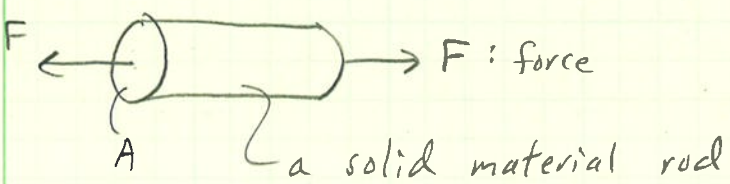
→ Chapter 3 in textbook

1) Stress and Strain → Section 3.3.2

a. Normal stress → σ : $[\sigma] = N/m^2$ or Pa (same units as pressure)



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

Tensile normal stress : rod is being pulled : $\sigma > 0$

Compressive normal stress : rod is being pushed on both sides : $\sigma < 0$

Normal Strain → S , $[S]$ = dimensionless

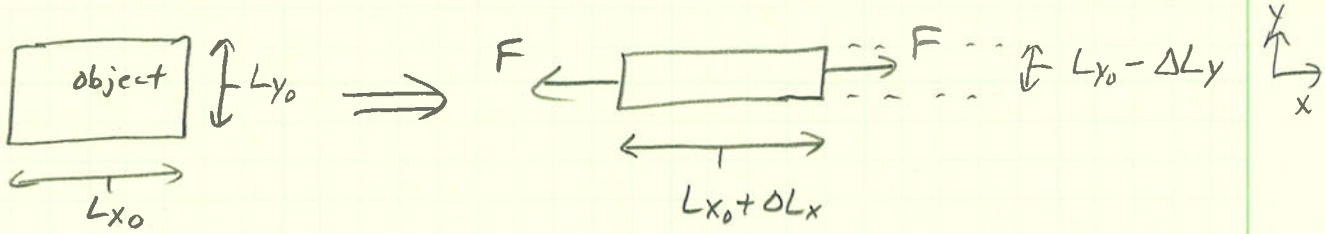
L_0 = original length

L = length under a normal stress

$$S = \frac{L - L_0}{L_0} = \frac{\Delta L}{L_0}$$ → also represented by "ε"

b. Transverse Effects

Consider this



no applied normal force

with applied normal force

strains: $\begin{cases} s_x = \dfrac{\Delta L_x}{L_{x_0}} \\ s_y = \dfrac{\Delta L_y}{L_{y_0}} \end{cases}$

Poisson's ratio, ν, is the ratio of s_x and s_y

$$\nu = \left| \frac{s_y}{s_x} \right| = \left| \frac{s_z}{s_x} \right|$$

ν, dimensionless, is a material property

c. Hooke's Law

normal stress and strain are related as follows:

$$\sigma = E s$$

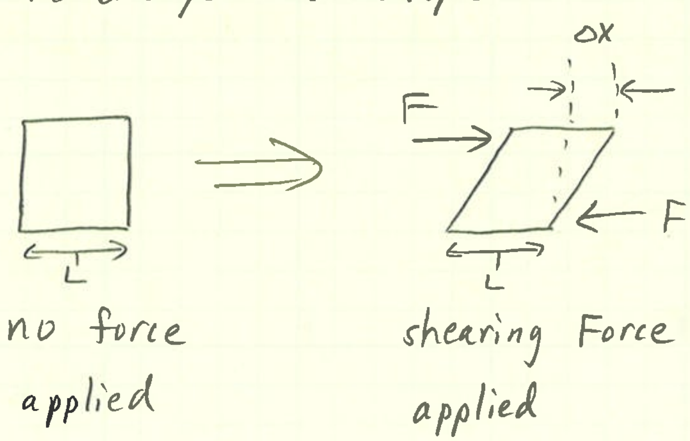
E → "modulus of elasticity" or "Young's modulus"

$[E] = Pa$ { often in GPa where $G = 1 \times 10^9$ }

E is a material property

d. Shear Stress, τ, $[\tau] = N/m^2$ or Pa

→ τ does not elongate or shorten an element, instead it changes it shape



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

shear strain $= \gamma$, $[\gamma]$ = dimensionless

$$\gamma = \frac{\Delta x}{L}$$

Shear stress and strain are related through G, the shear modulus : $G = \frac{\tau}{\gamma}$, $[G] = N/m^2$

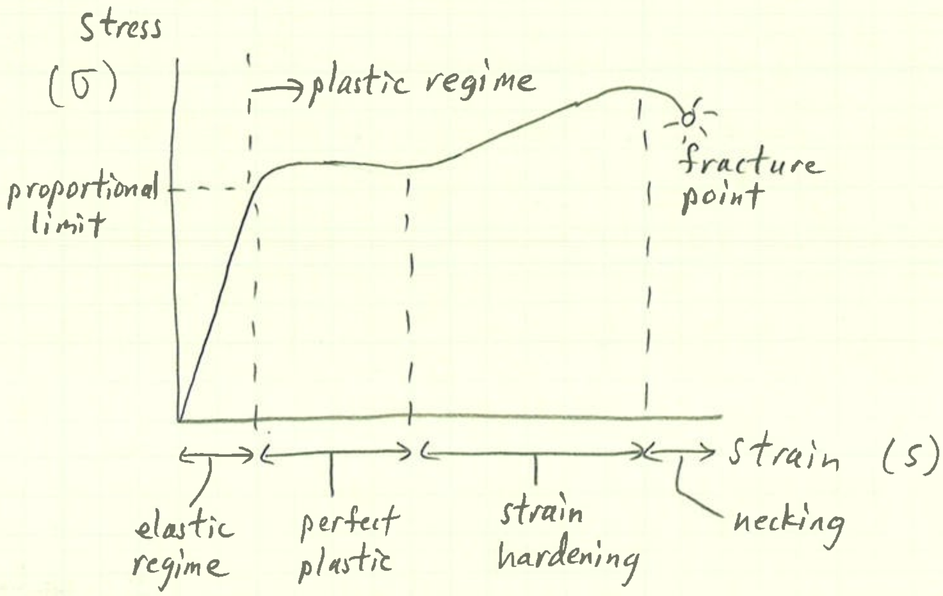
G is also a material property

G, E and ν are related:

$$G = \frac{E}{2(1+\nu)}$$

e. Relationship between tensile stress and strain (p. 87 in text)

A material like most metals:



Elastic Regime → linear relationship between stress and strain

$\sigma = Es$

→ when the force is removed, the object returns to its original shape

Plastic Regime → nonlinear relationship between stress and strain

$\sigma \neq Es$

→ when the force is removed, the object does not return to its original shape

A comparison of materials