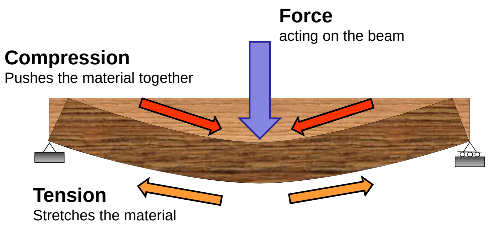
Internal Loads

Before you can design a structural member, it is necessary to understand the forces and moments that act on it.



Internal Loads

Axial Force - Buckling

Internal Loads

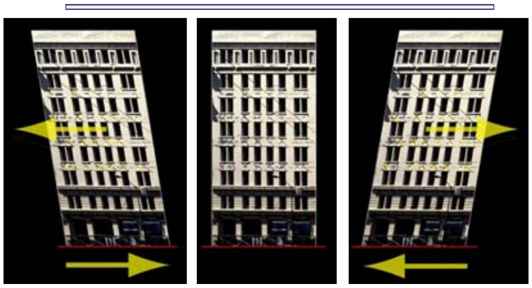
Axial Buckling Force

Internal Loads

Shear Force

Shear Force

Internal Loads



Horizontal Shear Force

Internal Loads

Compression and Tension Forces

Bending Moment

Internal Loads

- Internal Loadings Developed in Structural Members
- Before a structural member can be sized or designed, the forces and moments that act on the member must be determined.
- In this section, we will develop methods to calculate the forces and moment at any point along the member's axis.

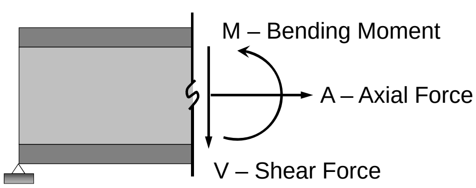
Internal Loads

Internal Loadings at a Specified Point

- In general, the internal load at a specified point can be determined by the ***method of sections***
- Typically, coplanar structures are subject to internal loadings that may consist of an axial force ***A***, a shear force ***V***, and the bending moment ***M***

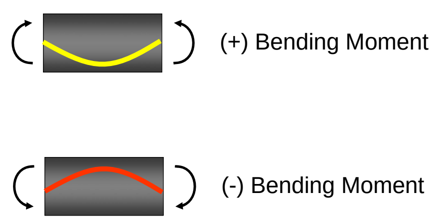
Internal Loads

Internal Loadings at a Specified Point



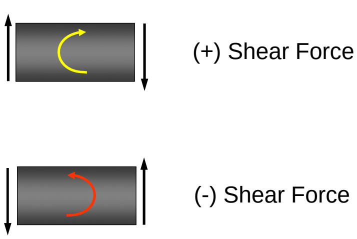
Internal Loads

Internal Loadings at a Specified Point



Internal Loads

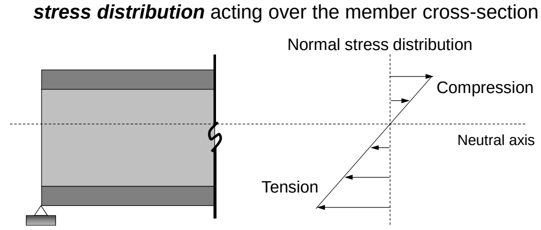
Internal Loadings at a Specified Point



Internal Loads

Internal Loadings at a Specified Point

- These three types of loadings are used to represent the ***stress distribution*** acting over the member cross-section



Internal Loads

Procedure for analysis - the following is a procedure for determining the internal forces in a member using the method of sections:

1. Before the member is "cut" or sectioned, determine the support reactions for the structure.
2. Keeping all external loadings in their exact locations, make an imaginary "cut" through the member at the point where the internal loading is desired.

   Draw the corresponding free–body diagram of one of the "cut" segments indicating the unknown reactions ***A***, ***V***, and ***M*** acting in their positive (+) directions

Internal Loads

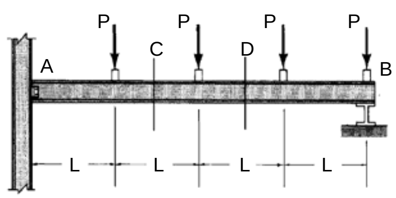
Procedure for analysis - the following is a procedure for determining the internal forces in a member using the method of sections:

3. Apply the three equations of equilibrium.

   In most cases, the moment equation should be summed at the cut section about the *centroid* of the member cross-section to eliminate the unknowns ***A*** and ***V***.

Internal Loads

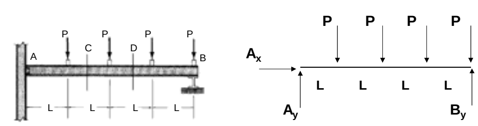
Example: Consider the following beam



Determine the shear and moment in the floor girder at points *C* and *D* (both points are at the center of each span L).

Internal Loads

Example: Consider the following beam



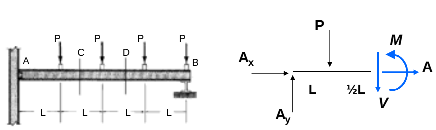
$$\circlearrowleft^{+} \sum M_A = 0 = -P(L + 2L + 3L + 4L) + B_y(4L) \qquad \boxed{B_y = 2.5P}$$

$$^{+}\uparrow \sum F_y = 0 = A_y + B_y - 4P \qquad \boxed{A_y = 1.5P}$$

$$\overset{+}{\rightarrow} \sum F_x = 0 = A_x$$

Internal Loads

Cut the beam at point C



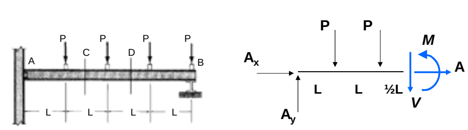
$$\circlearrowleft^{+} \sum M_{cut} = 0 = M + P\frac{L}{2} - A_y\frac{3L}{2} \qquad \boxed{M = 1.75PL}$$

$$^{+}\uparrow \sum F_y = 0 = A_y - V - P \qquad \boxed{V = 0.5P}$$

$$\overset{+}{\rightarrow} \sum F_x = 0 = A$$

Internal Loads

Cut the beam at point D



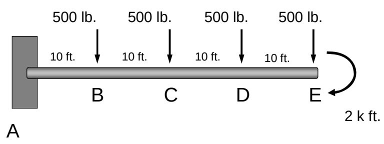
$$\circlearrowleft^{+} \sum M_{cut} = 0 = M + P\frac{L}{2} + P\frac{3L}{2} - A_y\frac{5L}{2} \qquad \boxed{M = 1.75PL}$$

$$^{+}\uparrow \sum F_y = 0 = A_y - V - P - P \qquad \boxed{V = -0.5P}$$

$$\overset{+}{\rightarrow} \sum F_x = 0 = A$$

Internal Loads

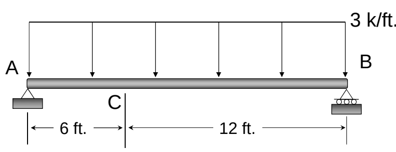
Example: Consider the following beam



Determine the internal shear and moment in the cantilever beam shown above at a section passing through point C.

Internal Loads

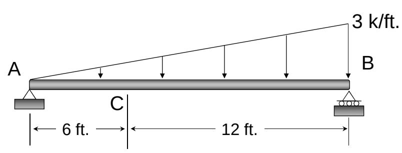
Example: Consider the following beam



Determine the internal shear and moment at a section passing through point C.

Internal Loads

Example: Consider the following beam



Determine the internal shear and moment in the at a section passing through point C.

End of Internal Loads – Part 1

Any questions?