Deformation of solids

Q-1) What are the mechanical properties of solids?

> There are 4 mechanical properties of solids.

1. Stiffness ; how easy it is to change shape
2. Strength ; max load it can withstand before breaking
3. Ductility ; drawn into wires
4. Toughness ; related to brittleness
   - a tough material is a one that is not brittle

* Steel has all these properties

* glass is only strong & stiff.

Q-2) What is elasticity?

> Elasticity is when a force is applied, the body changes dimensions and when the force is removed, it returns to its original dimensions and no permanant change occurs.

Q-3) Stress?

> Stress is the force applied per unit area.

$$\underset{(N/m^2)}{\text{Stress}} = \frac{\text{Force } (N)}{\text{area of cross section } (m^2)} \rightarrow \frac{F}{A}$$

Longitudinal stress (change in length)

$$= \frac{mg}{\text{area}}$$ (mass x gravity) or (force).

Volume stress (change in volume)

$= dp$ (little change in pressure $\rightarrow p = \frac{f}{a}$)

Sheer stress (change in shape without change in volume)

$$= \frac{\text{Force}}{\text{Area}}$$

Q-4) Strain?

> Strain is the ration of change in dimention to the original dimention.

$$\text{Strain} = \frac{\text{change (original - new)}}{\text{original}} \Big/ \frac{\text{extension}}{\text{original}}$$

↳ no units.

$\frac{x}{L}$

Longitudinal strain

$$\frac{\Delta \text{ Length}}{\text{Original length}} \quad \left(\frac{l}{L}\right)$$

Volume strain

$$\frac{\Delta \text{ volume}}{\text{original volume}} \quad \left(\frac{dv}{V}\right)$$

Sheer strain

$$\frac{\text{lateral displacement of any layer}}{\text{distance of that layer from a fixed layer}}$$

Q-5) What is Hooke's law?

> Stress is proportional to strain within elastic limits. or Force is proportional to extension.

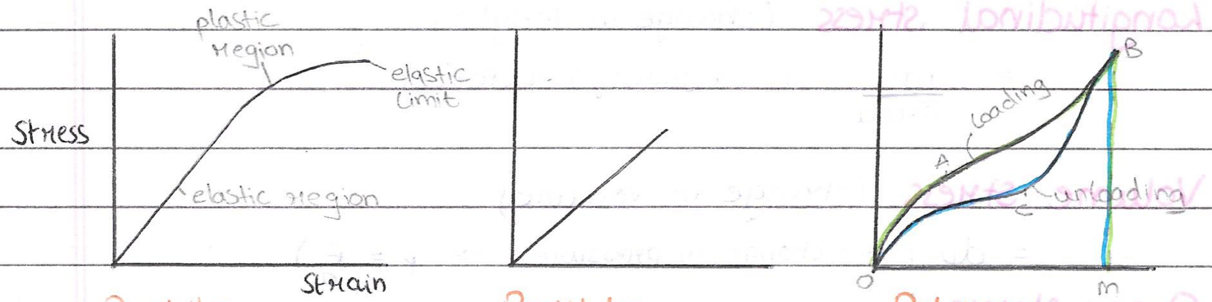
$F = \underline{\underline{k}}x$

gradient / constant. ∴ less the extension

The higher the value of k, the stiffer the spring. &

$$\frac{\text{stress}}{\text{strain}} = \text{constant (modulus of elasticity)}$$

↳ units = N/m^2



Ductile   Brittle   Polymer

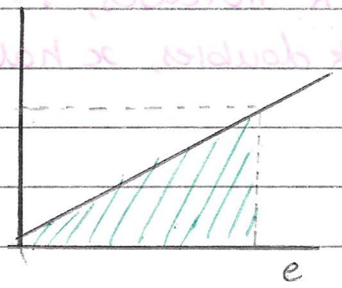
OABm = energy supplied

OCBm = energy released.

A resilient material is one that has less hysteresis loss. ← energy lost = OABm - OCBm

↳ hysteresis loss

Q-6) Strain energy.



work done = straina energy.

$W = \frac{1}{2} \times F \times e$ — area under graph (triangle)

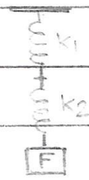
strain energy per unit volume (E) $= \frac{\frac{1}{2} \times F \times e}{V} = \frac{\frac{1}{2} \times F \times e}{A \times L}$

(V = volume, A = area, L = length)

$E = \frac{1}{2} \times \frac{F}{A} \times \frac{e}{L} = \frac{1}{2} \times$ stress $\times$ strain.

Q-7) Spring constants.

Series. When a force (F) is applied to a spring, extension is produced (x)



$F \propto x$ or $F = kx$ $\therefore$ $k = F/x$

units = N/m or $kgms^{-2}$

gradient of F / x → graph = spring constant k.

$x_1 = \frac{F}{k_1}$ $\quad x_2 = \frac{F}{k_2}$

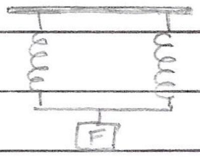
$x = x_1 + x_2 = \frac{F}{k_1} + \frac{F}{k_2} = F\left(\frac{1}{k_1} + \frac{1}{k_2}\right)$

$x = F\left[\frac{k_1 + k_2}{k_1 k_2}\right]$

$F = x\left[\frac{k_1 k_2}{k_1 + k_2}\right]$

Spring constant k in series decreases, $\therefore$ extention increases.
(k halves, extention doubles).

Parallel



in parallel, k increases, ∴ extension decreases (k doubles, x halves).

$F_1 = k_1 x \qquad F_2 = k_2 x$

$F = F_1 + F_2 = k_1 x + k_2 x$

$F = x(k_1 + k_2)$

Q-8) What is pressure?

> Pressure is the force acting per unit cross sectional area.

$$P = \frac{F}{A} \longrightarrow F = mg$$

$$m = v \times \rho$$

$$v = A \times h$$

$$\therefore F = A \times h \times \rho \times g$$

$$\therefore P = \frac{A \times h \times \rho \times g}{A}$$

$$P = \rho \times g \times h.$$