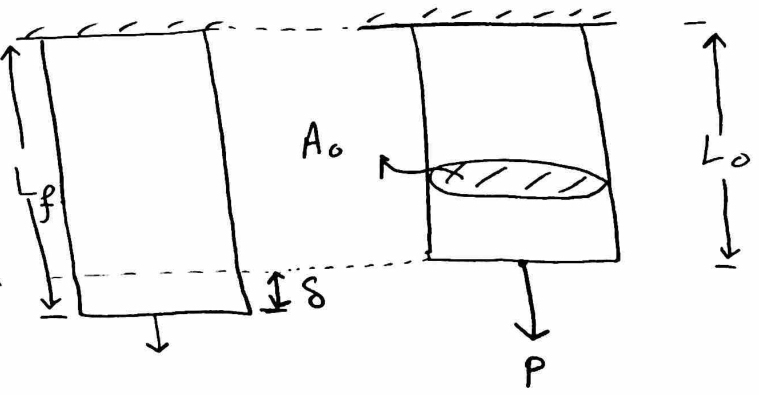
Chapter Two : Stress and Strain — Axial Loading.

L_0 : Original length

A_0 : Cross-sectional area



→delta

δ = Deflection, deformation
elongation

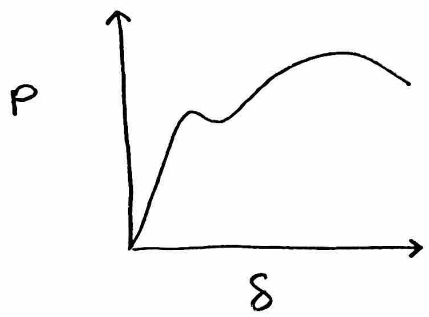
$$\text{stress } (\sigma) = \frac{P}{A_0} \quad [Pa]$$

$$\text{strain } (\epsilon) = \frac{\delta}{L_0} = \frac{L_f - L_0}{L_0} \quad [\text{unitless}]$$

epsilon

$$\epsilon = \frac{\text{change in length}}{\text{original length}}$$

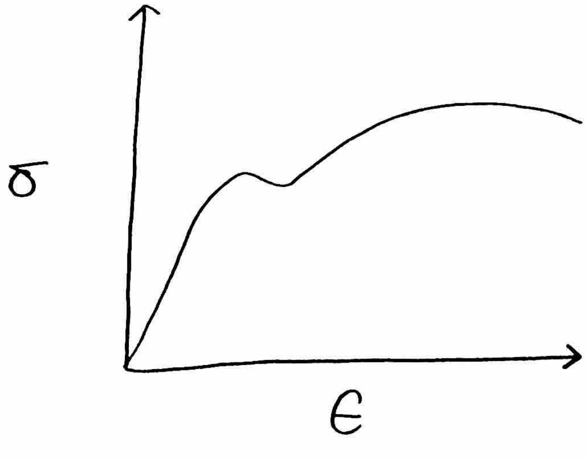
If $P \uparrow \rightarrow \delta \uparrow$



divide P by $A_0 \Rightarrow \sigma = \frac{P}{A_0}$

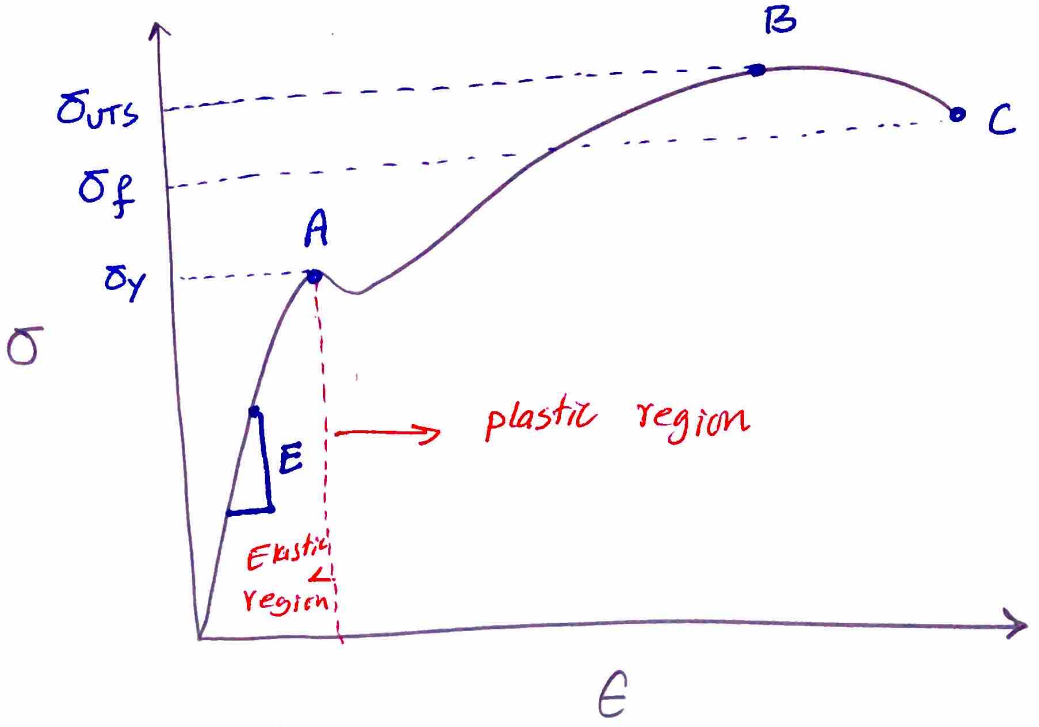
and δ by $L_0 \Rightarrow \epsilon = \frac{\delta}{L_0}$

→ Load-deflection curve



$\Rightarrow$ stress – strain curve

section 2.3



point (A)

⇒ Yield point or yield stress (σ_y)

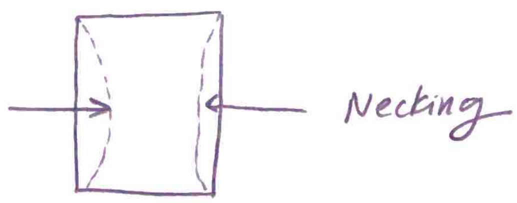
After this point, If we unload the specimen the strain will not go to zero

(Permanent deformation)

At point (B)

Maximum stress ⇒ Ultimate tensile stress (σ_{UTS})

at σ_{UTS} ⇒ Necking تخصر



At point (C)

الكسر Fracture stress (σ_f)

معامل المرونة

Slope of linear portion (E): (Modulus of Elasticity)

elastic modulus

Young's modulus

Hooke's Law $\boxed{E = \frac{\sigma}{\epsilon}}$

cont'd

Hooke's Law

$$E = \frac{\sigma}{\epsilon}$$

E: Elastic modulus (Pa) material property

remember, $\sigma = P/A$ $\quad \epsilon = \delta/L$

$$\Rightarrow E = \frac{P/A}{\delta/L} \Rightarrow \boxed{\delta = \frac{PL}{AE}}$$ deflection (m)

Example

If $P = 100$ kN, $E = 200$ GPa

$A = 200$ mm^2, $L = 300$ mm, Find δ and ϵ

Solution

$$\delta = \frac{PL}{AE} = \frac{(100)(10^3)(300)(10^{-3})}{(200)(10^{-6})(200)(10^9)} = 0.75 \times 10^{-3} \text{ m}$$

$$= 0.75 \text{ mm}$$

$$\epsilon = \frac{\delta}{L} = \frac{0.75 \times 10^{-3}}{300 \times 10^{-3}} = 2.5 \times 10^{-3} \left(\frac{m}{m}\right)$$

$$= 2500 \frac{\mu m}{m}$$