FLEXURAL STRESSES IN BEAMS

- <u>Flexural Stress</u>:
- The stresses caused by the bending moment are known as bending or flexure stresses.
- The tensile & compressive stresses that occur in a beam as a result of bending moment are often spoken as “flexure stresses”.

FLEXURAL STRESSES IN BEAMS

Assumptions:

- Following assumptions are made in deriving the relation between bending moment and flexural stresses and between vertical shear and the shear stresses.

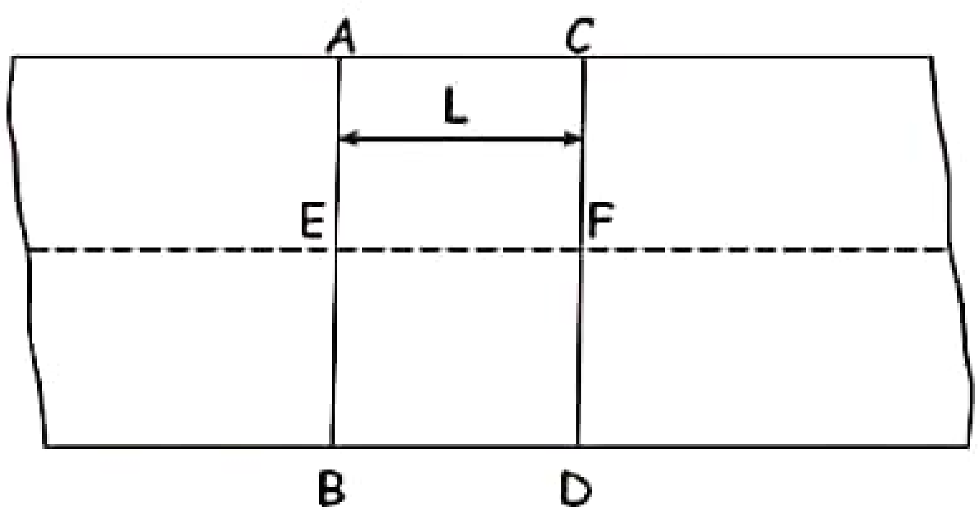
1. Plane sections of the beam, originally plane, remain plane.
2. The material in the beam is homogeneous and obeys Hooke's law.
3. The modulus of elasticity for tension and compression are equal.
4. The beam is initially straight and of constant cross section.
5. The plane of loading must contain a principal axis of the beam cross section and the loads must be perpendicular to the longitudinal axis of the beam.

FLEXURAL STRESSES IN BEAMS

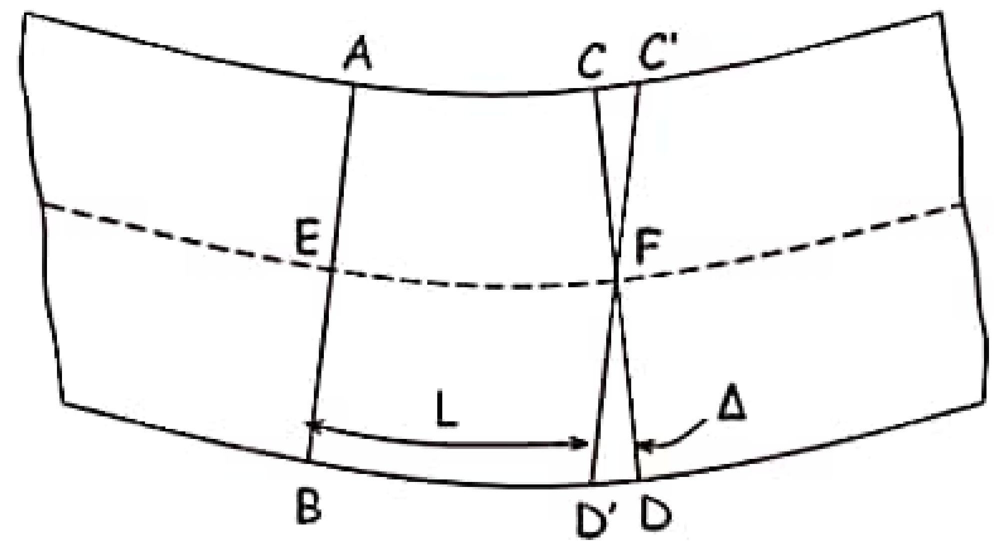
- <u>Derivation of Flexure Formula</u>
- Consider two adjacent sections AB & CD of a part of unbent beam separated by a distance ‘L’, After bending has occurred because of load, sections AB and CD rotate relative to each other but remain straight and undistorted (Assumption 1)

aman's screen

FLEXURAL STRESSES IN BEAMS



(a) Part of Unbent Beam



(b) Part of Bent Beam

FLEXURAL STRESSES IN BEAMS

- Fiber ‘AC’ at the top is shortened by an amount CC' and is in compression.
- Fiber ‘BD’ at the bottom is extended by an amount DD' and is in tension.
- Fiber ‘EF’ between Fiber AC and BD whose length is unchanged and is called neutral surface.

FLEXURAL STRESSES IN BEAMS

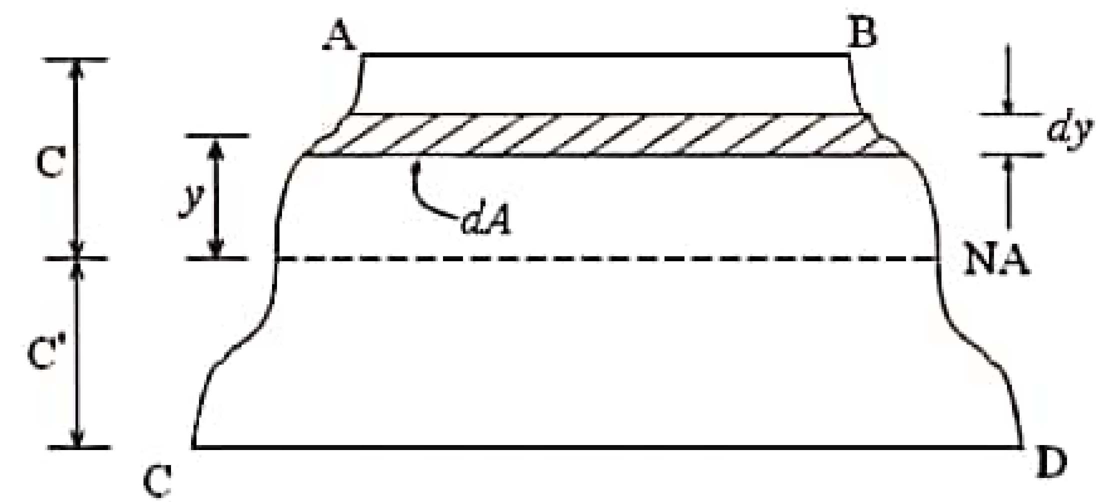


Fig. Cross Section of a Beam.

FLEXURAL STRESSES IN BEAMS

- Derivation of Formula:
  - Let 'ABCD' be any cross-section of a prismatic beam. The shaded strip dA ia an elementary part of the cross-section, its distance from N.A is 'y'.
  - Let, 'S' be the stress in the top fiber and 'C' be the distance of these fibers from NA.
  - Hence, elementary stress on dA is, $= \dfrac{S \times y}{C}$
  - Hence, elementary force on dA is, $= S \times \dfrac{y}{C} \times dA$
  - Hence, elementary moment about NA is, $= \left(S \times \dfrac{y}{C} \times dA \right) \times y$

$$= \frac{S}{C} \times y^2 \times dA$$

FLEXURAL STRESSES IN BEAMS

$$\text{Resisting Moment, } M_R = \int_{-c}^{c} \frac{S}{C} \times y^2 dA = \frac{S}{C} \int_{-c}^{c} y^2 dA = \frac{S}{C} I$$

$$[\because \; I = \int y^2 \, dA = \text{Moment of Inertia} \;]$$

$$\text{Resisting Moment, } M_R = \text{Bending Moment, } M$$

$$\Rightarrow M = \frac{S}{C} \times I \qquad \Rightarrow S = \frac{M \times C}{I}$$

Here; S = Stress in top & bottom fiber of the beam in psi or ksi

M = Bending Moment in lb-in or k-in

C = Distance of NA from Top or Bottom fiber in

I = Moment of Inertia in in^4