UNIT - 2 BEAMS & THEORY OF BENDING

INTRODUCTION

We see that whenever a horizontal beam is loaded with vertical loads, sometimes, it bends (*i.e.*, deflects) due to the action of the loads. The amount with which a beam bends, depends upon the amount and type of the loads, length of the beam, elasticity of the beam and type of the beam. The scientific way of studying the deflection or any other effect is to draw and analyse the shear force or bending moment diagrams of a beam. In general, the beams are classified as under:

1. Cantilever beam,

2. Simply supported beam,

3. Overhanging beam,

4. Rigidly fixed or built-in-beam and

5. Continuous beam.

TYPES OF LOADING

A beam may be subjected to either or in combination of the following types of loads:

1. Concentrated or point load,

2. Uniformly distributed load and

3. Uniformly varying load.

SHEAR FORCE

The shear force (briefly written as S.F.) at the cross-section of a beam may be defined as the unbalanced vertical force to the right or left of the section.

BENDING MOMENT

The bending moment (briefly written as B.M.) at the cross-section of a beam may be defined as the algebraic

sum of the moments of the forces, to the right or left of the section.

NOTE. While calculating the shear force or bending moment at a section, the end reactions must also be considered along with other external loads.

SIGN CONVENTIONS

We find different sign conventions in different books, regarding shear force and bending moment at a section. But in this book the following sign conventions will be used, which are widely followed and internationally recognized.

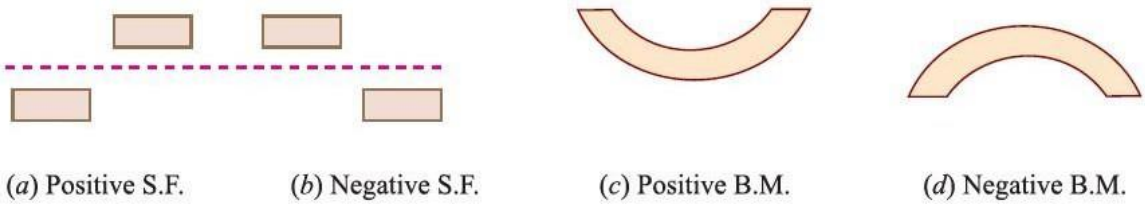

Figure 1

1. *Shear Force.* We know that as the shear force is the unbalanced vertical force, therefore it tends to slide one portion of the beam, upwards or downwards with respect to the other. The shear force is said to be positive, at a section, when the left-hand portion tends to slide downwards or the right-hand portion tends to slide upwards shown in Fig. 13.1 (*a*). Or in other words, all the downward forces to the left of the section cause positive shear and those acting upwards cause negative shear as shown in Figure 1.

Similarly, the shear force, is said to be negative at a section when the left-hand portion tends to slide upwards or the right-hand portion tends to slide downwards as shown in Figure 1. Or in other words, all the upward forces to the left of the section cause negative shear and those acting downwards cause positive shear as shown in Figure 1

2. *Bending Moment.* At sections, where the bending moment, is such that it tends to bend the beam at that point to a curvature having concavity at the top, as shown in Figure 1 is taken as positive. On the other hand, where the bending moment is such that it tends to bend the beam at that point to a curvature having convexity at the top, as shown in Figure 1 is taken as negative. The positive bending moment is often called sagging moment and negative as hogging moment. A little consideration will show that the bending moment is said to be positive, at a section, when it is acting in an anticlockwise direction to the right and negative when acting in a clockwise direction. On the other hand, the bending moment is said to be negative when it is acting in a clockwise direction to the left and positive when it is acting in an anticlockwise direction.

NOTE. While calculating bending moment or shear force, at a section the beam will be assumed to be weightless.