Experimentally Analysis of Free Vibration Cracked R.C.C Beam

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***Abstract*—**
In the present era, health of the structure is of great concern to avoid further hazards caused by deterioration of the structure. So due importance should be given to health aspect of a structure because health defines the long term performance of the structure. Health monitoring is the detection of the overall health of a structure, which includes cracking, spalling of concrete and anything which disturbs the utility of the structure. Many researchers are engaged in detection of cracks with the help of vibration analysis. This method of detection of cracks has been considered as an cost effective and reliable method of health monitoring. The effect of crack location and depth of crack on the natural frequencies and mode shapes has been reviewed in this paper.

The type of crack, its location and depth are the main governing parameters in this study and result parameters are mode shapes and frequencies. The experiment is performed on test beams by using fast forrier analyser, accelerometer and hammer. Validation of experimental results will be done by SAP 2000.

Keywords: Cracks, Free vibration, Frequencies, Mode shapes.

1. INTRODUCTION

Cracks are the most neglected type of damage that is caused to the structure. Many a times in our day to day life we neglect the existence of the cracks in our structure. But as a prominent civil engineer any crack however small may be can cause serious damage to the structure so it should not be neglected. These cracks disturbs the utility and life span of the structure. Cracks develop from flaws due to components like beams, columns, etc. will bear damage due to its long term use. Hence it becomes important to determine the damage characteristics on the structures. Cracks causes changes in the physical properties of a structure which eventually alters its dynamic response characteristics. To detect these cracks inexpensive methods should be found out. Vibration analysis is one of those method in which researchers are focusing on the changes of modal parameters like natural frequencies, mode shapes and modal damping values. The health of the structure should be monitored in an economical way. Using vibration technique researchers are analysing its reliability and cost effectiveness. Due importance should be given to crack depth, its location, type and the effects caused by it on the health of the structure. Type of the crack also plays an important role in this study, as whether the crack is breathing crack or closed crack. Location of the crack means whether the crack is near the supports, edges or in the middle of the beam. Any damage however small may be alters the dynamic response of the structure causing stiffness reduction eventually resulting into changes in the natural frequencies and mode shapes of the structure. In this paper, the research done by previous researchers has been studied, viewed and analysed. Thus, modeling and the dynamics of the cracked structures has been a subject of intensive investigations in the last three decades.

1.1 LITERATURE REVIEW

Here are some research reviews done by researchers

Prathmesh1 In this paper a model for free vibration analysis of a beam with an open edge crack has been presented. Variations of natural frequencies due to crack at various locations and with varying crack depths have been studied. The cracked beams with different boundary conditions have been analyzed. The results obtained by experiments performed by previous studies are compared with those obtained by finite element analysis by using ABAQUS software. It was observed that the natural frequency changes substantially due to the presence of cracks depending upon location and size of crack.

Saidiabdelkrim.et.al (2014)- He analyzed the vibration behavior of concrete beams both experimentally and using ANSYS software subjected to the crack under free vibration cases. Experiments were conducted by using FFT Analyzer, Accelerometer, Modal hammer. It was observed that when the location of the crack increases starting from the clamped end of the beam, natural frequencies of the beam and the amplitude of high frequency vibration also increase, but the amplitude of low frequency vibration decreases.

Sirca.et.al(2012)- presented system identification in structures using multi-paradigm approach for large structures with non linear behavior subjected to unknown dynamic loading such as strong ground motions.

Huszar.et.al- studied the dynamic behavior of cracked reinforced and prestressed concrete beams using eigen frequencies. The connection between the prestressing force and the virtual eigen frequencies of the cracked beam was investigate by numeric simulation.

Kilichi.et.al(2004)- In this study, a technique of analyzing the vibration problem of reinforced concrete beam members including bond slip of the reinforcements is proposed. Virtual work is used to derive equations based on finite element method and numerical examples are provided.

Jena.et.al- presented theoretical, numerical (FEM) and experimental analysis of composite cracked beams of different boundary conditions using vibration mode shape curvatures. The effect on natural frequencies and mode shapes for different boundary conditions are studied by varying crack positions and crack depth. It has been concluded from this study that with increase in crack depth, the relative frequencies reduce in order due to drop in stiffness of the

composite beam. It is also observed that the relative crack position affects the relative frequency of the composite beam.

Swapnil.et.al (2015)- carried out an experimental study on cracked cantilever beam using FFT analyzer. Accelerometer, Impact hammer and comparison of results using ANSYS. He concluded that natural frequency of the cracked beam increases as the crack location increases from fixed end and the crack depth is constant. Also, small crack depth ratios had small effect on the sensitivity of the natural frequencies. It was also observed that the changes become more significant as the crack depth grew deeper.

2. OBJECTIVES

1)To carry out vibration analysis experimentally on R.C.C beams with different boundary conditions.
2)To study behavior on natural frequencies of cracks at varying locations and depth.
3)To compare the results of frequencies and mode shapes by experiment and software.
4)To compare results of intact beam & corresponding cracked beam.

3. METHODOLOGY

The present work mainly focuses on the analysis of intact and cracked RCC beam using parameters like mode shapes and modal frequencies. The analysis is done by using Abaqus and ANSYS software and the results obtained for both the beams are compared. It includes vibrational analysis of cracked R.C.C beam experimentally by varying the crack location and depth of crack. Parameters studied will be natural frequencies and mode shapes.

4. TECHNICAL DETAILS OF THE PROJECT

Beam Size: 0.2 x 0.2 x 0.6 m
Mix Proportion: M20 (1:1.5:3)
Crack location: 100mm from support
Crack depth: 0.5mm, 1mm, 1.5mm, 2mm
Clear cover for beams: 20mm
Support Conditions: 1) One end fixed, one end free
2) Both ends fixed.
Location of crack: 100mm from fixed end.
4 beams for each support conditions casted by varying the crack depths as 0.5mm,1mm,1.5mm,2mm and analyzed.
The major parameters studied under vibration analysis are modal frequencies and mode shapes of those of the cracked beams and intact beams.

The Assumptions made in the analysis-

1. The beam is prismatic.
2. The crack is considered to be an open edge notch.
3. Crack does not grow.
4. The damping has not been considered.
5. It was also assumed that the cracks occur in the first mode of fracture: i.e., the opening mode.

The following ANSYS model shows the analysis of intact and cracked beams, in which the modal frequencies and load carrying capacities of both the beams are compared.

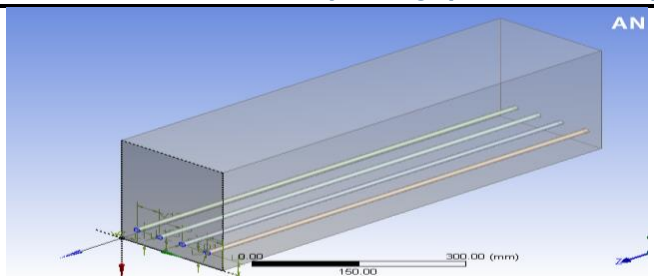

Fig No-1 Detail Model of Beam

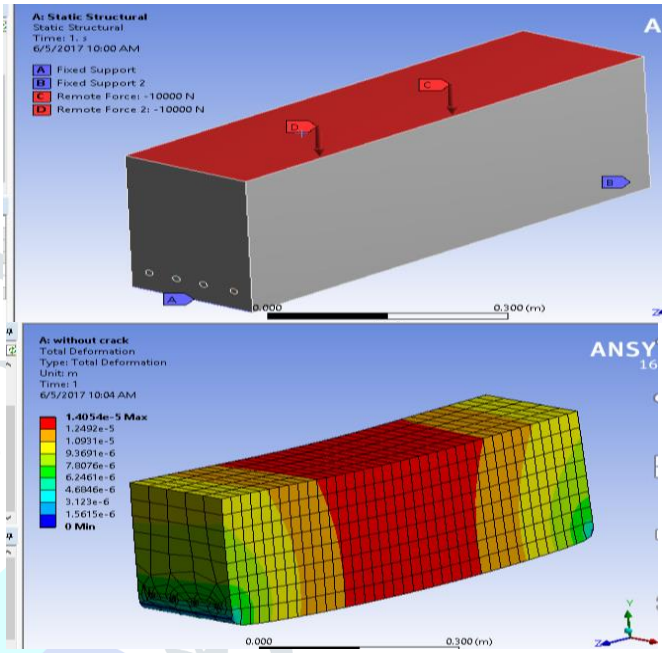

Fig No-2 ANSYS Model

5 RESULTS AND CONCLUSION

- The load carrying capacity of intact beam is 417.2 KN up to the first crack is involved in beam.
- The load carrying capacity of the beam after failure is shown by the further eigen values of the system which represents load carried after first crack evolved is 106.612 KN.
- Further failure was allowed, and it was noted that the beam was displaced in lateral direction and 70.26 KN load was beared by the system.
- Initially the failure was seen in the shear span of the beam at the support where the element support is disturbed.

6. FIELD APPLICATIONS

This topic finds many applications in the fields of civil and mechanical engineering structures.
1.Vibration analysis is used for early detection of faults in structural components.
2.The use of vibration for finding out natural frequency, mode shaped of the cracked beam is found to be cost effective and accurate method. Hence can be used for structural health monitoring of different components.
3.The dynamic behavior of different structural components can be studied.
4.Vibration analysis is also used to detect faults in rotating equipment and machineries like pumps, electric motors, internal combustion engines etc.

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