Q3 Ans →

Section-4 Q3 Ans :→

Hooke's Law :-

- It states that when a material is loaded within its elastic limit, the stress is proportional to the strain.

  Mathematically,

$$\frac{\text{Stress}}{\text{Strain}} = E = \text{Constant}$$

- It may be noted that Hooke's law equally holds good for tension as well as compression.

Stress-Strain Diagram for Mild Steel :-

- Stress vs strain diagram for the typical mild steel specimen.

The following salient points are observed on stress-strain curve :-

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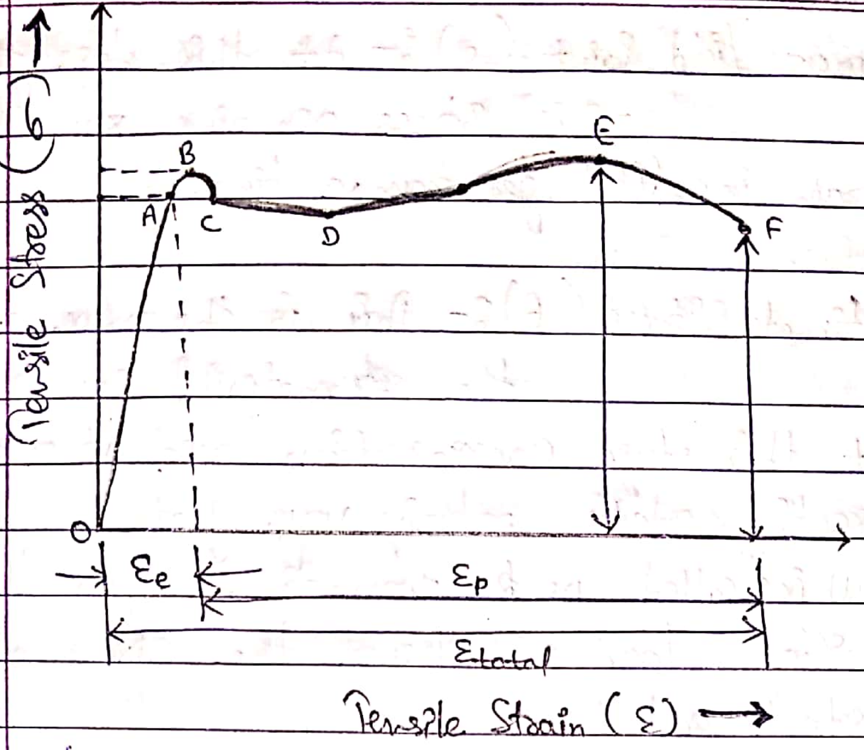

Fig :- Stress-Strain diagram for a typical Structural mild steel in tension.

- Limit of Proportionality (A) :- It is the limiting value of the stress up to which stress is proportional to strain.

- Elastic Limit :- This is the limiting value of stress up to which if the materials is stressed & then relased (unload) strain disppears completely & the original length is regained. This point is slightly beyond the limit of proportionality.

- Upper Yield Point (B) :- This is the stress at which, the load starts reducing & the extension inc. (res). This phenomenon is called yielding of materials.

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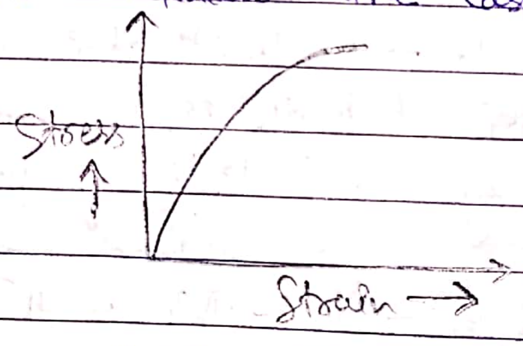
- Lower Yield Point (C) :- At this stage the stress remains same but strain Inc. (↑es) for some time.

- Ultimate Stress (E) :- This is the max. stress the material can resist. At this stage cross-sectional area at a particular section starts reducing very fast. This is called neck formation. After this stage, load and hence the stress developed starts reducing.

- Breaking Point (F) :- The stress at which finally the specimen fails is called breaking point.

⇛ Stress – Strain relationship for Brittle material :-

- The typical stress-strain relationship in a Brittle materials like cast iron is shown :-



- In these material, there is no appreciable change in rate of strain. There is no yield point & no necking takes place. Ultimate point & breaking point are one & the same. The strain at failure is very small.

The expression for strain energy is $\frac{1}{2} \times$ Stress $\times$ strain are given below :—

- The energy stored in a body is the strain energy, and the per unit volume is strain energy density, when a work is done on it by an external force to stretch or deform the body.

- Strain energy = $U = 0.5 F l$
where
'F' is external force applied to produce an extension 'l'.

- The strain energy density,

$$u = U/V = (0.5 F l)/V$$

or

$$u = \frac{1}{2} F/A \; l/L$$

where,
'A' is the area and 'L' is the length of the body before the external force is applied $V = AL$)

or $u = \frac{1}{2} \times \text{Stress} \times \text{Strain}$

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- Thus the energy density of a strained wire
  or
  The potential energy per unit volume of a stretched wire is derived.

* Strain Energy :-

- Strain energy is defined as the energy stored in a body to deformation. The strain energy per unit volume is known as strain energy.
- The area under the stress-strain curve towards the point of deformation.
- When the applied force is released, the whole the applied force is relased, whole system returns to its original shape. It is usually denoted by "U".
- The strain energy formula is given as:-

$$\boxed{U = F\delta/2}$$

where,

$\delta \rightarrow$ Compression.

$F \rightarrow$ Force applied.

- When stress 'σ' is proportional to strain 'ϵ', the strain energy formula is given by :-

$$U = \frac{1}{2} V \sigma \epsilon$$

where,

σ → Stress
ϵ → Strain
V → Volume of body.

- Regarding Young's modulus E, the strain energy formula is given as,

$$\boxed{U = \sigma^2 / 2E \times V}$$

where,

σ → Stress
E → Young's Modulus
V → Volume of body.