LECTURE NOTE

ON

STRUCTURAL MECHANICS

3RD SEMESTER

DEVELOPED BY

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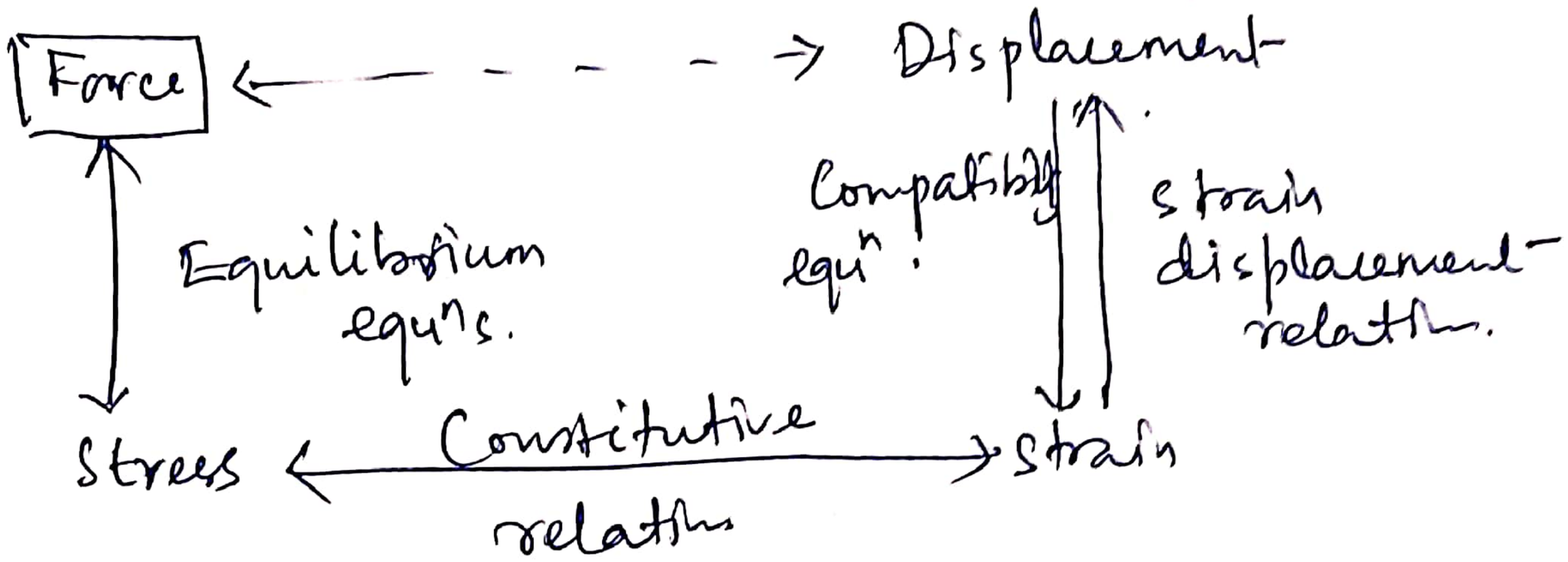
① S.M 25.08.2024

Concepts & Relations in Mechanics.



→ Force is a mathematical construct. used to explain displacement of bodies.

→ Force is a mathematical quantity vector.

Body - It is a collection of ordered countable or countless particles.

Countable - 1 to 10,000

countless - 0 to 1.

→ discrete.

→ Continuum.

① Basic principle of Mechanics.

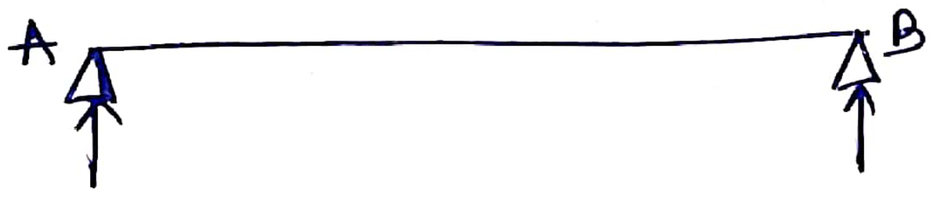
Force - Force is an external agent which produces or tends to produce, destroys or tends to destroy motion in a body.

Moment :- tendency ~~of~~ of force to cause a body to rotate about a specific point of axis.

→ It is the product of the distance from the point to the point of application of the force & the component of the force.

Support Conditions.

① Simple support-



Reaction each at supports in vertical direction.

② Roller support.

Reaction at support is vertical dirⁿ.

③ Fixed support.

Reaction at support one in vertical one in horizontal & other will be moment.

Beams

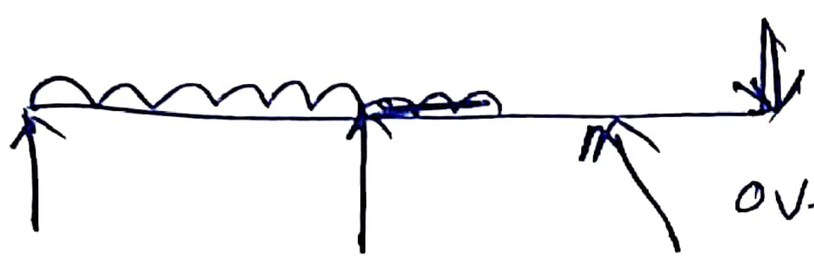
1. Cantilever beam

one end is fixed and other end is free.

2. Simply supported beam..

Both the ends of the beam are simply supported.

3. Over hanging beam

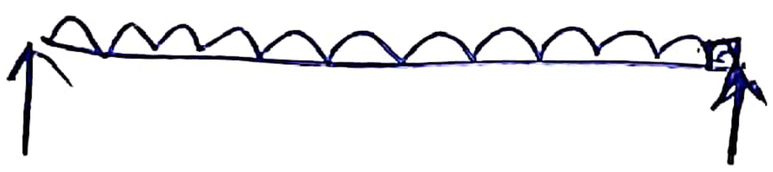


over hang.

Types of loads.

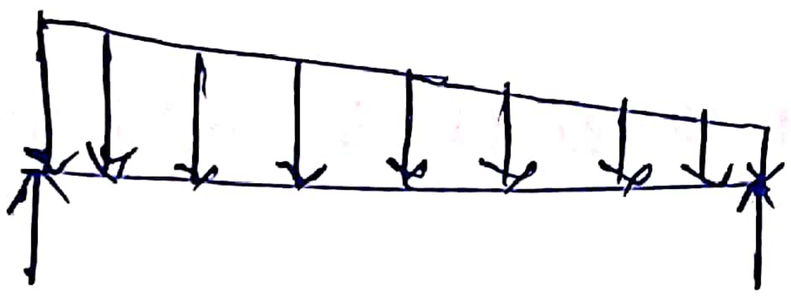
1. Concentrated Load or Point load.

2. Uniformly distributed load. (UDL)



each unit length of the beam carries same intensity of the loads.

3. uniformly varying load.



each unit of length carries uniformly varying intensity of loading.

Conditions of Equilibrium. (1)

→ The resultant of all the external forces and momentos acting on this object is zero.

Centre of gravity

It is the point through which the resultant of all the ~~act~~ frees act irrespective of the orientation of the body.

Centre of mass

It is the point where the entire mass of the body may be assumed to be concentrated.

Moment of Inertia. (I)

The moment of inertia of a body about an axis is defined as the resistance offered by the body to rotate about that axis.

~~Free body Diagram~~.

→ It is also defined as the product of the area and the square of the distance of the centre of gravity of the area from that axis.

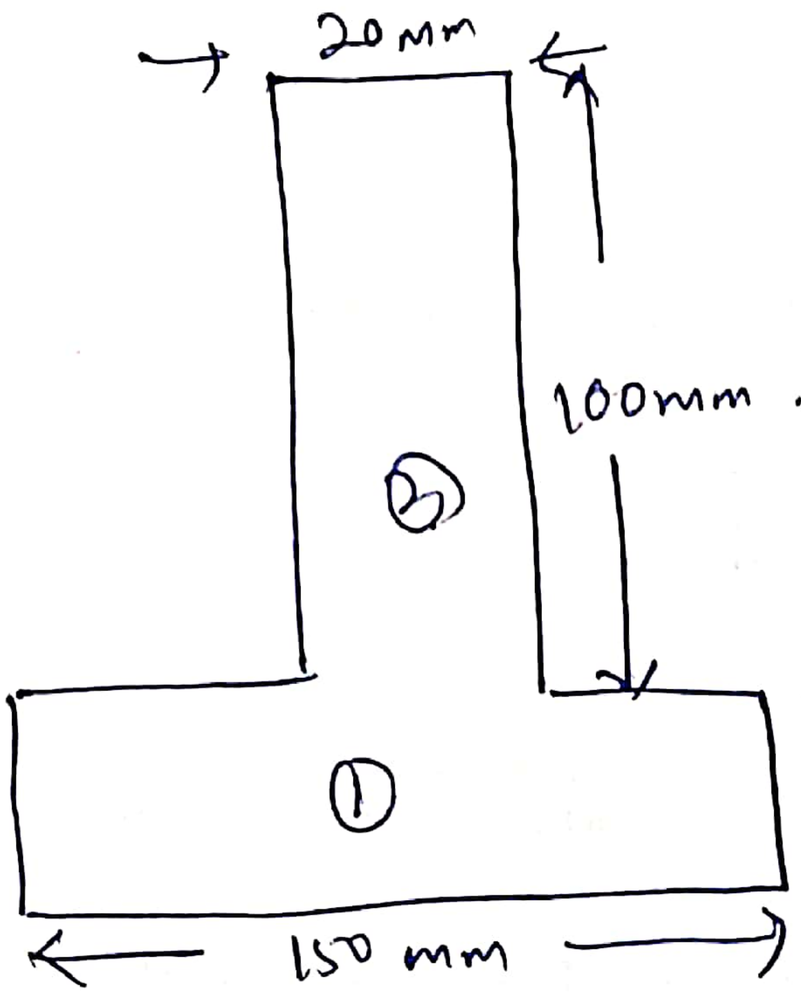
about x axis I_{xx}

about y axis I_{yy}.

Free body diagram.

There are the diagrams used to show the relative magitudes & directions of all external forces acting upon an object in a given situation. It is a example of vector diagrams.

① Find the centroid of the lamina as in the figure.

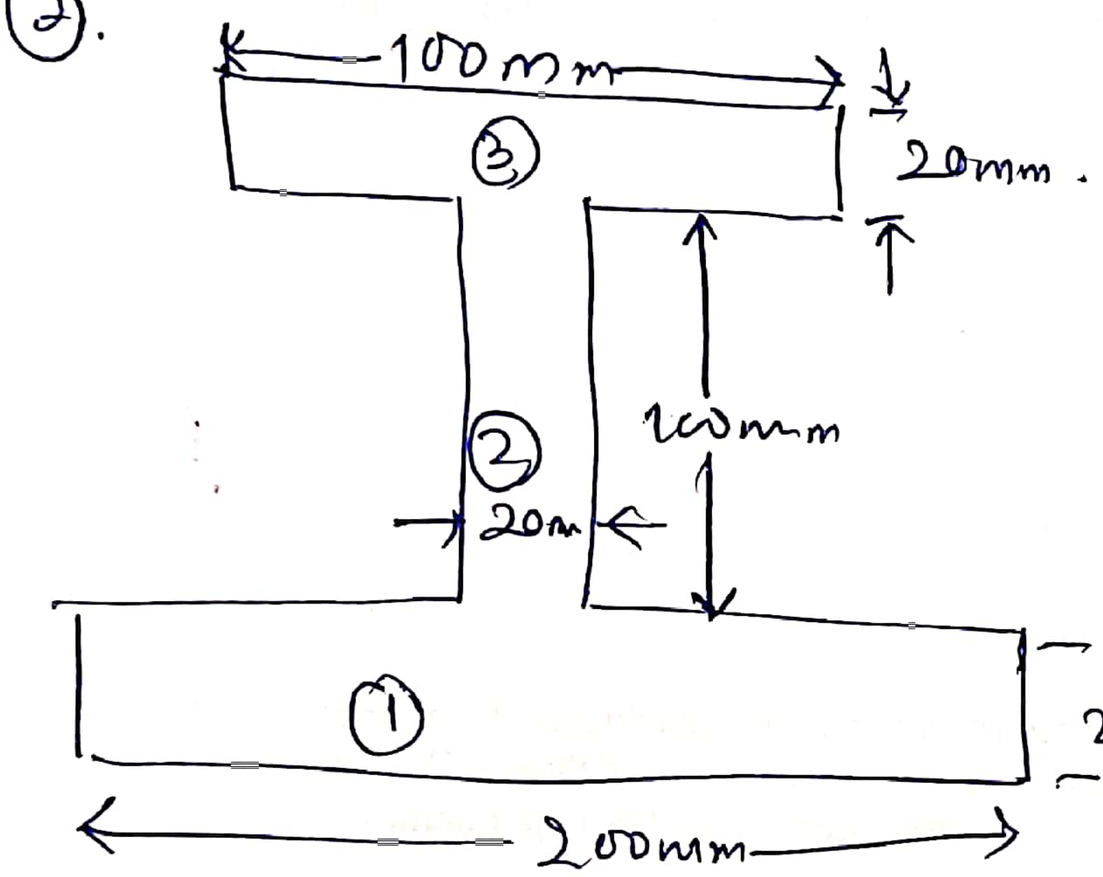


$$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2}.$$

$$\bar{y} = \frac{3000 \times 10 + 2000 \times 70}{3000 + 2000}$$

$$= 34 \text{ mm}.$$

②.

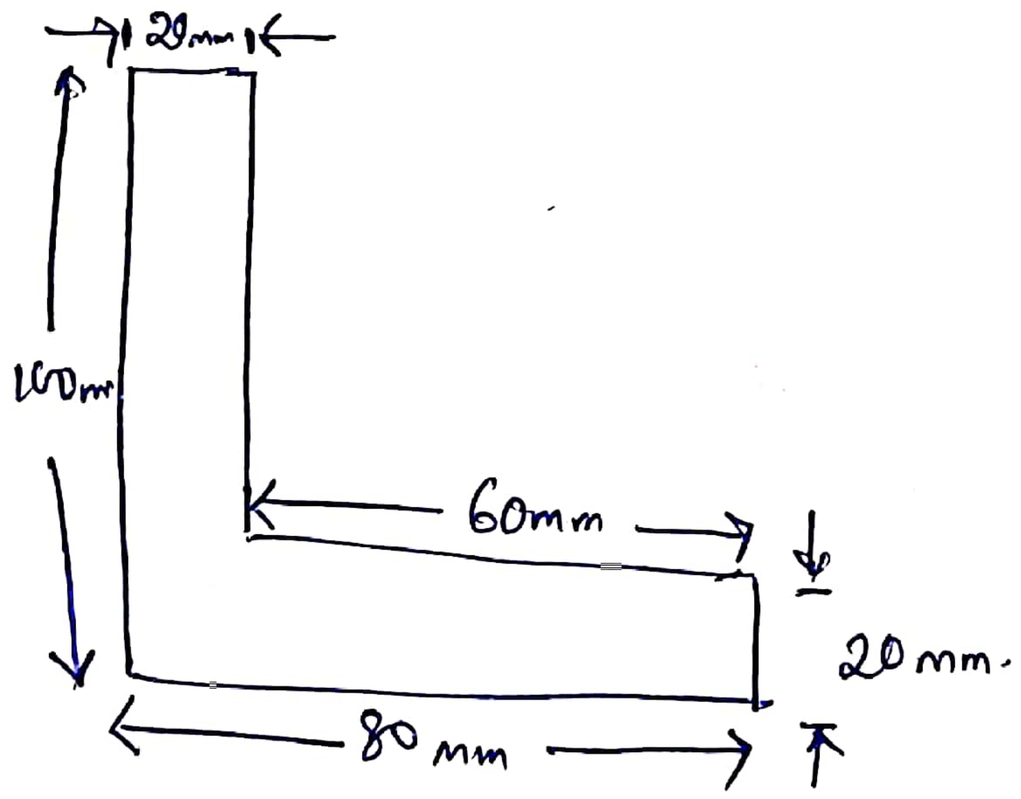


$$\bar{y} = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{A_1 + A_2 + A_3}.$$

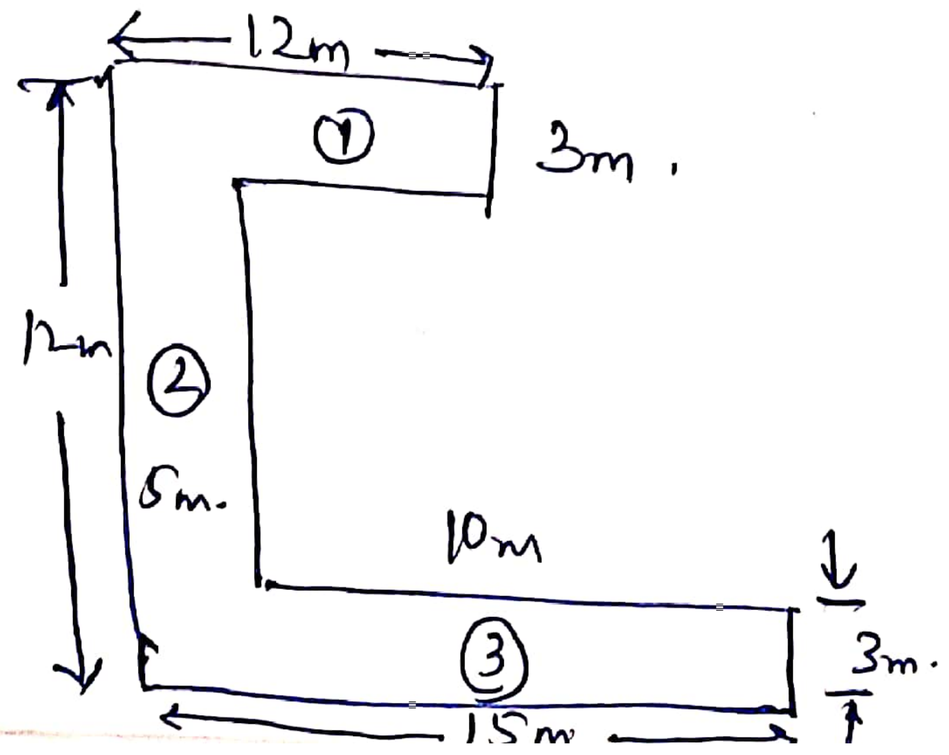
$$= \frac{4000 \times 10 + 2000 \times 70 + 2000 \times 130}{4000 + 2000 + 2000}$$

$$= 55 \text{ mm}.$$

Q.



$$\bar{y} = 35 \text{ mm}.$$

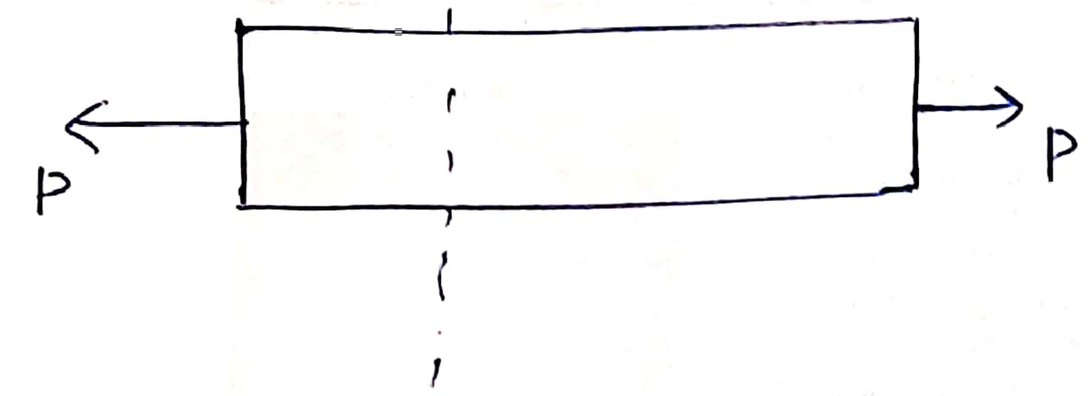


$$\bar{x} = 5.66 \text{m}.$$

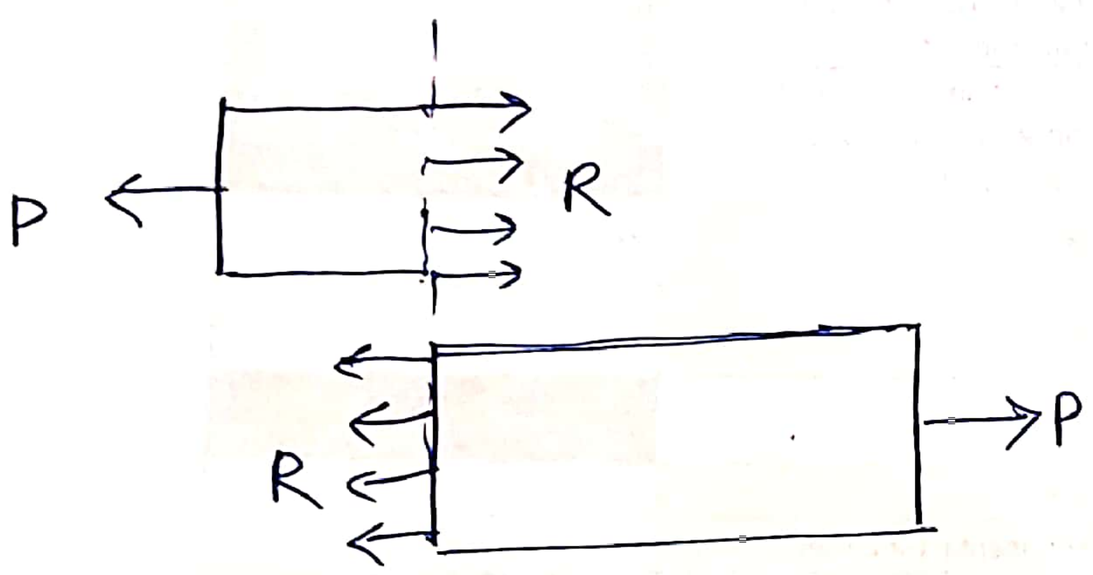
$$\bar{y} = 5.635 \text{ m}.$$

SIMPLE STRESS AND STRAIN

Stress:- It is a resistance force offered by a body against the deformation is known as stress denoted by 'σ'.



Let a rod of uniform cross area is subjected to a pulling force P to resist deformation the reaction will be 'R'.



∴ Stress = R/A

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

→ unit = $\frac{\text{Newton}}{m2}$

Stress = resisting force / area.

N/m^2 = pascal.

1MPa = 10^6 N/m^2

$= 10^6 \times \frac{10^{-3} kN}{10^6 mm^2}$

$= 10^{-3}$ kN/mm² = $10^{-3} \times 10^3$ N/mm².

1MPa = 1N/mm².

Mechanical Properties of Material.

Rigidity:- The property by virtue of which if an external force is applied on a solid material there won't be any change in its shape due to intermolecular attraction by the closely packed molecules.

Elasticity:- This is the property of the body by virtue of which it returns to its original shape ~~& size~~ after removal of the external force causing deformation which is applied on it.

Plasticity

This is the ability of a solid material to undergo permanent deformation where the force is applied to it.

Compressibility:-

This is the property of the object by which it tends to flatter & reduce the size under pressure.

Hardness

The property of the material by virtue of which it resists the local surface deformation when undergoes abrasion, drilling, impact etc.

- It also withstands friction.

Toughness.

It is the ability of the material to resist breaking when force is applied to it.

Stiffness:- The property of material which resists deformation when force

→ The material having more flexibility has more stiffness.

(8)

Brittleness :- The property of a material by which it fractures when subjected to stress without deformation.

→ ex- glass.

Ductility :- It is defined as the ability of a material to undergo permanent deformation through elongation & reduction increase- sectional area or bending at room temperature without- fracturing.

Malleability :-

This is the property of material by which it can be beaten to form its thin sheets.

ex- lead, tin, gold, aluminium, copper

Creep

This is the permanent change in shape & size of a material which increases as a function of- time under application of load & elevated temperature.

Fatigue :-

This is the weakening of a material caused by cyclic loading that results in progressive damage & growth of cracks.

Durability :-

The ability of a material to remain serviceable during the useful time without- damaging the material.

Tenacity :-

The property of material to resist the breaking is known as tenacity.