Vibration Analysis of Inclined Edge Crack Beam By Theoretical and Experimental Result.

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ABSTRACT

In this paper, work on vibration analysis of a inclined edge crack beam has been studied. Different type of crack have been prepare by varying the crack depth and crack angle and studied under the simply supported and cantilever boundary conditions for modal analysis. The Natural frequencies are obtained for various specimen using different boundary conditions. The results obtained are compared with the theoretical approach and finite element based model results.

The experiment is conducted with help of 2 channels FFT analyzer on various specimens with different boundary condition like cantilever beam and simply supported beam condition

Keyword: *cantilever beam condition, simply supported beam condition, natural frequency, FFT analyzer etc ….*

1. INTRODUCTION

Most of the members of engineering structures operate under loading conditions, which may cause damages or cracks in overstressed zones. The presence of cracks in a structural member, such as a beam, causes local variations in stiffness, the magnitude of which mainly depends on the location and depth of the cracks. The presence of cracks causes changes in the physical properties of a structure which in turn alter its dynamic response characteristics. The monitoring of the changes in the response parameters of a structure has been widely used for the assessment of structural integrity, performance and safety. Irregular variations in the measured vibration response characteristics have been observed depending upon whether the crack is closed, open or breathing during vibration.

Damage or fault diagnosis, as determined by variation in the dynamic characteristics of structures, is a major issue that has focused in the literature. Most of the researchers are doing their research work related to crack detection using various techniques. A crack in the dynamic structures can lead to untimely failure if it is not identified in early time. The existence of a crack in a structural member leads a local flexibility that changes its vibration response. The main objective is that modal parameters like modal frequencies, mode shapes and modal damping are the functions of the structural properties like damping, stiffness and mass of the structure. So, the variation of structural properties will cause the variation in the modal properties.

2. THEORETICAL ANALYSIS

In this present research work it has been analyzed that the crack can be detected in the various structures through visual inspection or by the method of measuring natural frequency, mode shape and structural damping. As the measurement of natural frequency and mode shape is quite easy as compared to other parameters, so in this chapter a logical approach has been adopted to develop the expression to calculate the natural frequency and the mode shape of the cantilever beam with the presence of a transverse crack and the effect of natural frequency in the presence of crack.

2.1 Theoretical Approach

In this analysis, theoretical modeling of un-cracked cantilever beam for calculating the modal parameters i.e. modal frequencies and mode shapes and also modeling of cracked cantilever beam for calculating the modal parameters of the crack beam having inclined edge crack for different crack parameters i.e. Crack locations, crack depths and crack inclinations. The proposed theoretical method has been established by comparing the results with numerical analysis (FEA).

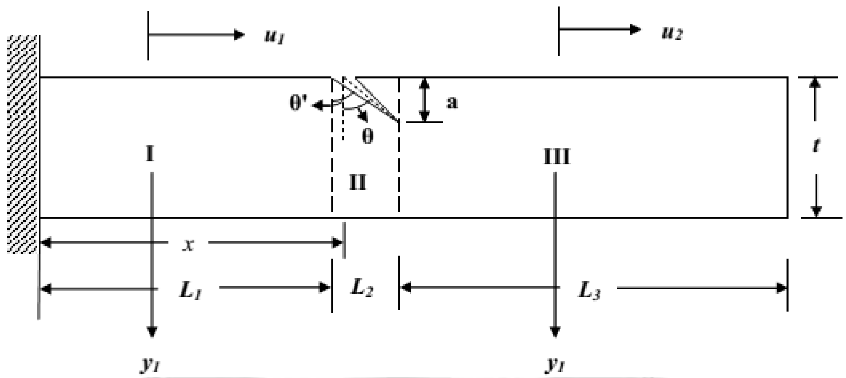


Fig.4.1 Geometry of inclined crack cantilever beam

2.2 MATERIAL PROPERTY

Table 1.1: Material Property and Dimensions of Aluminum Beam

Dimensions and Properties	Aluminum
Length	0.8m
Width	0.03m
Thickness	0.006m
Density	2700 kg/m^3
Young Modulus	70GPa
Poisson's ratio	0.3

2 EXPERIMENTAL APPROACHES

The experimental setup consists of a cantilever beam or simply supported Beam structure, transducers (strain gauge, accelerometer, and laser vibrometer), a data-acquisition systemand a computer with signal display and processing software (Fig. 2.1). Different types of inclined cracked beam materials are taken. Different combinations of beam geometries for each of the beam material. Accelerometer is a sensing element (transducer) to measure the vibration response (i.e., acceleration, velocity and displacement). Data acquisition system takes vibration signal from the accelerometer, and encodes it in digital form. Computer acts as a data storage and analysis system. It takes encoded data from the data acquisition systemand after processing (e.g., FFT), it displays on the computer screen by using analysis software.

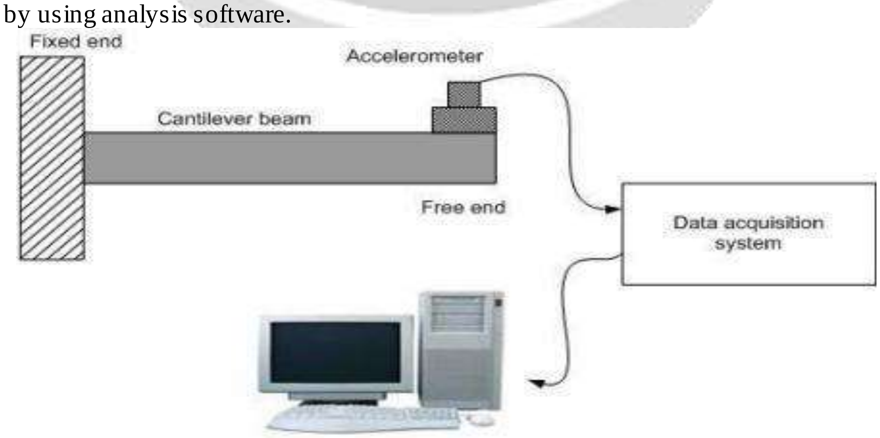


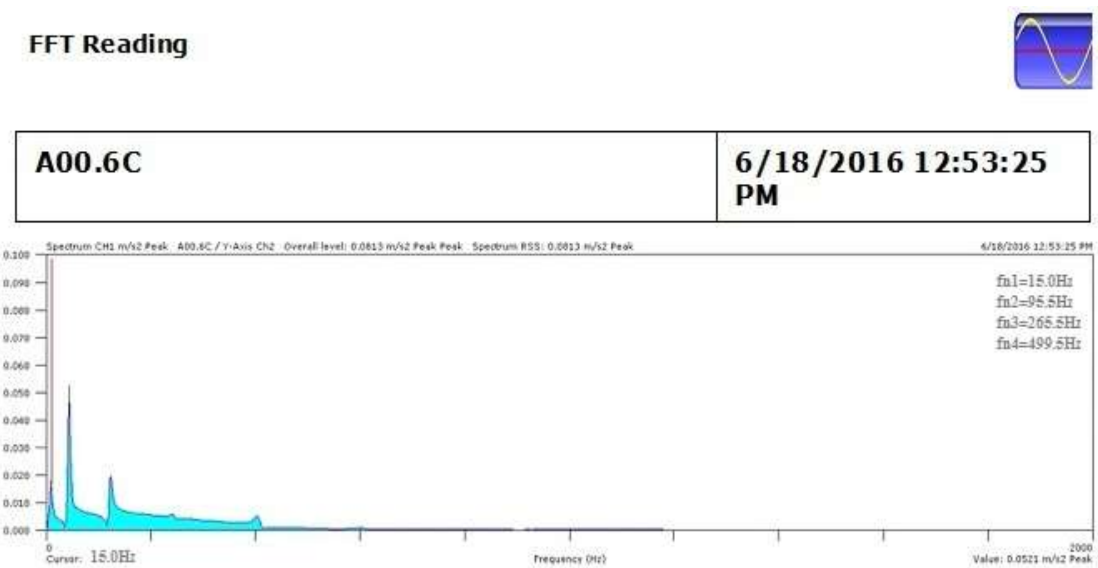
Fig. 2.1: An experimental setup for the free vibration of a cantilever beam

2.1 Experimental results

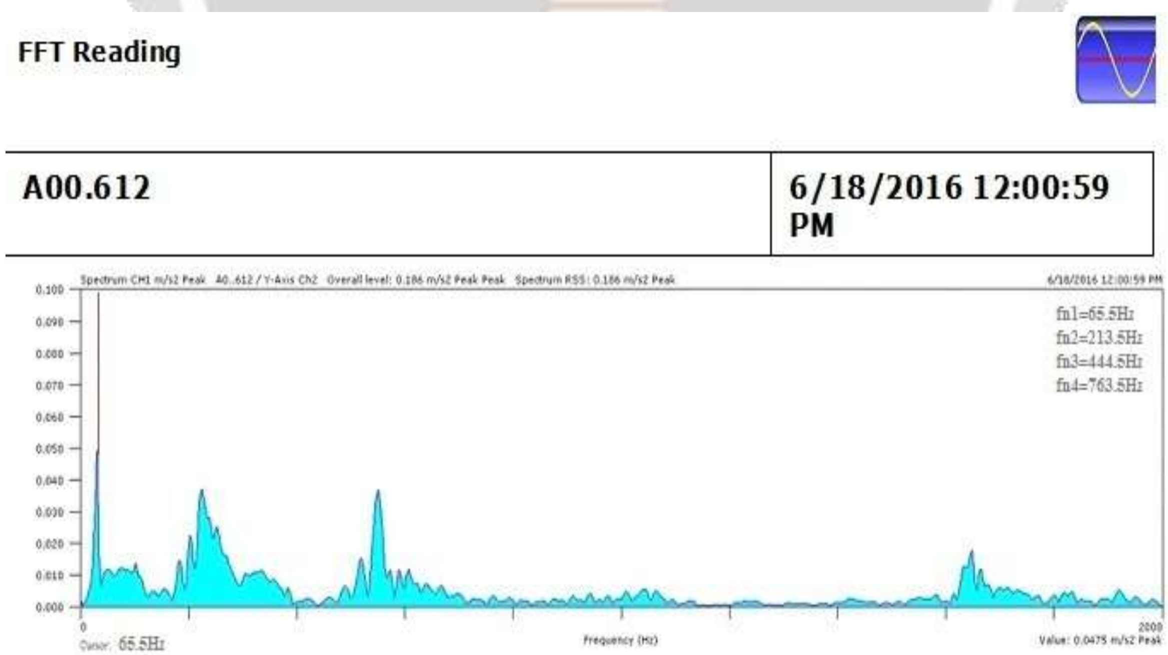
With the help of two channel FFT analyzer find out the free vibrational natural frequency for different mode. The various graphs of various specimens are obtained with the help of FFT analyzer, which shows behavior with free vibration.

The following graphs show the natural frequencies for different specimen which is obtained experimentally. The graphs are plotted with Mode v/s natural frequencies in Hz

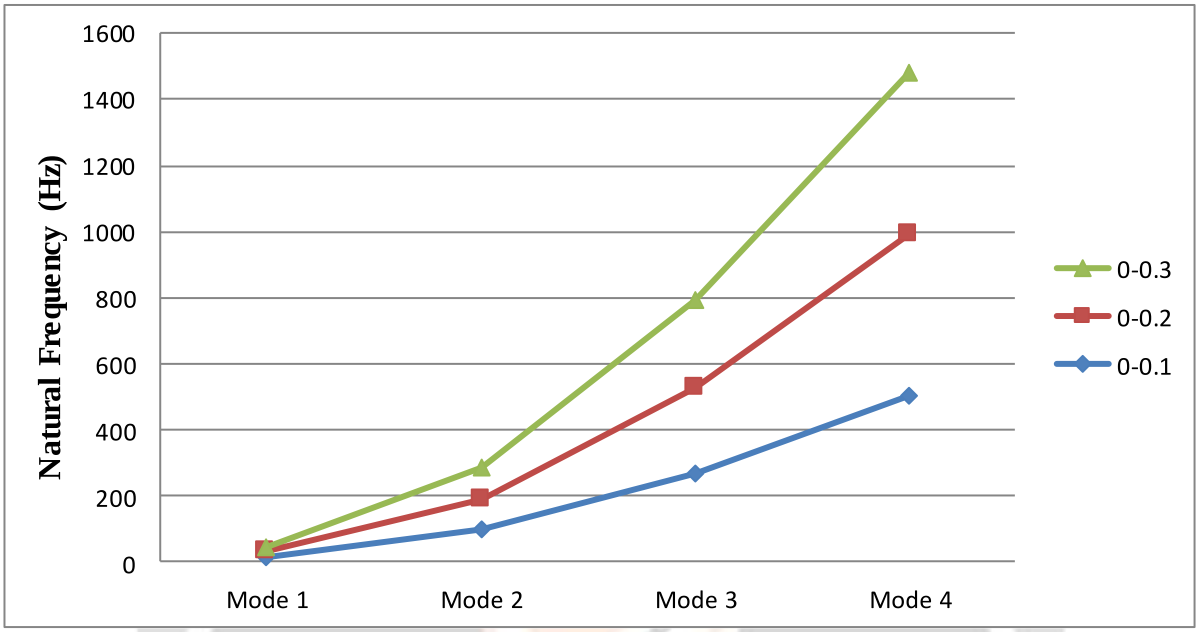
Graph No. 2.1 Natural frequencies for cantilever beam condition of 0^0 for 0.6mm depth.



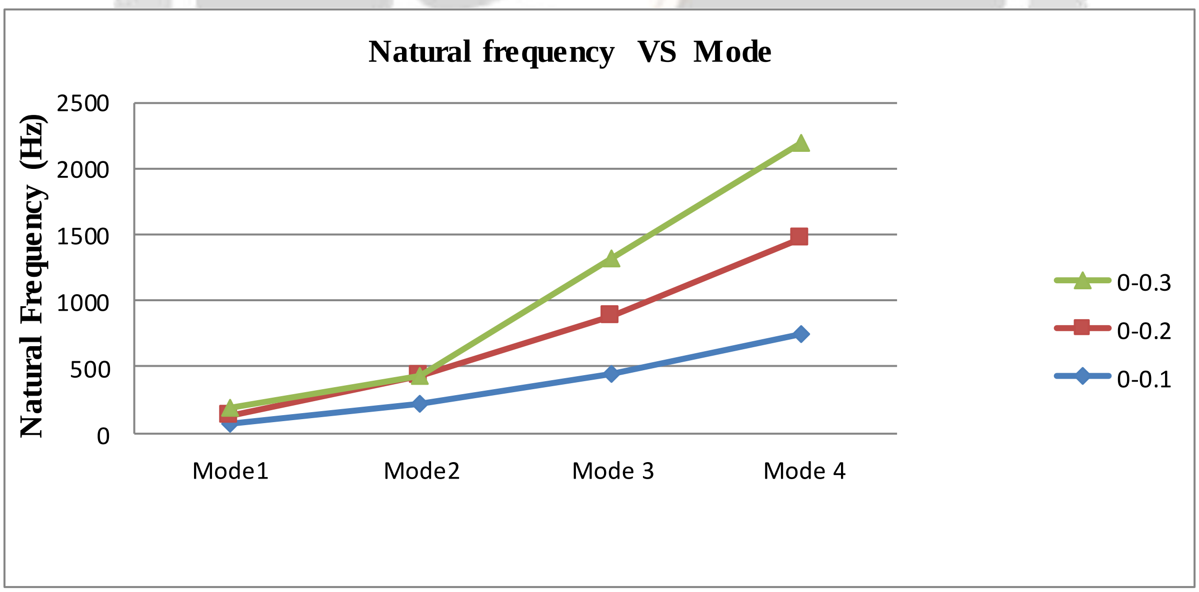
Graph No. 2.2 Natural frequencies for SSB beam condition of 0^0 for 0.6mm depth



Graph No. 2.3 Natural frequencies for cantilever beam condition of 0^0 for 0.6mm depth



Graph No. 2.4 Natural frequencies for SSB beam condition of 0^0 for 0.6mm depth

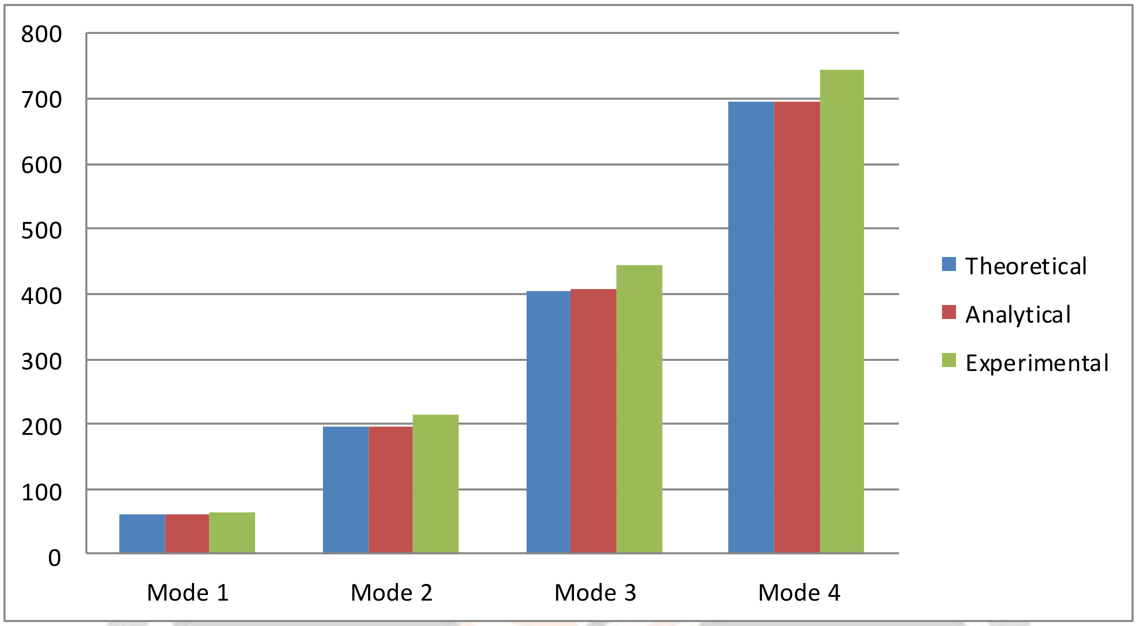


3. RESULTS ANALYSIS

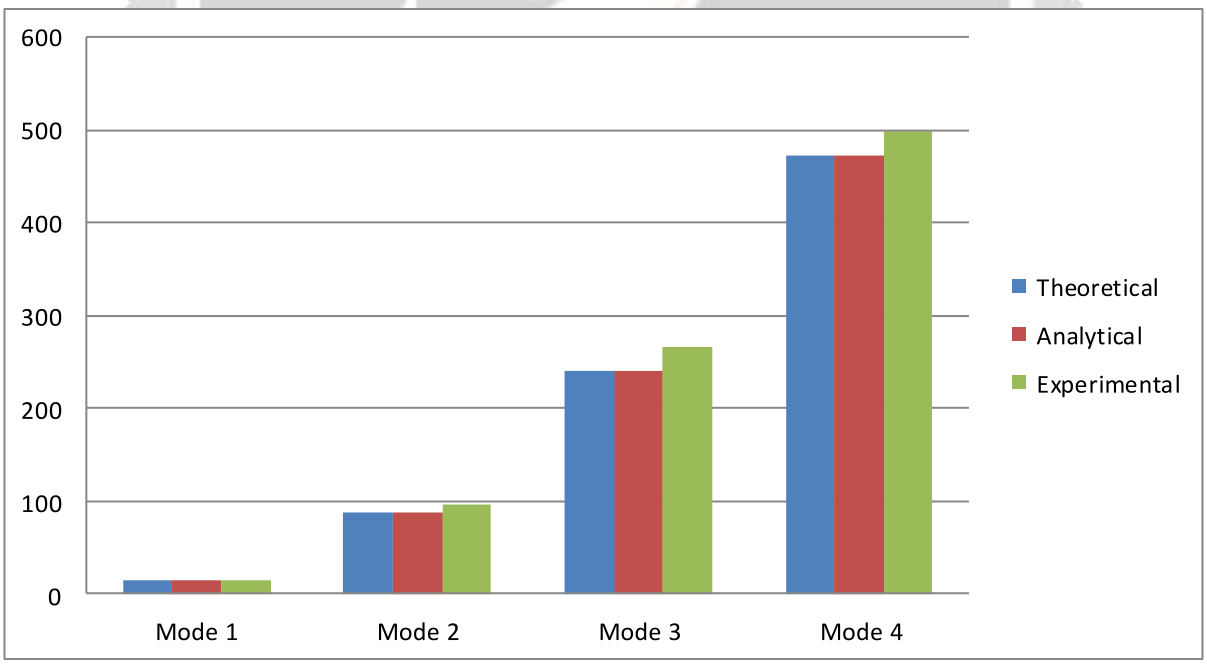
Graph shows that natural frequencies of the cantilever and simply supported beam with a inclined edge crack at various crack inclination and crack depths for first, second, third, fourth modes of vibration respectively. Results show that there is an appreciable variation between natural frequency of cracked and un-cracked beam

It is observed that natural frequency of the cracked beam decreases both with increase in crack inclination and crack depth due to reduction in stiffness. It appears therefore that the change in frequencies is not only a function of crack depth and crack inclination but also of the mode number.

Graph 3.1: Mode Analysis for 0^0- 0.6mm depth for Cantilever Beam condition



Graph 3.2 Mode Analysis for 0^0- 0.6mm depth for SSB Beam condition



4. CONCLUSIONS

Due to the changes in the crack parameters (crack location, crack depth and crack angle) there is always a significant change in the vibration parameters (natural frequencies and mode shapes).

The crack inclination angles are valid up to 45 ° for examining the transverse vibration. The crack location in the cantilever beam can be projected for crack size of more than 10% of depth

5. REFERENCES

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