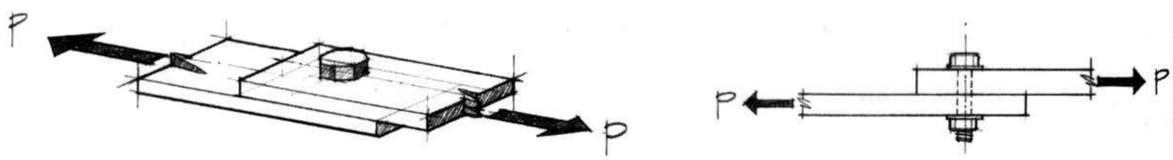
Connections & Stresses

Notation:

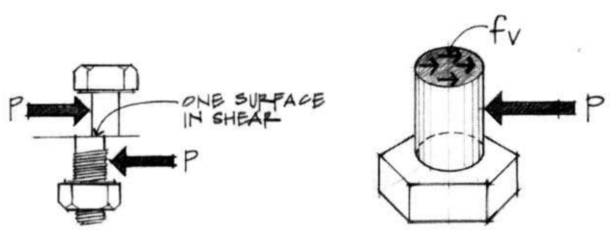
A = area (net = with holes, bearing = in contact, etc...)
d = diameter of a hole
f_p = bearing stress (see P)
f_t = tensile stress
f_v = shear stress
P = name for axial force vector, as is T
t = thickness
π = pi (3.1415 radians or 180°)

Bolts in Shear and Bearing

Single shear - forces cause only one shear "drop" across the bolt.



(a) Two steel plates bolted using one bolt. *(b) Elevation showing the bolt in shear.*



(c) *(d)*

f_v = Average shear stress through bolt cross section

A = Bolt cross-sectional area

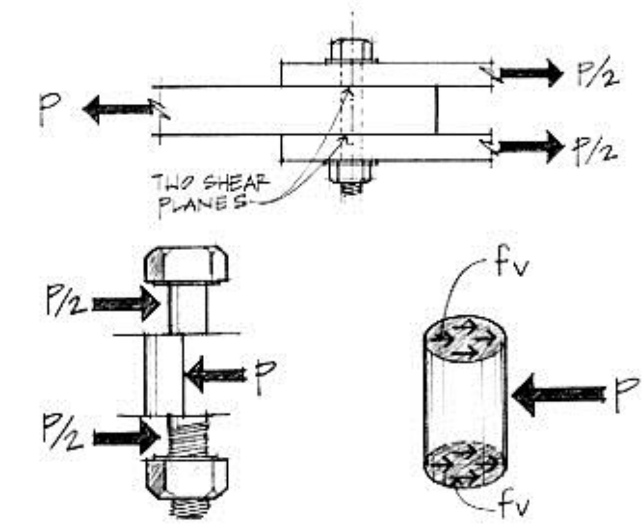
$$f_v = \frac{P}{A}$$

Figure 5.11 A bolted connection—single shear.

<u>Double shear</u> - forces cause two shear changes across the bolt.

$$f_v = \frac{P}{2A}$$

(two shear planes)

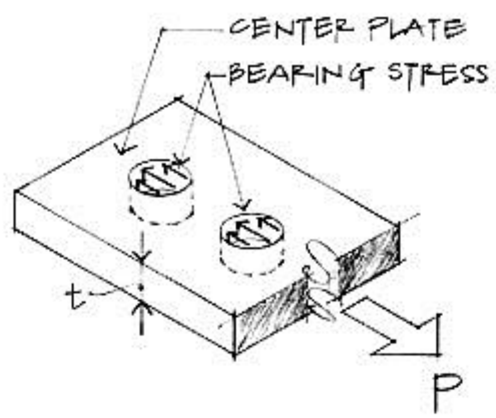


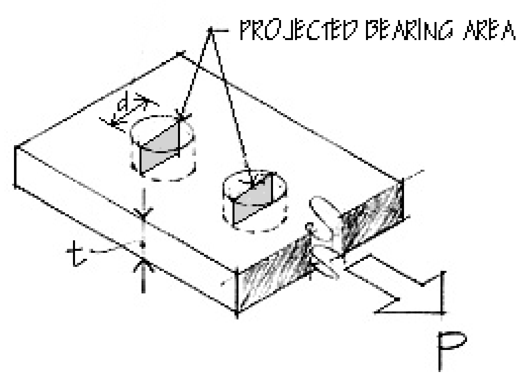
Free-body diagram of middle section of the bolt in shear.

Figure 5.12 A bolted connection in double shear.

<u>Bearing of a bolt on a bolt hole</u> – The bearing surface can be represented by *projecting* the cross section of the bolt hole on a plane (into a rectangle).

$$f_p = \frac{P}{A} = \frac{P}{td}$$





Bearing stress on plate.

Example 1

A pipe storage rack is used for storing pipe in a shop. The support rack beam is fastened to the main floor beam using steel straps $\frac{1}{2}$" × 2" in dimension. Round bolts are used to fasten the strap to the floor beam in single shear. (a) If the weight of the pipes impose a maximum tension load of 10,000 pounds in each strap, ~~determine the tension stress developed in the steel strap~~. (b) Also, what diameter bolt is necessary to fasten the strap to the floor beam if the allowable shear stress for the bolts equals $F_v = 15{,}000\ ^{lb.}/_{in.^2}$? Determine the bearing stress in the strap from the bolt diameter chosen.