area of the two angles, $A = 2180\ mm^2$, figure part (b)] having an ultimate stress in tension equal to 390 MPa. The angles are connected to a 12 mm-thick gusset plate at C [figure part (c)] with 16-mm diameter rivets; assume each rivet transfers an equal share of the member force to the gusset plate. The ultimate stresses in shear and bearing for the rivet steel are 190 MPa and 550 MPa, respectively.
Determine the allowable load P_{allow} if a safety factor of 2.5 is desired with respect to the ultimate load that can be carried.
(Consider tension in the bars, shear in the rivets, bearing between the rivets and the bars, and also bearing between the rivets and the gusset plate. Disregard friction between the plates and the weight of the truss itself.)



(a)



(c)



(b) Section a–a