Mechanics Of Solids
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Lecture – 08
Solutions of Plane Truss

Welcome back to the course mechanics of solids. So, in the last lecture we are talking about the plane truss and different say details of the plane truss. And we have seen in the last lecture that how we can find out or how we can determine the rigidity of the truss how we can calculate or how can check whether the truss is rigid or not. And then finally, we have seen that whether the truss is statically indeterminate or not, statically indeterminate will be having 2 components one is externally determinate or internally determinate. So, those things we have seen in the last lecture.

So, now in this particular lecture will be talking about the solution of plane truss; that means, how we can solve or how we can analyze, the plane truss system solution of plane truss.

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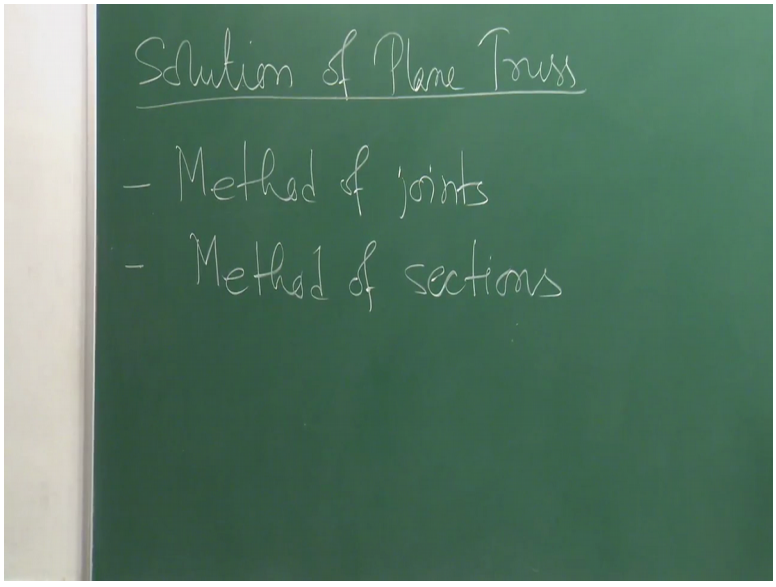

So, there are 2 methods by which we can solve or analyze the plane truss. First one is method of joints. So, we have little B it discussed about these thing in the last lecture, if you recall method of joints and second is method of sections.

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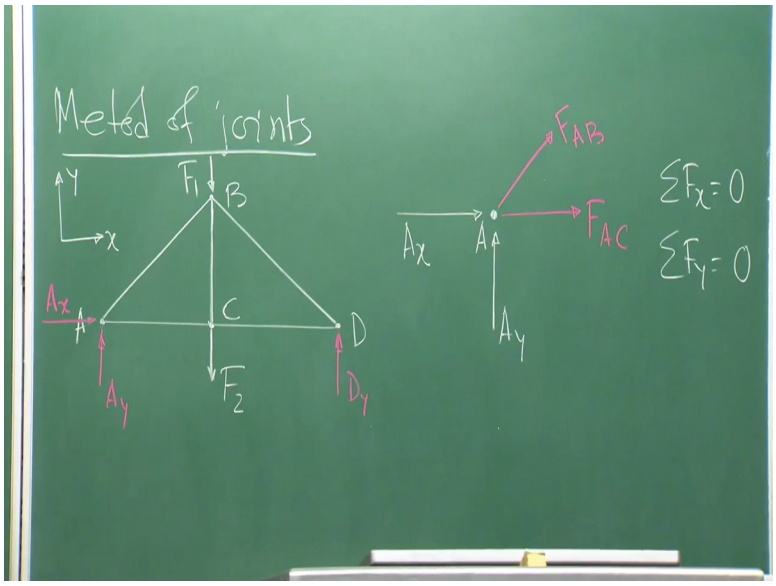

Now, will be coming one by one. So, first will be discussing about method of joints. So, what we do here whatever and of course, at this moment we are not going to analyze any internally indeterminate truss because whatever truss will be discussing in this particular chapter everything will be internally determinate truss. So, if you want to analyze a internally indeterminate truss then basically you need some other logic or some other conditions.

Otherwise you cannot solve the indeterminate structure that is very simple I mean as we discussed in the in the last lecture on last lecture when we are talking about the determinate and indeterminate structure. So, for the time being we are only discussing with all the these methods method of joints and method of sections we are just applying on the internally determinate as well as externally determinate truss.

So, now in this method basically suppose you have a truss like that, a load is applied F 1 here, another load is applied here and these are all joints, these are all joints this is your C point A B D. At A you have hinge support at D you have ruler support and at C you have a force F 2. So, this is a truss the first what is your first job. So, first job is to draw the free body diagram the whole truss.

So, if you want to draw the free body diagram of the whole truss the what is your first job you remove the system; that means, you are replacing the supports by corresponding support reactions. Ay Ax and D y, where x and y are like this. So, this is your free body

diagram of the truss. Now what are the things you need to check? First you check whether this truss is externally determinate or not; that means, whether you can manage to calculate or determine the support reactions right and that you can find out right.

So, how many support reactions you have Ax Ay and D y. So, you have 3 unknowns how many equations of equilibrium you have having with you 3 equations summation of F x equal to 0 summation of F y equal to 0 and summation of movement equal to 0. So, 3 equations 3 unknowns. So, you can find out those unknowns. So, therefore, this is externally determinate system.

Now, it is also statically or the internally determinate and you can check it because if it is not internally determinate then you cannot find out all the member forces and you will see that all the member forces can be obtained by using your equations of equilibrium. So, therefore, it is internally determines structure whether it is rigid or not. So, you just check it how many joints are there 1 2 3 4 there are 4 joints.

To get just rigid truss how many members you need, 4 joints means 2 into 4 minus 3. So, 5 members. 5 members minimum members 5 will be required to get the just rigid structure. So, how many members are there 1 2 3 4 5. So, therefore, this is a just rigid truss. So, all those check we have done before analyzing the problem. Now in method of joints what we do we consider each and individual each and every joint. And we try to satisfy the equations of equilibrium available with me at each and every joint and in that way we proceed for the whole truss to get the unknown member forces. What does it mean?

Now, let us talk about the free body diagram of joint A. So, this is your joint A. So, when I am talking about joint A, how many equations of equilibrium available with me 2 because moment equilibrium moment equation will be giving me the trivius origin. Because if I take the moment with respect to point A of course, the moment of all the forces will be 0 right. Whatever forces I getting converse or whatever forces I getting emerge from point A basically the moment will be all the forces will be 0.

So, that is not serving my purpose. So, 2 equations of equilibrium are available with me that is summation of F x equal to 0; that means, all the forces summation of all the forces along x direction is 0 summation of all the forces along y direction is 0. So, these 2 equations these 2 equations are available with me. So, if there are 2 equations are

available with me equations of equilibrium, then how many unknowns I can solve 2 if there are 3 unknowns at a particular joint, then you will not be able to solve it. So, that will become the statically or internally indeterminate structure.

So, now if you considered joint A, what are the forces are acting? This is you are Ay. Now it is known from our analysis Ax that is also known. So, before jumping on the actual truss problem or the calculation of the member forces you need to know the support reaction. So, Ax and Ay both are known right now. What are the things are unknown? So, let us draw that thing in different color.

So, unknown is member force because A B is a member and the and already we have decided that all the members are 2 force members. So, therefore, the line of action of the member force will be along the axis of the member there is no doubt. So, the line of action of member force A B will be along the line A B. So, that I am showing F A B and what is the other member which is emerging from point joint A that is AC.

So, F AC. So, you have 2 known parameters Ax and Ay. You have 2 unknown parameters F A B and F AC. And 2 equations of equilibrium available with you. So, conceptually you can get this values just by using your vectorial analysis right, by just doing your vectorial analysis whatever you have seen earlier in your 10 plus 2, physics class or something like that just, by following the vectorial analysis you will be getting the member force F A B and F AC right.

Now, I have shown Ay vertically upward direction Ax from left to right. The same thing I am showing here because I do not know whether it will be left to right or right to left, Ax will be left to right or right to left I do not know whether Ay will be vertically upward or downward, I do not know that will be dependent on the calculations or that will be depended on the magnitude right.

For the sake of say I mean completeness we are assuming that Ax is acting vertically upward direction and Ax Ay is acting vertically upward direction and Ax acting from left to right, but I have shown F A B in this direction which is coming out from joint A. Similarly, F AC in this direction that is also coming out from joint A. Now who told me that it will be coming out from joint A it could be towards joint A yes or no.

Because I do not know. I have not calculated and before calculation before obtaining these values who are telling me that is this should be coming out or coming in right.

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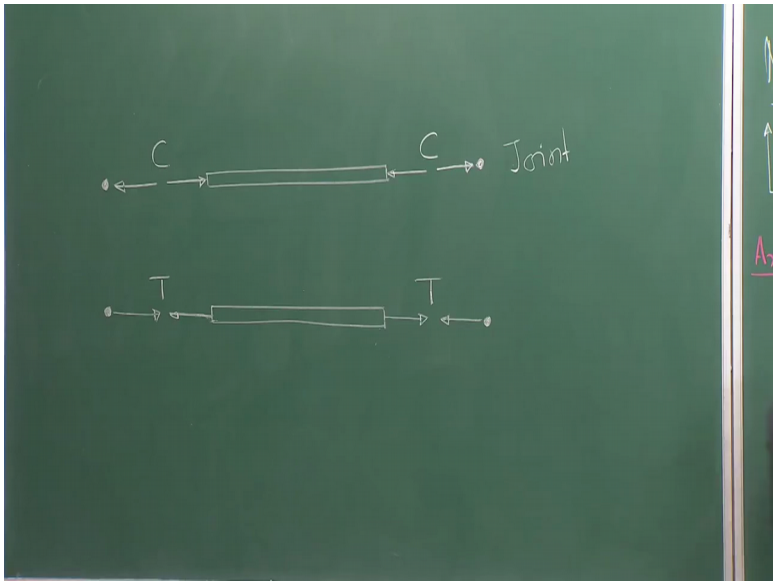

The direction of F A B is completely unknown to me because I do not know the magnitude I do not know the direction of F A B. Only I know the line of action of the force right. So, now, for understanding or fortune I mean how you will select the direction let us discuss one thing.

now I am considering 2 members 2 truss members. This is number one. And this is another member 2 say. So, this is the free body of the member 1. And this is the free body of member 2 these are the free bodies of joints which is which are connected at each end of the members. So, now, if I say this member is under compression, because as already we have decided that these members can only take axial force that is the 2 force members; that means, axial force only is applicable.

It could be tension or compression say for example, the this member is taking compression, if this member is taking compression then what should be the direction of force, this should be the direction of force. Compressive force say that is C. If the force is compressive on the member and if the direction of the force is like this, then from our previous discussion what will be the direction of force on the joint just equal and opposite. This will be the direction of force on the joint, agreed. In and out now I am saying this member is under tension.

So this is my tension force. So, this should be the direction of tensile force. If the member is under tension the altitude direction of the axial force. So, on the joint it will be giving equal and opposite force. Now what you have understood from this if the member is under compression; that means, the for compression member the arrow the force is if the member is under compression then the force will be acting towards a joint, you just see here it is acting towards the joint; that means, it is pointing towards a joint it is coming in.

If the member is under tension, then what is the direction of force on the joint it will be coming out from the joint right. It will be coming out from the joint. Now you come to this part what I have shown F A B and F AC both are coming out from joint, then what we are assuming because I do not know the force in member A B and member AC. So, what we are resuming we are assuming that the forces in both the members member A B and member AC are tensile in nature. Nobody told me I just assumed.

I just considered that these forces are tensile in nature. And it is always advisable to stick to a particular assumption what is that particular assumption that you considered that all the member forces are tension, or all the member forces compression. Do not scratch your head oh this force will be compressive or this force will be tensile or what will be like that do not get confused there it will be coming automatically.

So, what I mean to say you consider all the member forces are tensile in nature or all the member forces are compressive in nature. Now in the calculation or in the analysis in the process of analysis if they are coming opposite side then that whatever direction you considered that is not the right thing for example, now after calculation if I get F A B equal to minus of something.

Then of course, I will be understanding that whatever direction of F A B I considered; that means, the we considered F A B was tensile in nature, that is not true. If it is coming negative that should be compressive in nature. Similarly, if F AC whatever direction you considered and finally, you have got F AC equal to sum value positive value then of course, whatever direction you assumed or considered before the analysis that was correct.

So, what I mean to say do not spend any time in deciding what should be the probable say nature of the force in individual member it will be coming automatically. So, do not I

mean you just stick to the basic you consider all the forces tensile or all the forces compressor or you can mix up thou it is not advisable you can mix up if you consider compressive.

Suppose if I consider F AC compressive; that means, it is coming towards the joint and ultimately, if I get negative value of F AC then; that means, the compress in nature whatever I assume that is not correct right. So, you just stick to a particular thing and whatever things are coming automatically in the process of analysis you just follow that now. So, by considering the equilibrium of joint A we have virtually or conceptually or philosophically, we can say that we will be getting the magnitude of F A B and AC because we have 2 equations 2 unknowns we can solve it.

Now, after point A if you go to point B or point C whatever you want say point B I am going let us let us draw the free body diagram of joint B how do look like.

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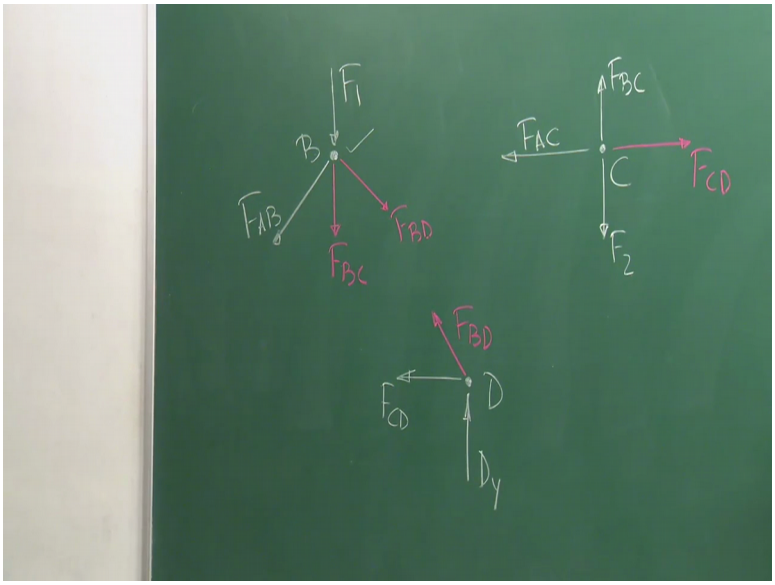

So, this is your joint B what are the forces are coming out. So, I am going to show a the known forces in white color and unknown forces in red color, that is my convention we are using say what is the what are the forces are coming out from joint A.

So, joint A is basically formed with 3 members connection member A B member B C and member B D. So, they are connected a joint B right they are connected at joint B. So, this is now my known force F A B because, if I considered joint A, and if I solve joint A

basically this force is known to me now that red color has been transformed to the white color because it is known to me and this is the externally applied force F 1 at joint B.

Now, what are the unknown forces at joint B. F B C and F B D. So, these 2 are unknown forces at joint B. Again we have 2 equations summation of F x equal to 0 summation of F y F y equal to 0. So, 2 equations 2 unknowns again we can solve it. Now after solving joint B we are moving to joint C this is my joint C. So, at joint C what are the member forces are acting member AC member B C member C D.

Now, member AC is known to me right member AC is known to me. When I considered joint A. Member B C is also known to me because I just considered joint B. And this is the externally applied force it is a force known to you. Now what is unknown to you, your unknown force is only F C D right. That is the only unknown force. Now if you look at if you want to exploit or if you want to satisfy the equations of equilibrium.

That means only summation of F x equal to 0 will give you the value of F C D and from this configuration it is very much clear that F C D must be equal to F AC equal and opposite right now will come to. So, which member forces left out B D is not known to me. Other forces in different members we have already got it. So, B D is not known to me. So, for B D would be considering joint D.

So, this is my joint D, in join at joint D you have D y, which is known to you have C D you have just came across when we considered joint C we have got F C D. Now only unknown forces is, oh no again A B D is known to you right. So, from this when we considered joint B you calculated B D also, but anyway for the sake of check you can consider joint D and again you can find out.

F B D and you will see you will be getting the same value whatever you have got when you consider joint B. So, in this process by considering each and every joint by moving from the joint A, you have considered different joints and you have got the member forces right. So, this method is known as method of joints.

So, I will stop here today. In the next lecture will be talking about the method of sections and then will be moving to the friction part.

Thank you very much.