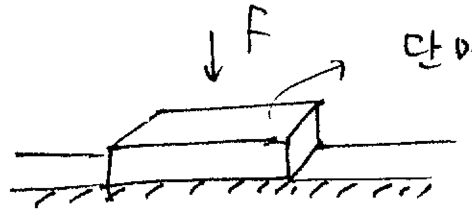
* Axial stress

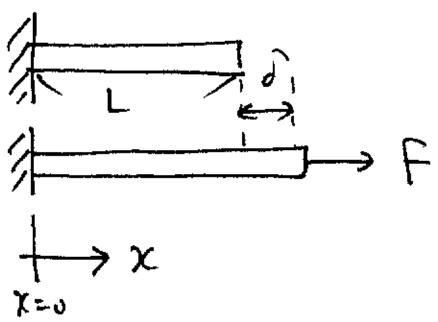
① Axial load



$$\sigma_{avg} = \frac{F}{A} = \text{average stress over } A$$

(F는 force 또는 load)

② Strain



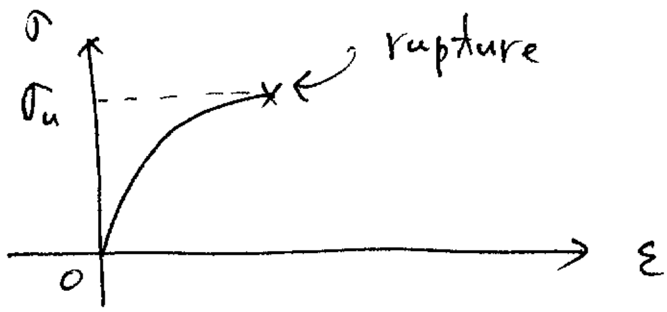
$$\varepsilon(x) = \lim_{\Delta x \to 0} \frac{\Delta \delta}{\Delta x} = \frac{d\delta}{dx}$$

$$\varepsilon_{avg} = \frac{\delta}{L} \ : \ \text{average strain}$$

(δ는 total deformation)

③ σ & ε curve

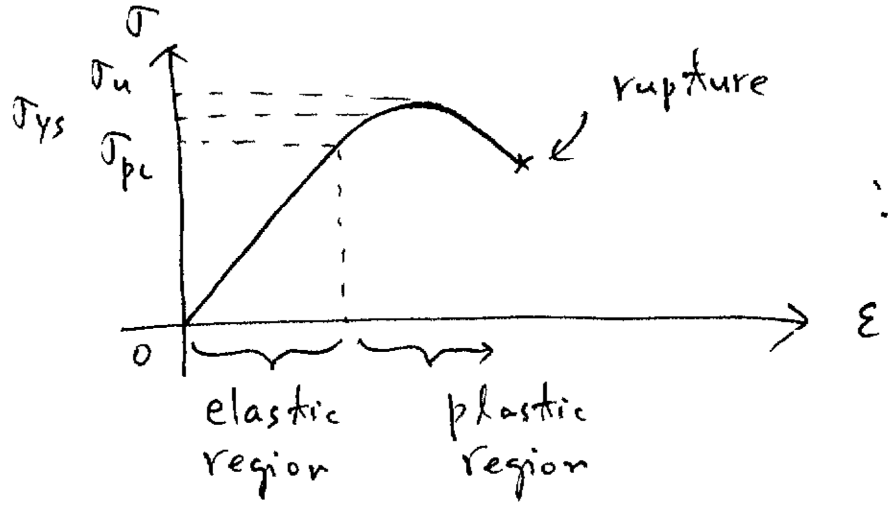
㉮ Brittle material (예, glass)



: non linear

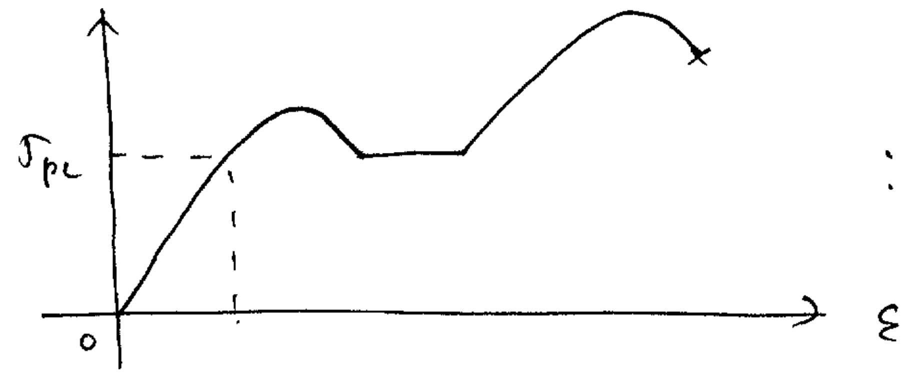
σ_u = ultimate stress

㉯ Ductile material (예, Al, steel)



: Al

σ_{ys} = yield stress



: steel

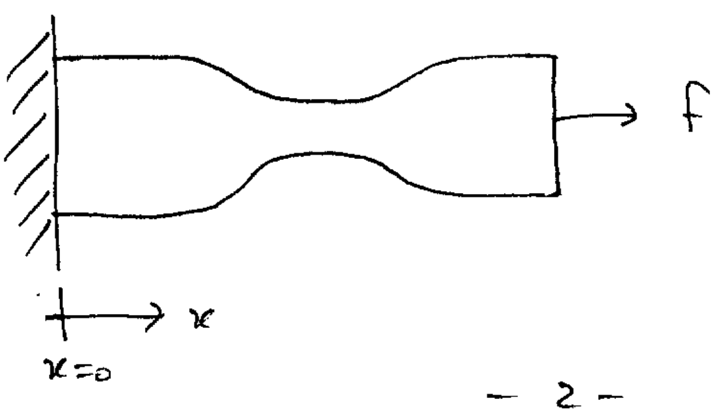
For elastic region ($\sigma \le \sigma_{pl}$),

$$\sigma = E\,\varepsilon \quad (\text{linear})$$

이 때, E = modulus of elasticity 또는 Young's modulus

[참고] $\sigma = \dfrac{F}{A}$, $\varepsilon = \dfrac{\delta}{L}$, $\sigma = E\,\varepsilon$

* Axial Load Formula ($\sigma \le \sigma_{pl}$)



$$\sigma(x) = \frac{F(x)}{A(x)} = E(x)\,\varepsilon(x)$$

$$\Rightarrow \quad \varepsilon(x) = \frac{F(x)}{E(x)\,A(x)}$$

$\varepsilon(x) = \dfrac{d\delta}{dx}$ 에서 $\quad d\delta = \varepsilon(x)\,dx$

$$\delta = \int_{x_j}^{x_{j+1}} \varepsilon(x)\,dx = \int_{x_j}^{x_{j+1}} \frac{P(x)}{E(x)\,A(x)}\,dx$$

Uniform load 인 경우, $\dfrac{P}{AE} = \text{constant}$

따라서, $x_{j+1} - x_j = L$ (total length) 이면

$$\delta = \frac{PL}{AE} \qquad (\sigma \le \sigma_{pc})$$