# ANALYSIS OF PURE BENDING

## Curvature of a beam

$$\kappa = \frac{1}{\rho} = \frac{M}{E \cdot I}$$

κ =curvature
ρ =radius of curvature
M=Applied Moment
E=Modulus of Elasticity
I=Moment of Inertia

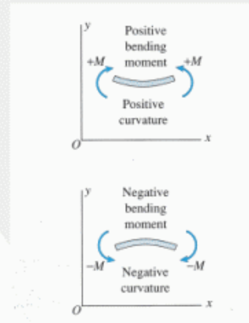


Figure 1: Relationships between signs of bending moments and signs of curvatures

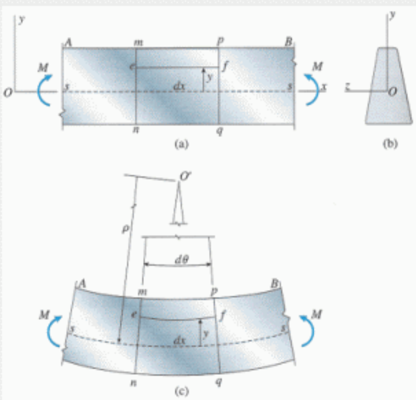


Figure 2: Deformations of a pure beam in bending: (a) side views of beam, (b) cross sectional view of beam, (c) shows resulting deformed beam

## Bending Strain

$$\varepsilon = \frac{-y}{\rho} = -\kappa \cdot y$$

ε=Strain
y= Centroidal Distance

## Bending Stress

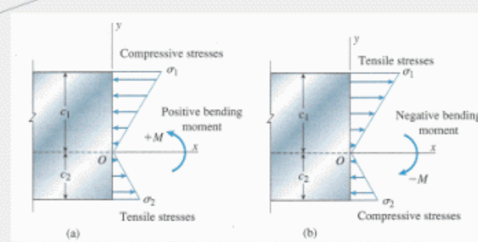


Figure 3: Relationships between signs of bending moments and directions of normal stresses:
(a) positive bending moment
(b) negative bending moment

$$\sigma_1 = \frac{-M \cdot (c_1)}{I}$$

$$\sigma_2 = \frac{M \cdot (c_2)}{I}$$

$\sigma_1$= Compressive Stress
$\sigma_2$= Tensile Stress
c= Distance to centroid

## Strain Energy per Unit Length

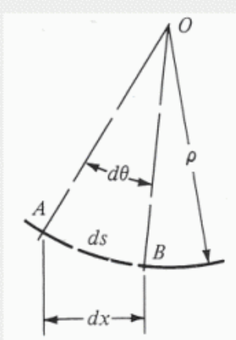


Figure 4: Beam in bending can be shown as a function of the curvature and displacements.

$$\frac{d}{ds}U = \left(\frac{1}{2}\right) \cdot \frac{M^2}{E \cdot I}$$

U=Internal Energy
*ds*= Length of Elastic Curve
*d*θ= Angle Associated with *ds*

## Composite Beams

$$\sigma_1 = \frac{M \cdot \left(\frac{h}{2}\right) \cdot E_1}{E_1 \cdot I_1 + E_2 \cdot I_2}$$

$$\sigma_2 = \frac{M \cdot \left(\frac{h_c}{2}\right) \cdot E_2}{E_1 \cdot I_1 + E_2 \cdot I_2}$$

hc= Thickness of material 2

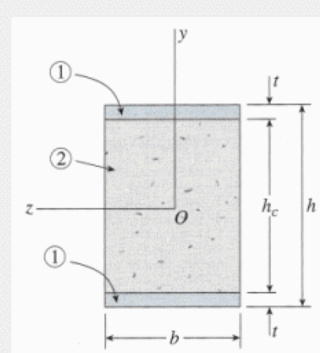


Figure 5: Cross section of a sandwich beam with double


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