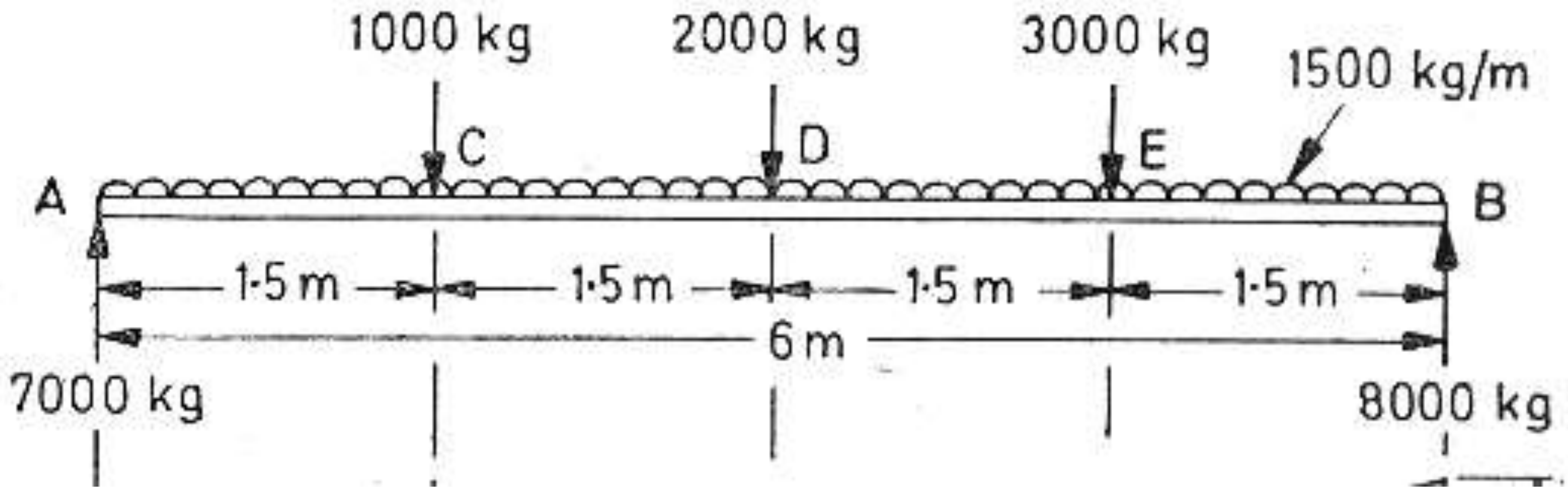
SF & BM

BENDING MOMENT SHEAR FORCE

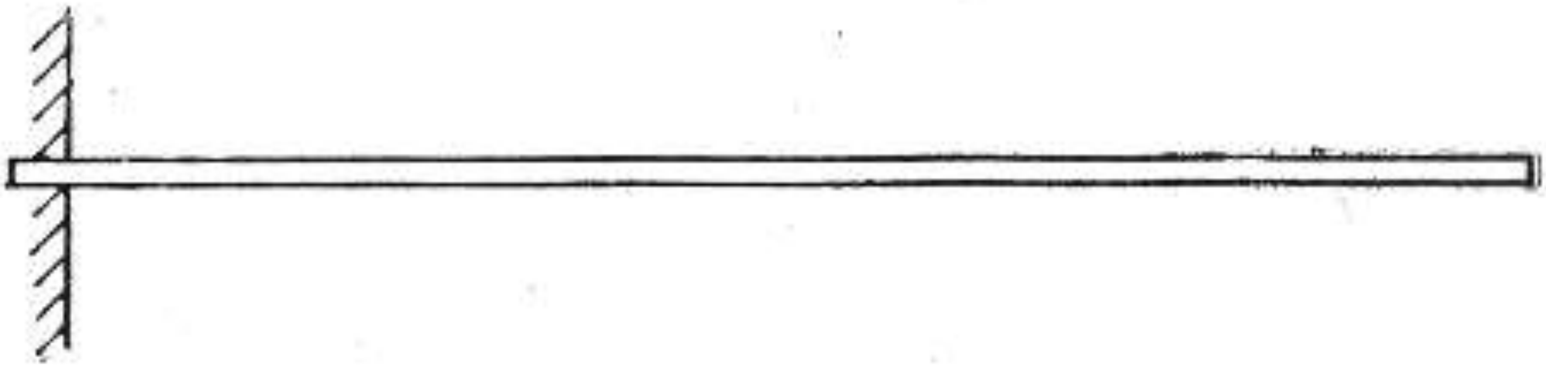
BEAM: - A beam is a structure member which is subjected to transverse load.



TYPES OF BEAM

- **CANTILIVER BEAM**: - A beam fixed at one and free at other is known as a cantilever beam.

Cantilever beam



SIMPLY SUPPORTED BEAM

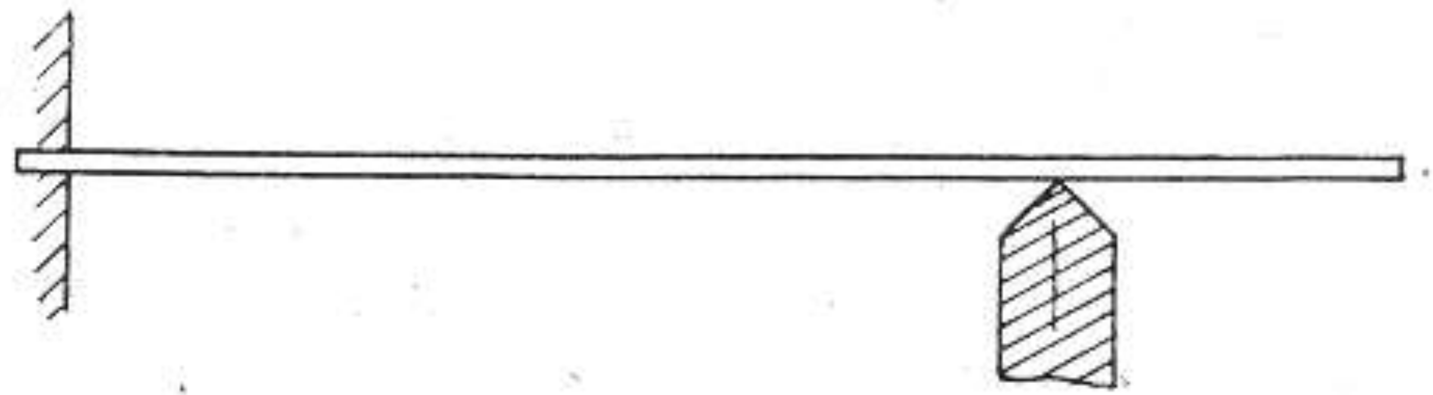
- A beam supported or resting freely on the walls or column at it’s both end is known as simply supported beam.

Simply supported beam

OVERHANGING BEAM

- A beam having it's end portion extended beyond the support is known as overhanging beam. A beam may be overhanging on one side or on both sides.

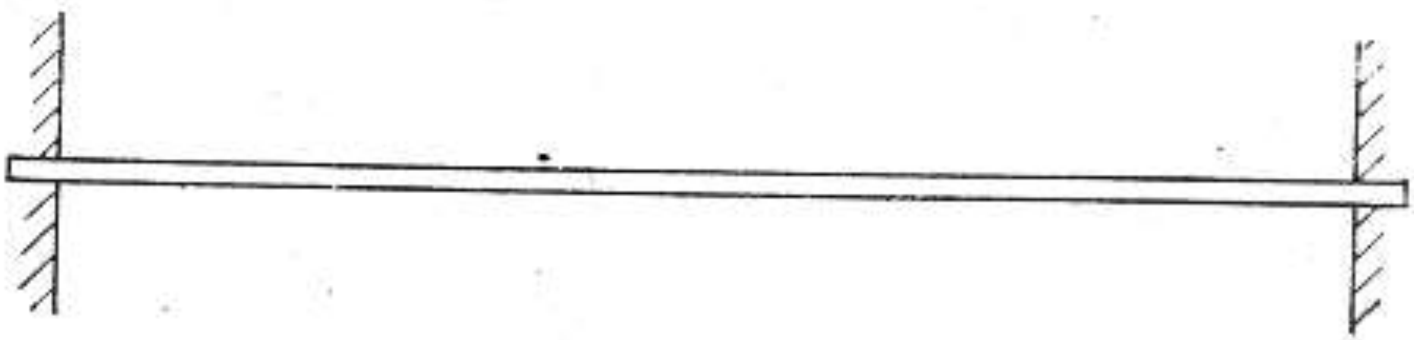
Overhanging beam



RIGIDLY FIXED BEAM

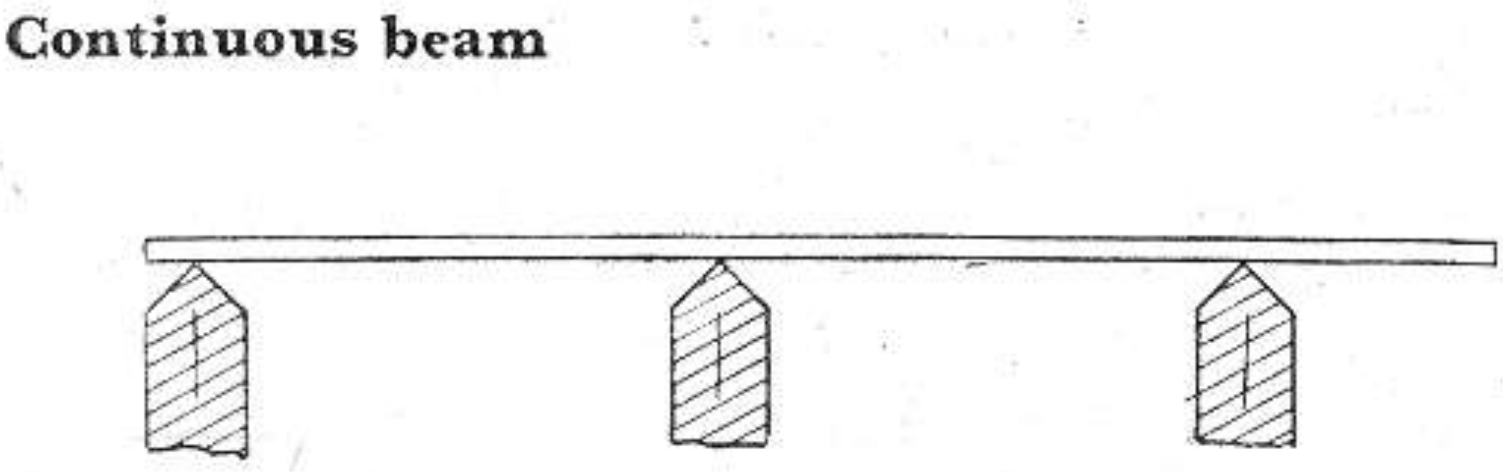
- A beam whose both end are rigidly fixed or built in walls is known as rigidly fixed beam.

Rigidly fixed beam



CONTINUOUS BEAM

- A beam supported on more than two supports is known as continuous beam.

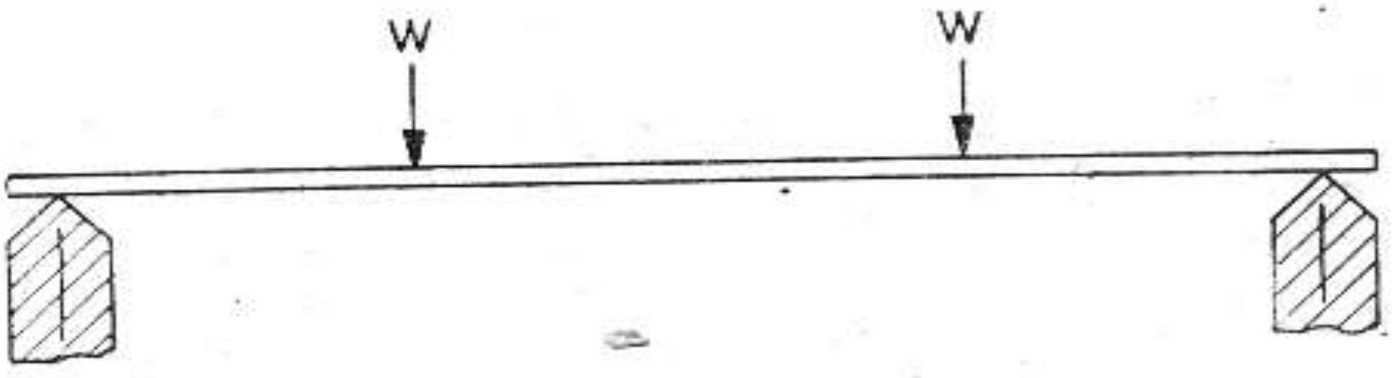


TYPES OF LOADING

- **CONCENTRATED OR POINT LOAD: -**

  A load acting at a point on a beam is known as a concentrated or point load.

Concentrated or point load



UNIFORMLY DISTRIBUTED LOAD

- A load which is spread over a beam in such a manner that each unit length is loaded to the same extent is known as a uniformly distributed load.

Uniformly distributed load

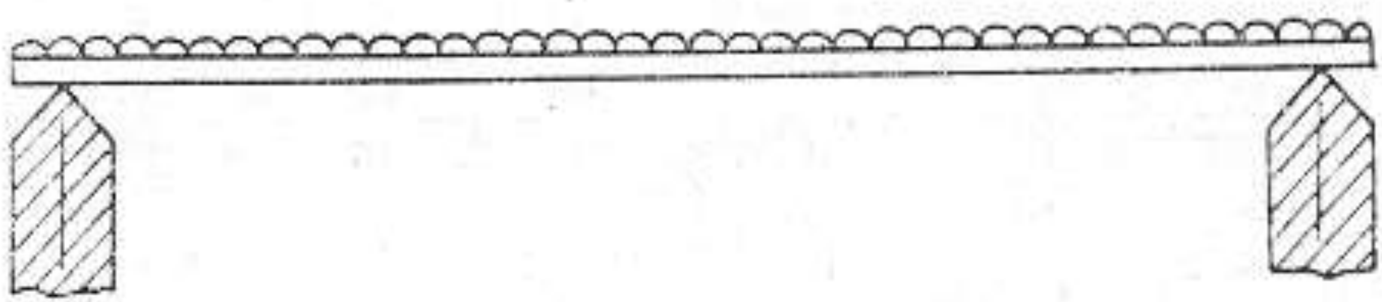


Fig. 7.7

UNIFORMLY VARYING LOAD

- A load which is spread in such a manner that it's extent varies uniformly on unit length is known as a uniformly varying load.

Uniformly varying load

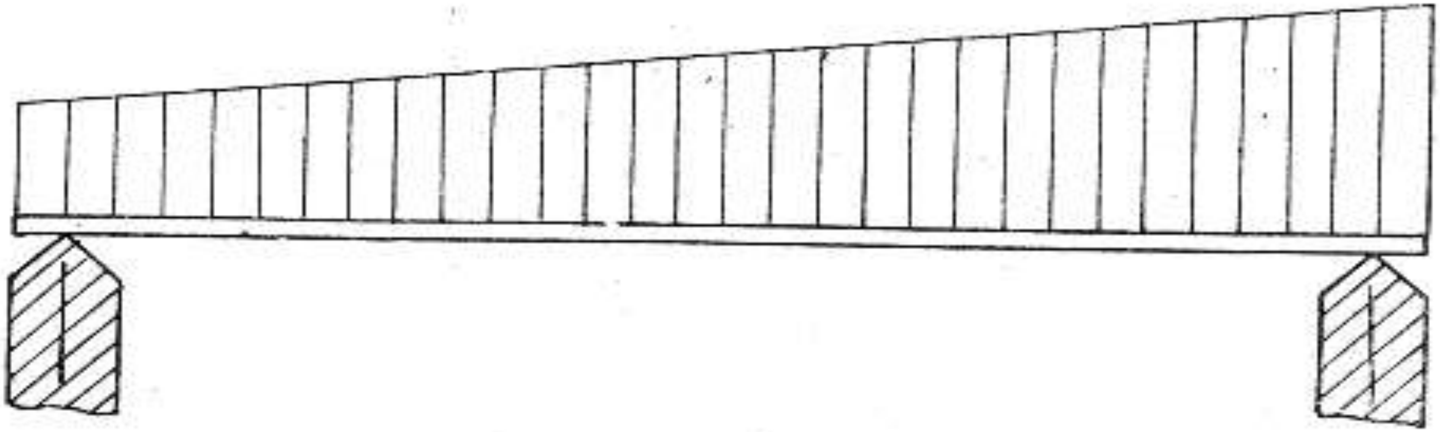
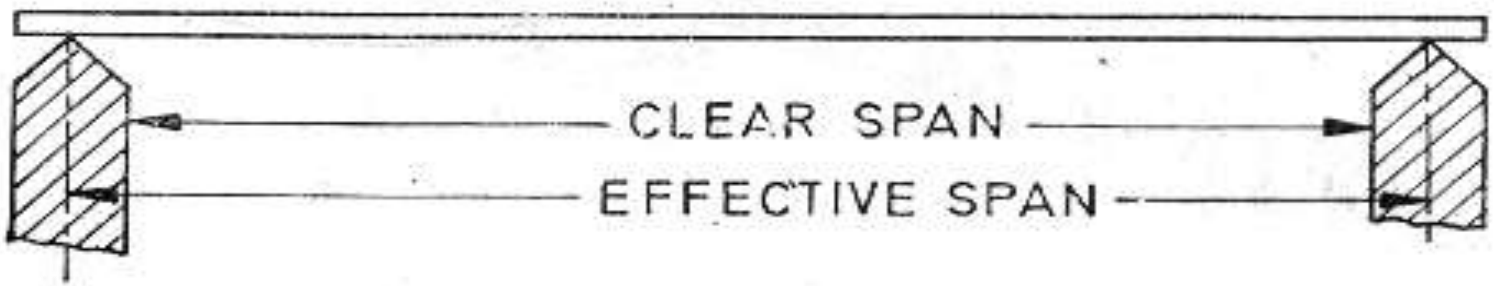


Fig. 7.8

SPAN OF THE BEAM

- The horizontal distance between the supporting walls is known as clear span of the beam. The horizontal distance between the lines of acting of the supporting walls is known as effective span. For calculation purpose we shall always consider the effective span.

Span of the beam

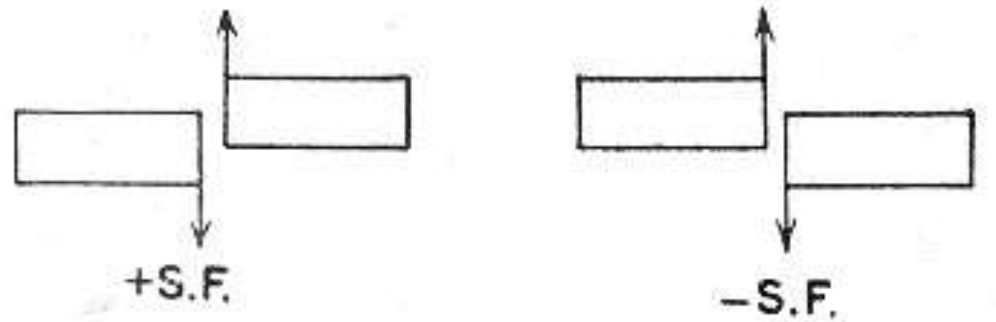


- **BENDING MOMENT (B.M.):-** The bending moment at the cross section of a beam may be defined as the algebraic sum of the moments of the forces to the right or left of the section.

- **SHEAR FORCE (S.F.):-** The shear force at the cross section of a beam may be defined as the unbalance vertical force to the right or left of the section.

SIGN CONVENTION

- **SHEAR FORCE (S.F.):-** The shear force is the unbalanced vertical force, therefore it tends to slit one portion of the beam, upward or downward with respect to the order. The shear force is said to be positive, at a section, when the right hand portion tents to slight upwards with respect to the left hand portion, or in other wards all the upward forces to the right of the section cause positive shear and those acting downwards cause negative shear.



BENDING MOMENT (B.M.)

- At section where the bending moment is such that it tents to bend the beam at the point to a curvature having concavity at the top, is taken as positive on the other hand where the bending moment is such that it tents to bend the beam at curvature having concavity at the top.

In other wards the bending moment is said to be positive at a section when it is acting is an anti clock wise direction to the right and negative, when acting in a clock wise direction. On the other hand (B.M.) is said to be negative when it is acting in a clock wise direction to the left and positive when it is acting in an anti clock wise direction.

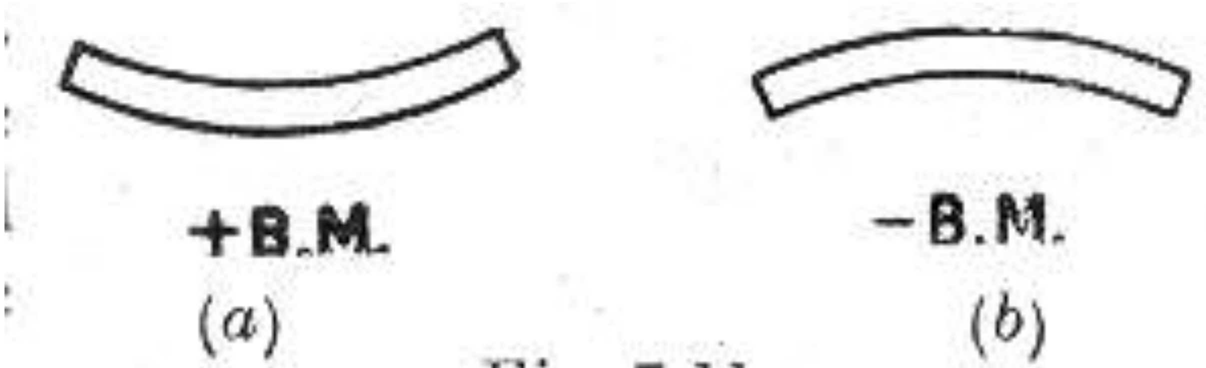


Fig. 7·11

BENDING STRESSES IN BEAMS

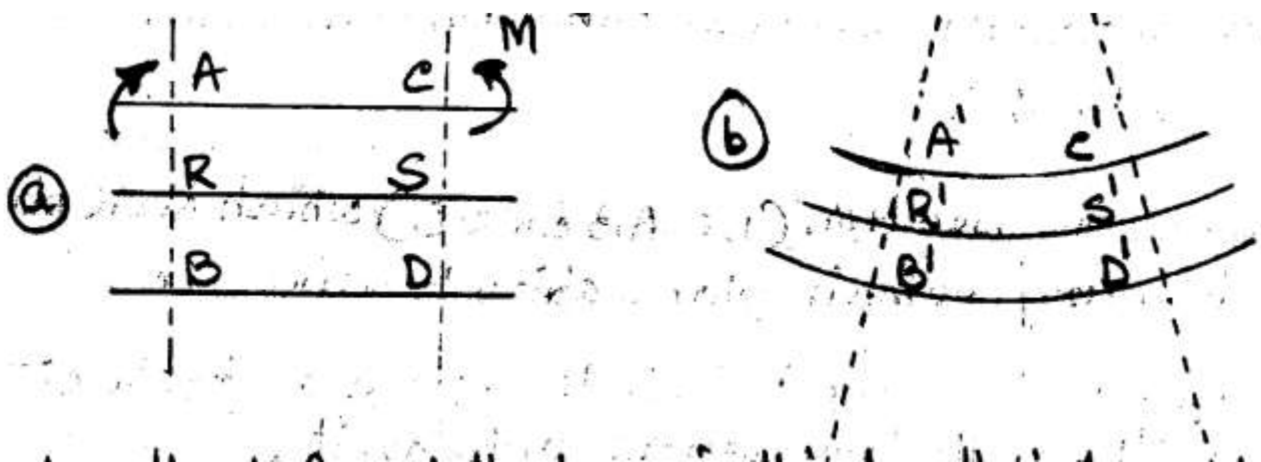
- **The bending moment at a section tents to bend or deflect the beam and the internal stresses resists it’s bending. The process of bending stops, when every cross section sets up full resistance to the bending moment. The resistance offered by the internal stresses to the bending is known as bending stress.**

THEORY OF SIMPLE BENDING

- Consider a small length ‘δ*x*’ of a simply supported beam to bending moment ‘M’ as shown in figure (a)

The section ‘AB’ and ‘CD’ are normal to axis of the beam due to the action of the bending moment, the beam as a whole will bend as shown figure (b).

We see that the layers above ‘RS’ have been compressed and those below, have been stretched. The amount, by which a layer is compressed or stretched, depends upon the position of the layer with reference to ‘RS’. This layer ‘RS’ which is neither compressed none stretched is known as neutral plane or neutral layer.



ASSUMPTIONS IN THE THEORY OF SIMPLE BENDING

- **The following assumptions are made in the theory of simple bending:-**

  - **The material of the beam is perfectly homogeneous (i.e. at the same kind elastic properties in all direction.)**

  - **The beam material is stressed within its elastic limit and thus obeys Hooke's law.**

  - **The transverse section (i.e. AB or CD) which were plane before bending, remain plane after bending also.**

  - **Each layer of the beam is free to expend or contract independently of the layer, above or below it.**

  - **The value of 'E' (Young's modulus of elasticity) is the same tension and compression.**

POSITION OF NEUTRAL AXIS

- ✓ The line of inter section of the neutral layer with any normal cross section of a beam is known as neutral axis of that section. On one side of the neutral axis there are compressive stresses and on the other there are tensile stresses. At the neutral axis there is no stress of any kind.

MOMENT OF RESISTANCE

- **We know that on one side of neutral axis there are compressive stress and the other there are tensile stresses. These stresses from a couple, whose moment must be equal to the external moment ‘M’. The moment of this couple which resists the external bending moment is known as amount of resistance.**

- **Mathematically,** $$\frac{M}{I} = \frac{f}{Y} = \frac{E}{R}$$
- **Where,**
- **M = Moment**
- **I = Moment of inertia**
- **f = Bending stress**
- **Y = Distance of the layer from neutral axis**
- **E = Modulus of elasticity**
- **R = Radius of curvature**

BENDING STRESS
IN SYMMETRICAL SECTION

- In a symmetrical section (i.e. Circular, Square, and Rectangular) the C.G. of the section lies at the geometrical center of section.

Mathematically,

$$y = \frac{d}{2}$$

Where ,'d' is the diameter (in a circular section) or depth (in square or rectangular section).