Computer Methods of Analysis of Offshore Structures
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Module - 01
Lecture - 30
Non - Prismatic Members (Part - 1)

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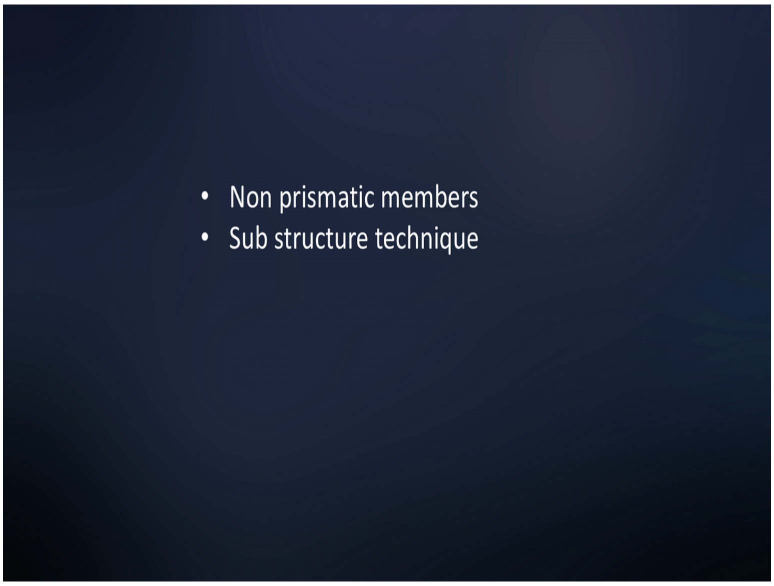

Friends; let us discuss one last example problem using non prismatic members which is the very common application of structures. Depending upon the top side requirement there may be a possibility; that the beam moment of inertia can vary depending upon the span length. Therefore, let us see how we can handle this kind of problem using substructure technique.

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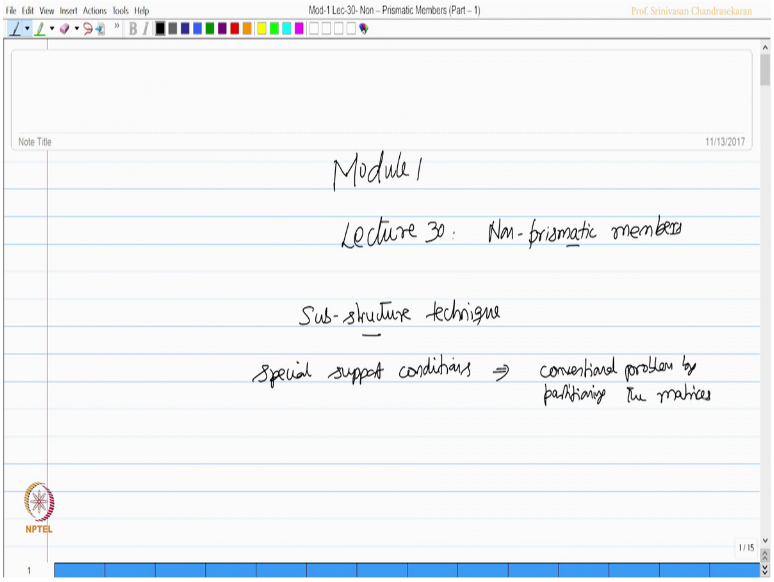

What is a substructure technique? The one which we discuss the last lecture that is a problem with special boundary condition or special support conditions can be handled as a conventional problem by partitioning the matrices.

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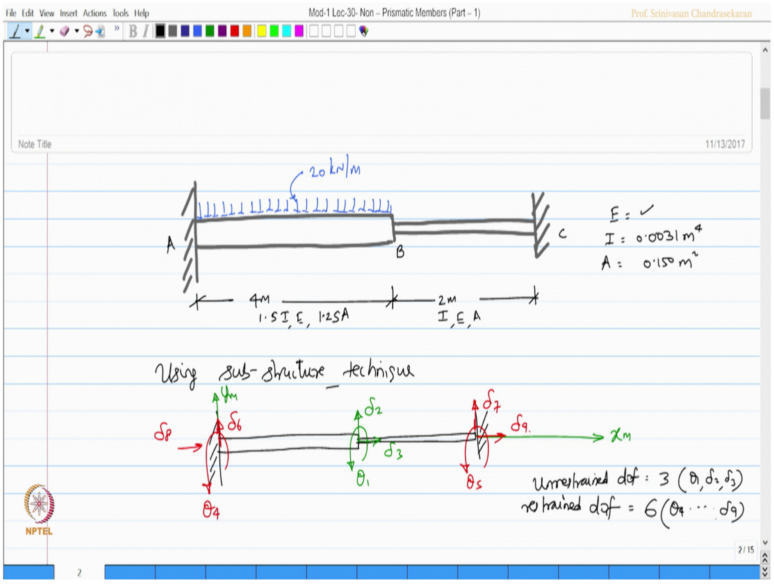

So, what we call as sub structure technique; let us take an example problem and solve this using the computer code; let us say I have problem with moment of inertia and cross section area varying as seen here.

Let us say this is my end A, this is B and this is C and this has 4 meter long and this is 2 meter long, this has 1.5 times of moment of inertia; whereas, this section as I whereas, E in both cases is same and A is 1.25 A, whereas this is A. So, E is standard section maybe steel or concrete moment of inertia is 0.0031 meter the power 4 and area is about 0.150 meter square; this is subjected to a load only on the span A B which is 20 kilo Newton per meter. We will analyze this problem using sub structure technique. So, now, as far as I M is concerned, we will handle this problem as if there are 2 members A B and B C separately. So, let us now mark the degrees of freedom let us say at this joint we assume a structural hinge therefore.

There will be free rotation there will be free displacements along y and along x axis. So, this is my x m and this is my y of the member these are understand degrees of freedom. Now the restrained degrees of freedom are theta 4, theta 5 and delta 6, delta 7, delta 8 and delta 9. Now, we understand that unrestraint degrees of freedom or 3 in number that is theta 1, delta 2 and delta 3 restraint degrees of freedom or 6 in number starting from theta 4 till delta 9 which are marked in red color these are marked in green color.

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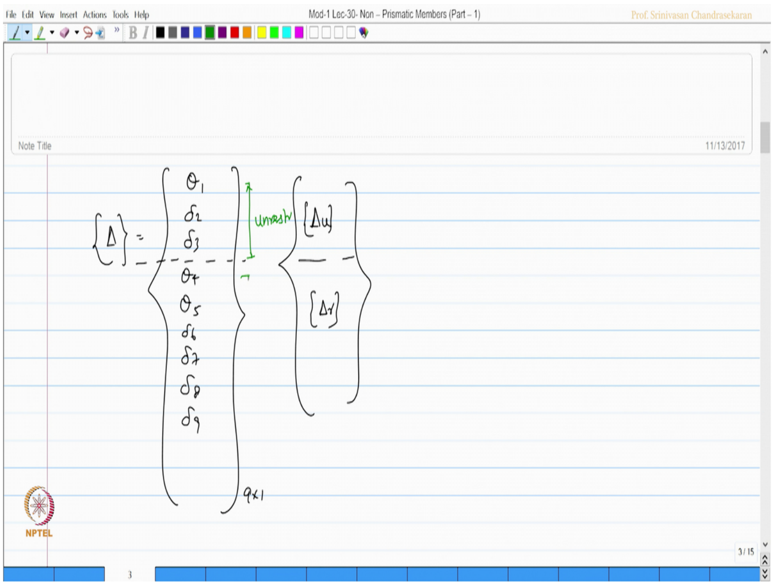

Similarly the delta vector the displacement vector will also have 9 by 1 which will be theta 1, delta 2, delta 3, then theta 4, theta 5, delta 6, delta 7, delta 8 and 9 where there will be a partition here. So, I can now say this vector can be portioned as delta u sub vector and delta r because these are unrestraint degrees of freedom.

Is it not and these are restraint degrees of freedom, we have assumed an internal hinge internal hinge at the point of change in cross section or moment of inertia.

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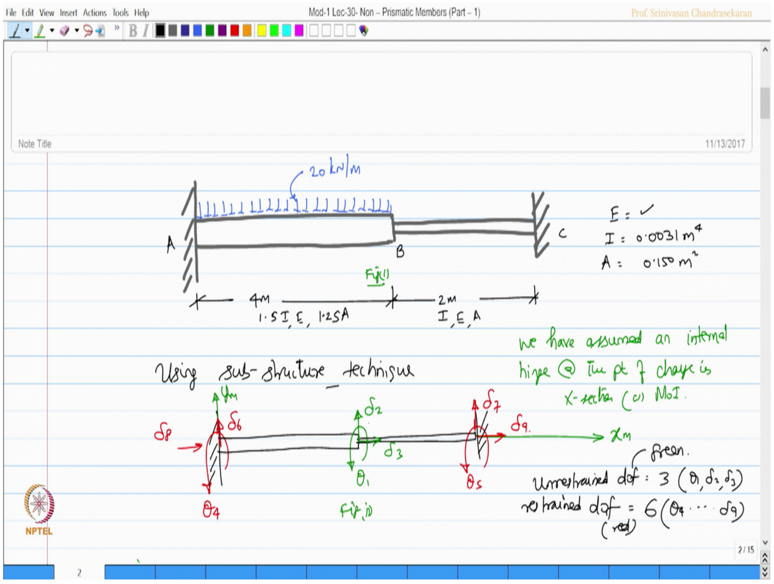

So, we are dividing the structure into sub structures as you have seen in figure 2; this is figure 2; this is the original figure which is the original problem. Now we will handle this problem as if there are 2 members and we will write down the stiffness matrix; let us say K AB will have E constant out.

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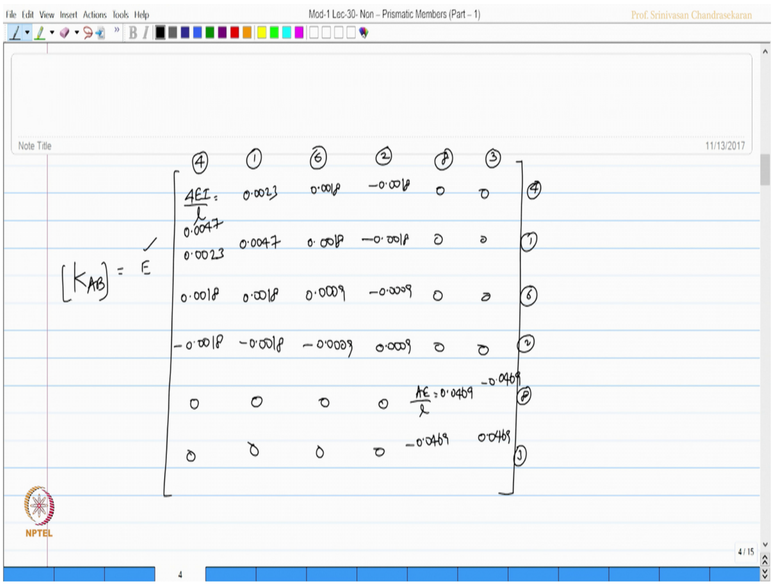

So, let us mark the degrees of freedom rotation 4 1, then displacement about y 6 and 2 then displacement along x 8 and 3 that is the standard stiffness matrix; let us say 4, 1, 6, 2, 8 and 3, 4, 1, 6, 2, 8 and 3; so 4, 1, 6, 2, 8 and 3. We know this value is actually 4 E I by l substitute for E I x etcetera and try to find the values which we substitute this will become 0.0047 and this will become 0.0023 and this will become 0.0018 minus 0.0018 and this will be 0 and this will be 0.0023, 0.0047, 0018, 0018, 01018, 0.0018; again 0.0009, 0009, 000018 negative; negative again triple 09; triple 0 9 positive 00 and this coefficient of stiffness matrix will be 0 and this will be actually A E by l E is anyway common substitute I will get 0.0469.

So, this is my K AB matrix which is a conventional stiffness matrix of 6 by 6; we are not done a special element here. Similarly I can do for K B C. Again E multiplayer common out and see the degrees of freedom for k B C. So, 1 5 2 7 3 9 that is rotation about x and y, I mean j and k; then displacement along y 2 1 7 displacement along x 3 and 9.

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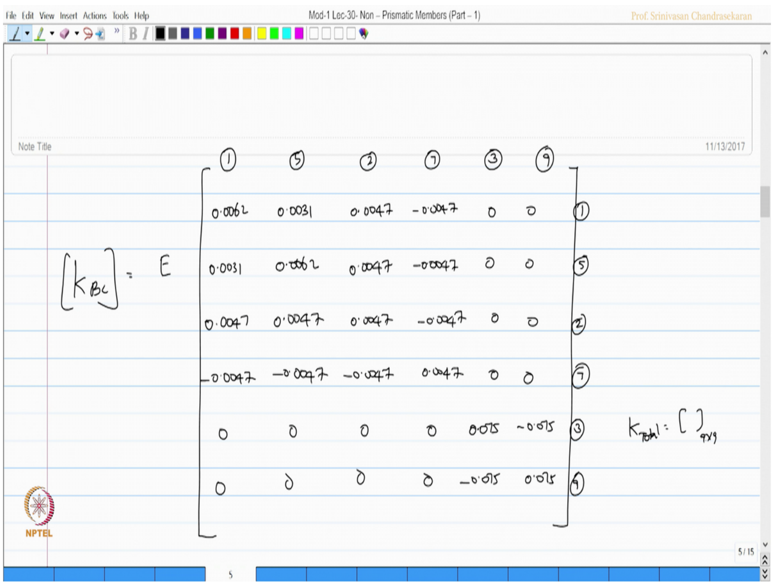

So, 1, 5, 2, 7, 3, 9; this is a E by l and so on. So, now, we can assemble these 2 and get the total stiffness matrix K total. So, the K total will be 9 by 9 with all the 9 labels. We can assemble them; then get the partition of this. Let us do this exercise using the computer program.