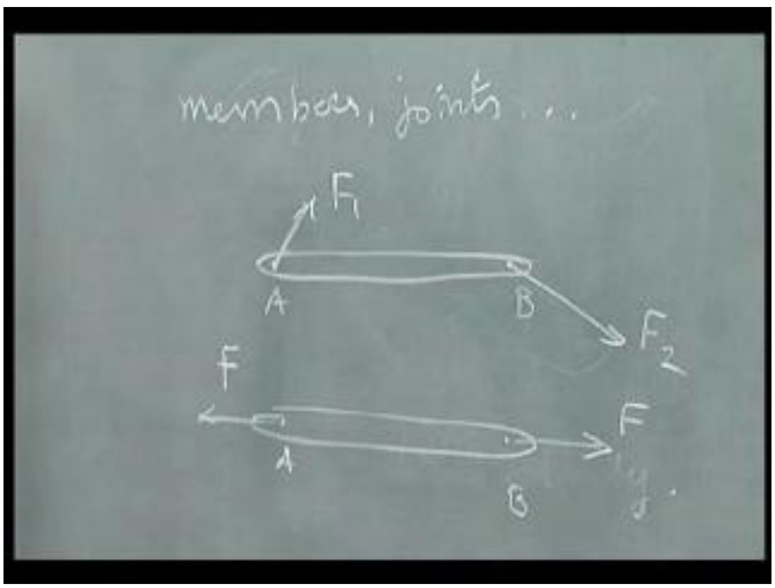
Engineering Mechanics
Prof. Siva Kumar
Department of Civil Engineering
Indian Institute of Technology, Madras
Statics – 2.2

Now let's look at types of one dimensional structural components or systems. I could have components or rigid bodies or systems of rigid bodies that make up a structure. The structure could be one dimensional structure or two dimensional structure or three dimensional structure but consisting of only one dimensional members. We are going to use the names, members, joints, etc in this particular module. Let's take up a simple one. The simplest of one dimensional member that we know of is a single one dimensional rigid body like this, a straight one dimensional rigid body like this. Now the forces acting on these which we have already examined that is the internal forces could be axial, shear or moment resultants. We will look at one particular type of force action.

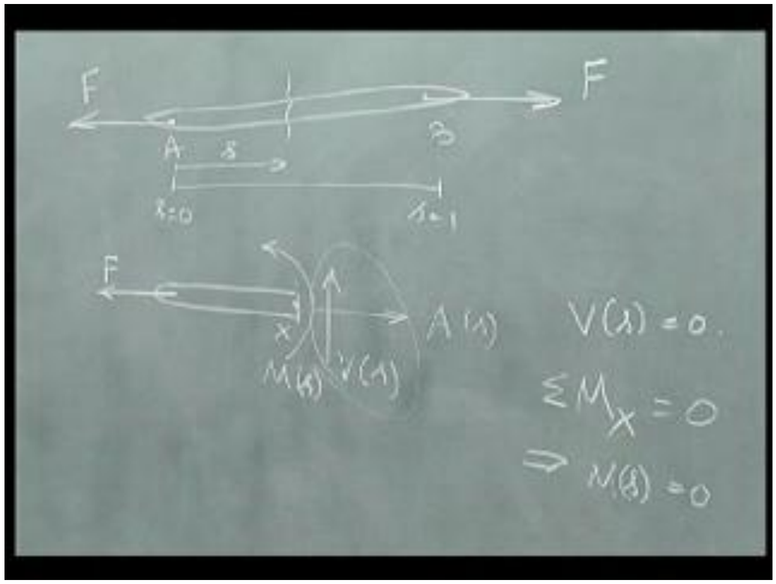
(Refer Slide Time 02:05)



Supposing I know that for this particular straight one d bar, if the forces are going to act, only force resultants are going to act at A and B say something like this. From an earlier observation we already know that we can reduce this system of forces for this rigid body as force acting like this. This is the result that we got earlier. We usually call this as a link member. Since these members form a structural system called truss system. They are also called a truss member. One of the ways in which engineers could accomplish forming structural systems is by simple members like this. The advantages are many, constructions is easy, you have a uniform type of member that you start using like what we did in the earlier clipping where we used an s form universally. Another thing to note is if you find out the internal forces in this member, we will get an idea as to what type of internal forces acting. Let's examine.

Supposing I take this particular member which is a link member and I already know that the force acting on this can be reduced simply as equal and opposite forces acting at A and B like this. Now I wish to examine let us say I take s equal to 0 to s equal to 1 and I wish to find out what will be the internal forces acting on this. If you have to know that, you have to section at a particular s from let's say a.

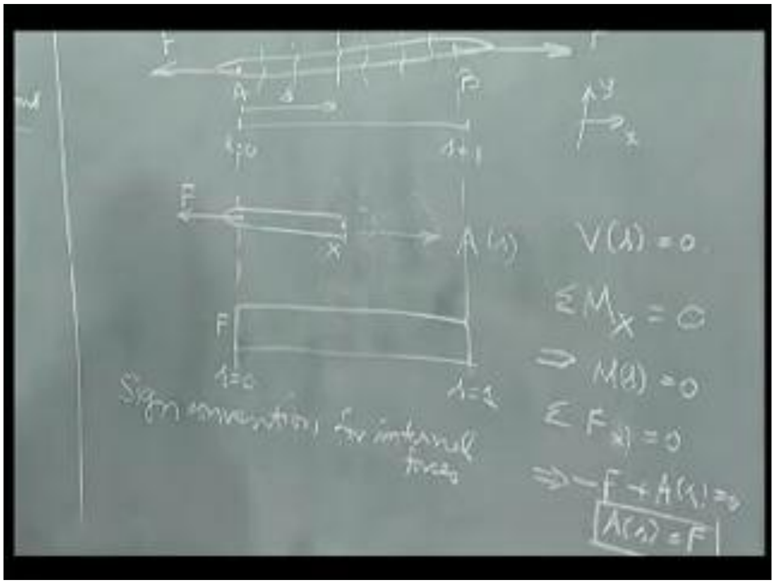
(Refer Slide Time 05:13)



Let's examine that this is the force f acting on it. All the possible ones are A at s, shear force at s and bending moment at s. Now we will use the three equations of equilibrium. Total vertical set of forces equal to zero, you have only one shear force acting here which means automatically I will have V of s is equal to 0, examining the vertical forces. If I take moment about this, let me call this as capital X. If I take moment about this, notice F is not going to take part in the moment equation. A and V by the very fact that they are acting at this particular point will not take part which means I will have only M (s) available there. It is equal to zero implies M of s is equal to 0.

This automatically means I don't have the shear force, I don't have bending moment as internal forces in this member. The only one that is acting is A of s. If I take the axial force static equilibrium. I am sorry, I should say F along x is equal to 0, if this direction is x and this is y. This implies that this is minus F plus A at s equals 0 which means A at s equals F. This is the nice result. It tells me that whether I cut here or cut here or cut here or here or here, the axial force at that s will always be equal to the force that is applied here. If I draw the distribution of axial force with s, this is equal to 0, s is equal to 0 and s equal to 1. I know that it will be a constant value and this value is equal to f. One another important thing to note here is should I take this axial force to be positive or negative? That's a question that arises and that becomes a confusion. So simplest thing that you can do is introduce what is called a sign convention for internal forces.

(Refer Slide Time 07:25)



Let me use my friend venkatesh rao to help me with understanding the sign convention for this. I have this member. He is pulling it, I am pulling it. I am applying a force, he is applying a force. I know at this particular point, if it is point force that I am applying. So let me make it point force so that it's easy for me. I am going to introduce pins over here just to make it clear that we are applying along a particular point here. So he is going to hold this pin only like this and only the pin like this and pull it. I know it's going to be difficult because he is pulling the pin, I am pulling the pin which means two axial forces are acting at the two ends which is equal to this force f.

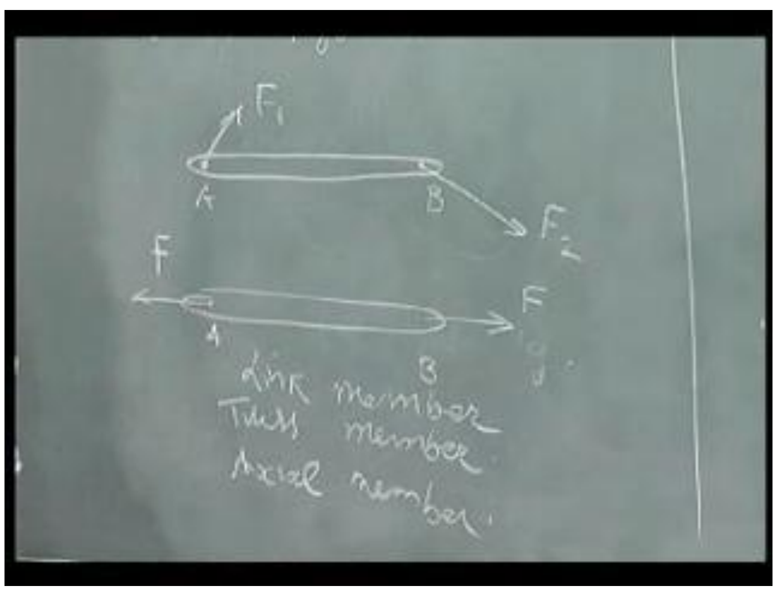
(Refer Slide Time: 08:26)

One other thing to note here is every point here on this is being pulled. Supposing I take this particular end, I have a force acting in the opposite direction to f. Can you hold it at this point, take this out. So he is pulling with a force f, I am pulling with a force f. The notion here is that it is under tension. If it is in the opposite direction, I will be pushing it, he will be pushing it. The net result is as it is getting compressed. In this particular case it gets buckled but if it is thick enough it will get compressed. Let me assume that if it is in the stretched or the pulled state, I am going to call it as a positive internal force or in another words if this one dimensional member is in tension, I am going to call that internal force which causes this tension as a positive value. Thanks.

In this case you notice that there is a pulling action. Simple way to understand is just hold this particular rigid body and examine what is happening here. It is being pulled and therefore we will have this as a positive value. Supposing this external force had been like this then the internal force direction also will change to like this and in this particular case, if you hold this. This is pushing it, compressing this particular rigid body and therefore the notion of this axial force is negative.

Let me just pivot back to the problem here. Therefore if this is the notion, I will put a plus sign here and since I know A (s) is equal to F, it is a plus F all through. One thing that I realize in this kind of member is let me write it down here. It has only axial internal force and the other thing is the axial internal force is a constant throughout. Such a member is called linked member or a truss member. We have examined one type of member which is called an axial member or a link member or a truss member.

(Refer Slide Time 12:29)



Sometimes they also called it as axial members, I am just going to write that also. Since the force is acting along the axis, I can call that has an axial member. This is a member that we came across in earlier examples of rigid bodies. This is a structure called the truss structure which will consist of members of this sort and therefore I can also call them as members of truss or a truss member. These three names hold good for this particular type. These are the very prevalent type of member that you will see in many structures built in a very simple manner, constructed in a very simple manner.

Thank you.