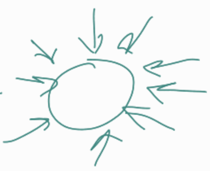
Solid Mechanics

Stress

$$\boxed{\sigma = \frac{F}{A}}$$

- Tensile
- Hydraulic (volumetric stress)



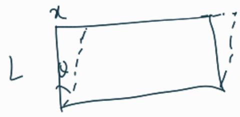
- Shear $\Rightarrow S.S = \dfrac{F}{A_{\parallel}}$

Strain

No units and no dimension

$$\boxed{\epsilon = \frac{\Delta l}{l}}$$

- longitudnal strain $(\Delta L/L)$
- (Bulk strain) volumetric strain $(\Delta V/V)$
- Shear strain



$\tan\theta = \dfrac{x}{L}$ (shear strain)

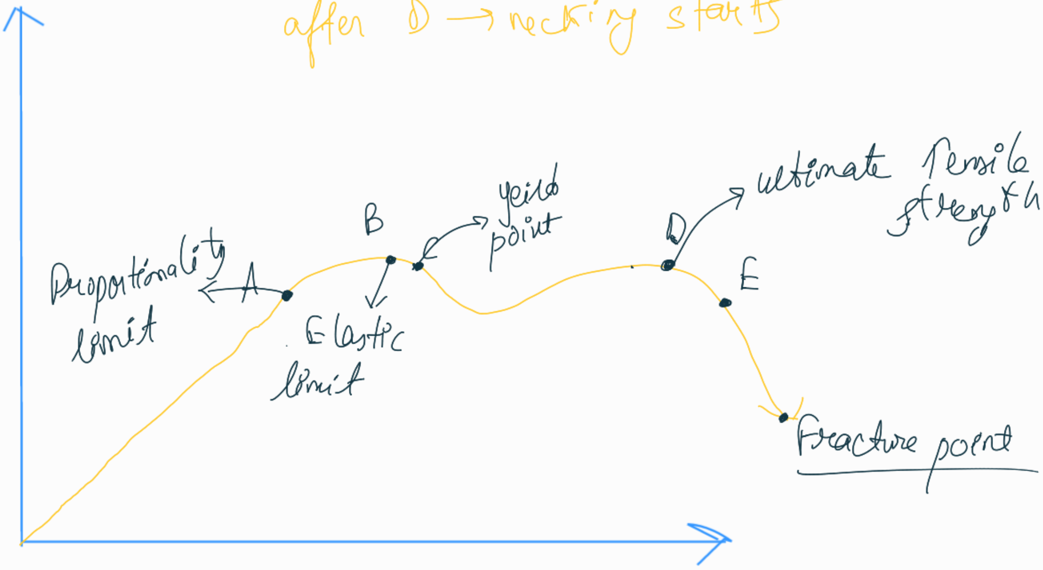
Modulus of Elasticity

Modulus of Elasticity $= \dfrac{\text{stress}}{\text{strain}}$

- $Y = \dfrac{\text{Tensile stress}}{\text{Tensile strain}}$ (young's Modulus)
- Bulk Modulus: $B = \dfrac{-P}{(\Delta V/V)}$
- $\eta = \dfrac{\text{Shear stress}}{\text{Shear strain}}$ → Modulus of rigidity or shear Modulus

Stress-strain Curve

OA → Elastic Deformation
BD → plastic deformation
after D → necking starts



Hooke's Law :- (valid till elasticity and proportionality limit)

$$\sigma \propto \varepsilon$$

$$\boxed{\sigma = E\,\varepsilon}$$ → Modulus of elasticity

E.g

$$\boxed{Y_B > Y_A}$$

Elastic Energy

$$Y = \frac{F \times l}{A \times \Delta l} \qquad \therefore F = \left(\frac{YA}{l}\right)\Delta x \quad (\Delta l \approx \Delta x)$$

$$\Rightarrow F = kx$$

$$\therefore \boxed{k = \frac{YA}{l}}$$

k is the spring constant

∴ Energy stored in per unit volume →

$$\boxed{\frac{U}{V} = \frac{1}{2} \times \text{stress} \times \text{strain}} \qquad \boxed{\frac{U}{V} = \frac{1}{2} Y \varepsilon^2}$$