Statics and Dynamics
Prof. Sivakumar
Department of Applied Mechanics
Indian Institute of Technology, Madras

Lecture – 11
Statics - 2.5

I mean example in this particular module, let us look at whether this particular structural system is stable in this statics sense, whether this is stable is a question that we have to ask.

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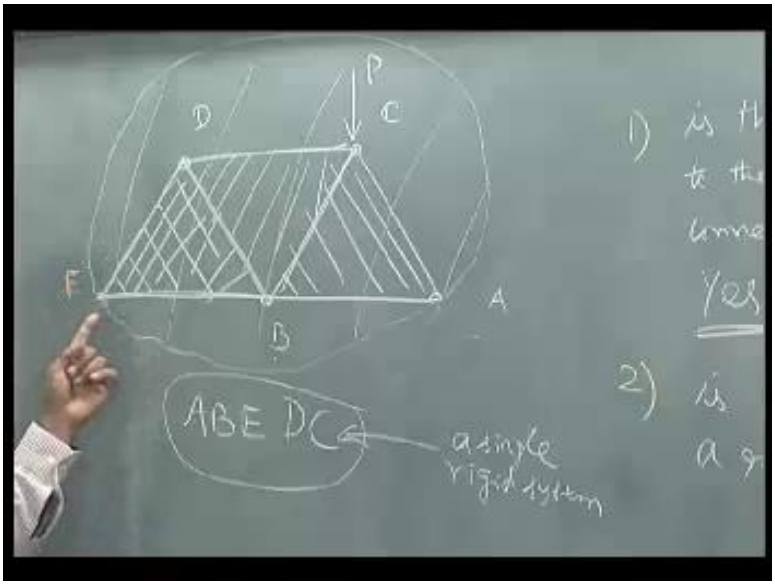

Let examinant step by step, the first thing that I would attempt to do is, I would look at this particular free body, let me just has it to indicate. So, I am going to take this particular entire structural system and look at, it support reactions and ask the question whether it is rigidly connected to the fixed frame of reference. If the answer is yes, then we can proceed to find out the nature of the structural system itself as a separate body.

Mind you, if I do this, at this particular point if I pin this particular body at this point, the only way that the body can rotate is like this. Assume that this body is stationary within itself and if I use a roller support to arrest the vertical moment over here at A, then I know that this particular body cannot move as an integral body with only these particular supports. In other words, these supports at A and E are enough to give a particular rigid body a stable support.

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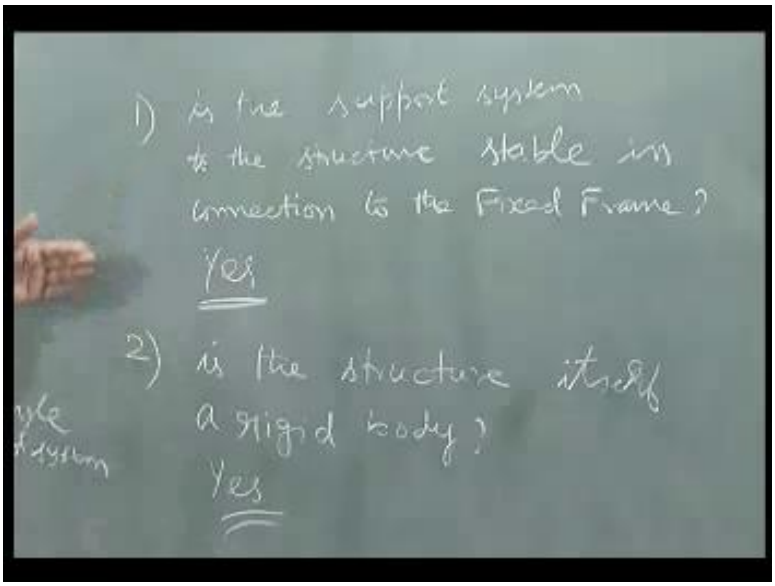

So, the first question that we answer is, is the support system to the structure, here the structure is this which consists of rigid bodies connected together. Is the support system to the structure and stably or stable in connection to the fixed frame? The answer that to the question in this particular problem is yes, if I fix if I inject E and have a roller supported A that is enough to pin this particular rigid body to the fixed frame of reference.

Therefore, the next question that I have to ask is, is the structure itself a rigid body. If it is a rigid body, then from the earlier concept that we know it will be a structure that is stable. So, let us examine in there, how do I examine that particular concept, it is not difficult. In order to do that, first let us make it a body with the supports removed, typically this particular body it should indicate the characteristics of a single rigid body.

So, if I start with this particular member for example I am going to take this member, I hold this member and ask the question if I connect these two and do not connected this particular point, these two members can rotate about B and E. So, if I take this particular member D E and this particular member B D and ask the question, if they are pinned at these two points what will happen to these. These members B D and D E will rotate about A and B.

Now, to adapt the rotation I am pinning it at D, the moment I pinned at D there is an arresting of rotation of B D as well as D E with respect to each other and with respect to B E. The net result is that this particular triangle that you see formed by pinning at these

three points itself forms a rigid body. Because, B D is rigid, D E is rigid and B E is rigid, this particular construction of D, B, E is a rigid body and to this rigid body, I will again examine by inserting to B C and C D instead pin that D and B.

Again they can rotate about B and D and if I hold the relative rotation of these two members at C, they become rigid again with respect to this rigid body, which means I can include this and say that both together form another rigid body. I can extent this argument and show that I can end up this region also and therefore, this entire body A, B, E, D, C is a single rigid system planar of course, provided each of these members that we have A B, B C, C D, D E and B E are rigid and that satisfies this condition and serve therefore, the answer is yes.

And if these two conditions are met, then I will say that this structure is a stable structure that is simple. This is one of the criteria that has to be met in order to analyze for the forces in the structure for stability and statics.

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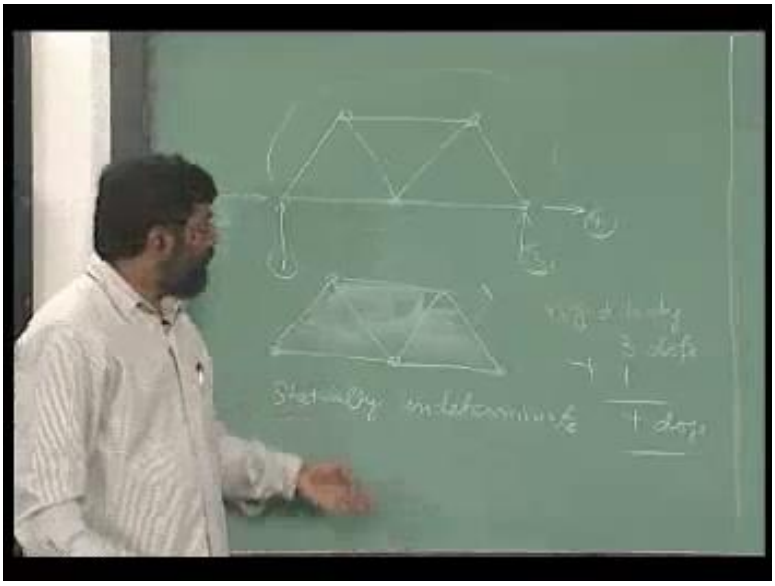

Now, let us look at some examples in relation to stability, so let say I have something like this, I have one like this and another like this, I ask the question is this the stable system, let us examine and find out. Unlike the previous system which I have just taken a similar system here, here I have take a roller support here and a hint support here. In contrast both are hint system, but I have one member last over here and I want to ask the question is this a rigid stable system.

Let us examine, first let us take this, this structure out of defects of frame of reference. I find that this has is a hints, this is a hints and if I remove these two, there are two reactions that occur. Or in other words, if I have to draw this as a free body and examine the equilibrium, there are four unknowns that I have to solve for it. But, mind you I can solve for only three equations, but one thing is clear it is rigidly connected to defects of frame of reference.

And therefore, let me go to the next step, the next step I will examine the free body of this. Like in the earlier case, as long as I have three members like this joined as a triangle, it becomes a rigid system, this rigid system is again forming a triangle with these two. And therefore, they together will be a rigid system, but this rigid system along with this is no more a rigid one, there is a degree of freedom that you see here.

And therefore, this no more remains a free body rigid body, if it a rigid body a rigid body has 3 degrees of freedom. But, here I have a system of rigid bodies, this is one rigid body that can have 3 degrees of freedom, in addition this can have a rotational degree of freedom and therefore, plus 1 4 degrees of freedom or possible in this particular system of rigid bodies. So, here I have a case where externally it is fixed to the system in a stable way, but internally there seems to be a mechanism possible.

But, since I have to find out four unknowns from the external support and I have 4 degrees of freedom for this body that I can form, it is possible to solve for the four unknowns through 4 degrees of freedom. So, in that sense if I take the entire thing together it the stable system, even though this particular body that I am looking at these not a stable body.

Let us look at a simpler example then this, supposing I had this also and I ask the question it is a stable system, the answer is immediate yes I have this also included in a single rigid body mind you single rigid body, means I have only 3 degrees of freedom which means I can generate three equations, I have to solve for four unknowns only three equations, which means I have to generate another equation from some other condition I cannot generate from the equilibrium conditions that I already know of.

Such a system is called a statically in determinant system, statically meaning there is no moment in determinant means you cannot determine using purely equilibrium equations, let me just show an example from this we had here let me modify a little bit of this.

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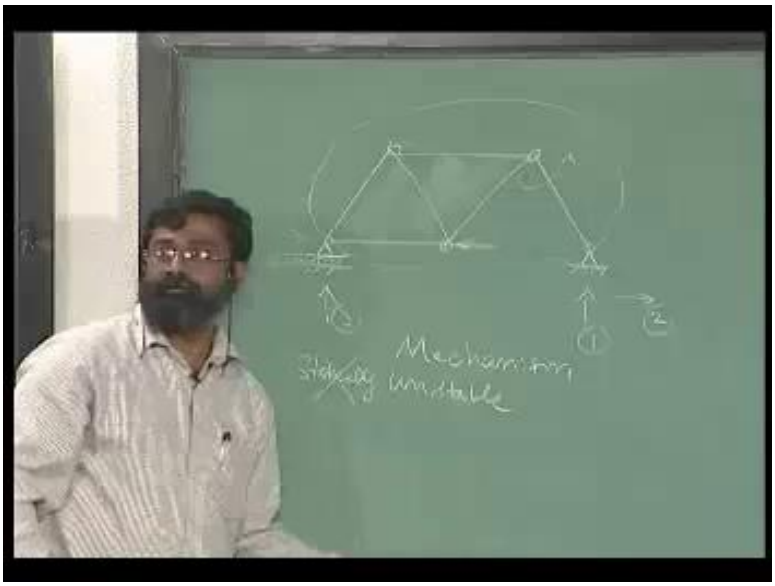

Let me remove that member and ask the question supposing I had something like this and will this be a rigid body or in other words will this be a stable system. Let us examine that earlier we did that exercise I ask that question, let us look at the external supports, external supports are introducing three reactions, 2 from here and 1 from here. So, 1, 2 and 3 reactions or in other words three members have to be solved from equilibrium of this particular body.

This body already we found out that these two can form a rigid body. Whereas, this body does not integrally form a single rigid body will this rigid body. Or in other words, it has a mechanism of being able to rotate and removes this and therefore, this particular system of rigid bodies will have not 3 degrees of freedom 4 degrees of freedom which means I can write four equations, but three unknowns only to be solved and we have a problem here.

Why it is a problem? Because we assume this particular body to be stationary whereas, it is not, it is not very difficult to understand thing of it like this. Supposing, I apply four slaves and look at this, this is inched if I apply a force this can move. So, what will happen is will move like this, you will get it something like this, it will move like this can you imagine that just moves down rotate like this, it moves down and moves like this which means if I apply a force here it becomes a non stationary system, such a body such a system is called a mechanism, other name to that is statically unstable system, many times people do not to put this statically and call it as just unstable system.