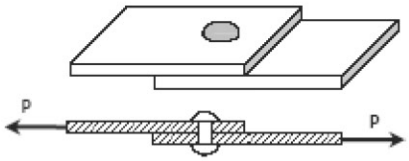
## *Shearing Stress*

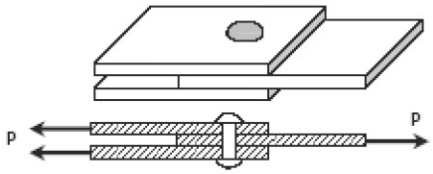
Forces parallel to the area resisting the force cause shearing stress. It differs to tensile and compressive stresses, which are caused by forces perpendicular to the area on which they act. Shearing stress is also known as tangential stress.

$$\tau = \frac{V}{A}$$

where (V) is the resultant shearing force which passes which passes through the centroid of the area A being sheared.



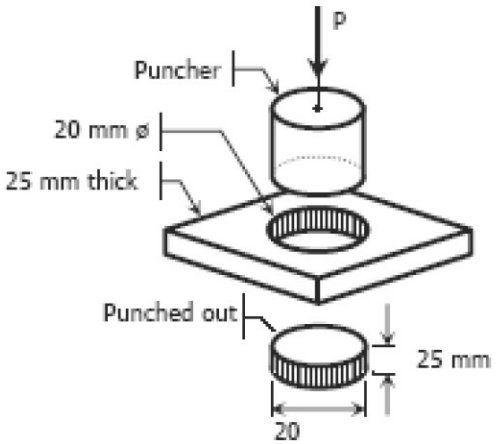

Single Shear




Double Shear

**Problem 1:** What force is required to punch a 20-mm-diameter hole in a plate that is 25 mm thick? The shear strength is 350 MN/m$^2$.

**Solution:**




The resisting area is the shaded area along the perimeter and the shear force $V$ is equal to the punching force $P$.

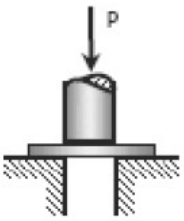
$$V = \tau A$$
$$P = 350[\pi(20)(25)]$$
$$= 549\,778.7 \text{ N}$$
$$= \mathbf{549.8 \text{ kN}}$$

**Problem 2:** As in Fig, a hole is to be punched out of a plate having a shearing strength of 40 ksi. The compressive stress in the punch is limited to 50 ksi.

(**a**) Compute the maximum thickness of plate in which a hole 2.5 inches in diameter can be punched.

(**b**) If the plate is 0.25-inch-thick, determine the diameter of the smallest hole that can be punched.

**Solution:**




(a) Maximum thickness of plate:
Based on puncher strength:

$P = \sigma A$

$= 50[\frac{1}{4}\pi(2.5^2)]$

$= 78.125\pi$ kips → Equivalent shear force of the plate

Based on shear strength of plate:

$V = \tau A$ → V = P

$78.125\pi = 40[\pi(2.5t)]$

$t = 0.781$ inch

(b) Diameter of smallest hole:
Based on compression of puncher:

$P = \sigma A$

$= 50(\frac{1}{4}\pi d^2)$

$= 12.5\pi d^2$ → Equivalent shear force for plate

Based on shearing of plate:

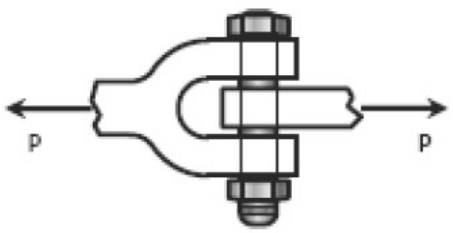
$V = \tau A$ → V = P

$12.5\pi d^2 = 40[\pi d(0.25)]$

$d = 0.8$ in

**Problem 3:** Find the smallest diameter bolt that can be used in the clevis shown in Fig if P = 400 kN. The shearing strength of the bolt is 300 MPa.

**Solution:**



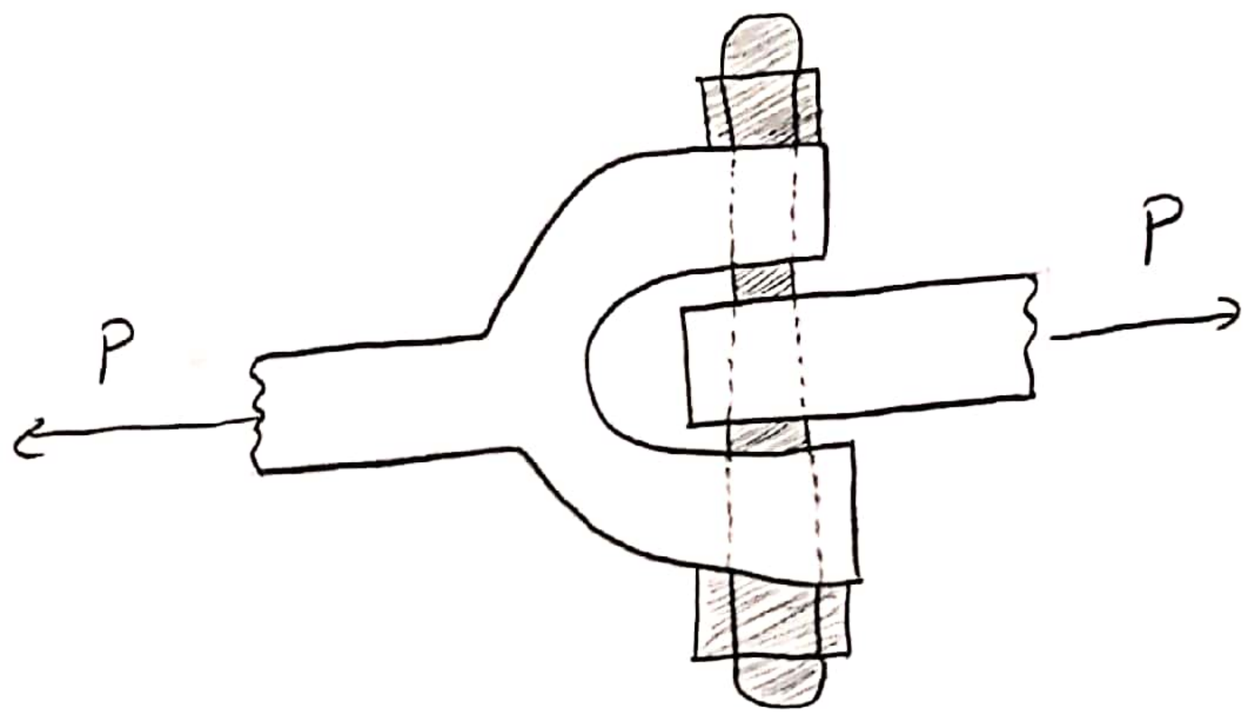

The bolt is subject to double shear.

$V = \tau A$

$400(1000) = 300[2(\frac{1}{4}\pi d^2)]$

$d = 29.13$ mm

Ex:- Determine the smallest diameter of bolt that can be used in the clevis shown in fig if P = 400 KN. The shearing strength of the bolt is 300 Mpa




Sol:- the bolt is subjected to double shear

$$\tau = \frac{V}{A} = 300\ MPa$$

$$A = \left(\frac{\pi}{4} * D^2\right) * 2 = \frac{\pi}{2} D^2$$

$$\therefore 300 = \frac{P}{A}$$

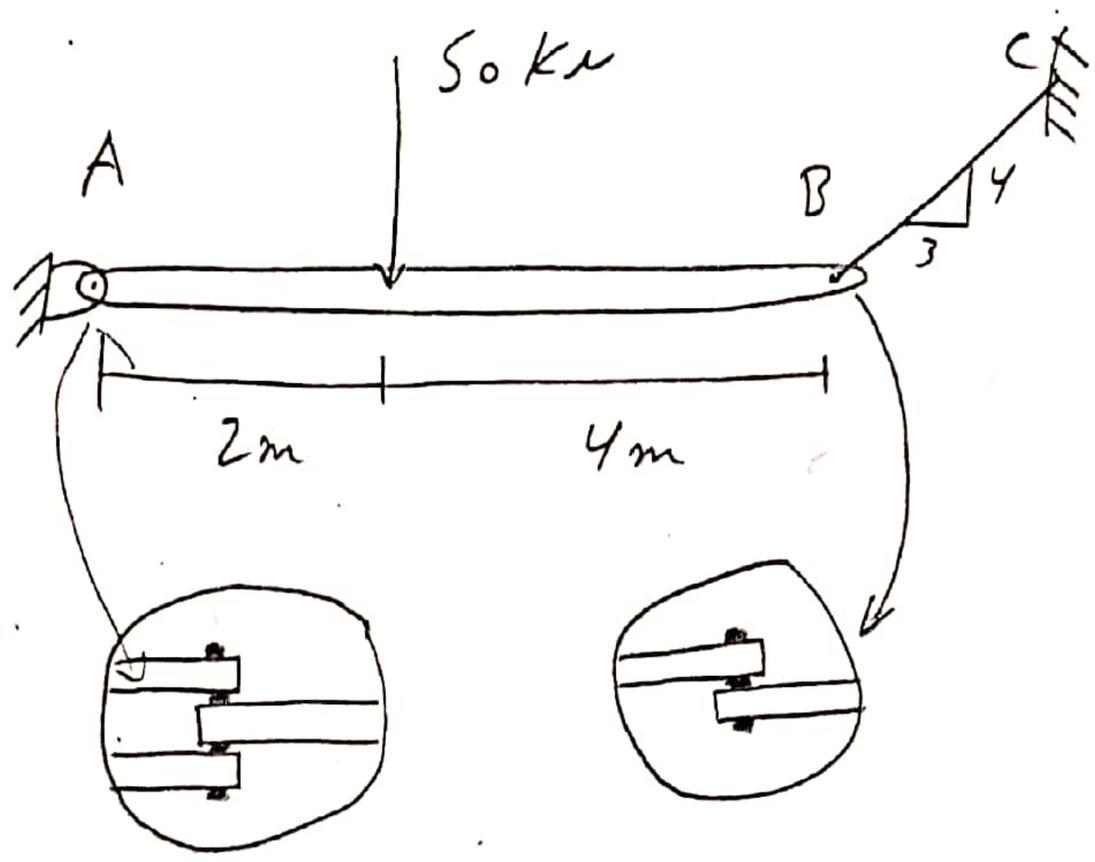
$$\therefore A = \frac{P}{300}$$

$$\therefore A = \frac{400 * 1000}{300} = 1333{,}33 = \frac{\pi}{2} * D^2$$

$$\therefore D^2 = \frac{1333{,}33 * 2}{\pi} = 849{,}25$$

$$\therefore D = 29{,}141\ mm$$

Find the shear stress at (A) and (B) in the 20mm pins



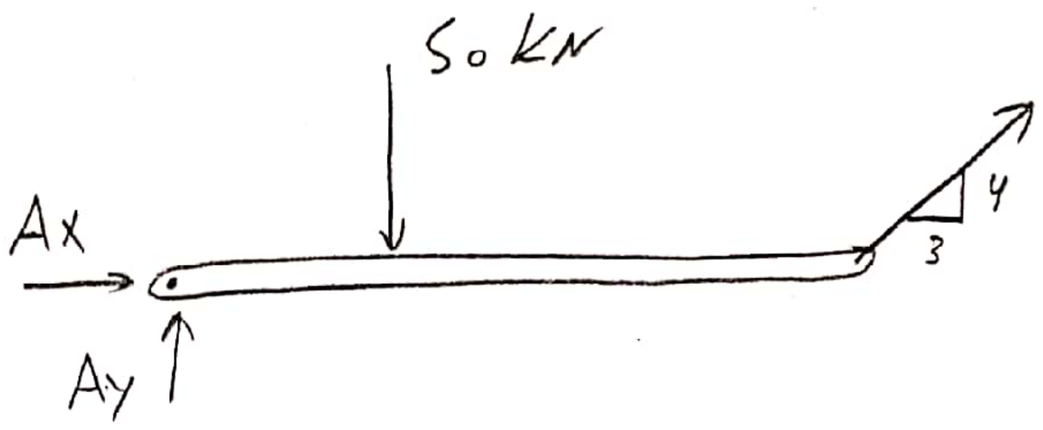

Sol:-

$$\tau = \frac{V}{A}$$

$$\therefore \tau_B = \frac{Bc}{A}$$

$$= \frac{20,83 * 1000}{\frac{\pi}{4} * 20^2}$$

$$= 66,33 \text{ Mpa}$$




$$\Sigma M_A = 0$$

$$0 = 50 * 2 - Bc * \frac{4}{5} * 6$$

$$100 = Bc * 4,8$$

$$\therefore Bc = 20,83 \text{ Tension}$$

$$\Sigma F_y = 0$$

$$0 = Ay - 50 + Bc * \frac{4}{5}$$

$$\therefore 0 = Ay - 50 + 20,83 * \frac{4}{5}$$

$$\therefore Ay = 50 - 16,664$$

$$Ay = 33,336 \uparrow$$

$$\Sigma F_x = 0$$

$$0 = Ax + 20,83 * \frac{3}{5}$$

$$\therefore Ax = -12,498$$

$$\therefore Ax = 12,498 \leftarrow$$

$$\therefore F_A = \sqrt{(12,498)^2 + (33,336)^2}$$

$$\therefore F_A = 35,601 \text{ KN}$$

$$\tau_A = \frac{F_A}{A}$$

$$= \frac{F_A}{2A}$$

$$= \frac{35,601 * 1000}{2 * \frac{\pi}{4} * 20^2}$$

$$= 56,689 \text{ Mpa}$$