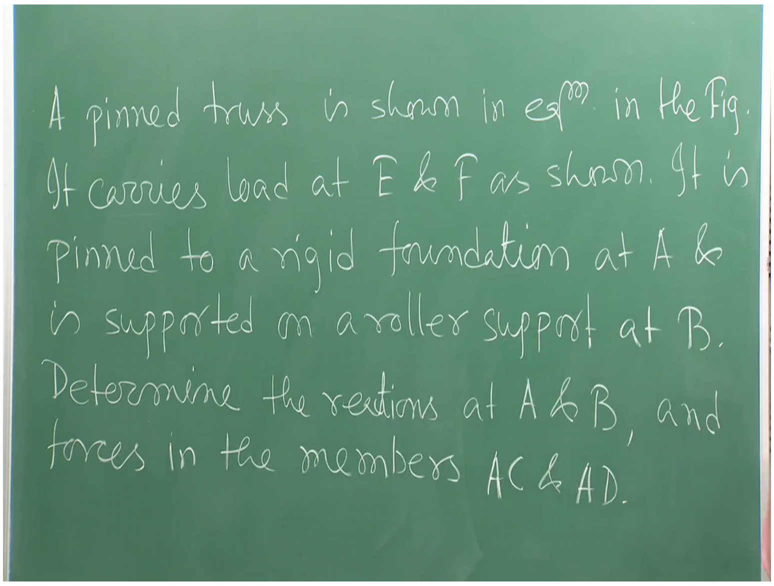
Mechanics Of Solids

Prof. Priyanka Ghosh
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Lecture - 11
Tutorial on Truss

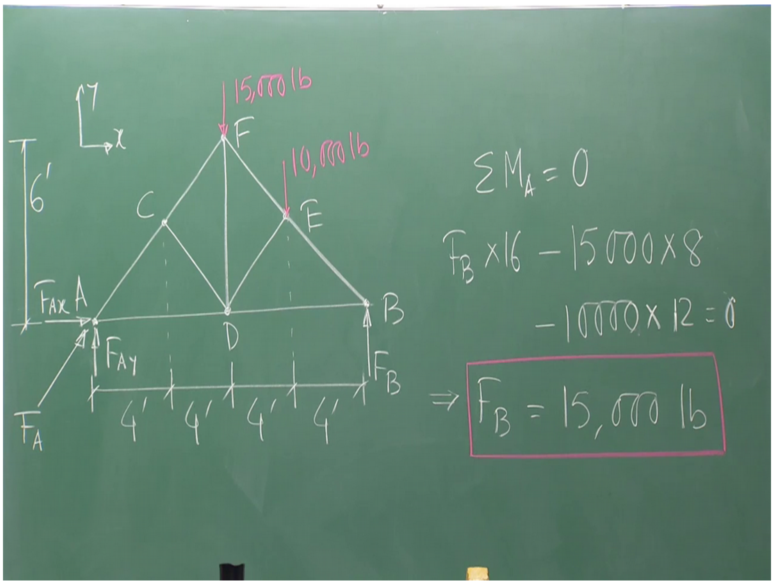
Welcome to the course Mechanics of Solids. So, in the last lecture, we were discussing about friction and method of section by which you can analyze the truss and today basically what we will do will take couple of examples, numerical examples, so that you will be absorbing the concept whatever we have discussed so far.

(Refer Slide Time: 00:40)



So, the first problem will take today a pinned truss is shown in equilibrium in the figure it carries load at E and F as shown. So, I will draw the figures after this. So, it is pinned to a rigid foundation at A and is supported on a roller support at B. Now determine the reactions at A and B and forces in the members AC and AD.

(Refer Slide Time: 03:17)



So, let me draw the truss. So, this is the truss, this is the pinned truss. So, these are all joints A B C D E F all are joints and this truss is supported at 2 supports - one is at a that is hinge support or the pinned support as given in the problem, another one is the roller support that is at B and the externally applied forces are 15000 pound at joint F and 10000 pound is at joint E and this is given in feet 4 feet, 4 feet, 4 feet and 4 feet this is the distance horizontal distance and this the vertical height of the truss is 6 feet.

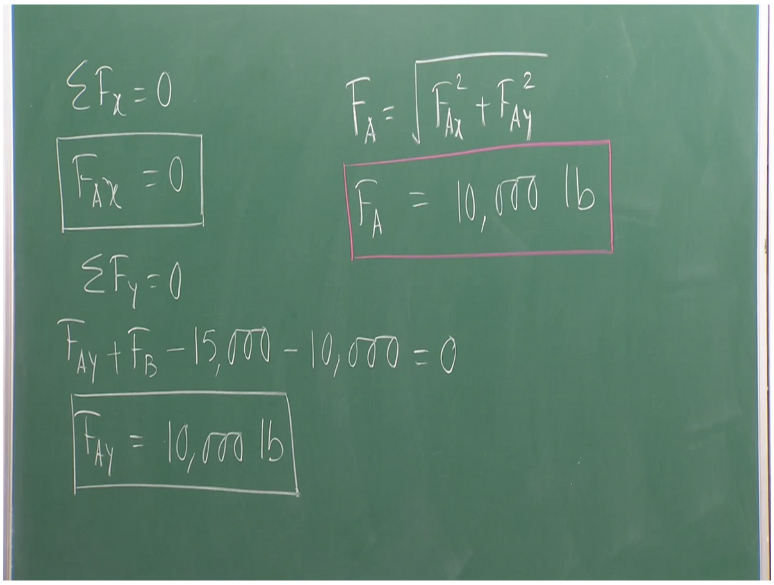
So, any way, we are taking this problem in a PS so that is not a problem while. So, our objective is to determine the reactions at A and B first this is the first objective to find the reactions at A and B and forces in the members AC and AD. So, these 2 members we need to find out the forces. So, so what is my first job? My first job is to draw the free body diagram of this truss, am I right. So, let us draw the free body diagram of the truss. So, if I want to draw the free body diagram of the truss. So, immediately what I should do? I should remove the truss system from the supports.

So, the supports will be replaced by the forces. So, I can, so this is reaction force F A and this is reaction force F B. So, these 2 things are the reaction force our objective is to find out these 2 forces. Now the question is that I have shown the direction or the line of action of F A is like this, but I do not know; what is the actual direction or whatever. So for the sake of convenience what we can think of we can resolved this forcing 2 components one is F A x, another one is F A y if this is your x y coordinate system. Then basically if we manage to find out F A x and F A y and then if you take the result and then I will be getting F A.

So, now my next job is to exploit the equilibrium conditions. So, first we will take the moment equilibrium that is the summation of moment with respect to point A or the whole truss because the whole truss is under equilibrium each and every point in the truss is under equilibrium. So, what I can take? I can take the moment equilibrium condition that is the summation of moment with respect to point A is 0.

So, if I do that; that means what I am doing summation of moment with respect to point A is 0. So, then basically I will not be getting any moment contribution of this F A force because F A is passing through point A. So, that is not contributing anything towards the moment. So, what I will be getting? F B in to 16 feet. So, 4 4 4 4, so 4 into 4 – 16, so F B in to 16 that is giving me the anti clockwise moment. So, as per our convention whatever we have decided in the last lecture, so that anti clockwise moment is positive minus these 2 forces will be giving me the clockwise moment right with respective point A. So, 15000 into 8 minus 10000 into 12 equal to 0, so that gives me F B equal to 15000 pound. So, one of the support reaction is obtained that is F B equal to 15000 pound. Now my next job is to find out F A. So, to find out F A what I can do? I can consider the force equilibrium conditions right that is summation of F x equal to 0. And summation of F y equal to 0 and by which I can get the magnitude of F A x and F A y as shown in the figure.

(Refer Slide Time: 10:40)



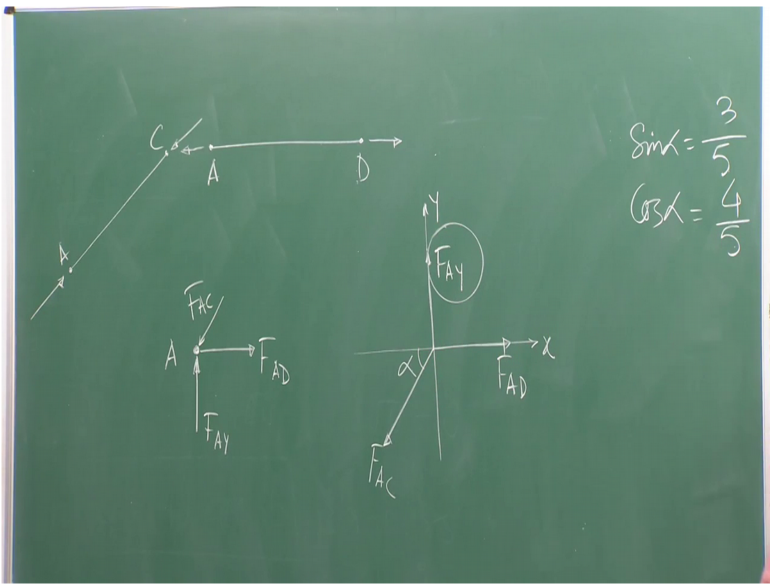
So, now, considering F x equal to 0; that means, summation of all the forces along x direction is 0. So, what are the forces are acting in x direction F A x towards a positive x direction any other force in x direction, no other force right. So, F A x is simply 0. Similarly I can satisfy this condition F y equal to 0 summation of F y equal to 0; that means, summation of all the forces along y direction is 0. So, if I do that then what are the forces are acting in y direction? First of all F A y plus F B all are working, all are acting along the positive y direction minus 15000 pound which is acting at point F in the vertical downward direction minus 10000 that gives me 0. So, from this I can get F A y equal to 10000 pound. So, ultimately our objective is to find out F A that is nothing, but F A x square plus F A y square that is the result, so that ultimately becomes F A equal to 10000 pound. So, our first objective is satisfied. So, first objective has been fulfilled.

So, I have got the support reactions at A and B. So, now, from these actually what are the conclusions you have conceived? The first thing is that you had 3 equilibrium conditions summation of moment is 0, summation of F x equal to 0, summation of F y equal to 0. So, you have exploited all the conditions all the equilibrium conditions to get the support reaction that is way you can find out the support reaction and that is your first job actually right. Immediately after drawing the free body diagram that will be your first job, then after that what you can conceived here you can see there right all the forces externally applied forces are vertical therefore, even if we take a horizontal at reaction here F A x that is simply coming 0 because there is no horizontal action horizontal forces acting in the x direction because there is no force in the x direction externally applied force in the x direction that is why this F A x is becoming simply 0.

So, now onward in different I mean problems what we will do if we do not have the horizontal force then will even if we have the hinge support we will not consider the horizontal reaction because if there is no action there is no reaction as simple as that. So, I do not have the horizontal action active force or the action therefore, I do not have horizontal reaction that already we have proved here right, F A x is simply coming 0. So, now, onward I will just simply, just se by seeing the loading condition we can consider that the horizontal reaction if the horizontal force is near not there, so the horizontal reaction is 0. Similarly there vice versa is also true that if you do not have the force in the y direction that is the vertical direction there will be no vertical reaction. So, that is the thing you should remember and will do this thing later on because most of the time. So, will not be showing all the reactive force right horizontal as well as vertical by seeing simply the loading condition will choose our reactions.

So, now, after that what is your next job? Next job is to find out the member forces. So, let us do that thing by using method of joints method of section also you can do, but let us do that thing using method of joints and I will just tell you that how you can solve the same problem by using method of section.

(Refer Slide Time: 15:45)



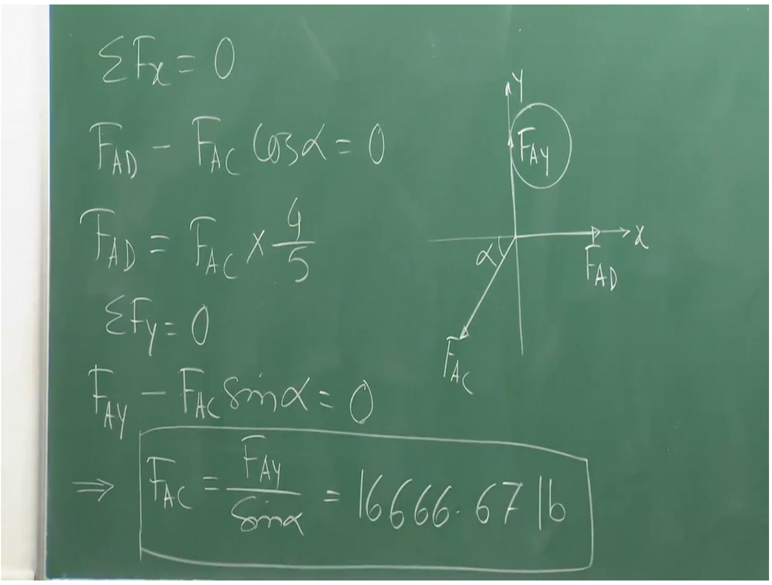
So, what is your next objective? Next objective is to find out the member force in member AC and AD fine. So, this is your AC member and this is your AD member what I am considering? I am just considering arbitrarily that let us say AC is under compression and AD this is your AC this is your AD and let say AD is under tension, this is my convention, you can choose both the forces both the members are on the compression or both the members under tension because I know the answer. So, that is why I am taking this thing arbitrarily, but if you do not I mean do not go by any intrusion that this should be compressive, this should be tensile do not go by that. So, you choose all the forces all the member forces that tensile as I told you if they are coming negative then of; obviously, there they will be compressive force. So, do not go by any preconceived notion right.

So, anyway, so I am what I am considering? Arbitrarily I am considering without seeing the problem I am just considering AC is under compression and AD is under tension and after solving this if I get the member force in AC is negative then that is not compressive force, rather that is tensile force. Similarly after analysis if I get the member force in AD is negative then whatever I considered that is tension that is not correct. So, it should be compressive. So, that is different thing or that will be coming later on. So, let us and if they are coming positive; obviously, whatever direction of whatever nature of the force we considered that is fine.

So, now, we are considering. So, we are going to find out the force AC and AD and these 2 members are connected at joint A. So, if I considered joint A. So, this is my joint A, this is my joint A and if I apply the forces here. So, this is my joint A I have considered the force in member AC as compressive therefore, the force F AC will be towards the joint as per our convention already we have discuss this thing enough, similarly member AD we are considering as tensile member. So, therefore, the force F AD will be going out from the joint any other force at joint A of course, the reaction force F A x is 0. So, simply you have F A y. So, these are the forces are acting at joint A. So, in the x y coordinate or the x y plane if you plot this, so this is your x, this is your y. So, I can simply show this is my F A y this is my F AD and this is my F AC and this angle is alpha which can be obtained as from the geometry sin alpha is given by 3 by 5 and cos alpha that you can 4 by 5 that can be obtained, so the angle between the horizontal and this member AC that can be obtained from the geometry.

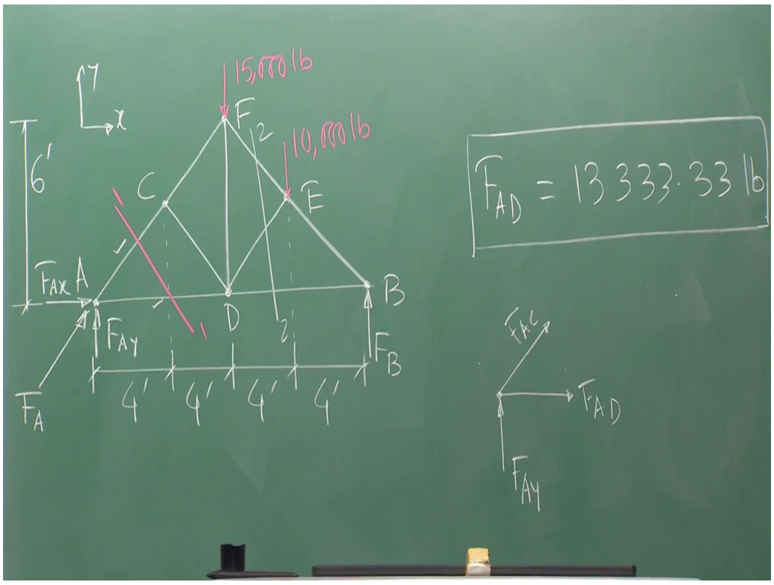
So, now, if you look at here, so, there are 3 forces out of these 3 forces basically; what are the different equations of equilibrium available with you? 2, right, each joint you have 2 equations of equilibrium available - one is summation of F x equal to 0 and summation of F y equal to 0 and if you look at this force diagram right this force is already known to you already you have found out F A y that is the reaction support reaction at A. So, these 2 forces are unknown. So, just by satisfying your vectorial analysis of force you can find out these forces. Now, let us see how you can find out.

(Refer Slide Time: 21:07)



So, first we are considering summation of F x equal to 0. So, what are forces acting in x direction F AD along the x direction minus F AC cos alpha is 0. So, from this I can simply write F AD equal to F AC in to 4 by 5 as it was given cos alpha is 4 by 5. Now similarly I can exploit this condition as well. So, from this what I will be getting? F A y which is acting in positive y direction, so, the hence it is positive and then minus F AC sin alpha is 0 right. So, this is known to me. So, from this I will be simply getting F AC is equal to F A y by sin alpha that gives me 16666.67 pound. So, that is your F AC.

(Refer Slide Time: 22:52)



Now by putting this value here in this equation you will be getting F AD equal to. So, my job is done. So, I have got the member force in member AC and member AD. Similarly if you want to find out the member force in member CD or CF or C FD, as you progress from joint A to joint C then joint D then joint F in that process actually you will be getting all the member forces.

Now, the same problem I was solving by method of joints the same problem can be solved by using method of section. So, what you will do? You take one section suppose this is your section A 1 1, I am just telling you how to do that I am not going to solve the whole problem. So, you can you can solve by yourself. So, I am taking one section 1 1 like this. So, this is your joint A, this is your F A y is acting and it takes, if you consider both the forces are say tensile you do not know. So, F AC and F AD and you can solve it you can solve it to find out this member forces. Now for this problem whether you take method of section or method of joints it eventually becomes the same thing because only one joint is considered but if you go for other member forces, suppose if I want to find out, say if I want to find out the member forces in E F then F D or D F and D B then I will be taking one section like this and then I will be taking, I will be using, I will be considering the right end part and to find out the member forces. So, this is the way we solve the truss problem.

Now, if you look at this problem we considered F AC was compressive right, before starting the analysis and we considered F AD that is the member force in AD was tensile. So, after analysis we found that F AC is coming to positive this is the value I will just coming positive therefore, whatever direction we considered for F AC that is the compressive that was perfect. Similarly for F AD we considered that was tensile and it is coming positive, so therefore, whatever direction we considered that is perfect. So, now, you can check if you consider F AC as tension as well as F AD as tension then you will be seeing that F AC value will be coming negative of this. So, that will indicate that whatever direction you considered before starting the analysis that is not correct, fine.

So, I will stop here today. So, in the next lecture will be solving couple of problems, couple of numerical problems more to understand the friction and other things.

Thank you very much.