Class 2: Shear Stress/Bearing Stress/Bolted Connections

Material covered on Feb. 10, 2015

Learning Objectives:

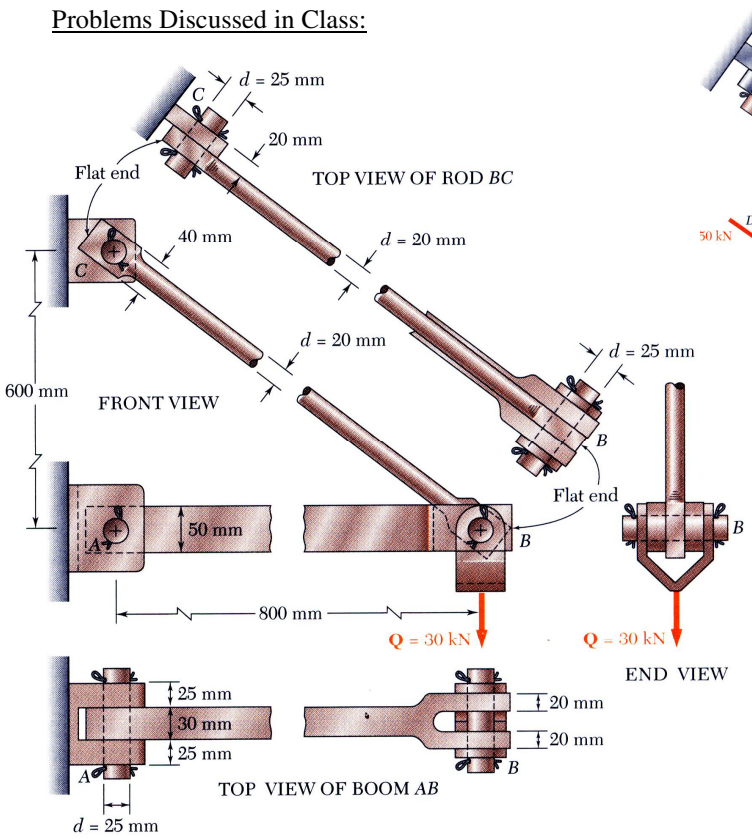
1. Identify the forces and areas involved in calculating normal stress, shear stress, and bearing stress.
2. Identify three types of problems that can be solved: find σ_{ave}, find min $A_{req'd}$, or find max P that can be carried.
3. Calculate average shear stress acting on a transverse area in connections and bolts due to shear forces (V).
4. Calculate the average bearing stress in connection elements or other bearing situations due to normal forces (P).

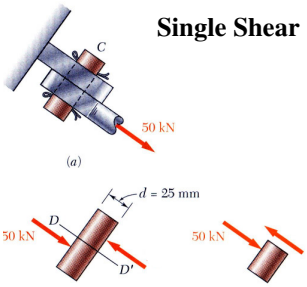
Average Normal Stress: $\sigma_{ave} = P/A$ Intensity of force acting normal to area

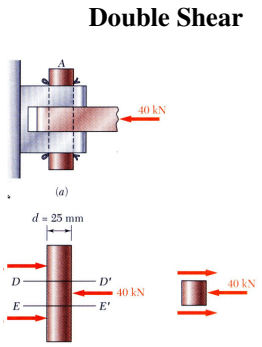
Average Shear Stress: $\tau_{ave} = V/A$ Intensity of force acting tangent to area

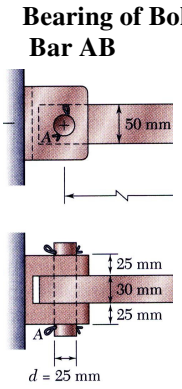
Bearing Stress: $\sigma_{ave} = P/A$ Intensity of force acting normal to area, occurs when one object presses against another

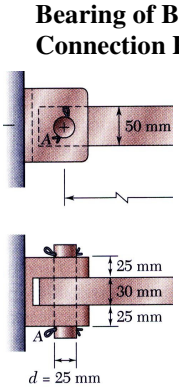
Problems Discussed in Class:







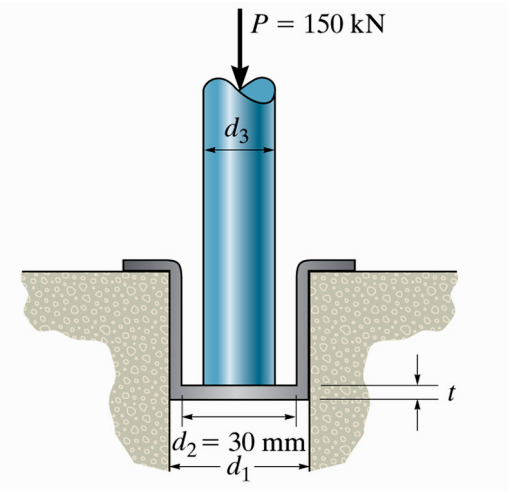




Ex. 1 The structure is designed to support a 30 kN load.

a) Calculate the average shear stress in the single shear bolted connection at C.
b) Calculate the average shear stress in the double shear bolted connection at A.
c) Calculate the average bearing stress of the bolt on bar AB.
d) Calculate the average bearing stress of the bolt on the gusset (connection) plates at A.

Ex. 2 Determine the smallest dimensions of the solid circular bar and circular end cap if the load it is required to support is P = 150 kN. The allowable tensile normal stress, bearing compressive stress, and shear stress are $(\sigma_t)_{allow}$ = 175 MPa, $(\sigma_b)_{allow}$ = 275 MPa, and τ_{allow} = 115 MPA.



Homework: Problems 1, 2, 3, 4 & 5 on this handout

Sections to Read in Textbook next: Sections 1.6 and 1.7

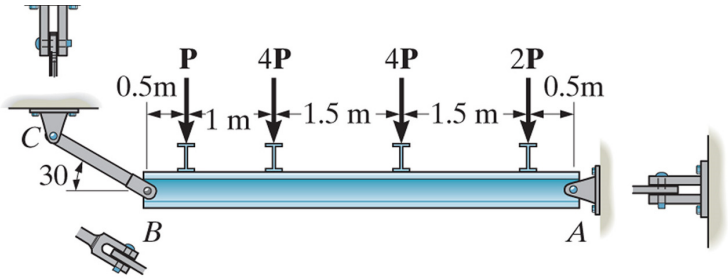
Look @ MecMovies as noted on Previous Handout

HW 2: Shear Stress/Bearing Stress/Bolted Connections

For all problems, it is helpful to sketch the area being sheared or the area in compressive bearing for each case examined.

Problem 1

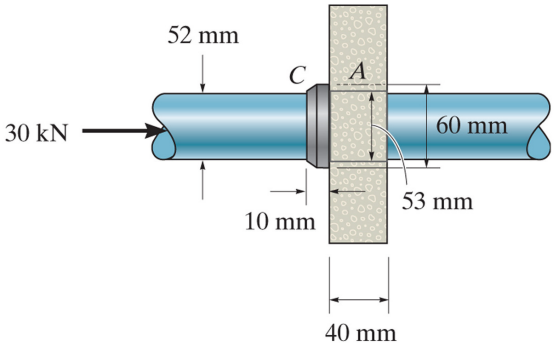
The beam is supported by a pin at *A* and a short link *BC*. Determine the maximum magnitude P of the loads the beam will support if the average shear stress in each pin is not to exceed 80 MPa. All pins are in double shear as shown, and each has a diameter of 18 mm.



(Hint: Find the reaction forces in terms of P. For the pin at A with reaction force components A_x and A_y, resultant shear force applied to the pin is A = sqrt(A_x^2+A_y^2))

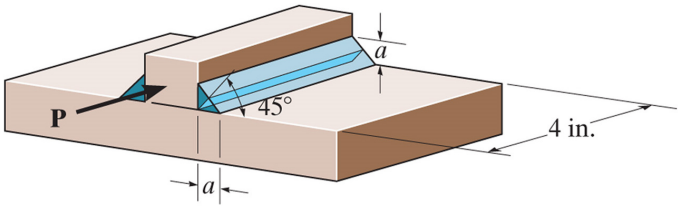
Problem 2

There is a 53 mm diameter hole in the wall that has a 53 mm bar passing thru. There is a ring collar attached to the bar that has an outside diameter of 60 mm that prevents the bar from moving to the right under the applied load. Determine the average shear stress between the rod and the ring collar C. Also determine the bearing stress between the ring collar C and the wall surface provided by the wall A.



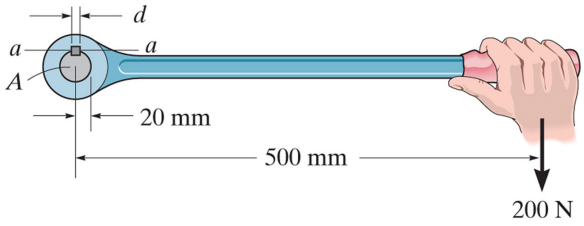
Problem 3

The fillet weld size a = 0.25 in. If the joint is assumed to fail by shear on both sides of the block along the shaded plane, which designates the smallest area cross-section, determine the largest force P that can be applied to the plate. The allowable shear stress of the weld material is τ_{allow} = 14 ksi.

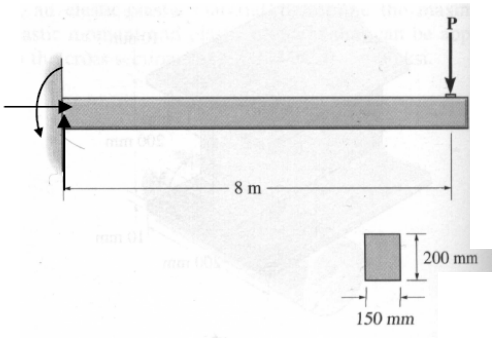


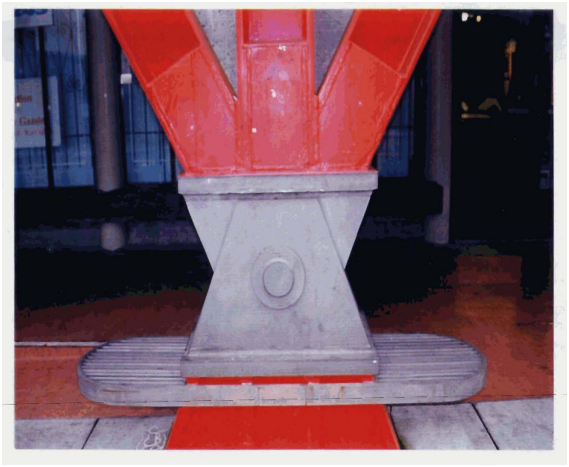
Problem 4 (Extra Credit)

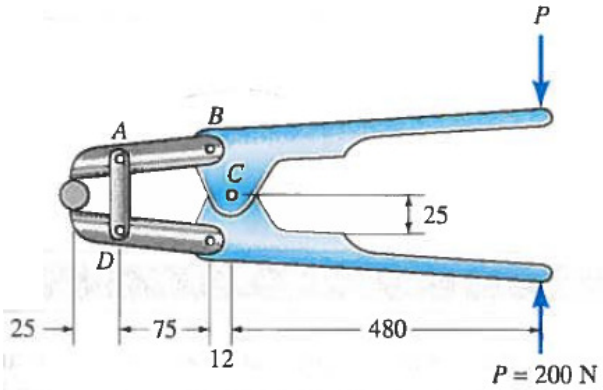
The lever is attached to the shaft *A* using a key that has a width d and length of 25 mm, into the page. If the shaft is fixed and a vertical force of 200 N is applied perpendicular to the handle, determine the dimension d if the allowable shear stress for the material the key is made out of is τ_{allow} = 35 MPa. Note: The 200 N force creates a moment about the shaft A, this can be used to determine the force acting on the key located at a distance of 20 mm from the center of A. Watch MecMovie 1.9 for a visual of a shear key shearing.

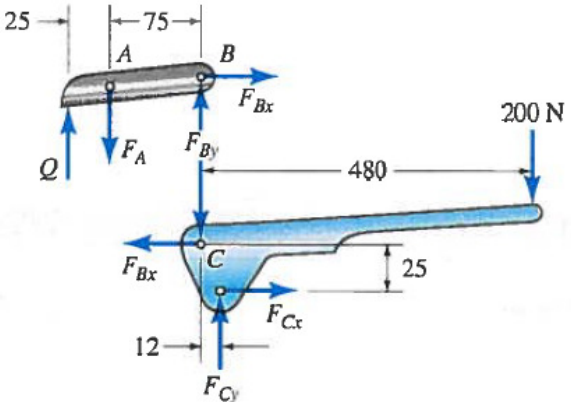


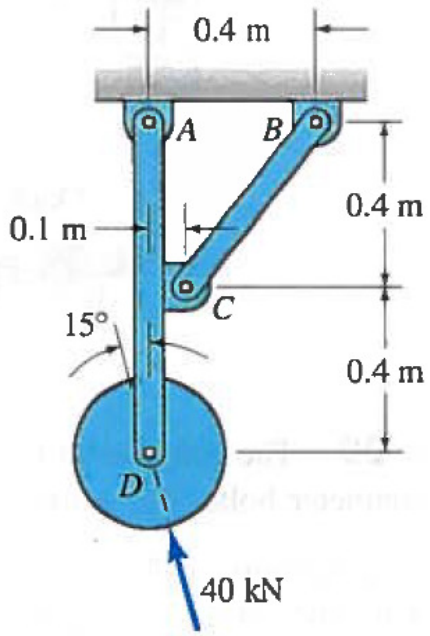
Problem 5 a) True or False - The normal axial stress in this beam is σ = P/A where A = (200 mm)(150 mm)
b) True or False – The average shear stress in this beam is τ_{ave} = P/A where A = (200mm)(150mm)






P
A
B
C
D
25
25
75
12
480
P = 200 N


25
75
A
B
F_{Bx}
200 N
Q
F_A
F_{By}
480
F_{Bx}
C
25
F_{Cx}
12
F_{Cy}


0.4 m
A
B
0.1 m
0.4 m
C
15°
0.4 m
D
40 kN