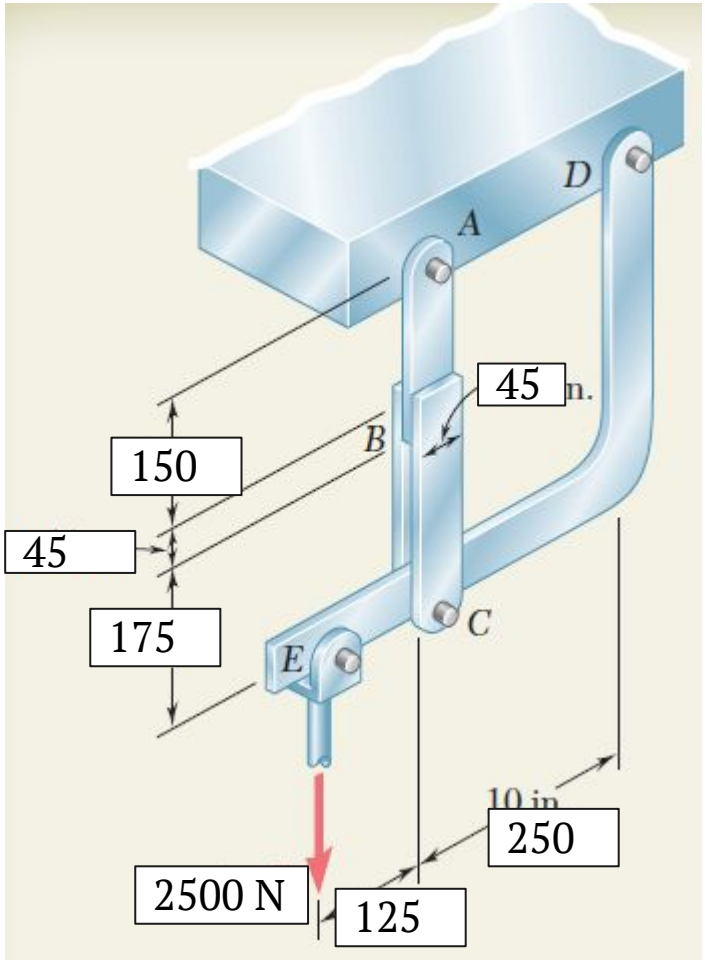
Tutorial Sheet - 5
Chapter 1
Mechanics of Materials



Problem 1

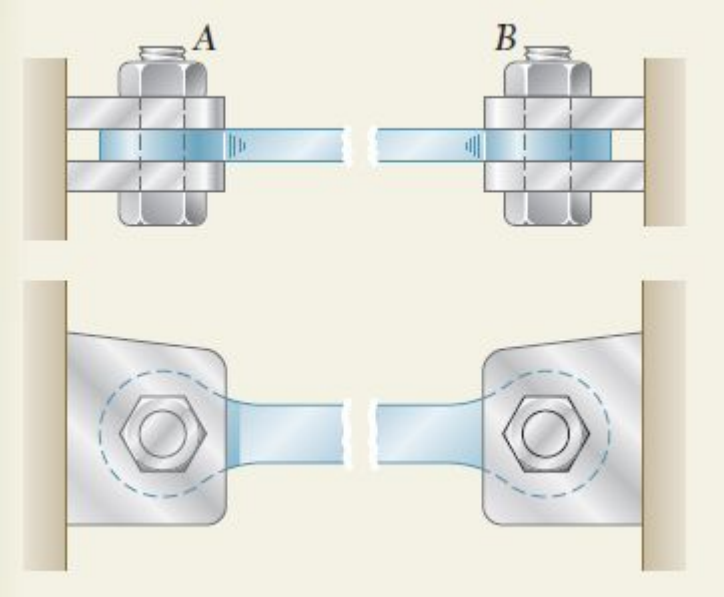
The upper portion of link ABC is 10 mm thick and the lower portions are each 6 mm thick.

Epoxy resin is used to bond the upper and lower portions together at B.

The pin at A is of 10 mm diameter. 6 mm diameter pin is used at C.

Determine (a) the shearing stress in pin A, (b) the shearing stress in pin C, (c) the largest normal stress in link ABC, (d) the average shearing stress on the bonded surfaces at B, (e) the bearing stress in the link at C.
(All dimensions are in mm)

Problem 2



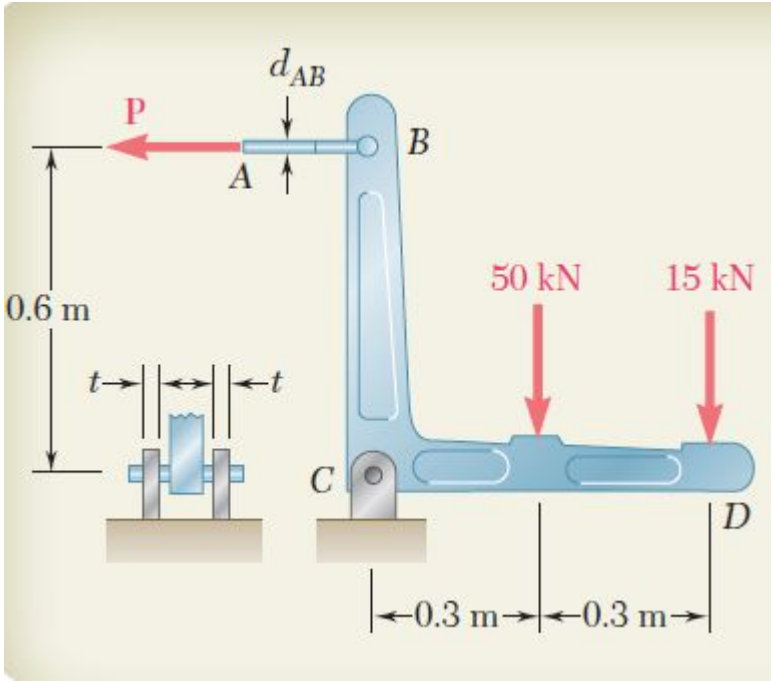
The steel tie bar has to carry a tension force of magnitude P = 120 kN when bolted between double brackets at A and B.

The plates are 20-mm-thick.

The maximum allowable stresses are: 175 MPa , 100 MPa, 350 MPa.

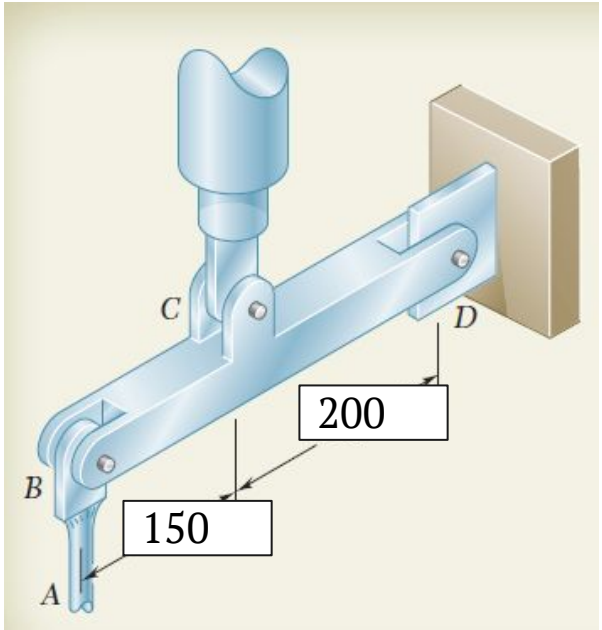
Design the tie bar by determining the required values of (a) the diameter d of the bolt, (b) the dimension b at each end of the bar, (c) the dimension h of the bar.

Problem 3



Two forces are applied to the bracket BCD. (a)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. The allowable bearing stress of the steel used is 300 MPa.

Problem 4



The rigid beam BCD is attached by bolts to a control rod at B, to a hydraulic cylinder at C, and to a fixed support at D. The diameters of the bolts used are: dB = dD = 10 mm, dC = 12 mm.

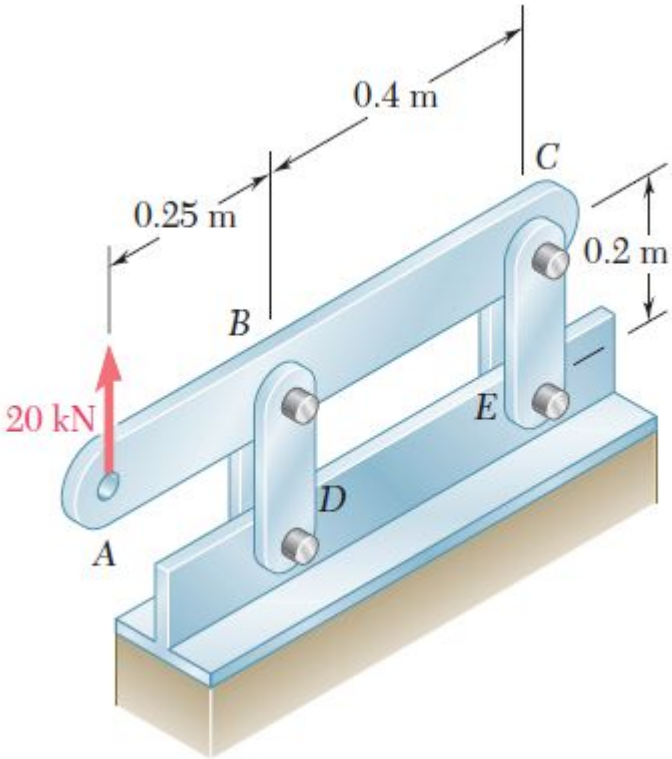
Each bolt acts in double shear and is made of steel.

The control rod AB has a diameter 10 mm. It is made of a steel.

Determine the largest upward force which may be applied by the hydraulic cylinder at C.

The ***minimum factor of safety*** is 3.0 for the entire unit.

Problem 5

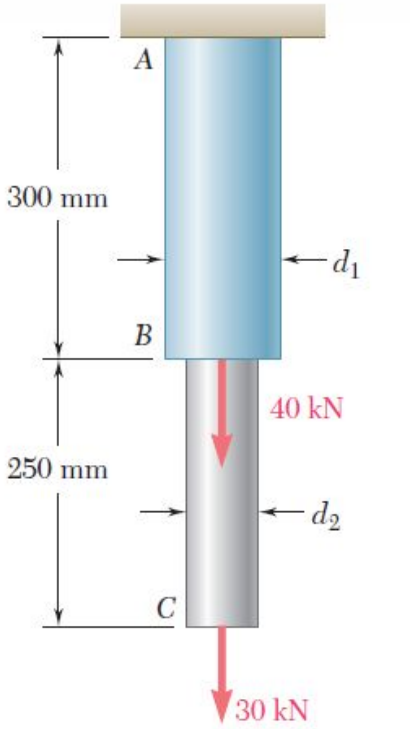


Each of the four vertical links has an 8 X 36 mm uniform rectangular cross section.

Each of the four pins has a 16-mm diameter.

Determine the maximum value of the average normal stress in the links connecting (a) points B and D, (b) points C and E.

Problem 6

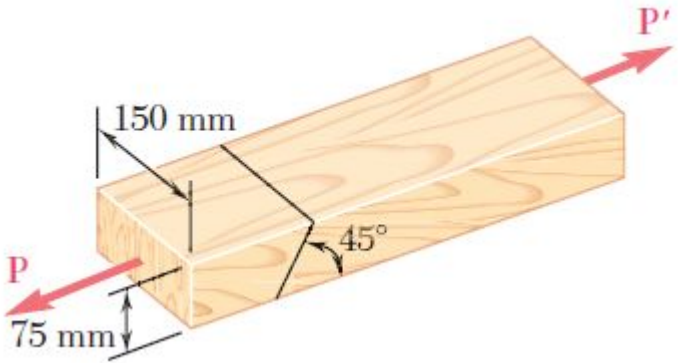


Two solid cylindrical rods AB and BC are welded together at B and loaded.

The average normal stress must not exceed 175 MPa in rod AB and 150 MPa in rod BC.

Determine the smallest allowable values of d1 and d2.

Problem 7

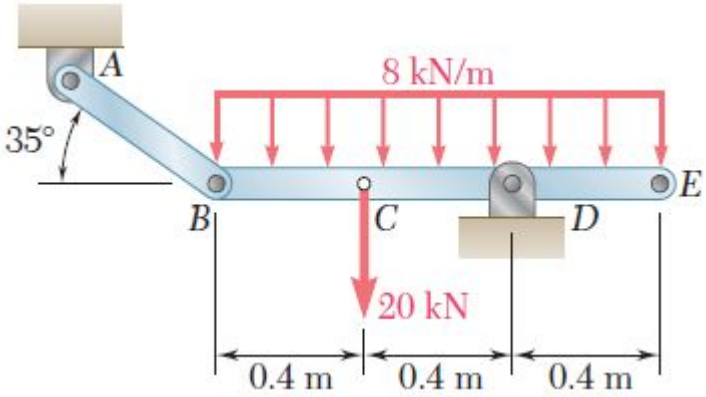


Two wooden members of uniform rectangular cross section are joined by the simple glued scarf splice.

P = 11 kN

Determine the normal and shearing stresses in the glued splice.

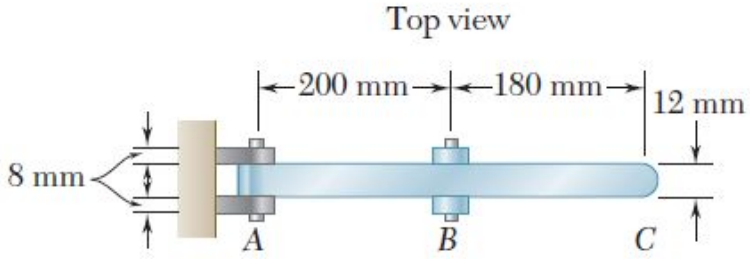
Problem 8

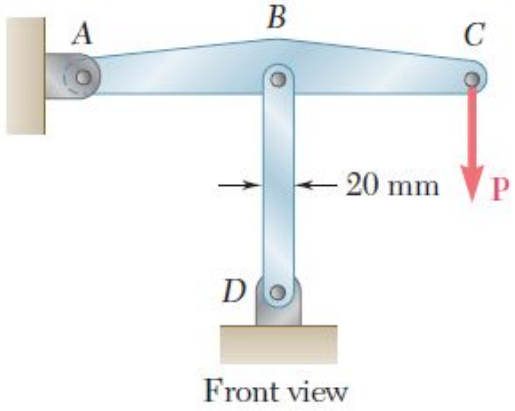


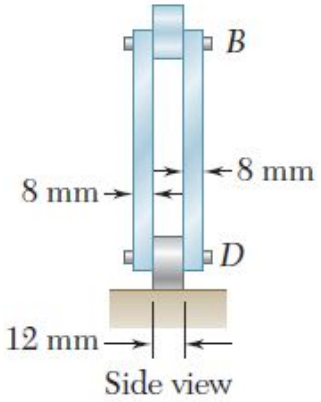
Link AB is to be made of a steel for which the ultimate normal stress is 450 MPa.

Determine the cross-sectional area of AB for which the factor of safety will be 3.50.

Assume that the link will be adequately reinforced around the pins at A and B.







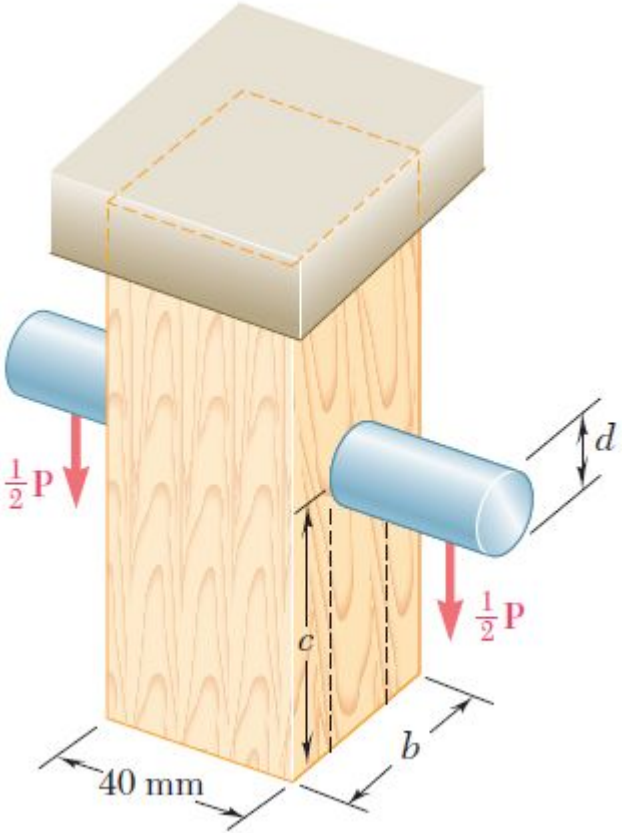
Problem 9

An 8-mm-diameter pin is used at A, and 12-mm-diameter pins are used at B and D.

The ultimate shearing stress is 100 MPa at all connections. The ultimate normal stress is 250 MPa in each of the two links joining B and D.

Determine the allowable load P.

An ***overall factor of safety*** of 3.0 is desired.



Problem 10

Load P is supported by a steel pin inserted in a short wooden member hanging from the ceiling.
The ultimate strength of the wood is 60 MPa in tension and 7.5 MPa in shear. The ultimate strength of the steel is 145 MPa in shear.

b = 40 mm, c = 55 mm, and d = 12 mm

Determine the load P.

An ***overall factor of safety*** of 3.2 is desired.