UNIFIED HANDOUT

MATERIALS AND STRUCTURES - #M-14

Spring, 2009

Concept Review Sheet

for Unified Q3M: Units M4.3-4.5

THE BEAM

- A beam is long compared to its other two dimensions (L >> b,h).
- The load applied is perpendicular to the long dimension.
- The two pertinent internal resultants are the Shear, S, and the Moment, M.
- The change in the Shear resultant is equal to the applied loading.
- The change in the Moment resultant is equal to the Shear resultant.
- The only significant stresses have components in the direction along the long dimension.
- The centroid is the center of area.
- Plane sections remain plane and perpendicular to the midplane (centroid line) after bending displacement (*Bernouilli-Euler Hypothesis*).
- All displacements and deformations can be defined through the displacement of the midplane/centroid line, w.
- The shear resultant at any location along the beam is equipollent to the shear stress acting and integrated over the "cut" surface.
- The moment resultant at any location along the beam is equipollent to the moment caused by the axial stress acting and integrated over the "cut" surface.
- The area (second) moment of inertia, I, defines the geometric contribution of the structural configuration to the resistance to bending deformation.
- The extensional modulus defines the material contribution of the structural configuration to the resistance to bending deformation.
- The total bending stiffness is EI.
- Maximum magnitude of axial stress occurs at a point farthest from the centerline/centroid of the beam.
- Shear stress is related to the (first) moment of area about the centerline/centroid, Q.
- Maximum magnitude of shear stress occurs at a point in the cross-section where Q divided by the width is maximized.
- There is no axial stress or strain due to bending at the centerline/centroid.
- Stress is compressive (negative) on the top surface and tensile (positive) on the bottom surface when a beam bends up.
- Stress is tensile (positive) on the top surface and compressive (negative) on the bottom surface when a beam bends down.
- The moment of inertia of a body about any axis is the moment of inertia of the body about its centroid plus its area times the square of the distance from its centroid to the axis (*Parallel Axis Theorem*).
- The efficiency of a cross-section in carrying bending load is measured by the ratio of moment of inertia to area.