SHEAR FORCE (SF) AND BENDING MOMENT:

Shear Force :

The shear Force at the cross section of a beam may be defined as an unbalanced vertical force/forces to the right or left of the section.

Bending Moment :

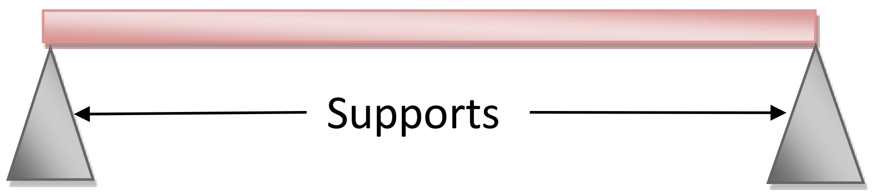
The bending Moment at the cross section of a beam may be defined as the algebraic sum (∑) of the moment of force/forces to the right or left of the section.

- **Cantilever Beam:**

A beam fixed at one end and free at another end as shown in figure below is known as Cantilever Beam.

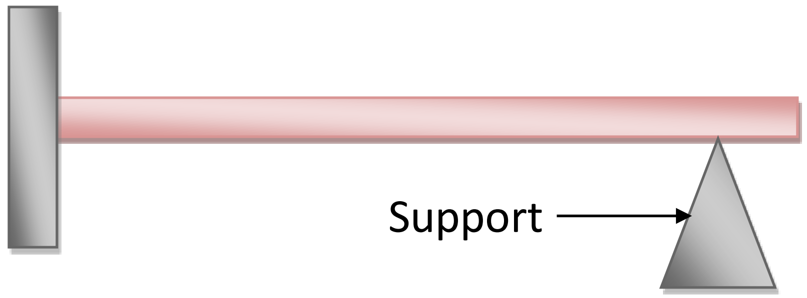
•Simply Supported Beam:

A beam supported or resting freely on the walls of supports at its both end as shown in figure is known as simply supported beam.



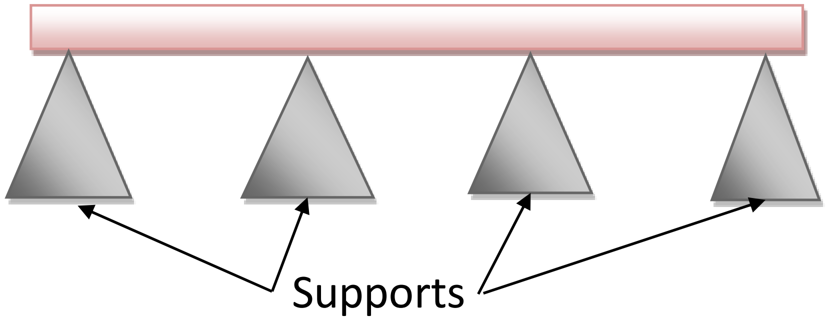
▪Overhanging Beam:

A beam having its end portion extended in the form of a cantilever beam, the support as shown in figure is known as overhanging beam.



Continuous Beam:

A beam supported on more than two supports as shown in figure is known as continuous beam.

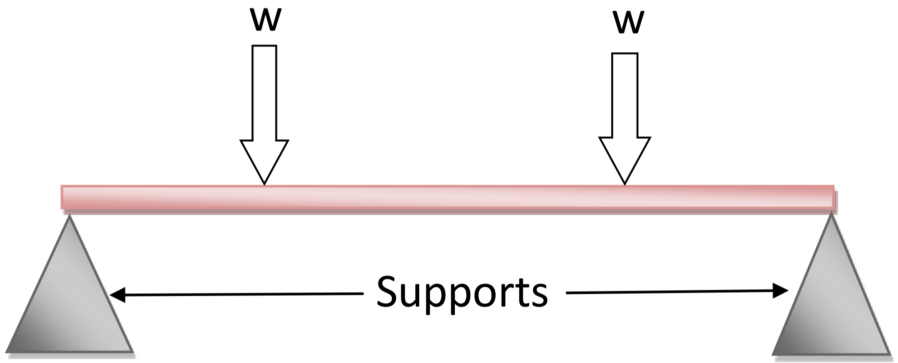


TYPES OF LOADING:

A beam may be subjected to the following types of load –

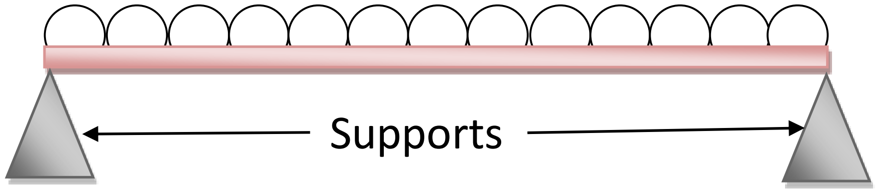
▪CONCENTRATED OR POINT LOAD :

A load acting at a point on a beam(w) as shown in figure is known as concentrated or point load. In actual practice, it is not possible to apply a load at a point, as the points must have some contact area but these area being very small as compare to the length of the beam, so it is negligible.



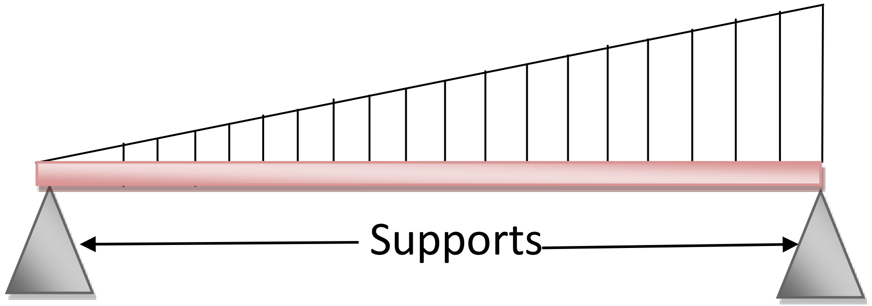
▪UNIFORMLY DISTRIBUTED LOAD (UDL):

A load which is spread over a beam in such a manner that each unit length is loaded to the same extent as shown in figure is called uniformly distributed load (UDL). For all calculations, the uniformly distributed load is assumed to act the through the centre of gravity (C.G) of a load.



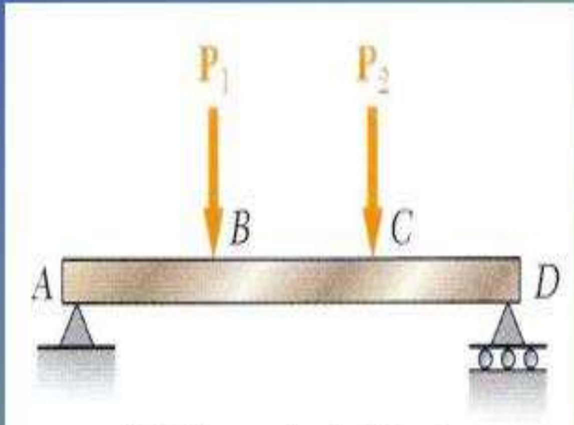
▪UNIFORMLY VARYING LOAD :

A load which is spread over a beam in such a manner that its extent varies uniformly on each unit length as shown in figure is known as uniformly varying load. It is “zero” at one end and increase uniformly to the other end, such load is known as triangular load.

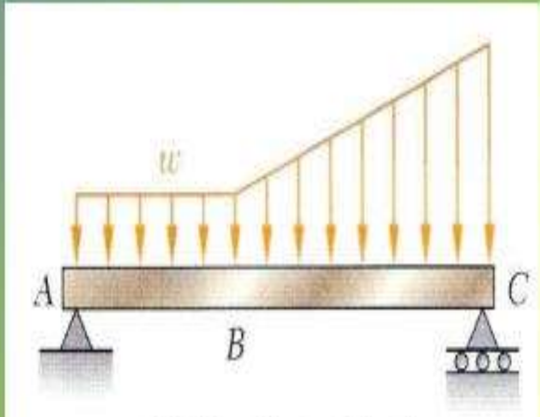


Types of Load and Beam

- The transverse loading of beam may consist of
  - Concentrated loads, P1, P2, unit (N)
  - Distributed loads, w, unit (N/m)



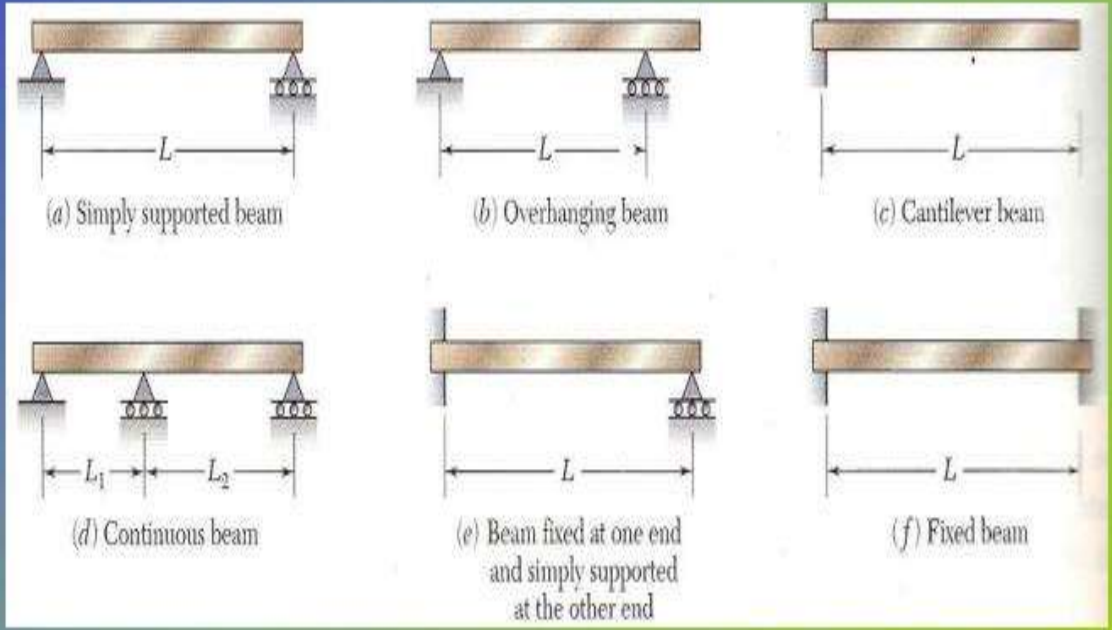
(a) Concentrated loads



(b) Distributed load

Types of Load and Beam

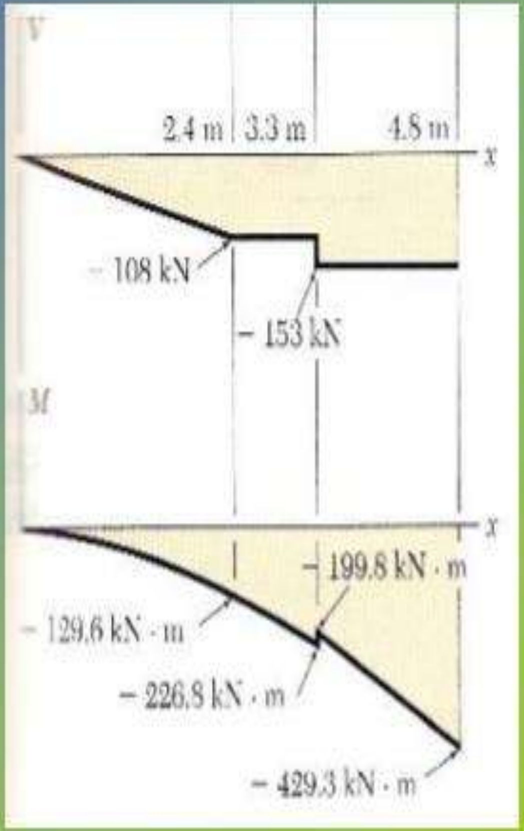
- Beams are classified to the way they are supported
- Several types of beams are shown below
- L shown in various parts in figure is called 'span'



(a) Simply supported beam (b) Overhanging beam (c) Cantilever beam (d) Continuous beam (e) Beam fixed at one end and simply supported at the other end (f) Fixed beam

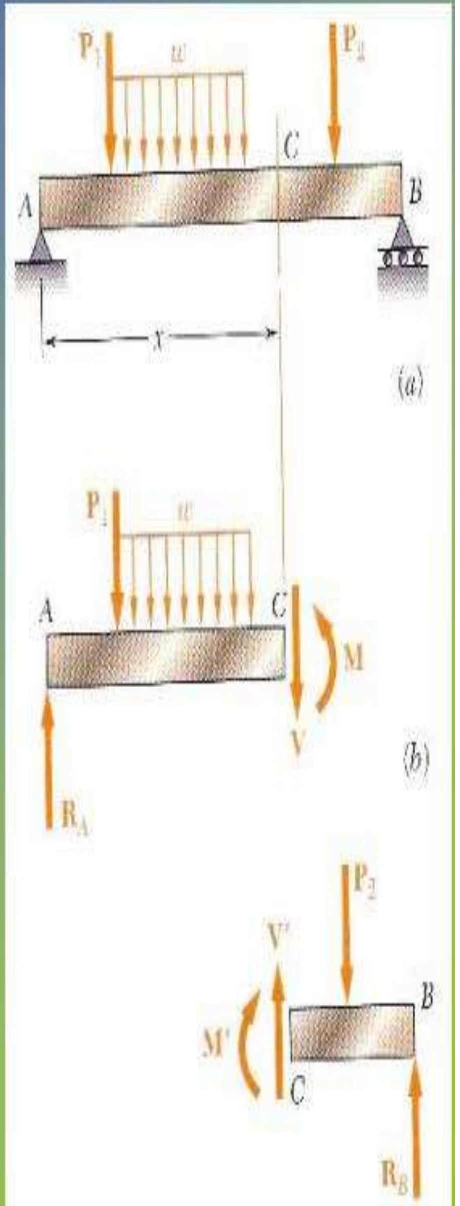
SHEAR & BENDING MOMENT DIAGRAMS

- Shear Force (SF) diagram – The Shear Force (V) plotted against distance x Measured from end of the beam
- Bending moment (BM) diagram – Bending moment (BM) plotted against distance x Measured from end of the beam



DETERMINATIONS OF SF & & BM

- The Shear & bending moment diagram will be obtained by determining the values of V and M at selected points of the beam

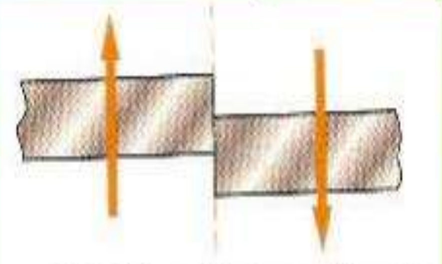


DETERMINATIONS OF SF & & BM

- The Shear V & bending moment M at a given point of a beam are said to be positive when the internal forces and couples acting on each portion of the beam are directed as shown in figure below

(a) Internal forces
(positive shear and positive bending moment)

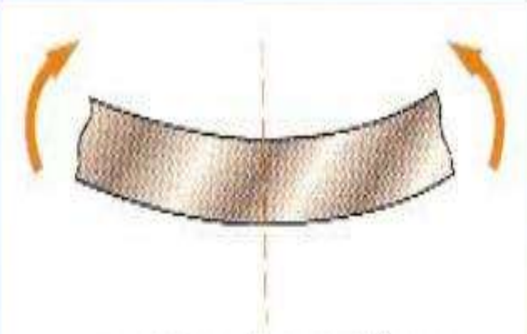
- The shear at any given point of a beam is positive when the external forces (loads and reactions) acting on the beam tend to shear off the beam at that point as indicated in figure below



(b) Effect of external forces
(positive shear)

DETERMINATIONS OF SF & & BM

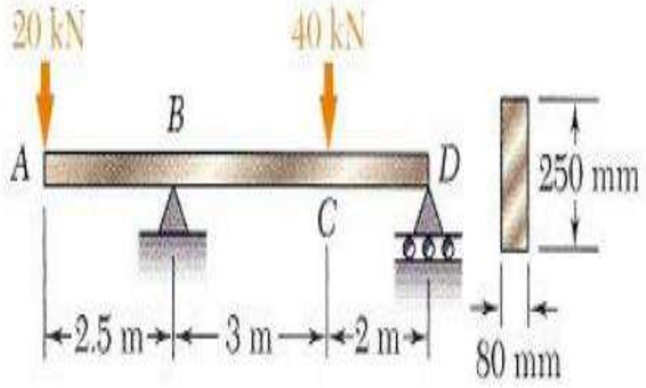
- The bending moment at any given point of a beam is positive when the external forces (loads and reactions) acting on the beam tend to bend the beam at that point as indicated in figure below

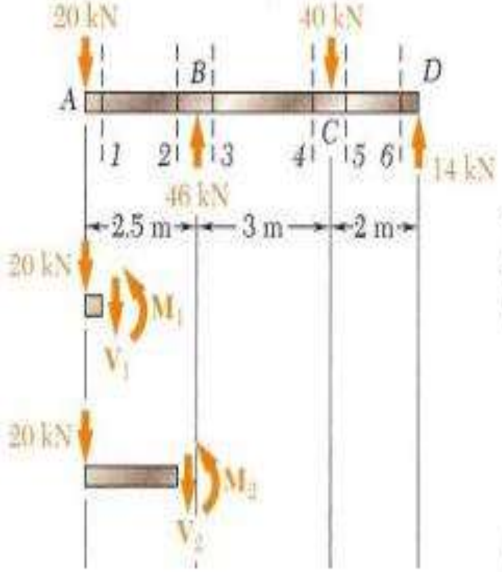


(c) Effect of external forces
(positive bending moment)

SAMPLE PROBLEM 5.1

For the timber beam and loading shown, draw the shear and bending-moment diagrams and determine the maximum normal stress due to bending.





SOLUTION

Reactions. Considering the entire beam as a free body, we find

$$\mathbf{R}_B = 40\ \text{kN}\uparrow \qquad \mathbf{R}_D = 14\ \text{kN}\uparrow$$

Shear and Bending-Moment Diagrams. We first determine the internal forces just to the right of the 20-kN load at A. Considering the stub of beam to the left of section 1 as a free body and assuming V and M to be positive (according to the standard convention), we write

$$+\uparrow\Sigma F_y = 0: \qquad -20\ \text{kN} - V_1 = 0 \qquad V_1 = -20\ \text{kN}$$
$$+\circlearrowleft\Sigma M_1 = 0: \qquad (20\ \text{kN})(0\ \text{m}) + M_1 = 0 \qquad M_1 = 0$$

We next consider as a free body the portion of beam to the left of section 2 and write

$$+\uparrow\Sigma F_y = 0: \qquad -20\ \text{kN} - V_2 = 0 \qquad V_2 = -20\ \text{kN}$$
$$+\circlearrowleft\Sigma M_2 = 0: \qquad (20\ \text{kN})(2.5\ \text{m}) + M_2 = 0 \qquad M_2 = -50\ \text{kN}\cdot\text{m}$$