Sec. 5 - ans 1 :- Expression for Bending Eqn :-

Bending theory is also known as flexure theory is defined as the axial deformation of the beam due to external load that is applied perpendicularly to a longitudinal axis which finds application in applied mechanics.

For a material, flexural strength is defined as the stress that is obtained from the yield just before the flexure test. It represent the highest stress that is experienced within the material at the moment of its yield. σ is used as the symbolic representation of flexural strength.

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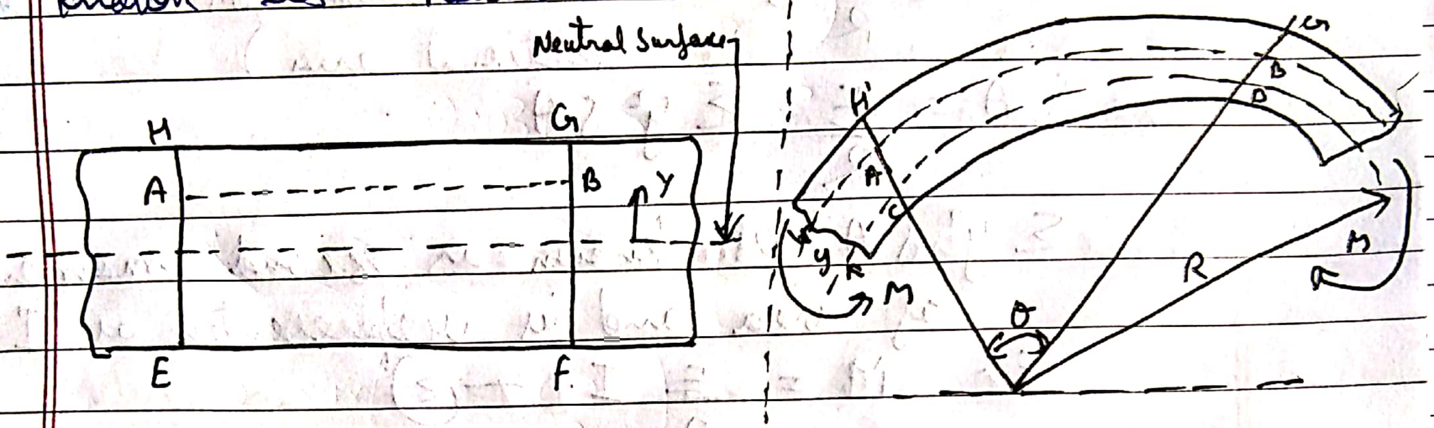
Consider an unstressed beam, which is subjected to a constant bending moment such as the beam bends up to radius R. The top fibres are subjected to tension whereas the bottom fibres are subjected to compression. The locus of points with zero stress is known as neutral axis.



With the help of above fig., the following are the step involved in the derivation:—

$$\text{Strain in fibre } AB = \frac{A'B' - AB}{AB}$$

$$\therefore \text{Strain} = \frac{A'B' - C'D'}{C'D'} \quad (\text{as } AB = CD \ \& \ CD = C'D')$$

CD & C'D' are on the neutral axis & stress is assumed to be zero, therefore strain is also zero on the neutral axis. $= \dfrac{(R+y) - R}{R}$

$$= \frac{R + y - R}{R} = \frac{y}{R}$$

$\dfrac{\sigma}{E} = \dfrac{y}{R}$, where, E is Young's Modulus of elasticity.

or $\dfrac{\sigma}{y} = \dfrac{E}{R}$

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$$\therefore \quad \sigma = \frac{E}{R} y \quad — (1)$$

$$F = \sigma \delta A = \frac{E}{R} y \delta A$$ (force acting on the strip with area δA)

$$F y = \frac{E}{R} y^2 \delta A$$ (momentum about neutral axis)

$$M = \Sigma \frac{E}{R} y^2$$ (Total momentum for entire cross-sectional area)

$$\delta A = \frac{E}{R} \Sigma y^2 \delta A$$

$\Sigma y^2 \delta A$ is known as second moment of area and is represented as I.

$$\therefore \quad M = \frac{E}{R} I \quad — (2)$$

from eq (1) & (2), we get

$$\boxed{\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}}$$

Assumptions :—

- The beam used is straight with constant cross section.
- The beam used is of homogeneous material with a symmetrical longitudinal plane.
- The plane of symmetry has all the resultant of applied lo
- The primary cause of failure is bucking.
- E remains same for tension and compression.
- Cross section remains the same before & after bending.

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