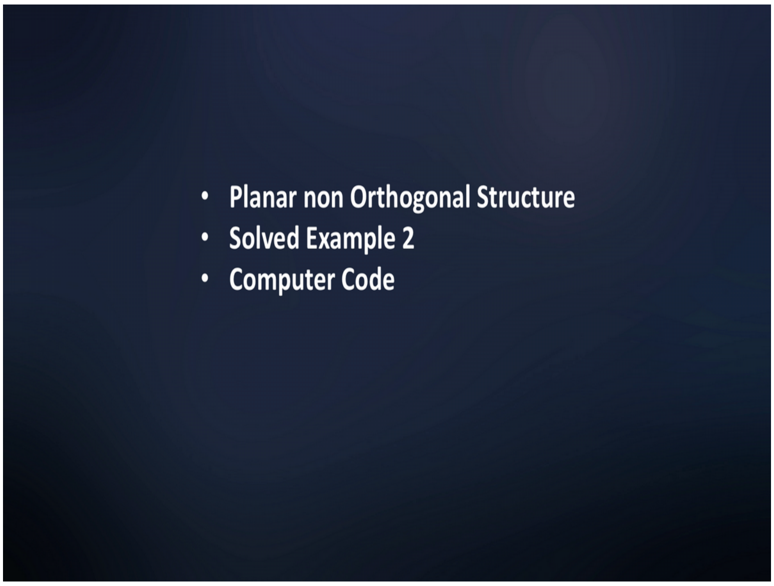
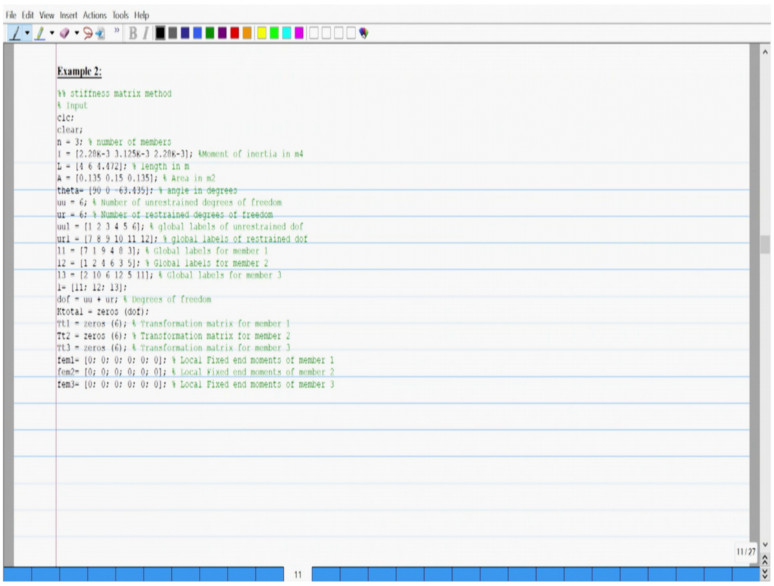
Computer Methods of Analysis of Offshore Structures
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module - 01
Lecture – 16
Planar non-orthogonal frame using computer code

(Refer Slide Time: 00:16)

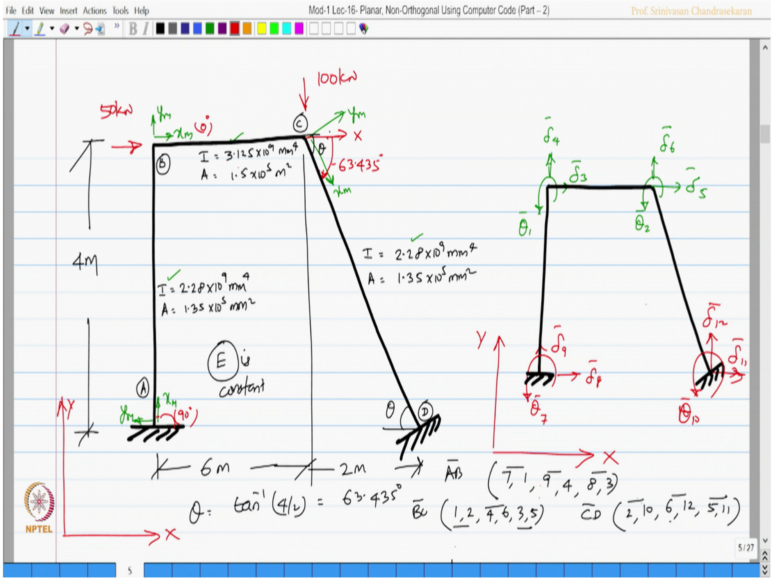


(Refer Slide Time: 00:22)



Start with the program. So, number of members are 3 number of members are 3 let us input the I value.

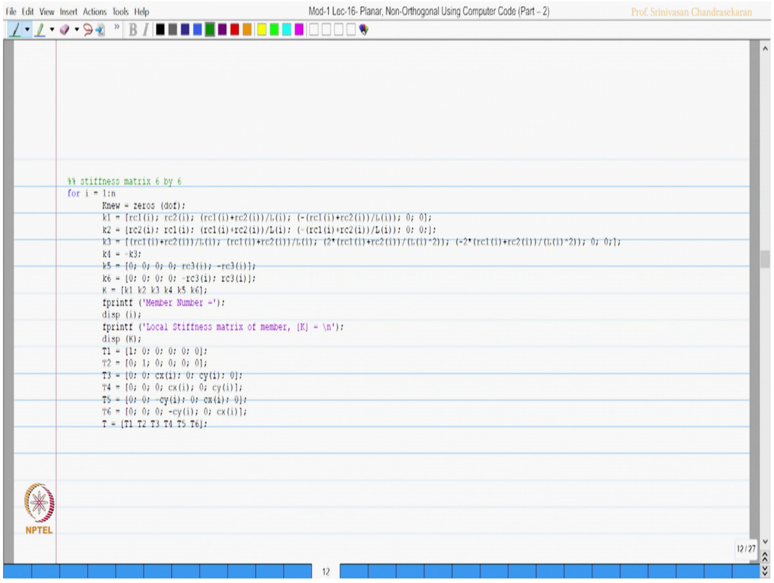
(Refer Slide Time: 00:36)



The I value you know 2.28; 3.125 and 2.28 in meter to the power 4 let us do that 2.28 3.125; 2.28, let us input the length, let us input the area, let us get theta unrestrained degrees are 6 in number you can see that unrestrained degrees are 6 in number, they are green in number and remaining 6 are restrained degrees.

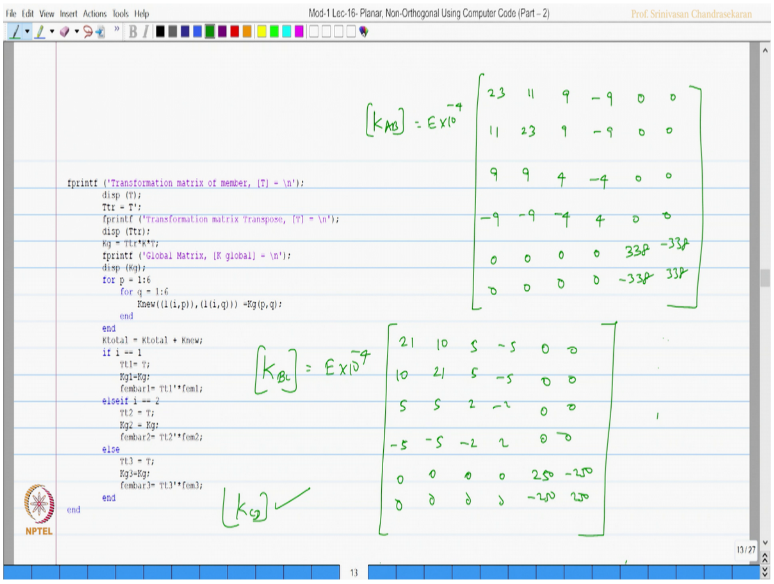
So, 6 in number and 6 in number the global labels of L 1, L 2, L 3, you can see here 7, 1, 9, 4, 8, 3; 7, 1, 9, 4, 8, 3 and so on, then I can find the transformation matrix; you can find the rotational stiffness.

(Refer Slide Time: 01:25)



Find the member matrix, then find the transformation matrix and get the transpose; let us get these values; I am directly getting it here, I am entering it here.

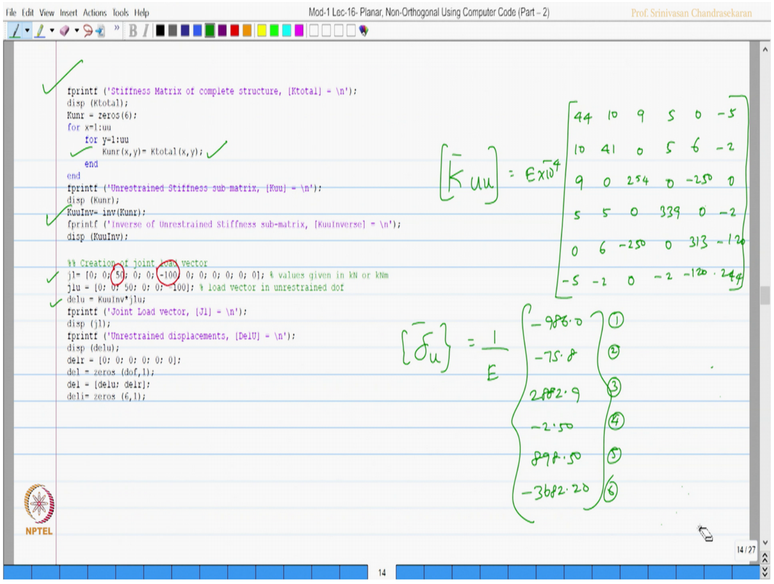
(Refer Slide Time: 01:42)



So, I am trying to get each member here. So, I am writing it here. So, we get K A B as E into 10 power minus 4, 23, 11, 9 minus 9, 0, 0, 11, 23, 9 minus 9, 0, 0, 9, 9, 4 minus 4, 0, 0 minus 9 minus 9 minus 4, 4, 0, 0, 338 minus 338, 338, 338.

Similarly, I can find K B C which is E 10 to the power minus 4, 21, 10, 5 minus 5, 0, 0, 10, 21, 5 minus 5, 0, 0, 5, 5, 2 minus 2, 0, 0 minus 5 minus 5, 2, 0, 0, 250. Similarly, one can find K C D also; there is no big deal about it, you assemble this and get K u u bar.

(Refer Slide Time: 03:38)



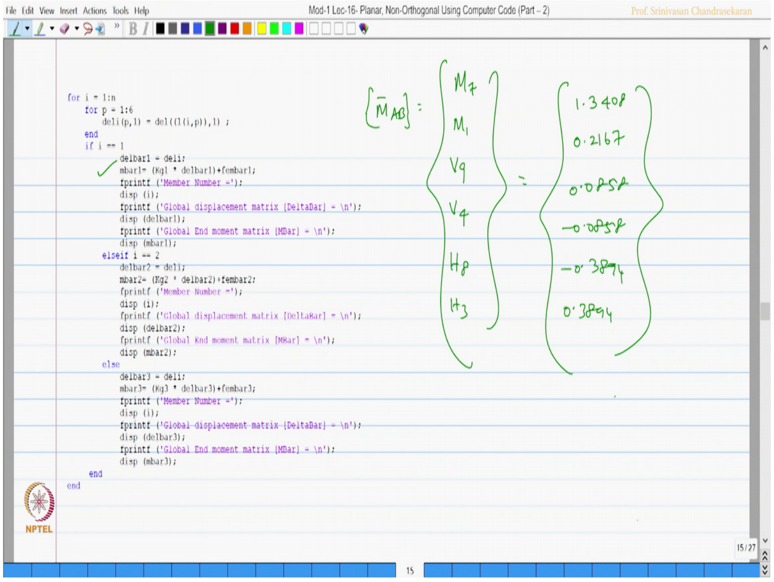
So, get the total stiffness matrix complete get the total stiffness matrix.

Then plug out the unrestrained matrix alone. So, we get K u u, but in the global degree which will be E into 10 power minus 4, 44, 10, 9, 5, 0, 0 minus 5, 10, 41, 0, 5, 6 minus 2, 9, 0, 250, 4, 0 minus 250, 0. So, 5, 5, 0, 339, 0, minus 2 minus 250, 0, 3, 1, 3, minus 120. So, minus 5, minus 2, 0, minus 2, minus 120, 2, 44 K u bar.

We directly get this from this statement then we inverted we get K u u inverse, then we get the joint load vector; we can see at the joint load vector if you look at the figure the joint loads are applied for this problem, I shown the figure here, I get; I have one load of 50 kilo Newton and other one of 100 kilo Newton applied along the degree of freedom 3 and 6.

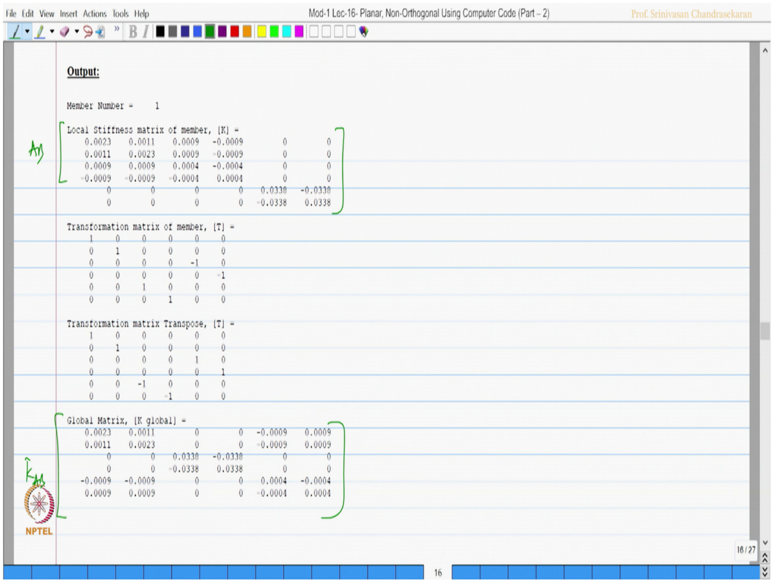
So, joint load along 3 and 6 along 3 it is positive along 6 negative from this, you plug out the joint load unrestrained degree then get delta u. So, the delta u obtained in the global degree is actually 1 by E of minus 986.0 minus 75.8, 2882.9 minus 2.50, 898.50 minus 3682.2 at degrees of freedom level 1, 2, 3, 4, 5 and 6.

(Refer Slide Time: 07:02)



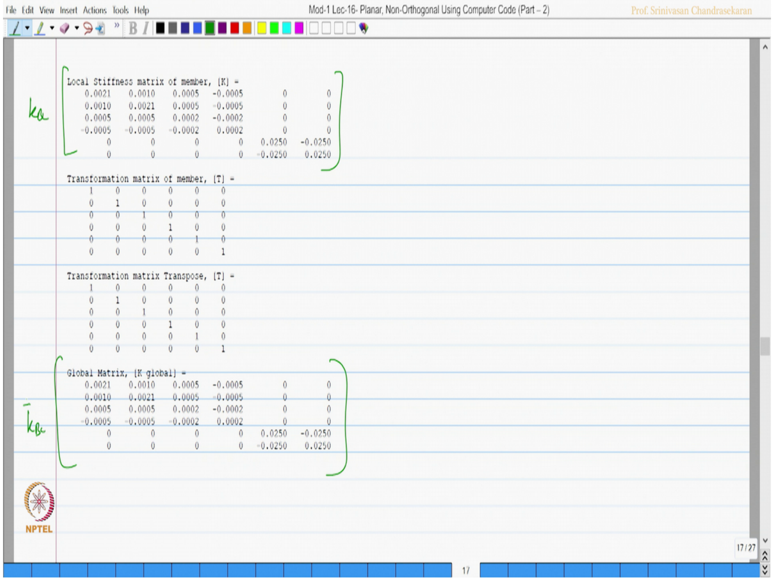
Once we get this, then we try to find the del bar and M A bar of every member for every member. So, we now find M bar A B which will be M 7, M 1, V 9, V 4, H 8, H 3 which actually is equal to 1.3408. There is a multiplier of E outside 2.167, 0.0858 minus 0.0858 minus 0.3894; 0.3894.

(Refer Slide Time: 08:05)

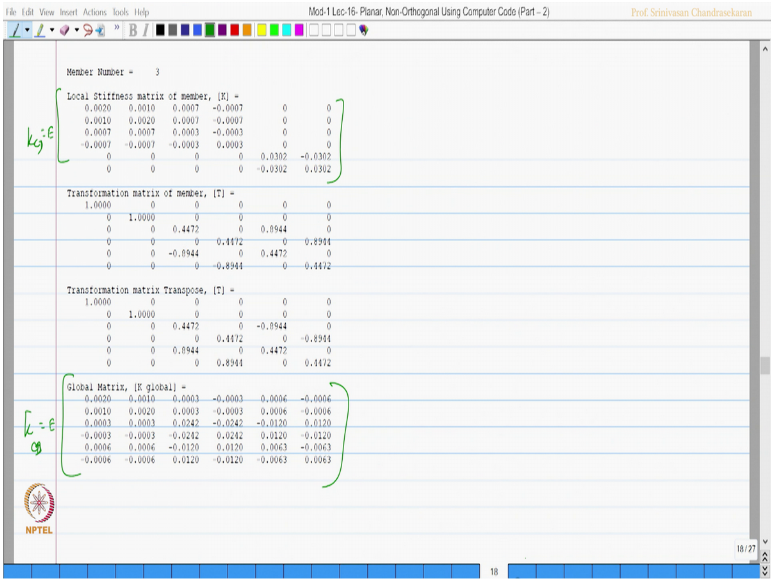


Similarly, I get this is my local stiffness matrix of A B, this is my global matrix of A B, this is my local stiffness matrix of B C, this is my global stiffness matrix of B C.

(Refer Slide Time: 08:22)

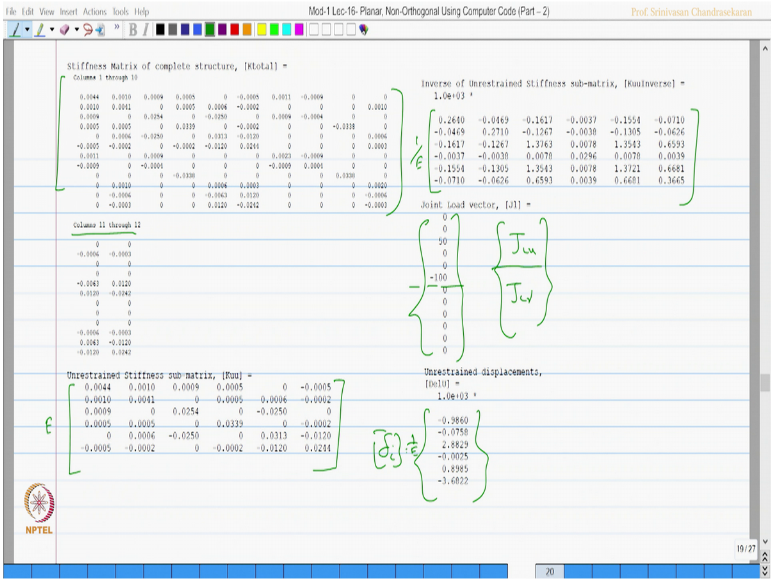


(Refer Slide Time: 08:35)



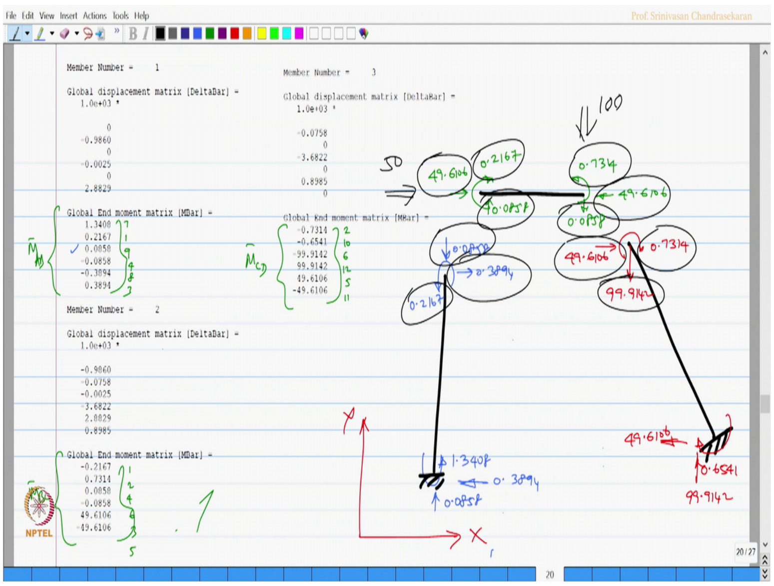
This is my local stiffness matrix of C D, this is my global stiffness matrix of C D where all have an multiplier of E outside.

(Refer Slide Time: 08:51)



Then we are able to get the full stiffness matrix the column 11 and 12 are here, then K u u, E is common out here inverse of K u u. So, we have 1 by E, here this is my joint load vector this is my partition. So, this is my J L u and this is my J L r, then I get unrestrained degree of freedom which is del bar of the whole system.

(Refer Slide Time: 09:34)



Where one by E is a multiplier once I get this, I get M bar A B, I get M bar B C and I will get M bar C D. So, let us see the labels of A B, B C and C D. So, the labels of A B, B C and C D could be 7, 1, 9, 4, 8, 3 similarly for B C it is 1, 2, 4, 6, 3, 5; for this, it is going to be 2, 10, 6, 12, 5, 11; let us try to plot these results maybe here itself, there are 3 elements; let us mark those elements first element second element third element let us enter the values.

You know this is going to be 1.34 plus. So, 1.3408 there is an E multiplier, we cannot entering in that value here, then plus 0.2167, then along y is my reference axes is going to be the third value which is 0.0858; the forth value is negative 0.0858, the fifth value is negative. So, opposite 0.3894 and this is 0.3894; let us do it for the next member 1 and 2. So, this going to be minus of clockwise 0.2167, 2 is anticlockwise 0.7314; this is upward 0.0858, this is downward 0.0858 and this is 49.6106 and this is 49.6106; let us do it for the third member.

This is minus. So, 0.7314 and minus again. So, clockwise which is 0.6541, then minus minus 99.9142 and this is plus 99.9142 and this is positive 49.6106; this is negative 49.6106. So, friends please check the compatibility the moments are compatible; the reactions are compatible the moments are compatible the reactions are compatible we know there is the net force of 50 applied here which is actually equal to this plus this is it not.

Which is opposed by this 450, similarly there is a net downward force of 100 applied here which is actually equal to this plus this system is in equilibrium now and we are solve the problem.

So, friends, we have explained you how to solve a planar non-orthogonal structure using computer code which has been slightly modified to accommodate the input as per the problem. So, we have solve 2 examples of non-orthogonal planar structure with 2 member and 3 member, we can solve n number of problems by using this code by making appropriate modification adding the fixed end moments for the member loading and do the procedure I hope you have understood and you will practice this coding and solve such similar examples for your tutorials.

Thank you very much.