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

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det undamped shear building, expressed by the Eps of motion as below:	
$M\ddot{x} + kx = F - (B)$	
Charactership for to determine Eiter values make strope is prisely:	
$(k - \omega_c^{\Lambda} M) \not\in c = 0.$	
when wi- Eigen value	
&:- Concepandi, mode shope	-

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.

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	1		-	- kn	kn	
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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 minus k n and k.

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[m] -	0 m2	-	
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Mass matrix is given by M 1, M 2, M n; expanding the above equations.

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			\$1- \$1-1 \$1- \$1-1 \$- \$0}.	Water Ling

For 1 and r modes and reorganizing in terms of stiffness and mass parameters following equation is generated, the phi 1 1, phi r 1, minus omega 1 phi 1 1, minus omega r phi r 1, phi 1 1 minus phi 1 2, phi r 1 minus phi r 2 and that goes and says phi 1 n minus phi 1 n minus 1 omega 1, phi 1 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.

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$\mathcal{F} = 1$	then the above equation	visit reduce to the fo	im as below,
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. h [a'] i.		in which the last Q.	rows Ecolums
wher less y	1 tu order (2n-2)x(2n-2)) [B] an elimina	t-i	Stor 1
		•	

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.

{ b } is (2n-2) x(1) verter is which last 3) mendes of { b } are Invisional NPTEL Now, solving for the unknown mans I differes prevambers (ki, mi) we get: $\begin{cases} b' \\ b' \\ kn = \frac{\omega_{k} \phi_{kn}}{\phi_{kn} - \phi_{kn}}$

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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 1 phi 1 n, omega r phi r n, which tells me k n is equal to omega 1 phi 1 n or phi 1 n minus phi 1 n minus 1.

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(3) This can be applic.		el Buldly	
(3) This is valid only	for undamped systems		
			AA

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 I 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.

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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.