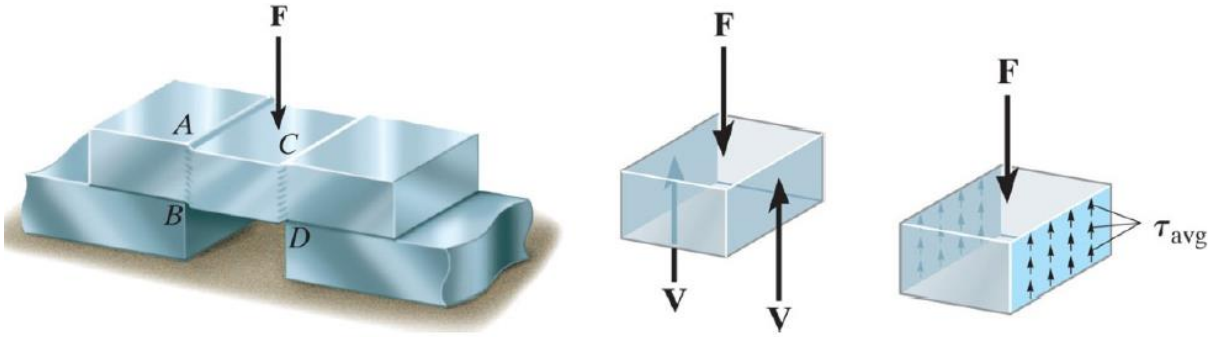
CHAPTER 1 STRESS

5. AVERAGE SHEAR STRESS

Shear Stress is the stress component that acts in the plane of the sectioned area.



$$\tau_{avg} = \frac{V}{A} \qquad V = \frac{F}{2}$$

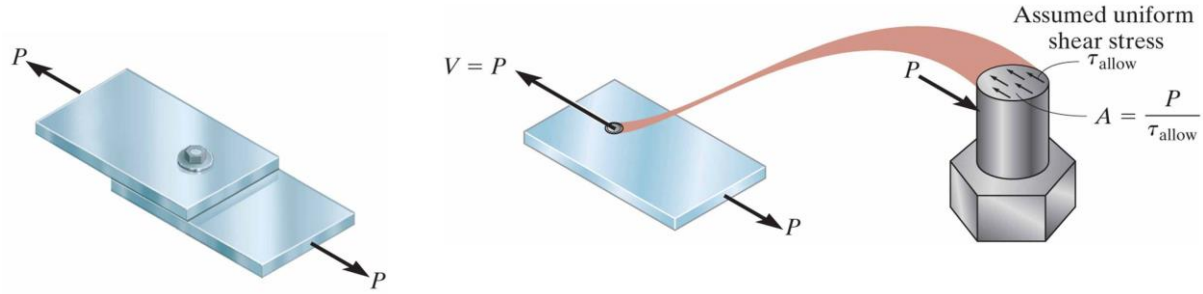
$\boldsymbol{\tau_{avg}}$ = average shear stress at the section

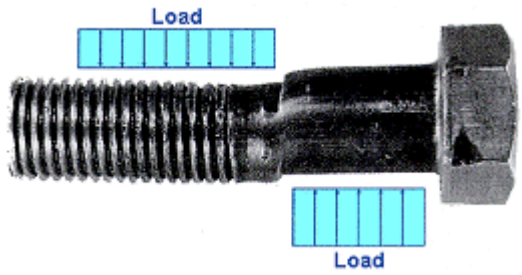
$\boldsymbol{V}$ = internal resultant shear force

$\boldsymbol{A}$ = area at the section

The loading case discussed here is an example of ***simple or direct shear***, since the shear is caused by the direct action of the applied load **F**. This type of shear often occurs in various types of simple connections that use bolts, pins, welding material, etc.

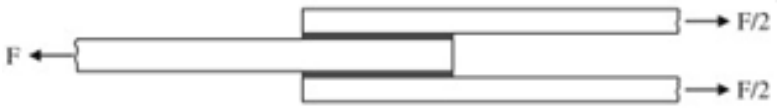
Another example of direct shear stress is the lap joint. Two plates are held together by a bolt or a rivet. If *P* is applied to the plates and friction between the plates is negligible, then the bolt or rivet must transfer the force from one plate to the other. The last figure shows a bolt failed in single shear.

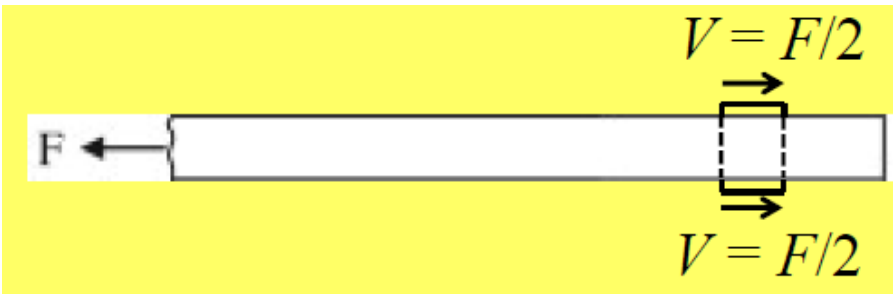




Shear stress is never uniformly distributed, but this equation can be used when dealing with small areas such as the area of a bolt or rivet.

A double lap joint creates a situation called ***double shear***. In this case, the force is transferred between the plates via two cross sections of the bolt or rivet.

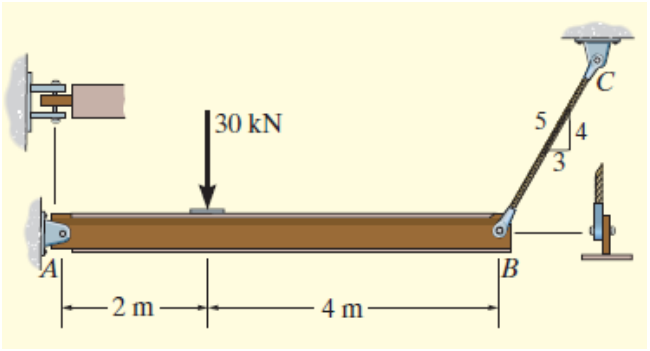




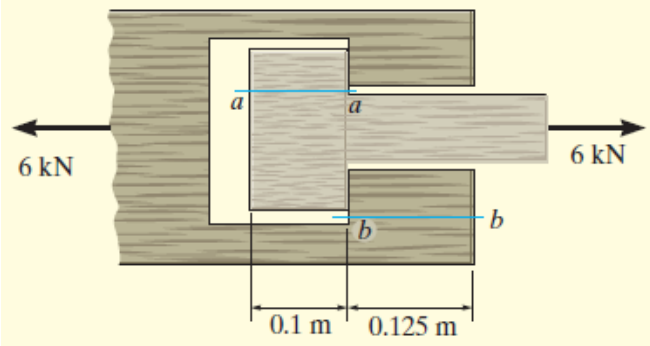
Thus:

$$V = \frac{P}{2} \qquad \tau_{avg} = \frac{V}{A}$$

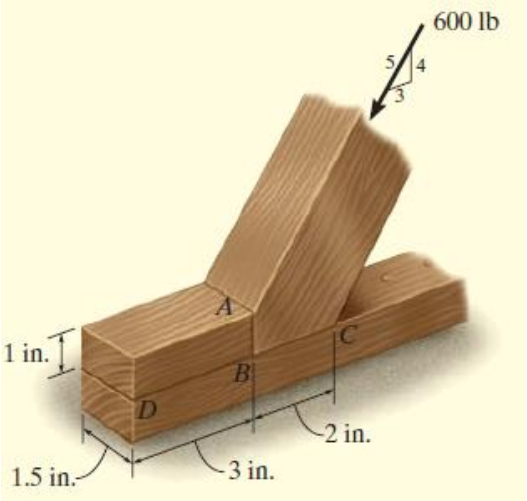
Example 10: Determine the average shear stress in the 20-mm-diameter pin at *A* and the 30-mm-diameter pin at *B* that support the beam in Figure.



Example 11: If the wood joint in Figure has a width of 150 mm, determine the average shear stress developed along shear planes *a–a*, and *b–b*. For each plane, represent the state of stress on an element of the material.

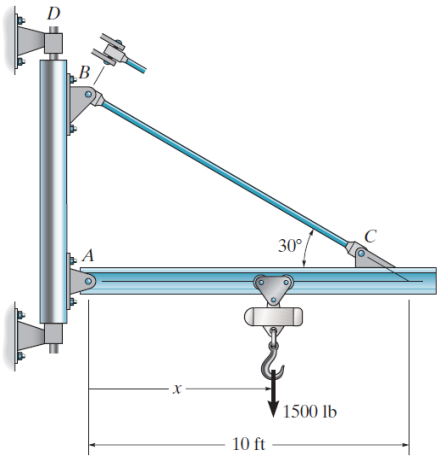


Example 12: The inclined member in Figure is subjected to a compressive force of 600 lb. Determine the average compressive stress along the smooth areas of contact defined by *AB* and *BC*, and the average shear stress along the horizontal plane defined by *DB*.

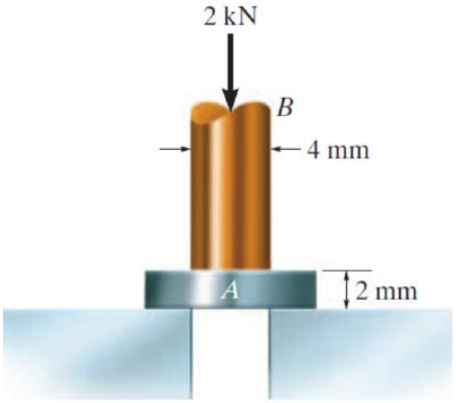


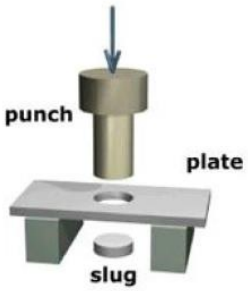
Sheet No. 2

Q 1: The jib crane is pinned at A and supports a chain hoist that can travel along the bottom flange of the beam, 1 ft ≤ x ≤ 12 ft. If the hoist is rated to support a maximum of 1500 lb, determine the maximum average normal stress in the 3/4-in.-diameter tie rod BC and the maximum average shear stress in the 5/8-in.-diameter pin at B.



Q 2: The circular punch B exerts a force of 2 kN on the top of the plate A. Determine the average shear stress in the plate due to this loading.





Q 3: If the joint is subjected to an axial force of P = 9 kN, determine the average shear stress developed in each of the 6-mm diameter bolts between the plates and the members and along each of the four shaded shear planes.