## UNIT II

# SHEAR FORCE AND BENDING MOMENT OF BEAM

### INTRODUCTION

The algebraic sum of the vertical forces at any section of a beam to the right or left of the section is known as shear force. It is briefly written as S.F.

The algebraic sum of the moment of all the forces acting to the right or left of the section of the beam is known as bending moment. It is briefly written as B.M.

In this chapter the shear force and bending moment diagrams for different types of beam for different types of load acting on the beams, will be discussed.

### SHEAR FORCE AND BENDING MOMENT DIAGRAMS

Shear force diagram is one which shows the variation of the shear force along the length of the beam.

Bending moment diagram is one which shows the variation of the bending moment along the length of the beam.

### TYPES OF BEAMS

The following are the important types of beams. They are

(a) Cantilever beam

(b) Simply supported beam

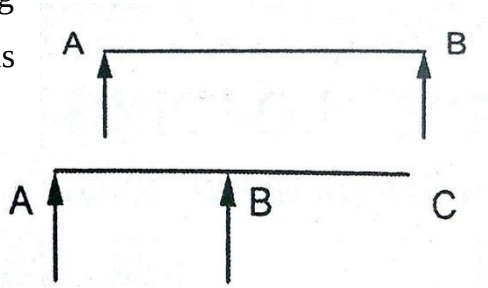
(c) Overhanging beam

(d) Fixed beam

(e) Continuous beam

**Cantilever beam:** A beam which is fixed at one end and free at the other end, is known as cantilever beam.

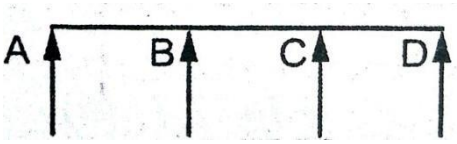

**Simply supported beam:** A beam supported or resting freely on the supports at its both ends is known as simply supported beam.




**Overhanging beam:** It is same as the SSB but the end portion of the beam is extend beyond the support is known as overhanging beam.

**Fixed beam:** A beam whose both ends are fixed or built in walls is known as fixed beam.


**Continuous beam:** A beam having more than two supports, such type of beam is known as continuous beam.




## TYPES OF SUPPORTS

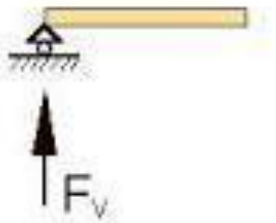
The following are the important type of supports. They are

(i) Roller support

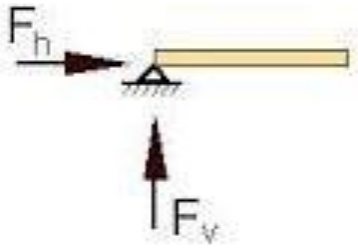
(ii) Hinged support

(iii) Fixed or built-in support

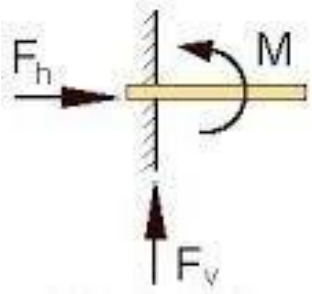
**Roller Support**: The roller is used as an external support since it allows rotation and horizontal translation. Therefore it will have a vertical support reaction. Here beam AB is supported on the rollers. The reaction will be normal to the surface on which rollers are placed.

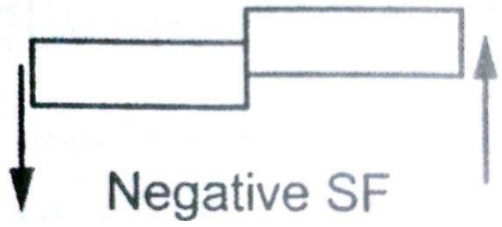



**Hinged support:** Here the beam AB is hinged at point A. the reaction at the hinged end may be either vertical or inclined depending upon the type of loading. If load is vertical, then the reaction will also be vertical. But if the load is inclined, then the reaction at the hinged end will also be inclined. A hinge resists horizontal and vertical translation but allows rotation. Therefore a hinge consists of horizontal and vertical support reaction




**Fixed or built-in support**: In this type of support the beam should be fixed. The reaction will be inclined. Also the fixed support will provide a couple.





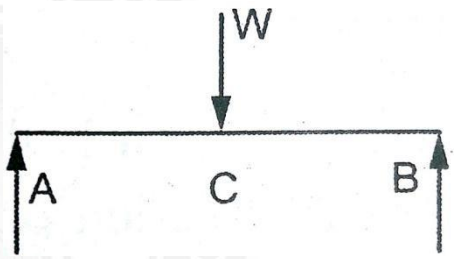

## TYPES OF LOAD

A beam is normally horizontal and the loads acting on the beams are generally vertical. the following are the important types of load acting on a beam

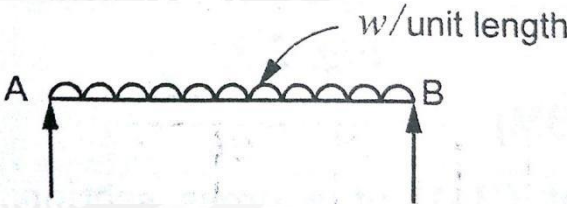
(b) Concentrated or point load

(c) Uniformly distributed load

(d) Uniformly varying load

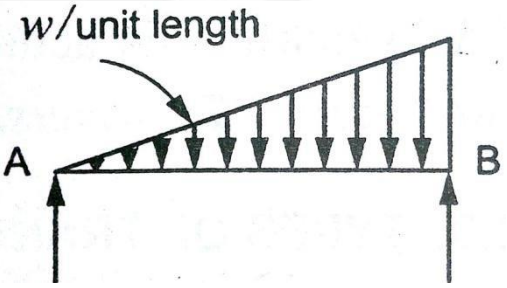



**Concentrated or point load:** A concentrated load is one which is considered to act at a point, although in practice it must really be distributed over a small area.




**Uniformly distributed load:** A uniformly distributed load is one which is spread over a beam in such a manner that rate of loading w is uniform along the length. It is expressed as w N/m run. It is denoted by UDL

For numerical problem solving, the total UDL is converted into a point load acting at the centre of load.




**Uniformly varying load:** A Uniformly varying load is one which is spread over abeam in such a manner that rate of loading varies from point to point along the beam from zero to rated at w N/m run. Such load is known as triangular load.

For numerical problem solving, the total UVL is converted into a point load as the area of the triangle and it acting at the C.G of the triangle. Take at a distance of 2/3 of total load acting from zero load.

## CONCEPT AND SIGNIFICANCE OF SHEAR FORCE AND BENDING MOMENT SIGN CONVENTIONS FOR SHEAR FORCE AND BENDING MOMENT

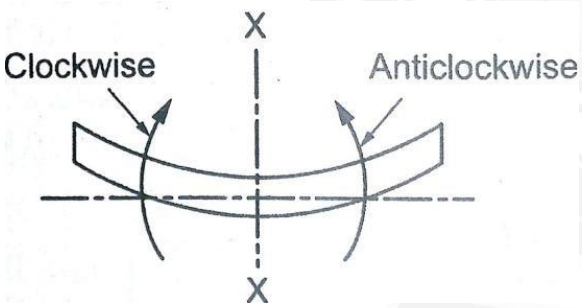
**(i) Shear force:**

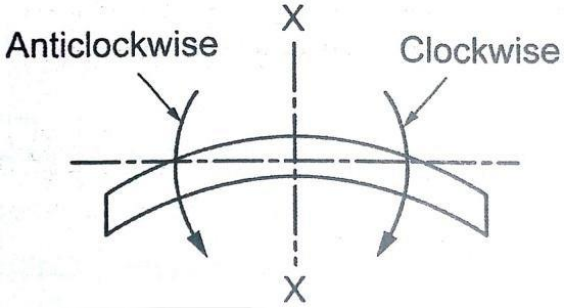
The shear force at a section will be considered positive when the resultant of the forces to the left to the section is upwards, or to the right of the section is downwards.

Similarly the shear force at the section will be considered negative if the resultant of the forces to the left of the section is downward, or to the right of the section is upwards. Here the resultant force to the left of the section is upwards and hence the shear force will be positive.


**(ii) Bending moment:**

The bending moment at a section is considered positive if the bending moment at that section is such that it tends to bend the beam to a curvature having concavity at the top as shown in Fig. The positive B.M. is often called sagging moment.




Similarly the bending moment at a section is considered negative if the bending moment at that section is such that it tends to bend the beam to a curvature haling convexity at the top. The negative B.M. as hogging Moment.

The bending moment will be considered positive when the moment of the forces and the reactions on the left portion is clockwise, and on the right portion anti-clockwise. In the given figure the bending moment at the section X-X is positive.

Similarly the bending moment will be considered negative when the moment of the forces and the reactions on the left portion is anti-clockwise, and on the right portion clockwise. In the given figure the bending moment at the section X-X is negative.

## 2.1.7. IMPORTANT POINTS FOR DRAWING SHEAR FORCE AND BENDING MOMENT DIAGRAMS

The shear force diagram is one which shows the variation of the shear force along the length of the beam. And a bending moment diagram is one which show the variation of the bending moment along the length of beam. In these diagrams, the shear force or bending moment are represented by ordinates whereas the length of the beam represents abscissa.

The following are the important points for drawing shear force and bending moment diagrams

1. Consider the left or the right portion of the section.

2. Add the forces (including reaction) normal to the beam on one of the portion. If right portion of the section is chosen, a force on the right portion acting downwards is positive while force acting upwards is negative. If the left portion of the section is chosen, a force on the left portion acting upwards is positive while force acting downwards is negative.

3. The positive values of shear force and bending moments are plotted above the base line, and negative values below the base line.

4. The shear force diagram will increase or decrease suddenly i.e., by a vertical straight line at a section where there is a vertical point load.

5. The shear force between any two vertical loads will be constant and hence the shear force diagram between two vertical loads will be horizontal.

6. The bending moment at the two supports of a simply supported beam and at the free end of a cantilever will be zero.