Modal Analysis – Case-Study of Testing on a Single Storey Roof Slab (A) Of Structural Laboratory at IIT Kharagpur with Construction Joint

Shashi Shekhar Singh[1] Ayush Srivastava[2] Sharma Ganesh Mohandatta[3] Avinash Kumar[4] Pankaj Kaushik[5]

[1,3,4]Assistant Professor [2]Student [5]Lecturer

[1,2,3,5]Department of Civil Engineering [4]Mechanical Engineering

[1,2,3,5]MVN University, Palwal, Haryana [4]Satya College of Engineering and Technology, Palwal, Haryana

Abstract— Modern structures are becoming more and more slender but with improved stiffness with use of large number of materials in combination, making the predictions of dynamic characteristics of such structures extremely difficult for the analysis using commercially available general purpose finite element softwares. On the other hand, if a building floor is properly excited and the input force and the resulting responses are accurately measured with proper hardware, the dynamic characteristics can be found out without much error. The present work is focused on actual physical measurement of input force of a reaction mass shaker to a typical building floor to determine the floor dynamics. A case study on a Single storey roof slab establishes the advantages of this kind of combined experimental and numerical methods. This work is in continuation with our previous work, published in IJSRD, Volume 3, Issue 2, entitled, "Modal analysis – Case-Study of testing on a Double storey Laboratory floor" and paper published in IJSRD, Volume 3, Issue 2, entitled, "Modal Analysis – Case-Study of testing on a Single Storey Laboratory Floor".

Key words: FEM – Finite Element Modelling, EMA – Experimental Modal Analysis, Modal Analysis – A method to obtain the modal parameters of any structure, FRF – Frequency Response Function, Stiffness – It is the rigidity of an object

I. INTRODUCTION

Modal testing procedure was thought to be practiced on different types of Reinforced Concrete floor systems. The usage of this type of system is actually independent of the size, type and properties of any flooring system. A Single storey roof slab was chosen for testing. It was a RC roof slab of structural lab 'A', near to the laboratory. This slab has a different geometry as compared to the previous case studies. It is simply supported on the walls. Simply supported from three sides and fixed from one side. It's one part of structural lab slab.

II. CASE STUDY

A. General:

The test structure is a slab of structures lab in Civil Engineering Department, IIT Kharagpur.

The dimension of the roof slab is 15.6m X 10.4m. The beams are of dimension 0.55 x 0.345m (primary beam) and 0.35 x 0.20m (secondary beam) and columns are of dimension 0.345 x0.51 m. the primary beam is in the direction of shorter side and secondary beam is in the direction of longer side.

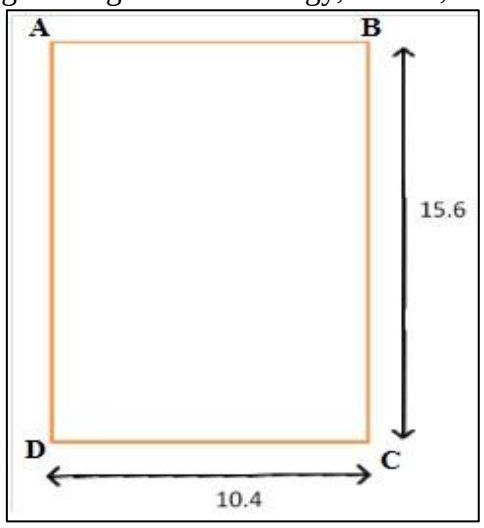

Fig. 1: Plan of Test Floor Slab

Young's Modulus of elasticity of slab = 2.0 x 10^{10} Pa

Young's Modulus of elasticity of columns and beams = 2.0 x 10^{10} Pa

Poisson's ratio = 0.2

Density of concrete = 2400 Kg/m^3

In case of analytical analysis, we consider the construction joint CD assumed to be a fixed joint.

B. Preparatory Phase (Pre Test Analysis of the Test Floor):

The element constants for the model are as given below:-

Element type	Parameter	Value
Primary beam 0.55 x 0.345	TKZ	0.50
	TKY	0.30
	Area	0.15
	IZZx10^{-3}	3.125
	IYYx10^{-3}	1.125
Secondary beam (0.35x0.25)	TKZ	0.30
	TKY	0.20
	Area	0.60
	IZZx10^{-4}	4.50
	IYYx10^{-4}	2.00
Column(0.51x0.345)	TKZ	0.45
	TKY	0.30
	Area	0.135
	IZZx10^{-3}	2.28
	IYYx10^{-3}	1.0125
Slab	TKI, TKJ, TKK, TKL	0.12

Table 1: Element Constants for Pre Test Model

All rights reserved by www.ijsrd.com

The columns were considered fixed at the floor below which was at the height of 5.85 m. The modal analysis was carried out similar to that of previous case studies.

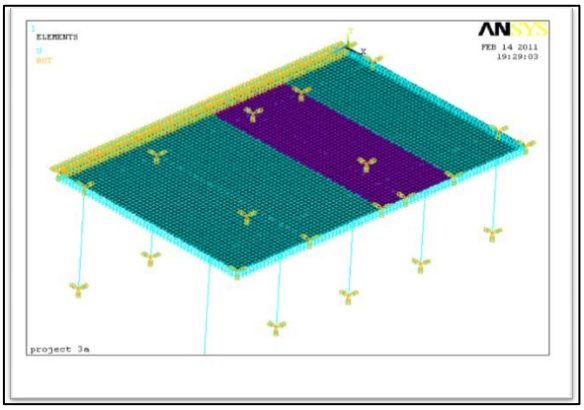

Fig. 2: Pre Test FE Model

The first 4 natural frequencies were recorded and are as tabulated below

Mode	Natural Frequency(Hz)
1	14.028
2	17.451
3	19.426
4	23.185

Table 2: First Four Frequencies of Pre Test Model

The first four frequencies and mode shapes after pre test analysis are:

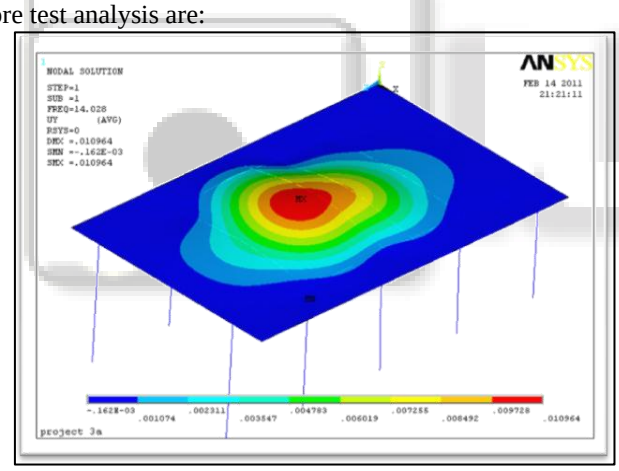

Fig. 3: First Mode

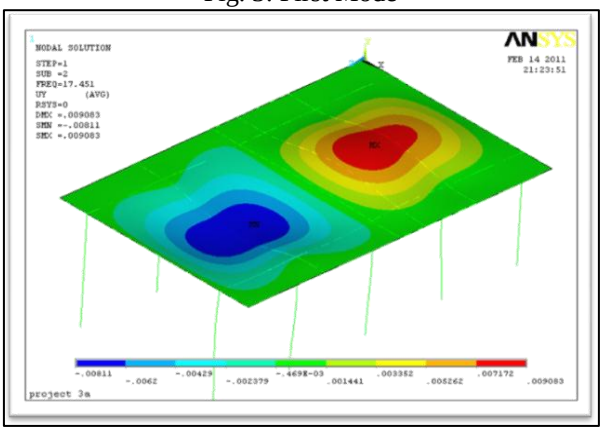

Fig. 4: Second Mode

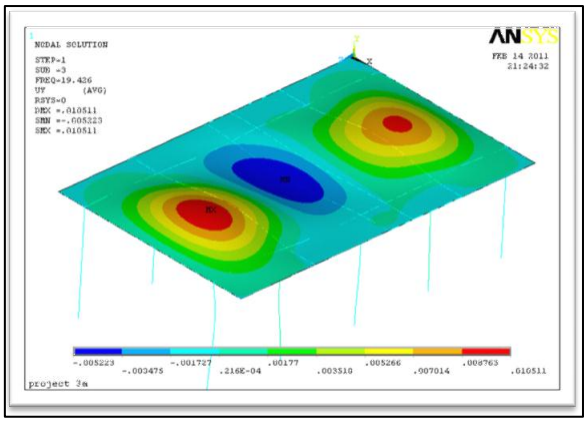

Fig. 5: Third Mode

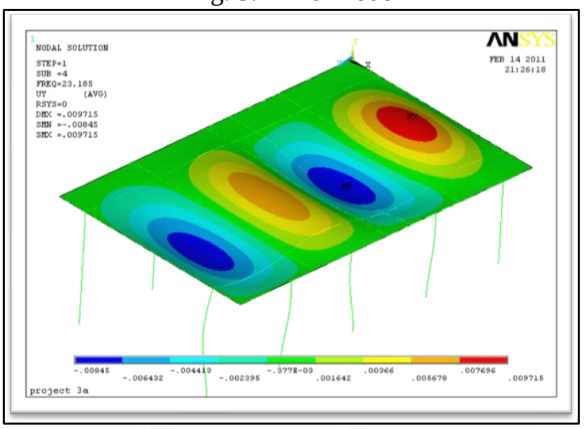

Fig. 6: Fourth Mode

C. Measurement And Post Analysis Phase:

The shaker position and 54 point grid was made for data acquisition. The slab was accessible. The data acquisition parameters were kept same as that of previous case study since the frequency range was found to be same. The FRFs were recorded for the points on the slab. The recorded signals were found to be good. There was no response seen at the edges of slab and at the line of columns. The FRFs were then exported to MEScope to extract the Frequencies and mode shapes.

Mode	Frequency(Hz)	Damping Ratio(ζ) (%)
1	12.90	1.59
2	16.40	0.92
3	18.30	0.80

Table. 3: Experimental Natural Frequencies

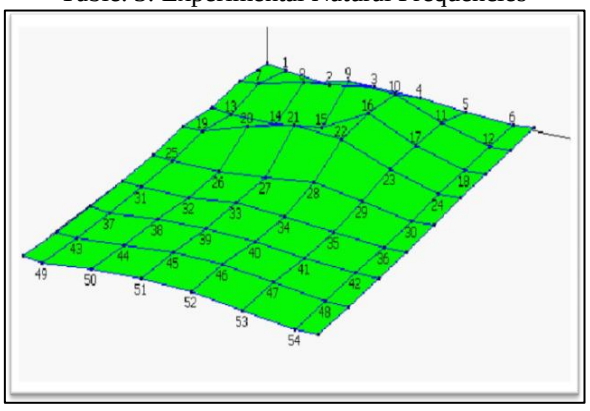

Fig. 7:First Mode

All rights reserved by *www.ijsrd.com*

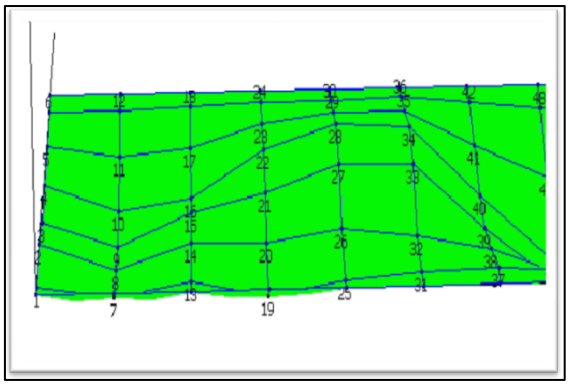

Fig. 8: Second Mode

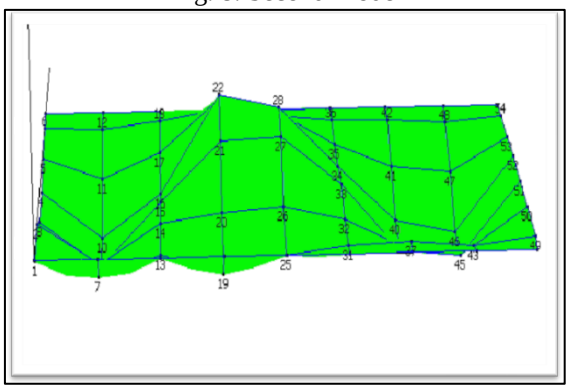

Fig. 9: Third Mode

Mode	Frequency (Hz)	
	Experimental	ANSYS
1	12.90	14.028
2	16.40	17.451
3	18.30	19.426
4	-	23.185

Table 4: Comparison of Frequencies (Hz)

III. CONCLUSION

The comparison of frequencies shows that the stiffness of the slab in pretest modelling was high.

REFERENCES

[1] Modal testing of Reinforced Concrete Building Floors using Reaction Mass Shaker – A Thesis submitted to Department of Civil Engineering, IIT Kharagpur in May, 2011, by Shashi Shekhar Singh.
[2] Article published in IJSRD, Volume 3, Issue 2, entitled, "Modal analysis – Case-Study of testing on a Double storey Laboratory floor".
[3] Article published in IJSRD, Volume 3, Issue 2, entitled, "Modal analysis – Case-Study of testing on a Single storey Laboratory floor".

All rights reserved by *www.ijsrd.com*