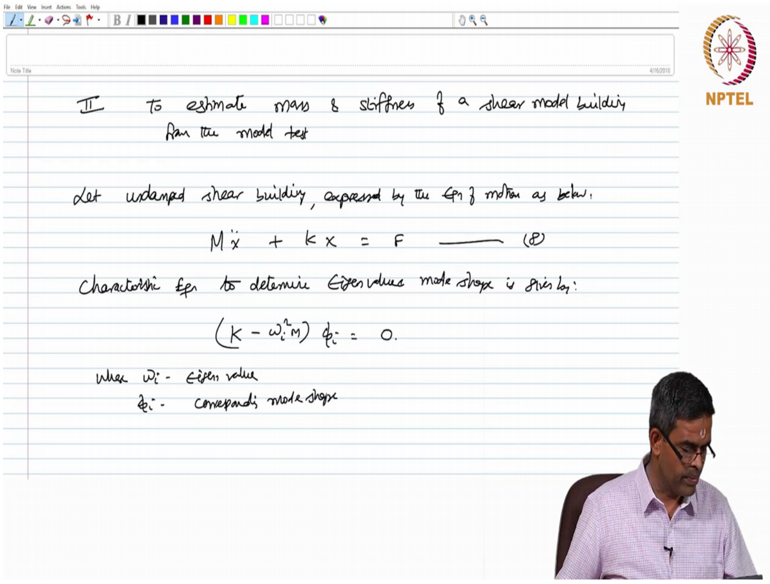
Structural Health Monitoring (SHM)
Prof. Srinivasan Chandrasekaran
Department of Ocean Engineering
Indian Institute of Technology, Madras

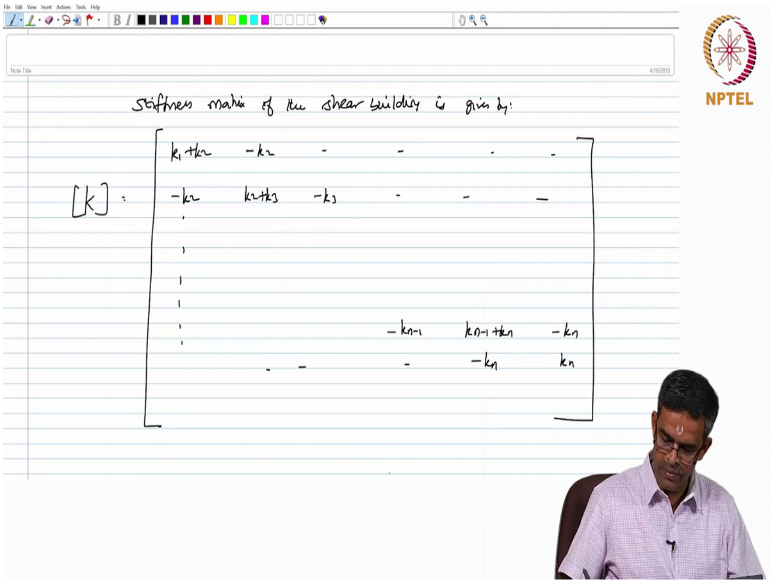
Lecture – 28
Structural health monitoring methods: 1 – Part 2

(Refer Slide Time: 00:20)



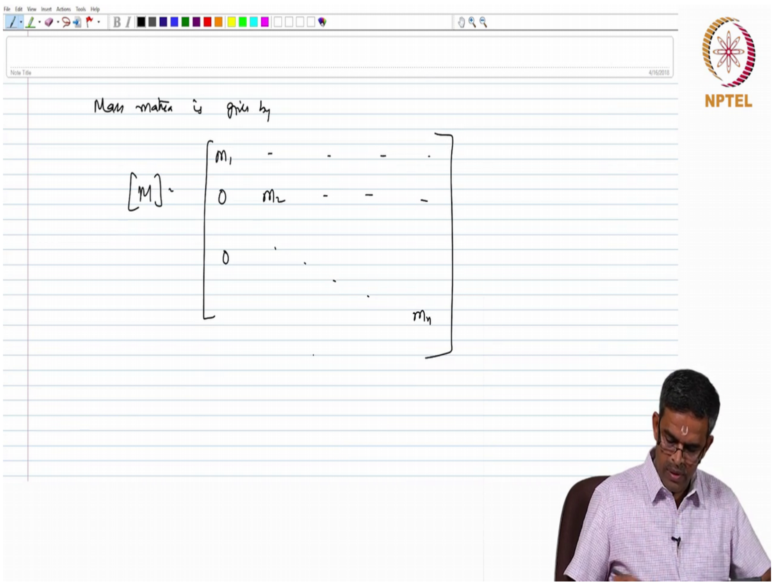
So, the second argument is to estimate mass and stiffness of a shear model building from the model test. Let undamped shear building expressed by the equation of motion as below, that is M x double dot plus k x is F. The characteristic equation to determine Eigen value and mode shape is given by k minus omega square M phi i is 0 where omega i is the Eigen value and phi i is a corresponding mode shape.

(Refer Slide Time: 02:16)



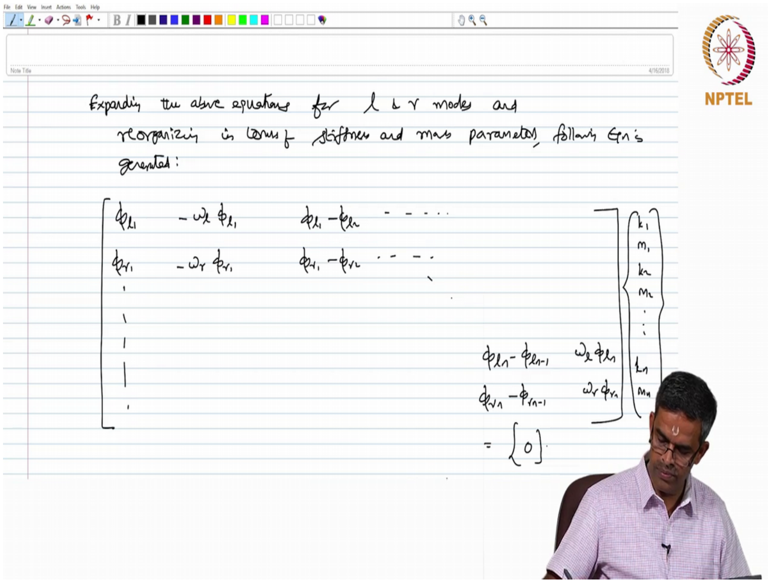
Stiffness matrix of the shear building is given by k 1 plus k 2 minus k 2 minus k 2 k 2 plus k 3 minus k 3 and so on; let us say minus k n minus 1 k n minus 1 plus k n minus k n minus k n and k.

(Refer Slide Time: 03:18)



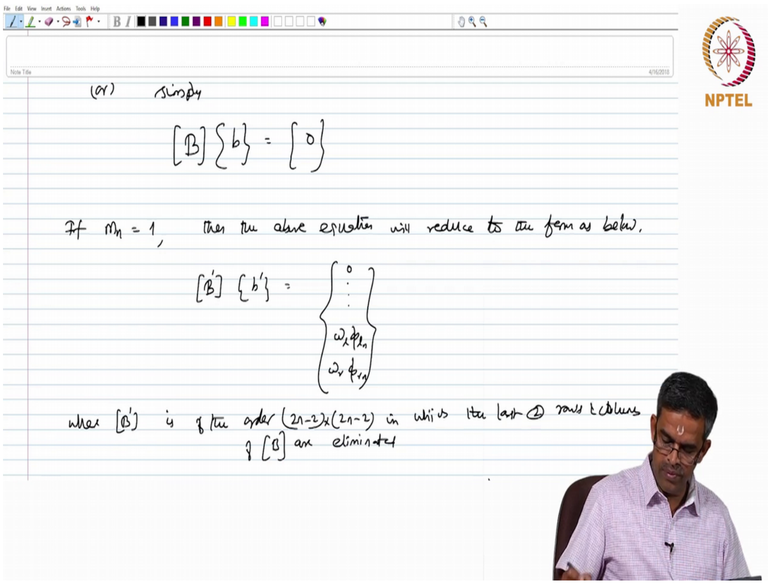
Mass matrix is given by M 1, M 2, M n; expanding the above equations.

(Refer Slide Time: 03:42)



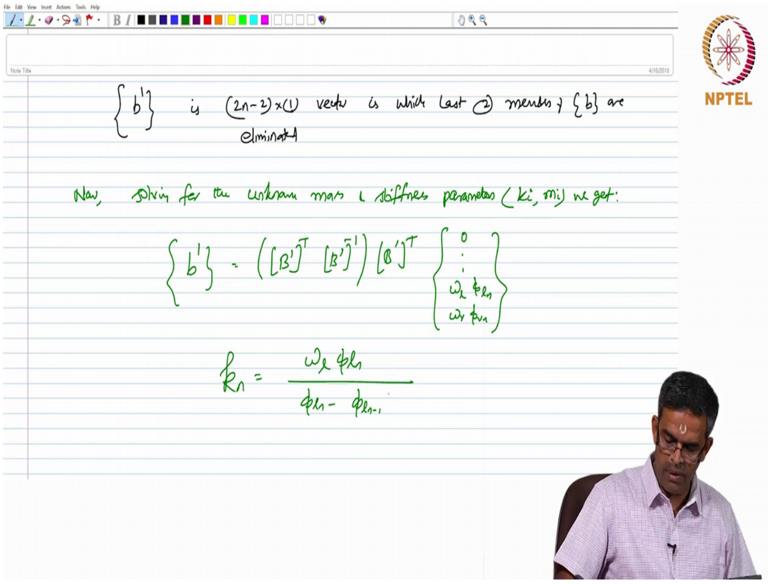
For l and r modes and reorganizing in terms of stiffness and mass parameters following equation is generated, the phi l 1, phi r 1, minus omega l phi l 1, minus omega r phi r 1, phi l 1 minus phi l 2, phi r 1 minus phi r 2 and that goes and says phi l n minus phi l n minus 1 omega l, phi l n phi r n minus phi r n minus 1 omega r phi r n multiplied by k 1 M 1, k 2 M 2 like k n M n will be equal to 0 or simply B multiplied by b vector is 0.

(Refer Slide Time: 05:46)



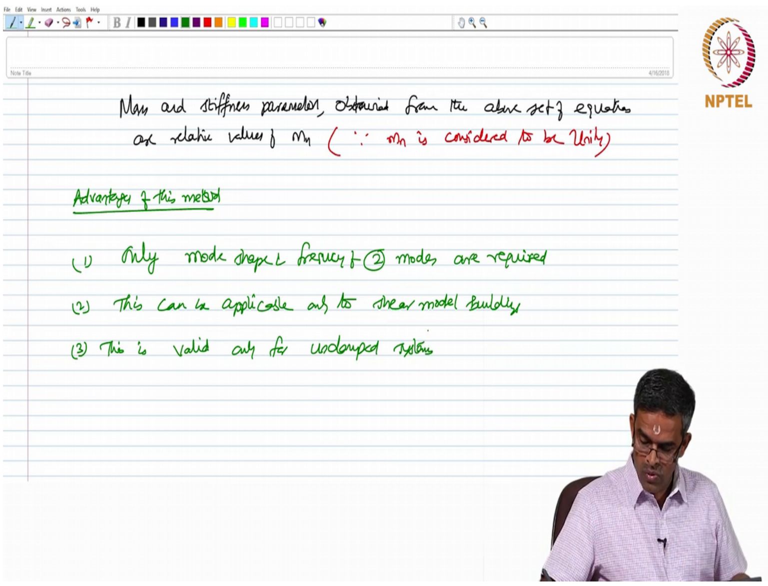
Now, if M n is equal to unity, then the above equation will reduce to the form B dash, b dash is equal to 0 omega l phi l n, omega r phi r n where beta prime is of the order 2 n minus 2 2 n minus 2 in which, the last two rows and columns of B matrix are eliminated; b dash is 2 n minus 2 by 1 vector in which last two members of b vector are eliminated.

(Refer Slide Time: 07:15)



Now, solving for the unknown mass and stiffness parameters, that is k i and M i, we get b dash is equal to B prime transpose B dash inverse B dash transpose 0 omega l phi l n, omega r phi r n, which tells me k n is equal to omega l phi l n or phi l n minus phi l n minus 1.

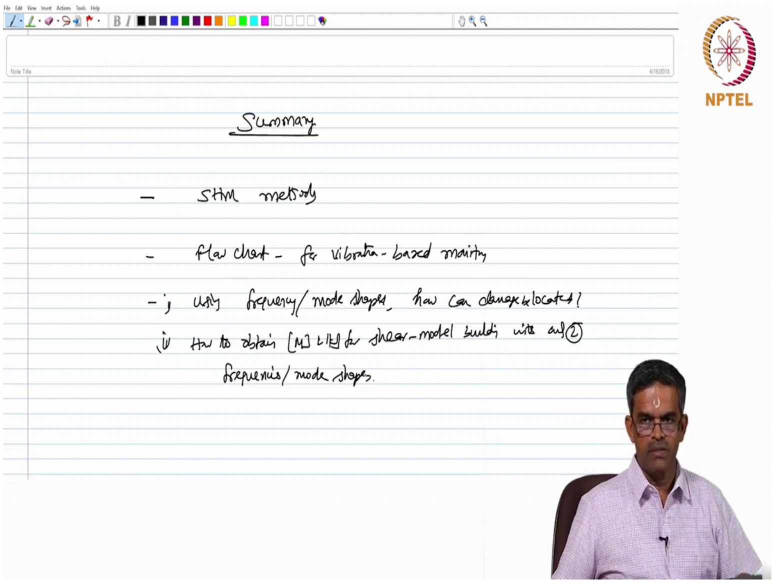
(Refer Slide Time: 08:51)



Now, the mass and stiffness parameters obtained from the above equation or relative values of M n, because you can see here M n is taken to be unity. Therefore, the relative value 7 because M n is considered to be unity. This method has second advantage; one, only mode shape and frequency of two modes are required, see here l and n.

This method has a limitation, this can be applicable only to shear model buildings. Thirdly, this is valid only for undamped systems. So now, let us see the summary friends.

(Refer Slide Time: 10:52)



In this lecture, we are attempting to learn Structural Health Monitoring methods. We also saw the flowchart for vibration based monitoring.

We learnt two methods; one, using frequencies and mode shapes; how can damage located damage be located; second, how to obtain mass and k for shear model building with only two frequencies and mode shapes. We will continue to see other methods in the coming lecture.

Thank you.