B. Architecture

AR6301 : Mechanics of Structures II

Unit 1 –Shear Force and Bending Moment

Lecture 1

Introduction to Beams:

Let us see what is beam? Actually in a structure the load distribution takes place like loads will be transmitted from slabs to beams supporting. So the load coming over the slabs will be transmitted to the beams and the beam in term will transmitted to supporting columns and then the column will transmitted to the foundation. This is the distribution of load in a structure. So we know a beam is a horizontal structure transmitting the load coming over it to the supporting structures. This is the definition of beams, now we will see the types of beams.

Types of Beams:

We have different types of beams to start with we see, what is a cantilever beam? So a cantilever beam is a beam which is supported from the left hand and which is free at the other end. The practical example of cantilever beam will be a canopy beam. And then we have simply supported beams so beam which is supported at both the ends is a simply supported beam and the practical example will be if we take a class room their a slab is supported over the room, the slab will be resting on the beams and the beams rest on columns. Here imagine these are two columns and the beam is simply resting over the columns.

And then we will see what are called as overhanging beams, the overhanging beam is like this that is will have a support and some portion will be extended beyond the support. Say this may be your room and here we have some canopy portion or we can have a balcony portion in this side. So this is an example of overhanging beams.

We have seen various types of beams such as cantilever beams, canopy beams, and overhanging beams. In addition we also have propped cantilever beams, say a beam which is support at the free end or propped at the free end is called a propped cantilever beam. And then we also have fixed beams, say a beam is fixed like this and practical example will be the beam is end astern inside the wall or columns like this. Almost all structures will have fixed types of beams only. We also have continuous beam that is a beam which is rest on more than two supports. This are the types of beams which we need to know.

Now will move on to what are the different types of supports and reactions. We have a fixed support as I mentioned in case of cantilever beam. Say a fixed support will offer three reactions like this, it will have one vertical reaction v, it will have one horizontal reaction H and in addition it will have a moment m. So this is called fixed supports. Then will see what are called hinged support, a supports which is offer two reactions such as one vertical reaction and one horizontal reaction is called a hinged support and then we have roller support. A roller support has only one reaction which is vertical reaction or a reaction perpendicular to the axis of the roller.

A physical meaning of a fixed support is say a fixed support will not allow the support to move either vertically or horizontally and it will not allow any rotation. Where as in the hinged support, it won't the support to move either vertically or horizontally alone it will allow for rotation for example a door hinge.

Shear Force:

This is the actual topic of our concern and the knowledge of shear force and bending moment is essential in designing any structure. Say if you want to provide shear force in the form of stirrups in a beam then we need to know the shear force at every section of a beam.

Now we will see the bending moment, if you want to design reinforcement then you have to carefully calculate the value of bending moment at any section.

LC – Left clockwise

LAC – Left anticlockwise

RC – Right clockwise

RAC – Right anticlockwise

Before going to the calculation of shear force and bending moment the most important thing is the sign conventions. So if we see the sign convention is mentioned here,

SF		**BM**
Lu	+	LC
Ld	+	LAC
Ru	+	RC
Rd	+	RAC

Where SF refers to the shear force and the BM refers to the bending moment. Here the shear force the name itself telling it's a mere force. So the force we should see whether it act upwards or downwards and the corresponding sign conventions also mentioned. Now we will see the definition of the shear force.

Shear force – Definition:

Shear force is an algebraic sum of vertical forces acting either to the left or to the right of a section. So Shear force in case of point load, first we need to know the definition point load. Say if we have a simply supported beam like this and if your load acts at particular point then that load is a point load. Then if the load is distributed uniformly over the length of the beam then that is called uniformly distributed load. The unit of points is important in case of load; say the

units for the point loads will be kilo newton. Similarly if you take a uniformly distributed load the load is uniformly distributed and the unit will be kilo newton per meter and we call this as intensity of the load. We have a simply supported beam the load can vary like this it can uniformly vary, so we call this as uniformly varying load. In beams we will have different types of loads. So at this point we should be clear what is a beam, what are the different types of beams, what are the different types of supports, what are the different types of reactions.

Bending Moment:

Now we will move on to the bending moment, the word moment indicates that force multiplied by distance. In case of point load the distance multiplied by force between the loads about which load is the bending moment is taken. Say you have bending moment at one point and your load acts at two meter from your point. So the bending moment produced by the load multiplied by two meters will be the moment created by the load.

It should be seen whether the load produces clockwise or anticlockwise moment. In case of shear force we deal only with force that is why we are bother about it acts upward or downward. But here the moment comes into concern or action then we should see whether it should produce clockwise or anticlockwise moment. For example if your load is here say 10 kilo newton of load acts here and the distance is three meters. And I'm interested in finding the bending movement here. The distance between the point about which moment is required and the line of action of the load, this distance is which we are interested in finding the movement produced by this particular 10 kilo newton load.

The moment 10 kilo newton load about point A will be this 10 kilo newton multiplied by 3. So its 30 kilo newton meter. And we should also see what is the moment produced by the load. The moment produced by the 15 kilo newton will be this 15 multiplied by 2. And the nature of moment produced by this load will be if we connect like this we will see various arrows. If we see the arrow that itself will show the nature of the moment. This will produce an anticlockwise moment.

So if we have several loads you should be now in a position to calculate the moment produced by various loads about any required points. I should know what are the forces acting and then what is the distance line of action of individual force on the point and nature. Say this distance will be one meter and this distance will be 2 meters and then it will be 3 meters. So we have 5 kilo newton load acting on at the distance of 1 meter from C therefore this will produce an anticlockwise moment of 5 into 1, so 5 kilo newton. The nature of moment produced by this will be 10 into 2 that is 20 kilo newton meter. It will be clockwise moment. Like this connecting this we will get the total moment as 75 kilo newton meter.

SF		**BM**
Lu	+	Lu
Ld	-	LAC
Ru	-	Rc
Rd	+	RAC

In case of uniformly distributed load it will be distributed over a length. So we should see the total load first and then distance where the load concentrated. Say for example if we have the uniformly distributed simply supported beam subjected to some 30 kilo newton per meter. Or we can take a cantilever beam to explain easier we have points A and B and 10 kilo newton load acting. Here we are interested in finding the bending moment acting at some particular point C and that distance is 3 meters. Here the total load acting beyond C is (10 X 3 = 30) kilo newton. In this we have a load concentrated at a point with 1.5 meter then the total moment produce by the udl will be 45 kilo newton meter. To calculate the load itself we have the intensity of uniformly distributed load (udl).

In case of Uniformly distributed load (udl):

Here the bending moment will be the multiples of intensity of udl, length over which it acts and the distance between center of gravity of load and the point or section considered.