Computer Methods of Analysis of Offshore Structures
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Module - 01
Lecture - 30
Non - Prismatic Members (Part – 2)

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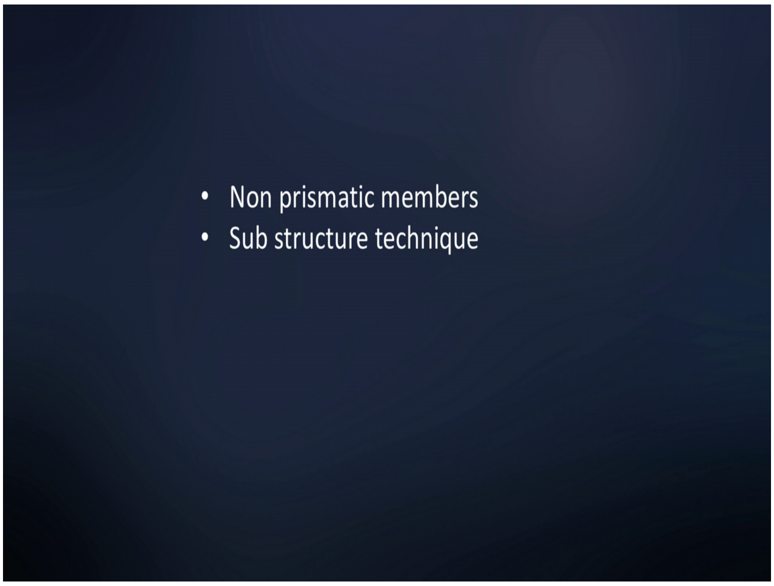

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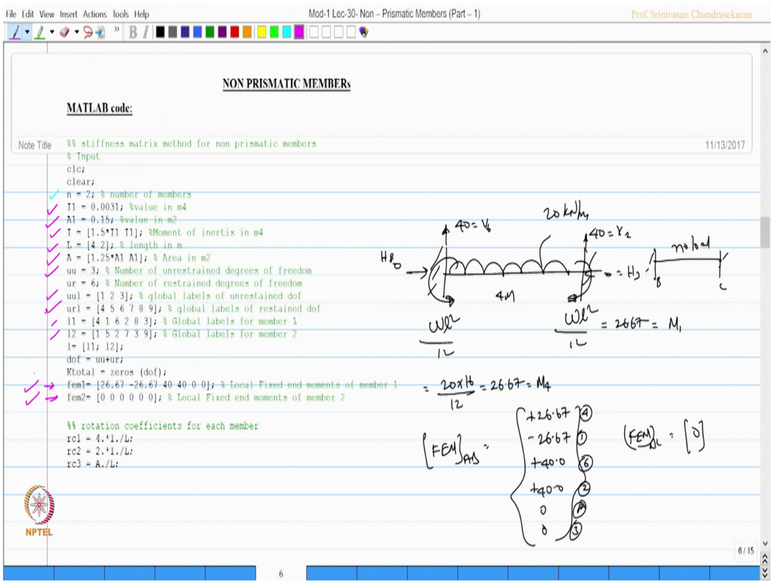

You see here number of elements 2.

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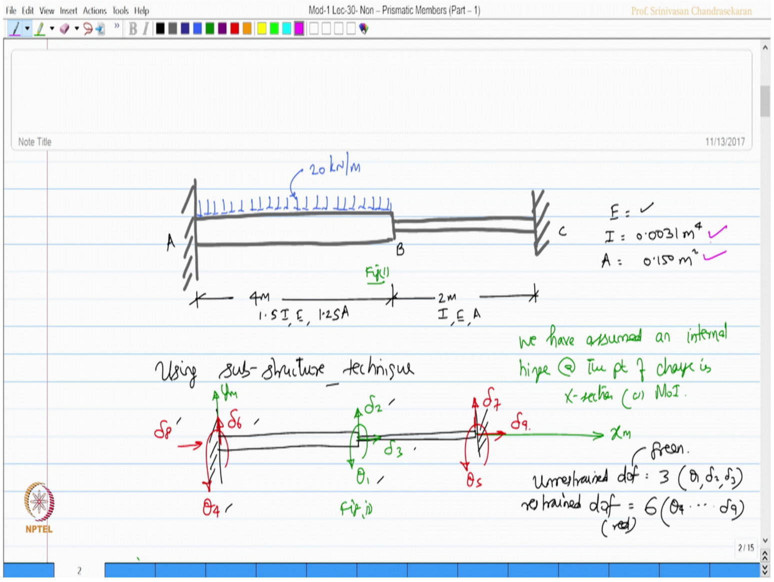

I value is 0.0031 and 0.15 this is what we have in the problem; 0031 and 0.15. 1.5 I and I length is 4 into A is 1.25 A and A. Number of unrestrained degrees 3; you can see here unrestrained degrees 3 mark in green restrained degrees 6 is it not. So, we enter that then the labels are 1, 2, 3 and 4 to 9.

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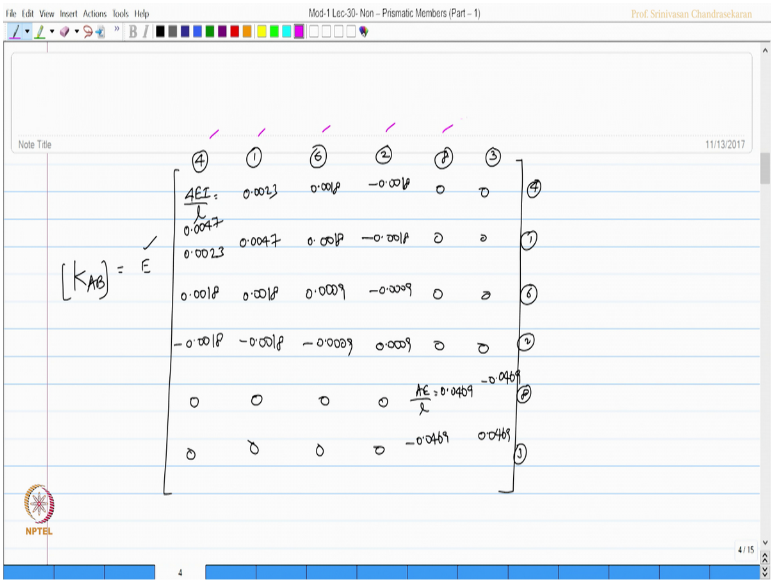

Then the labels for the member 1, 4, 1, 6, 2, 8, 3 you can see here 4, 1, 6, 2, 8, 3, then member 2 1 5 2 7 3 9; 1 5 2 7 3 9 we need this for mapping done this.

Then we want to calculate the fixed end moments. Let us know the beam is loaded with this; let us marked that figure here. The beam is loaded with a load of 20 kilo Newton per meter is it not for a span of 4 meters. So, now, we know this value is w l square by 12 this is w l square by 12 which will become 20 into 16 by 12; which will be 26.67 is it not and this is also 26.67 and this loading is going to be 20 into 480.

So, this is 40 and 40 and these values are going to be 0 and 0. So, if you look at the degrees of freedom this is 4, 1, 6, 2 and 8, 3. So, this is actually M 4 this is actually M 1 this is V 6 this is V 2 and this is H 8 and H 9 and H 3 is it not. So, I can write the fixed end moments of the member AB as plus 26.67 that is the anticlockwise minus 26.67 plus 40 plus 40, 0 and 0 in the labels will be obviously, 4, 1, 6, 2, 8 and 3 ok.

If you look at span BC, there is no load therefore; fixed end moment of span BC will be a null vector. Such what entered here 26.67 minus 26.67, 40, 40, 0, 0 and f e m to is 0 ok.

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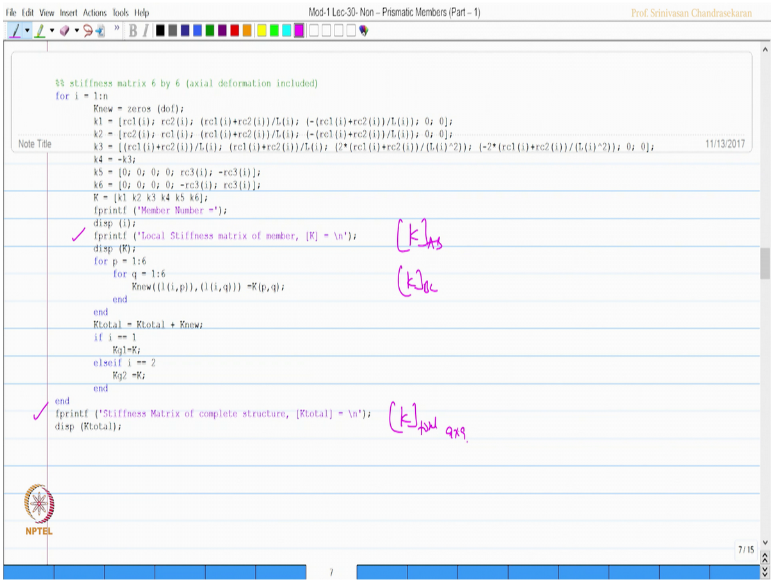

Then we compute the rotational coefficients, then we found the stiffness matrix the local stiffness matrix, then the complete stiffness matrix we assembling the member and get the complete K.

So, that is what I trying to get. So, in this we get K local of AB, K local of BC in this step we get K total which will be of 9 by 9 matrixes. Once we get that you separate K uu.

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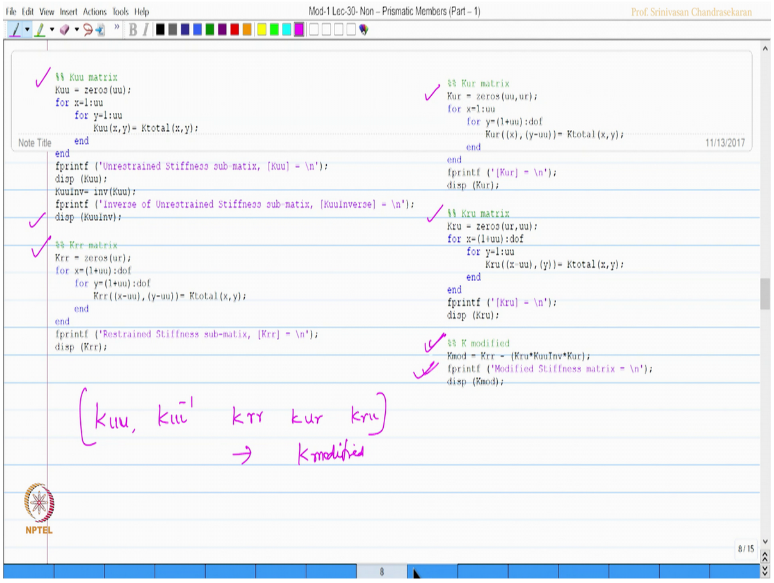

You get K rr, you get K ur and K ru plugs it out and then finds K modified. So, we get K uu; we also get K uu inverse we can see that here; we also get K rr. We also get k ur we also get K ru, then using this manipulation from the equation, we get completely K modified which is printed here ok.

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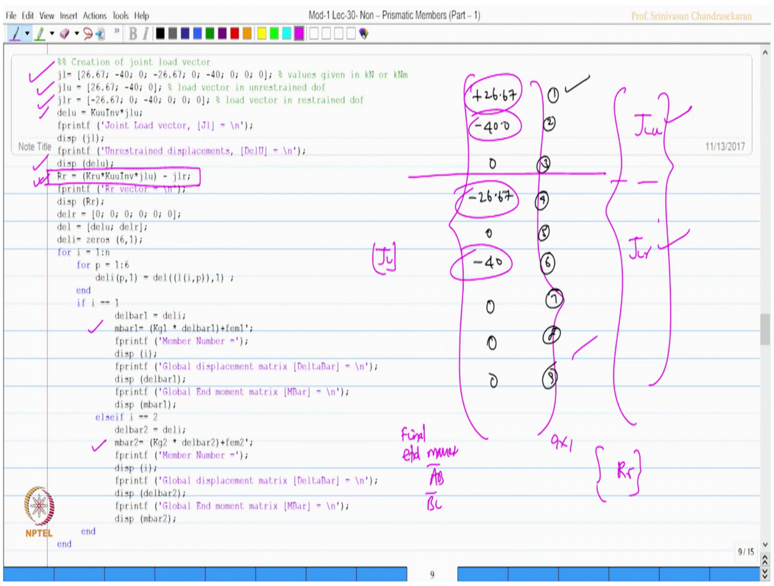

Once I get that we create a joint load vector. Joint load vector is a reversal of fixed end moments. So, joint load vector will be again A 9 by 1 is or not, that is; a joint load vector which will be reversal of this, which will be plus 26.67 minus 40, 0 minus 26.67, 0 minus 40, then remaining 0s. So, this will correspond to label 1, 2, 3, 4, 5, 6, 7, 8 and 9 you can check that; for example, in label 1 the fixed end moment was plus sorry minus 26.67.

So, here it becomes plus 26.67. Similar label 2; for label 2 it was plus 40 here it is minus 40. So, joint load vector is reversal of fixed end moments at 3 it was 0 there is no a 3 it was 0 at 4 plus. So, at 4 this is minus at 5 it is 0 at 6 it is plus 40. So, 6 it is minus 40 and similarly 7, 8 and 9, 8, 0, 7 and 9 or 0 you get 7890.

So, joint load vector has been obtained here. From this, we plug out J Lu and J Lr. So, this is going to be joint load unrestrained, and this is joint load restrained and this is going to be 3, because unrestrained degrees of freedom are 3 in this problem. So, we have got J Lu and J Lr. So, we have got these two sub matrices from this vector. Then we found the del u matrix or del u vector, then we find the unrestrained displacements, then we found M bar of both the members. So, we get now the final end moments of both member AB and member BC ok.

Then, we ultimately find the R r vector which is the final result of the problem. So, we get R r vector the restrained vector at both the supports will see that now.

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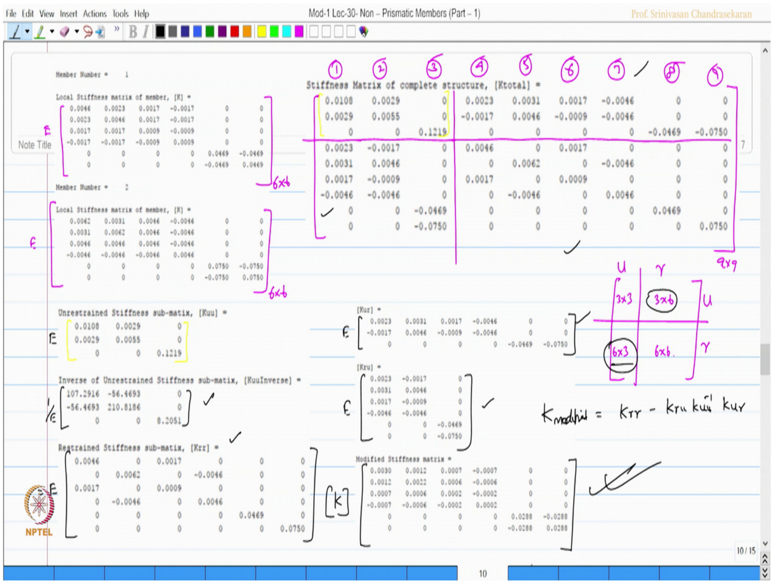

Let us see the output now member 1; 0.0046 of course, this is the multiplier E here this studies exactly with the matrix what we have here. 472318 you can see that 472318 etcetera. Similarly member 2 again 6 by 6 with E multiplier so, what I do here we find assembling this a complete stiffness matrix which is 9 by 9.

So, 1, 2, 3, 4, 5, 6, 7, 8 and 9 so we have a partition at 3 is it not. We make a partition here. So, if you compare this matrix with the partition this is the unrestrained, restrained, unrestrained, restrained this is 3 by 3. And this is going to be 6; 3 rows and 6 columns this is going to be 6 rows and 3 columns and this is going to be 6 by 6; 6 rows and 6 columns. So, this can be entertain now from this we plugged out K uu you can see here we have plugged out this matrix, the sub matrix which is here then found the inverse of that.

So, this will have E multiplier. So, this will have 1 by E, then we found out K rr which is this matrix which is here is or not within E multiplier here. We also found out K ur which will be this matrix that is; this matrix which will be here right within E multiplier and we also found K ru r-th row and u-th column this one which is this 1 which is here. Then we found out the modified stiffness matrix from a simple expression. Modified stiffness matrix is given by K rr minus K ru, K ur inverse K ur. So, I have all the matrices K rr I have ok.

K ru I have K uu inverse I have and K ur I have to the manipulation and get this matrix which is my modified stiffness matrix for the special element. The problem does not stop here; I want to solve the problem. So, I got the stiffness matrix is modified, then the modified stiffness matrix obtained here.

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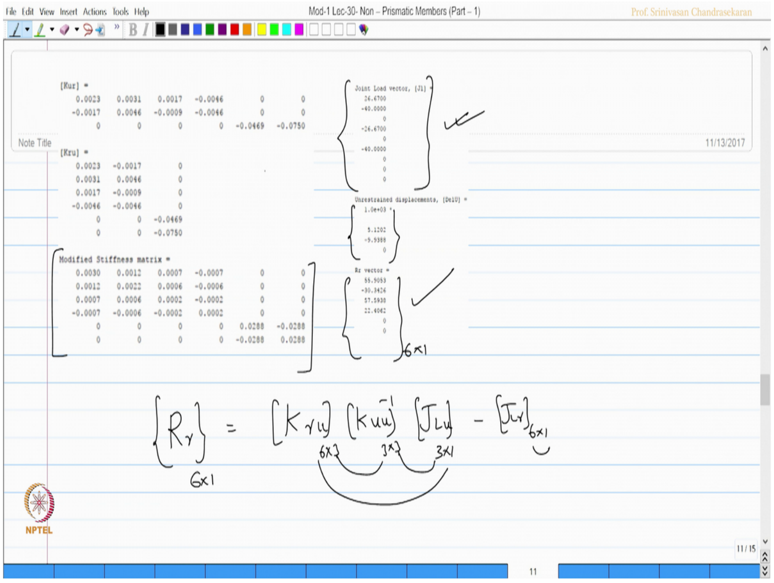

Then the joint load vector is taken out which we already have; we have already unrestrained displacements. Then the R r vector is actually given R r vector is given by K ru, K uu inverse multiplied by J Lu this is the matrix of 6 by 3 this is 3 by 3 and this is the vector of 3 by 1 minus J Lr which is 6 by 1.

So, compatibility 3 and 3, 3 and 3, 6 by 1, 6 by 1, 6 by 1 which is this vector ok.

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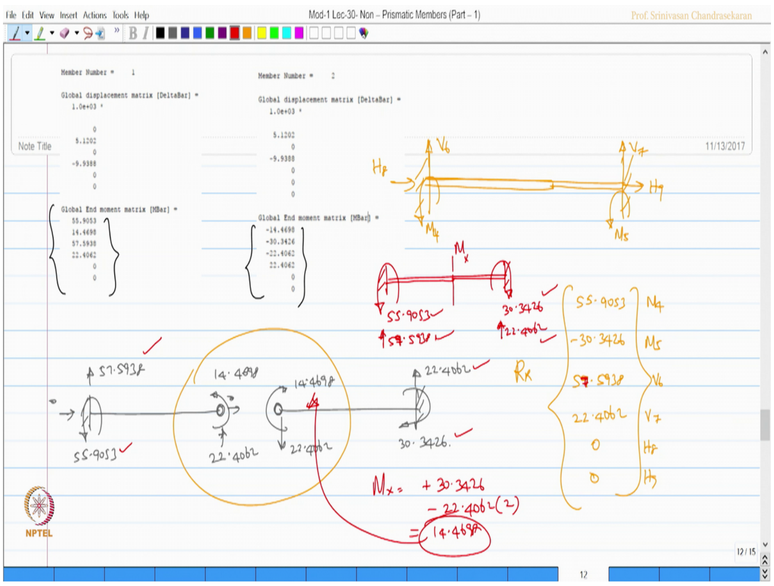

Then we found out the member values for member 1, this is the global end reaction for member 2 let us plot this. Let us take this member 1 and member 2; there is a hinge here internal hinge here and fixed. So, you know for member 1 theta 1 is 59.9053 plus anticlockwise 55.9053 and here it is again positive.

So, there is an internal hinge rotation 14.4698. Then this reaction is 57.5938 then this reaction is 22.4062. These reactions are actually 0; then let us come here. So, this had anticlockwise. So, this is going to be clockwise of 14.4698 and; this is going to be again clockwise of 30.3426 and this reaction is negative 22.4062 and this is positive 22.4062 ok.

You can see a very good that there is a perfect compatibility at the internal hinge. Now ultimately the end reactions R r are given by this vector which I am copying back here I am copying this vector here there are 5 values 6 values let us do that. So, ultimately if you look at the problem I want theta 4, theta 5, delta 6, delta 7 delta 8 delta 9 let us mark them here. So, I want for this member s so I should say M 1 and instead of theta 1 I call this M moment M 1 or M 4 it should be M 4.

Then, M 5; then I should have V 6 and V 7, then I should have H 8 and H 9 correct; H 8 and H 9. Let us copy this vector back again and write down that. So, let us copy this vector. So, I am copying the R r vector from here 55.9053 minus 30.3426 57.5938 22.4062. So, as per the labels this should be M 4 this should be M 5 this should be V 6 V 7 H 8 and H 9 let us mark them here.

So, this is anticlockwise 55. So, let us mark that let us draw the figure 55.9053 and this is 30.3426 and this value is 59.5938 and this reaction is 22.4062 and remaining towards zero let us check this is going to be exactly same you can see here 55 and 55 this is 57 57. So, this is actually 57 this is 57. So, 57 57, then clockwise 30.34 clockwise 30,.34 upward 22, 22 ok.

Let us take a sectional see what is the moment here let us say M x. M x should be actually equal to plus 30.3426 minus 24.4062 into 2 meters, because this distance is 2 meters which gives me exactly 14.4698 which is same as this.

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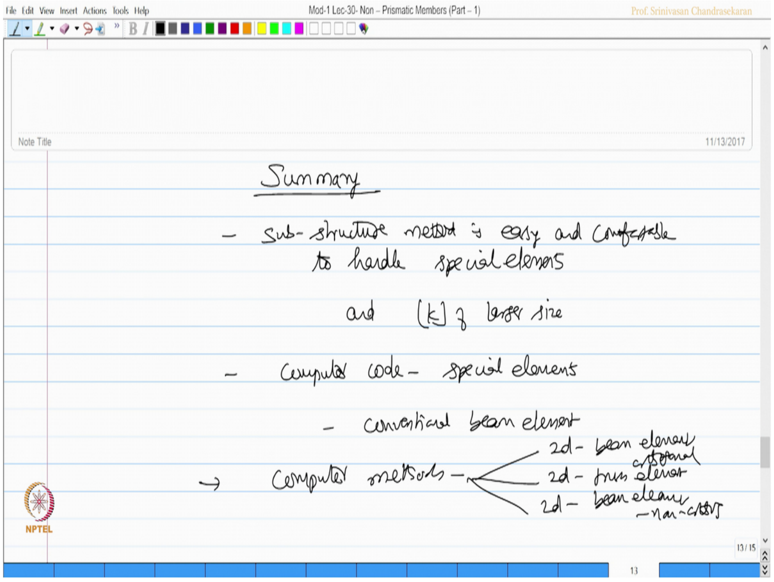

So, there is a perfect compatibility of the solution what we have got we have also solve the problem using sub structured technique. So, friends sub structure technique is easy and comfortable to handle special elements and stiffness problems of larger size I should say that.

We have also seen the computer code used for solving problem with special elements. We have not modified the method; we have use the conventional beam element to solve this, that is; A beauty about the whole experiment. So, we have used effectively the computer methods for solving various types of problems varying from 2-dimensional beam element, orthogonal frames, then 2-dimensional truss element, then 2-dimensional beam element with non orthogonal frames.

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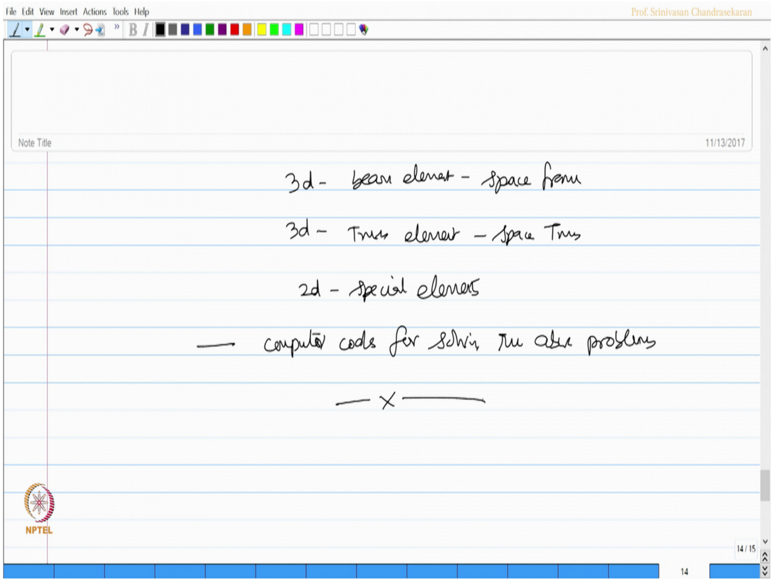

Then 3-dimensional beam element space frame, then 3-dimensional truss element which we call as space truss then also 2d special elements. We have also seen the computer codes for solving the above problems. And we have seen the advantages of using stiffness method and solving them.

So, friends with these we conclude the lectures on first module; hope you have understood all the 30 set of lectures and first module. There are lot of tutorials available to solve these problems in parallel computer programs are also given on the screen. Please play them near MATLAB and try to solve different verities of problems and any doubt arises please post it to us. I will try to help you more in detail. So, the second module and third module are more interesting. Will have sub more codes on solving problems dynamic analysis and fatigue analysis in different models.

So, the whole course is going to be very interesting and more and more practically; experience on writing computer codes for solving complicated problems and offshore structures.

Thank you very much and bye.