Computer Methods of Analysis of Offshore Structures

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Module - 01
Lecture - 27
3d Analysis Example – 2 (Part – 2)

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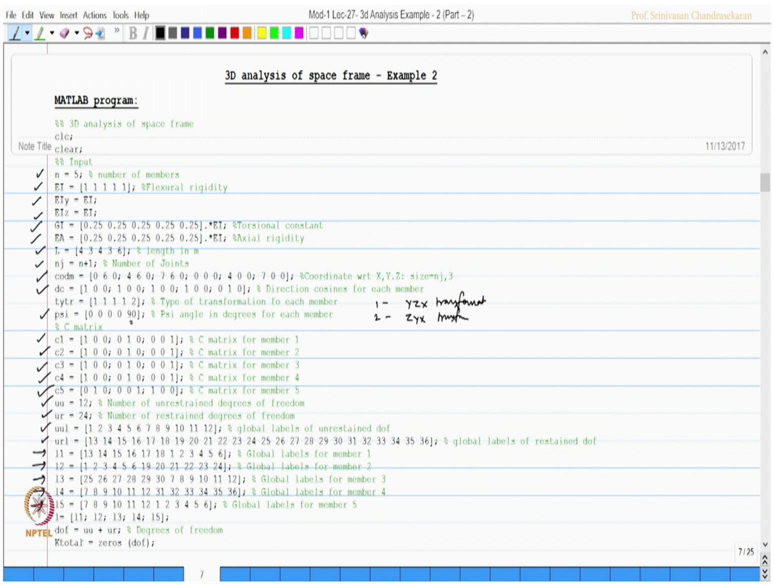

You can see here, there are 5 members in the problem. Flexural rigidity is taken as 1, E I y and E I z as a same as E I. G I as Torsional constant as 0.25 of E I, E A is again 0.25 of E I, the length of the member you see here we already said that 4 3 4 3 6 we have the same thing here 4 3 4 3 6 ok.

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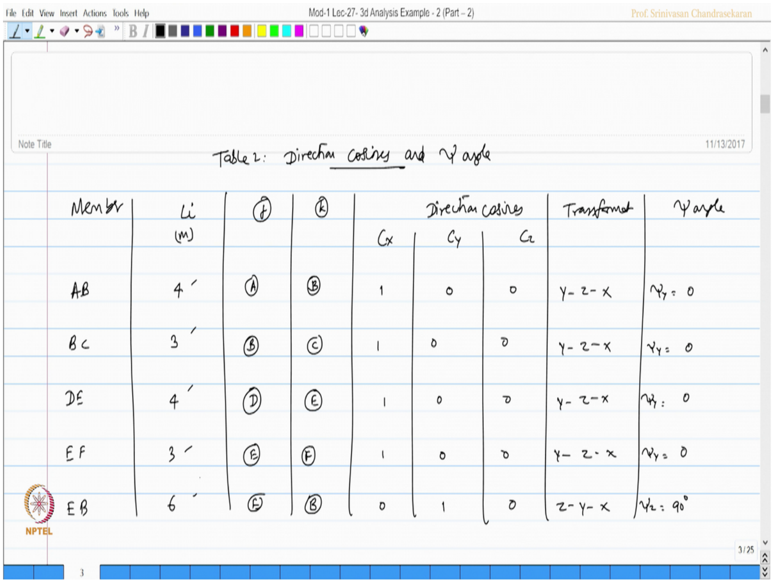

Number of joints will be; obviously, 6 there are 5 members, then we also enter the coordinates of this matrix, that is; 0 6 0 you can see here 0 6 0; 4 6 0 etcetera, we enter this here.

So, 0 6 0; then the direction cosine matrix for each member there are 5 members. So, let us enter this direction cosine matrix, we already have it here 1 0 0; 1 0 0 and so on. Let us enter that here 1 0 0; 1 0 0 and so on; you can see that here the direction cosines. Then we also ensure the type of transformation; one here represents Y Z X transformation, and two represents Z Y X transformation. So, all are one four members fifth member is 2, then the psi angle is entered, you see here the psi angle is when calculated - 0 0 0 0 and 90 degree.

So, we entered that here 0 0 0 0 90 degree; then the direction cosine matrix C; C matrices for all the members. You know is three by three matrixes. So, we know that we already computed the matrix here.

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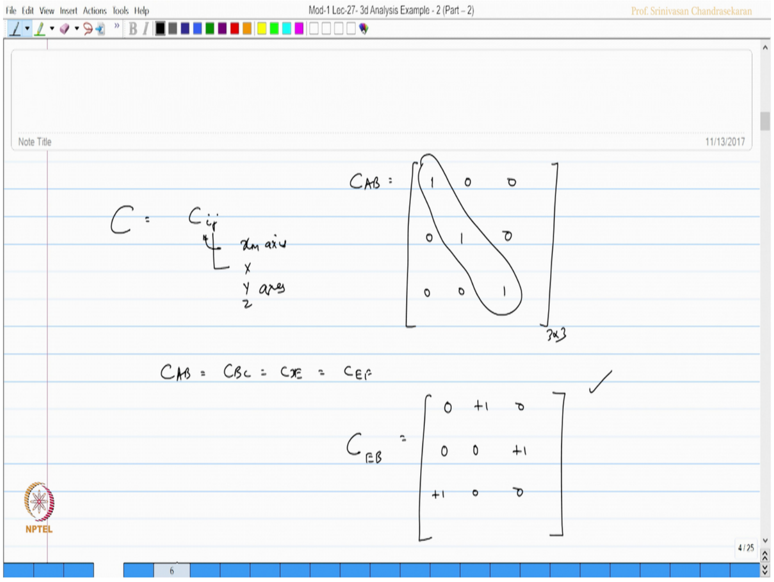

1 0 0; 0 1 0; 0 0 1; diagonal once so we entered that here 1 0 0; 0 1 0; for c 1, c 2, c 3, c 4 for c 5 it is different for c 5 it is 0 1 0; 0 0 1; 1 0 0; so 0 1 0; 0 0 1; 1 0 0.

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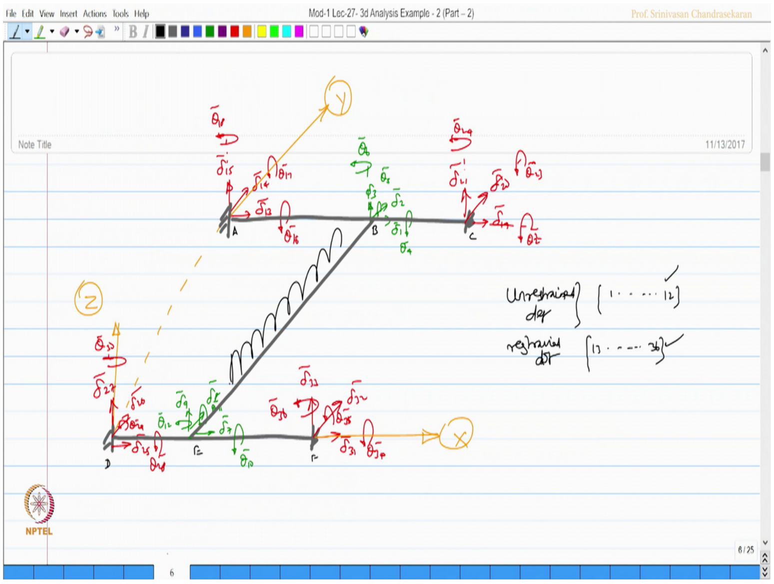

There are 12 unrestrained degrees, and there are remaining 24 is restrained degree, then the labels are unrestrained degree 1 to 12, then 13 to 36, for each member we introduce the labels. I think this is the same procedure, what we have in the previous example; you can easily follow these labels, then we worked out the total stiffness matrix.

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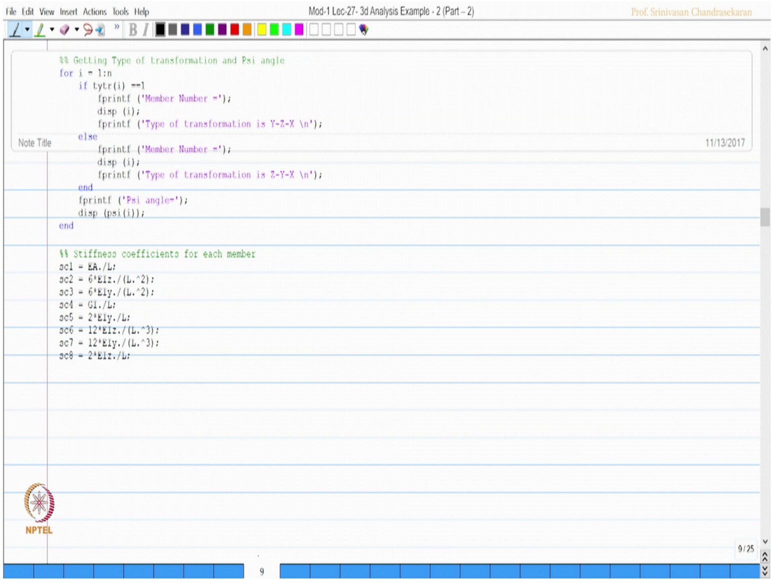

Then found the transformation matrix for each member.

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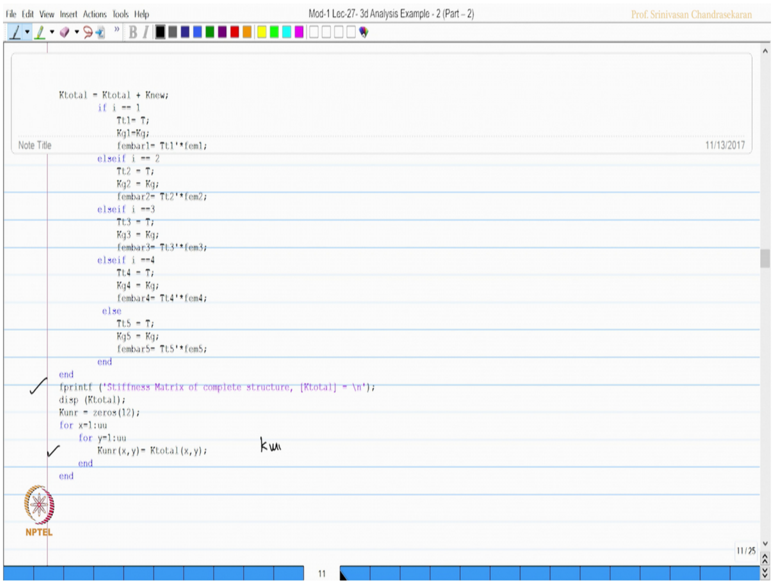

Then entered the type of transformation then found out the stiffness coefficients.

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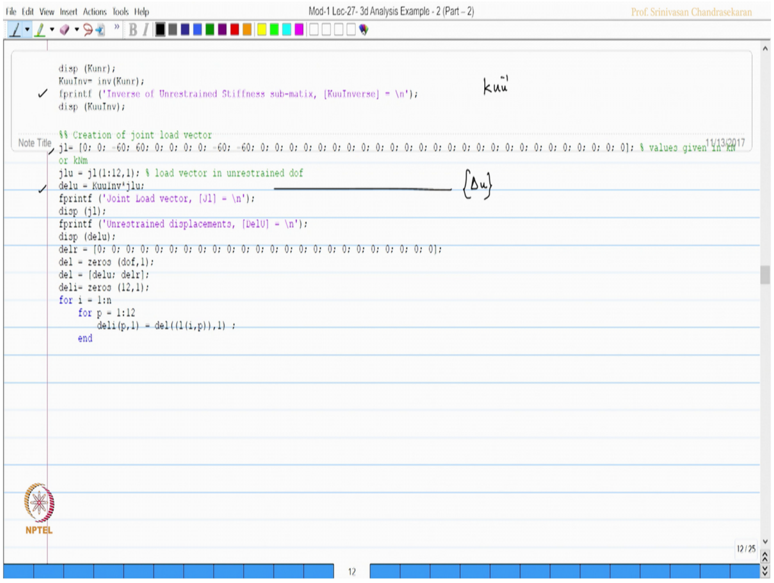

Then found the stiffness matrix for each member the local stiffness matrix ok.

Then we found the global stiffness as K bar is T transpose k T we did that K global. We assemble this get the total stiffness matrix, then from that we plugged out, the unrestrained stiffness matrix; the unrestrained stiffness matrix alone we plugged out K u u then we found out K u u inverse, then we get the joint load vector we can see is 0; 0; minus 60 which is corresponding to what we have here 0; 0; minus 60 and so on we exactly have that here.

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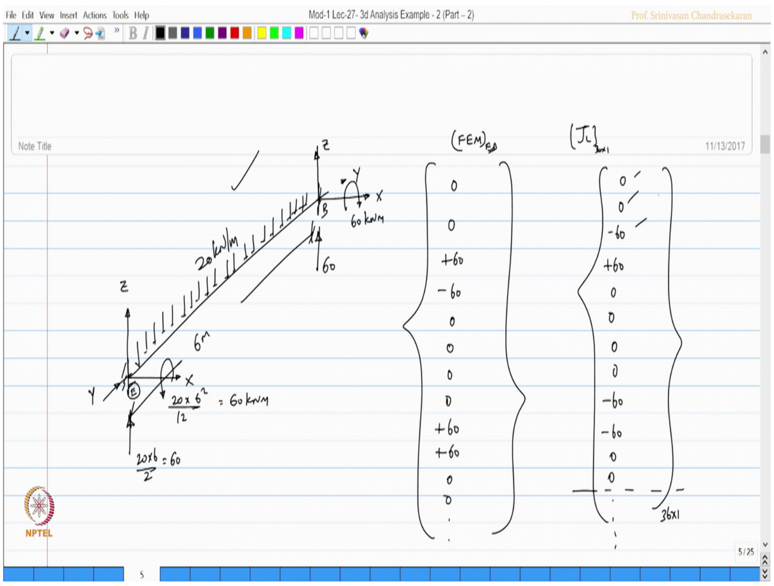

So, is entered, then we found out del u. So, in this line we got unrestrained displacements. Of course, E I multiplied by is there in all the entire case. We found del u.

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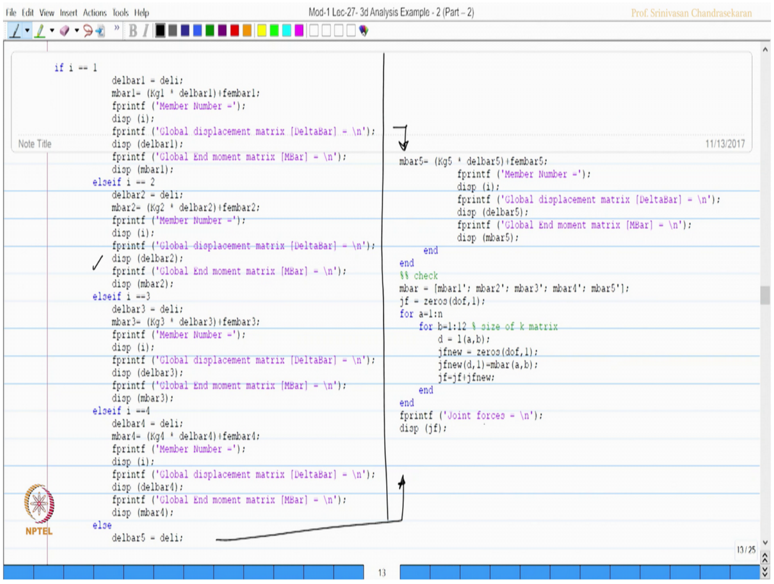

Then we found the member end forces by each member for member 1; member 2; member 3; member 4 and member 5. So, there is a line here; the program continuous from here it goes here member 5, then we found the entire joint forces.

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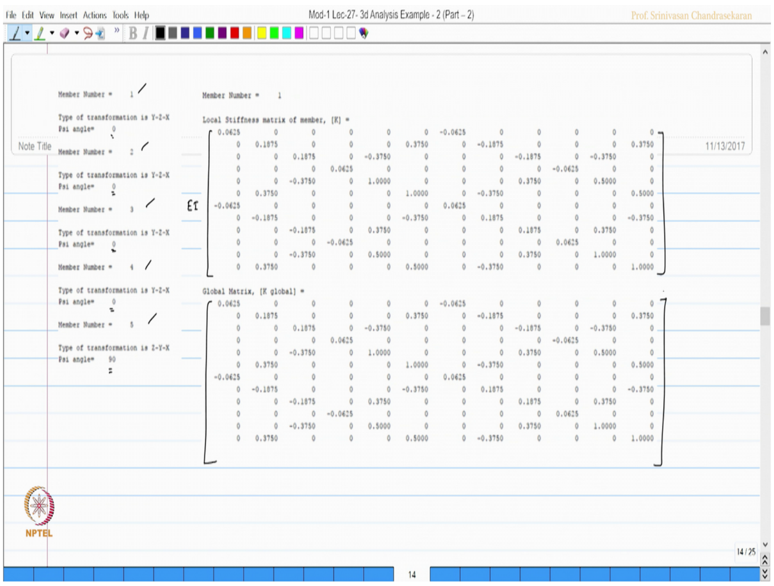

So, the results are like this; type one: member 1, 2, 3, 4 and 5, we have entered we got the psi angles. We also got the type of transformation and now for each member we have got the local stiffness matrix; there is a multiply E I here.

Then the global stiffness matrix and the labels of course, entered as per the order what we already have for each member the member 1 for member 2 you can see here it is 12 by 12.

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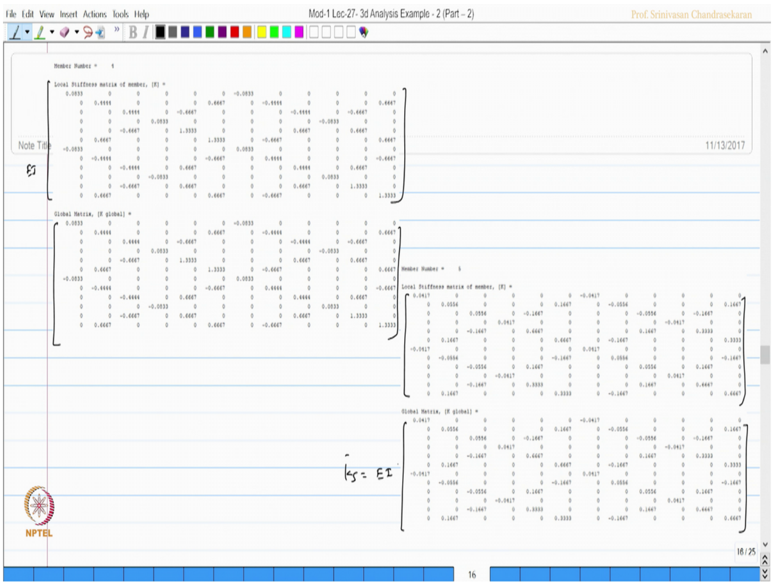

And this is K global, which will be actually K global is T transpose k local T. We obtain this is for member 3 and this is K global for member 3 there is an E I multiplayer here K global for member 4 K local for member 5 and K global for member 5. So, now, we have got the global stiffness matrices of the 5 members.

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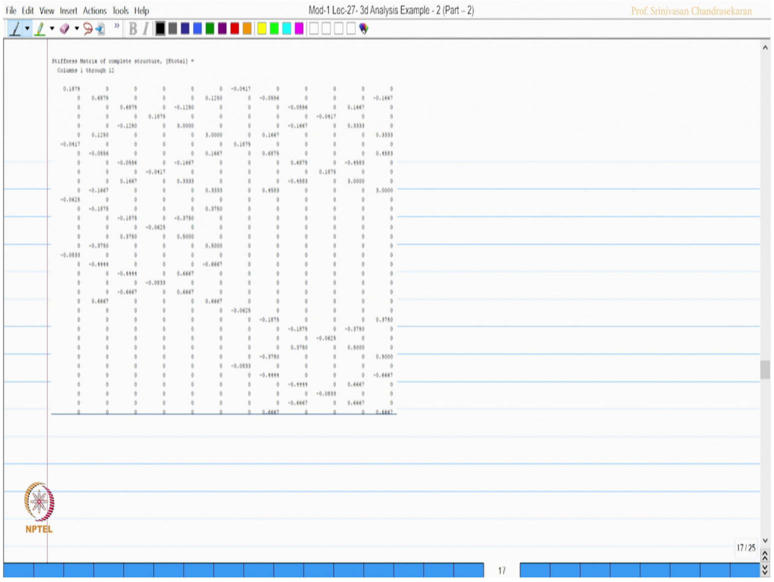

We assemble them and get the total stiffness matrix which is 36 by 36.

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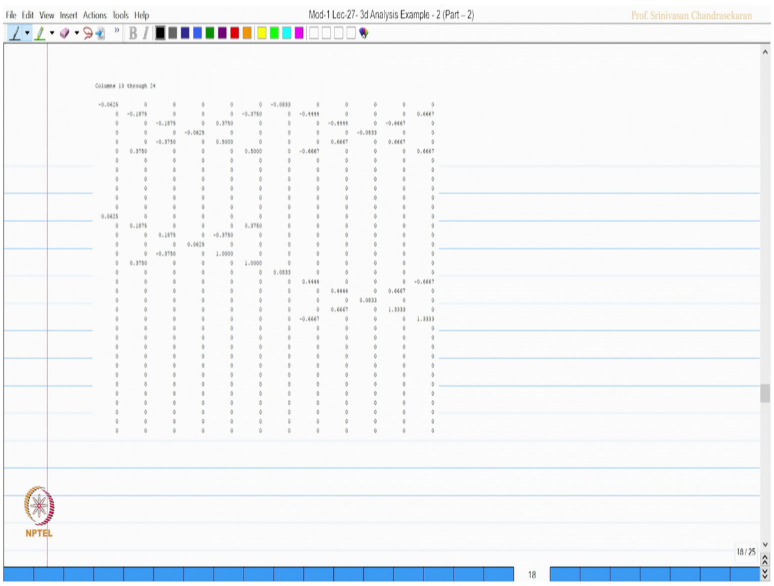

This is from column 1 to 12, then this is from 13 to 24 and this is from 25 to 36 the total matrix ok.

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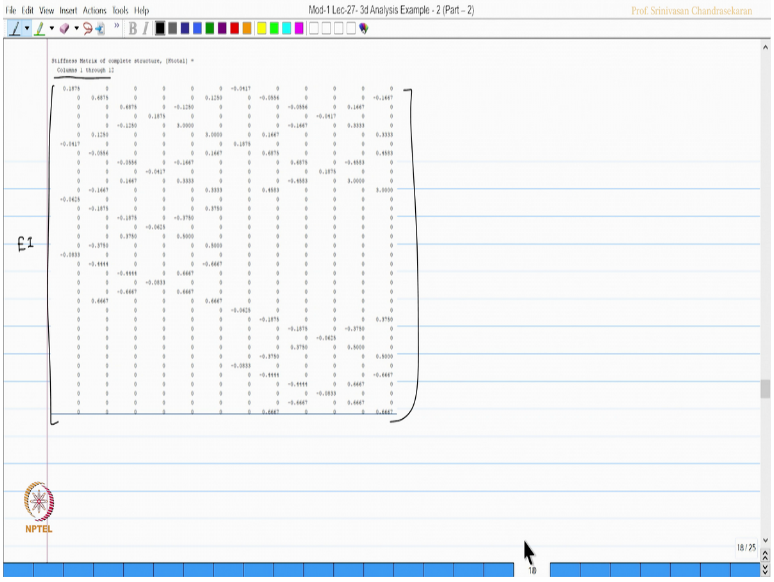

Of course in all these cases there is an E I multiplier, which I want you to understand; there is an E I multiplier ok.

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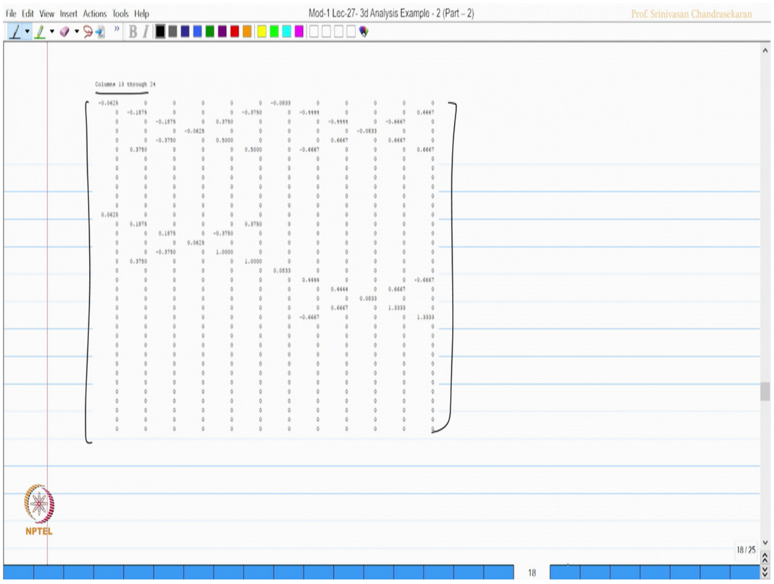

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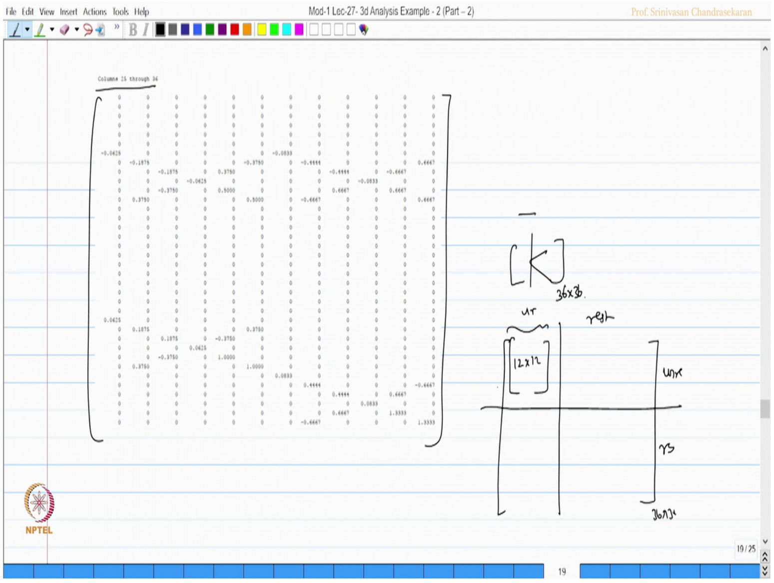

There is an E I multiplier. So now, I have the total K global of the entire which is 36 by 36. Now we know very clearly that this K global will have unrestrained degrees of this is unrestrained, this is restrained, unrestrained and restrained this is 12 by 12, this is 36 by 36 the remaining.

So, this can be now inverted. So, I got the invert of this.

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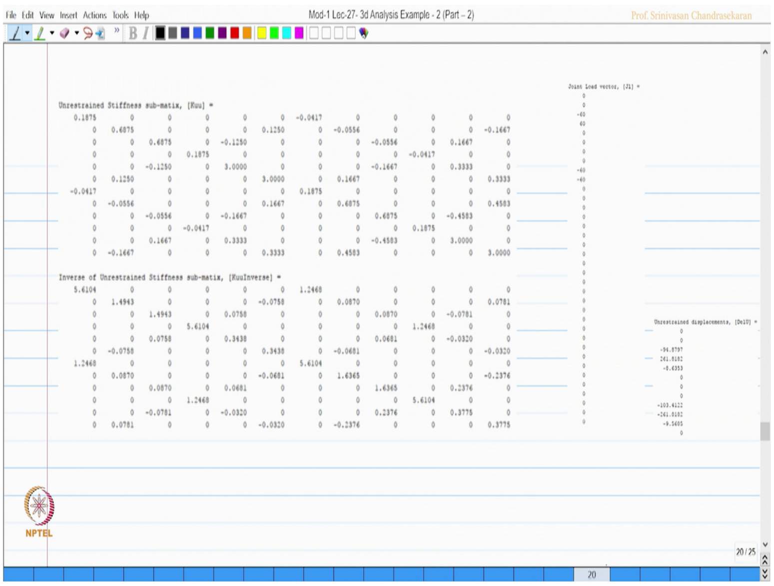

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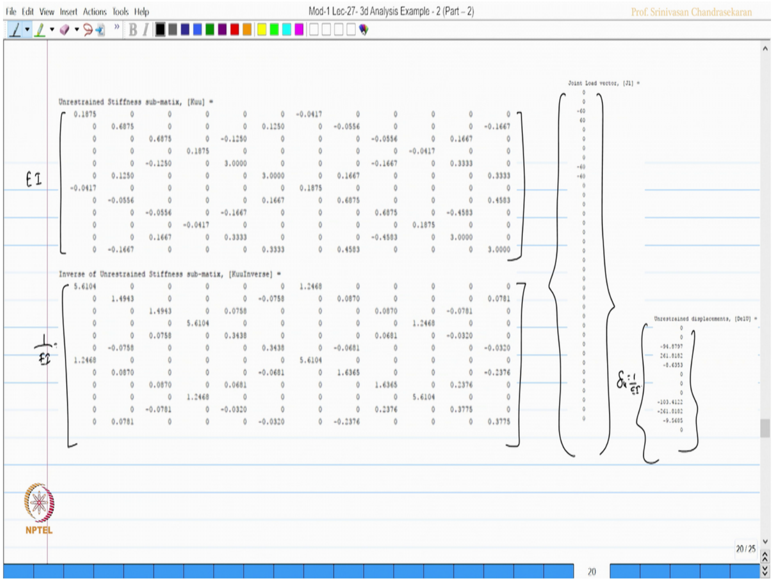

Now, this is unrestrained stiffness matrix which has been taken out. There is an E I multiplier. There is an inverse of this, where 1 by E I will be there, then the joint load vector is displayed here which was an input for the problem, then we have the del u. So, del u will have 1 by E I as a multiplier. Once we get del u, we use a standard equation. Find the global end moments of member 1, member 2, member 3, member 4 and then member 5 ok.

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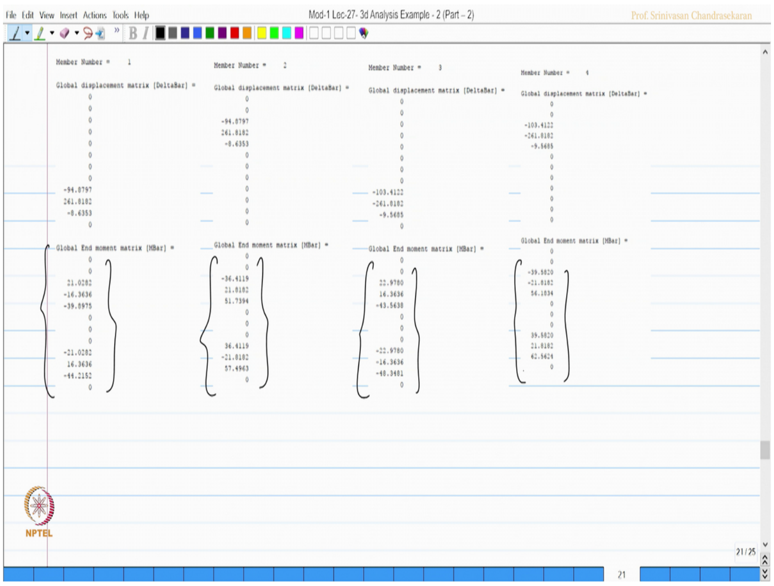

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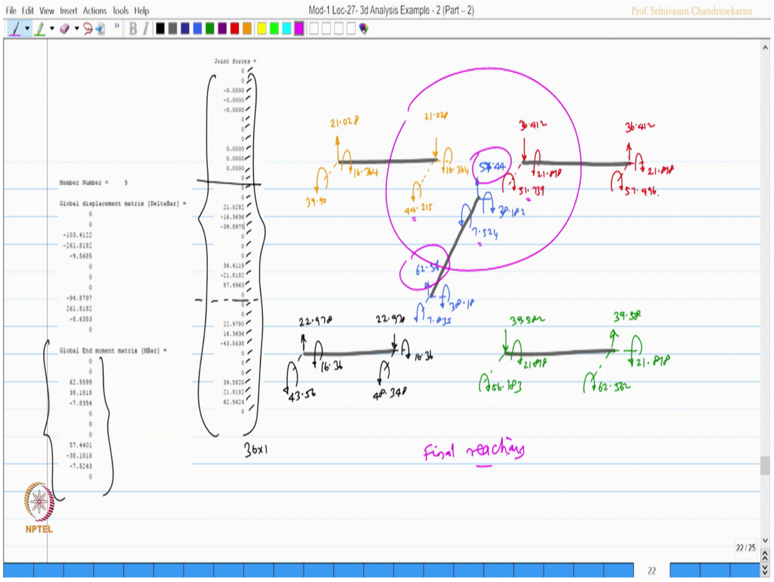

Once we get this we find the end joint forcers of whole structural system from degrees of freedom starting from 1 to 36 ok.

You can see 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36. So, we have a vector of 36. I want to plot this ensure the result. Let us do it for member wise; though this from this member separately and this member separately.

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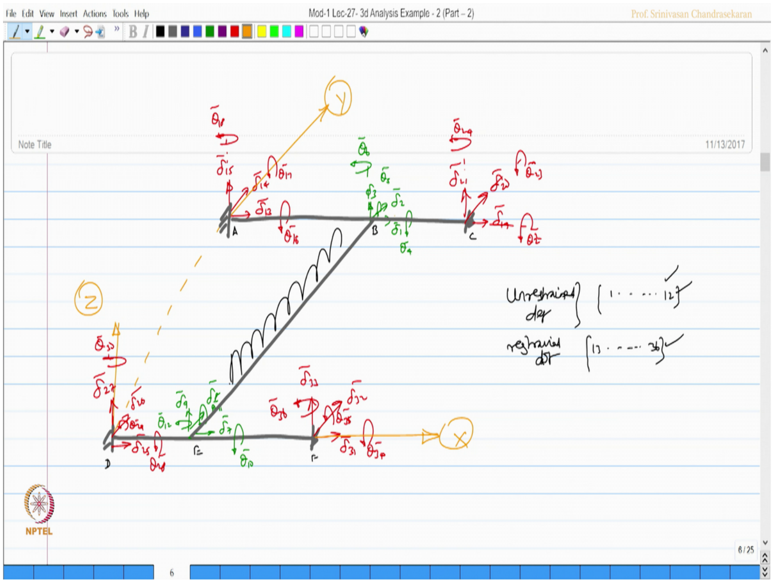

So, now degree of freedom once starts from here, you can see a degree of freedom starts from here. So, along X along Y and along Z, that is; how we have going to label this, we are going to interpret the results like that. So, along X along Y is 0; I am not marking the zero values, I am only marking the known values. So, let us say; all this member it is going to be 21.028 and this is going to be 16.364 and for this it is going to be 39.90 for this member it is going to be downward 21.028 and this is going to be 16.364 and this is going to be 44.215 for the member.

Next member for this it is going to be 36.412 and here it is 36.412 and this is going to be 21.818 and this is going to be 21.818 and this value is going to be 51.739 and this is 57.496. Let us do for this member this value is going to be 57.44, 38.18 and 7.524.

Similarly, at this joint it is 62.56 and 38.18 and 7.835, so for this member, 22.978, 22.978 and 16.16, 16.36, 43.56, 48.348. And for the last member 39.58, 39.58, 21.818, 21.818, 62.562, 56.183 that's a final end moments. So, now, interestingly the total reaction makes the total downward load and you can see the compatibility for example, take this joint 44 anticlockwise, 7 anticlockwise, that is; about y axis right which makes 51 clockwise and so on. So, one can see the compatibility this is the final end moments we are final reactions.

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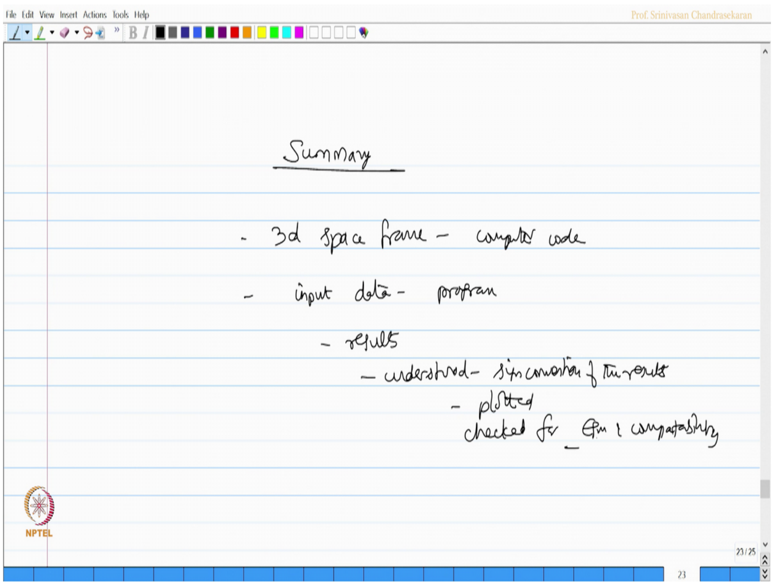

So, friends we have solved a 3d space frame problem using computer code. We are able to use the input data properly to run the program and obtain the results understood, the sign convention of the results and they are plotted and check for compatibility.

So, friends I would argue that you should try to do some more problems on your own. Derive the input data as required from the problem from the local axis alignments and try to solve uses computer program and see how you can solve them very easily and conveniently. So, friends you will realize now that, what all program we have given use in input data, the algorithm the pattern of analysis using stiffness method as never changed for 2d orthogonal frames, 2d non orthogonal, 2d truss members and non orthogonal truss members 3d we have the same algorithm continuing and therefore, there is a complete iterative scheme available. So, that the program can be easily done using MATLAB and you can solve the problems by hand as well as by computer coding.

I hope you enjoy this and you will try this program as a input data for variety of problems which are available in tutorial sheets, in the coming days and weekends for you to solve the problem. We are also giving with the solutions of the problem; I hope you will try to have a new facet of understanding 3d analysis using this lectures.

Thank you very much.