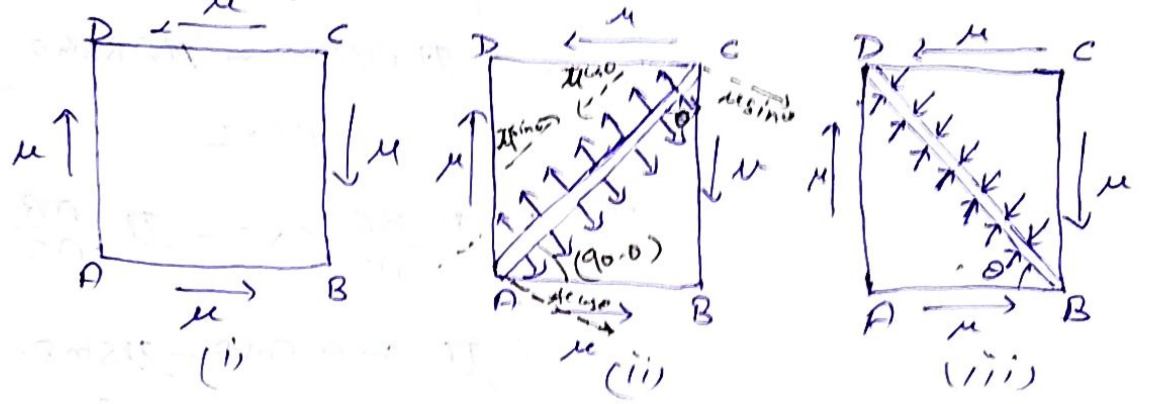
Diagonal stresses produced by simple shear on a square block:

Let us consider a square block ABCD having side length equal to 'l'. Let thickness of block normal to plane of paper is equal to unity.



μ → intensity of shear stress

Normal stress T_n on plane AC is given by

$$T_n = \frac{\text{normal force on plane AC}}{\text{Area of section AC}}$$

$$T_n = \frac{\mu BC \sin\theta + \mu AB \cos\theta}{AC \times 1}$$

$$= \mu \frac{BC}{AC} \sin\theta + \mu \cdot \frac{AB}{AC} \cos\theta$$

$$= \mu \cdot \cos\theta \cdot \sin\theta + \mu \cdot \sin\theta \cdot \cos\theta$$

~~= 2μ cosθ sinθ~~

$$= 2\mu \cos\theta \sin\theta$$

{ See fig ii) Triangle ABC }

$$T_n = \mu \sin 2\theta \quad \text{—— (1)}$$

In ∠ABC, ~~angle~~.

$$\tan\theta = \frac{AB}{BC} = \frac{l}{l} = 1$$

$$\Rightarrow \theta = 45^\circ \quad \text{—— (2)}$$

From (1) and (2)

$$T_n = \mu \sin(2 \times 45^\circ) = \mu \sin 90^\circ$$

$$\boxed{T_n = \mu} \quad \text{—— (3)}$$

Similarly the tangential stress on plane AC is given by

$$\tau_t = \frac{\text{Tangential force on plane AC}}{\text{Area of plane AC}}$$

$$\tau_t = \frac{\mu\, BC \cos\theta - \mu\, AB \sin\theta}{AC \times 1}$$

$$\tau_t = \mu \frac{BC}{AC}\cos\theta - \mu \frac{AB}{AC}\sin\theta$$

$$= \mu \cos\theta \cdot \cos\theta - \mu \sin\theta \cdot \sin\theta$$

or $$\tau_t = \mu(\cos^2\theta - \sin^2\theta) = \mu \cos 2\theta$$

$\because \theta = 45^\circ$

$$\boxed{\tau_t = \mu \cos 90^\circ = 0} \quad \text{— (4)}$$

⇒ On plane AC, a direct tensile stress of intensity μ is acting and this tensile stress is parallel to diagonal BD. Thus, diagonal BD is subjected to tensile stress of intensity μ.

In similar way, we can show that on plane BD a direct compressive stress of intensity μ is acting. This compressive stress is along the diagonal AC or thus is perpendicular to plane BD.

Thus AC is subjected to compressive stress of intensity μ