A Review on Vibration Analysis of Cracked Cantilever Beam Using Different Methods

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Abstract - The objective of this paper is to understand the different types of vibration based Crack or damage detection techniques presented by various researchers for a cracked cantilever beam. In these methods use experimental results validate with “Finite element analysis” to find out the damage in fibre reinforce composite cantilever beam and non composite structures its vibrations. If damage or crack is present in structure it affects on dynamic characteristics and also there will be change in natural frequencies and stiffness of the beam. An analysis of these changes helps to identify the location of crack, depth and angle of crack.

Keywords – Crack detection, Vibration analysis.

I. INTRODUCTION

The physical discontinuity occurred in the geometry of the structures or machine components is termed as 'Crack or Damage'. beam is use as structural element in mechanical, civil, aeronautical, automobile engineering, damage is one of the important aspects in structural analysis and engineering. damage analysis is done to promise the safety as well as economic growth of the industries. generally damage in a structural element may occur due to normal operations, accidents, deterioration or severe natural events such as earth quake or storms. now a days the plants as well as industries are running round the clock to achieve the industrial goal. during operation, all structures are subjected to degenerative effects that may cause initiation of structural defects such as cracks which, as time progresses, lead to the catastrophic failure or breakdown of the structure. the inspection for quality assurance of manufactured products is thus very much important. to avoid the unexpected or sudden failure, earlier crack detection is essential. taking this ideology into consideration crack detection is one of the most important domains for many researchers. the most common structural defect is the existence of a crack in machine member. the presence of a crack could not only cause a local variation in the stiffness but it could affect the mechanical behaviour of the entire structure to a considerable extent.

Anish Pandey¹ the author has present inclined open edge crack in a cantilever beam and analyses the model using a finite element package, as well as experimental approach. The experiments are carried out using specimens having inclined edge cracks of different depths, positions and crack inclinations to validate the FEA results achieved.

Aniket S. Kamble [2] the author has presented the crack is modeled as a rotational spring and equation for non-dimensional spring stiffness is developed. By evaluating first three natural frequencies using vibration measurements, curves of crack equivalent stiffness are plotted and the intersection of the three curves indicates the crack location and size.

Missoum Lakhdar [3] the author has presented the detection of damage by vibration analysis, whose main objective is to exploit the dynamic response of a structure to detect understand the damage. The experimental results are compared with those predicted by numerical models to confirm the effectiveness of the approach.

Amit Banerjee [4] the author has presented to obtain information about the location and depth of transverse open multiple cracks in a rotating cantilever beams. Vibration parameter in the form of mode shape of damaged rotating beam is obtained using finite element simulation. Using fractal dimension of mode shape profile, damage is detected. It is also shown that this method can produce satisfactory results with some limitation based on profile.

Marco A. Perez [5] the author has presented the results of an extensive experimental campaign conducted to investigate the feasibility of using vibration-based methods to identify damages sustained by composite laminates due to low-velocity impacts. The experimental programme included an evaluation of impact damage resistance and tolerance according to ASTM test methods, characterization of induced damage by ultrasonic testing and quantification of the effects on the vibration response. The damage identification involved the detection, localization, quantification and estimation of the remaining bearing capacity.

Kausar H. Barad [6] the author has presented detection of the crack presence on the surface of beam-type structural element using natural frequency is presented. First two natural frequencies of the cracked beam have been obtained experimentally and used for detection of crack location and size.
Baviskar[7] the author has addressed the method of multiple cracks detection in moving parts or beams by monitoring the natural frequency and prediction of crack location and depth using Artificial Neural Networks (ANN). Determination of crack properties like depth and location is vital in the fault diagnosis of rotating machine equipments. To investigate the validity of the proposed method, some predictions by ANN are compared with the results given by FEM FB Sayyad[8] the author has develop suitable methods that can serve as the basis to detection of crack location and crack size from measured axial vibration data. This method is used to address the inverse problem of assessing the crack location and crack size in various beam structure. The method is based on measurement of axial natural frequencies, which are global parameter and can be easily measured from any point on the structure and also indeed, the advantage in modelling complexity. In theoretical analysis, the relationship between the natural frequencies, crack location, and crack size has been developed. The experimental analysis is done to verify the practical applicability of the theoretical method developed. Saidi abdelkrim[9] the author has present vibration behaviour of concrete beams both experimentally and using FEM software ANSYS subjected to the crack under free vibration cases. Besides this, information about the location and depth of cracks in cracked concrete beams can be obtained using this technique. Murat Kisa[10] the author has presented a novel numerical technique applicable to analyse the free vibration analysis of uniform and stepped cracked beams with circular cross section. In this approach in which the finite element and component mode synthesis methods are used together, the beam is detached into parts from the crack section.

P. K. Jena[11] This paper addresses the fault detection of Multi cracked slender Euler Bernoulli beams through the knowledge of changes in the natural frequencies and their measurements. The spring model of crack is applied to establish the frequency equation based on the dynamic stiffness of multiple cracked beams. Theoretical expressions for beams by natural frequencies have been formulated to find out the effect of crack depths on natural frequencies and mode shapes. The equation is the basic instrument in solving the multi-crack detection of beam.

D.K. Agarwalla[12] the author has presented inverse problem of assessing the crack location and crack size in various beam structures. The study is based on measurement of natural frequency, a global parameter that can be easily measured at any point conveniently on the structure. In theoretical analysis the crack is simulated by a spring, connecting the two segments of the beam. The catachrestic equation obtained from the vibration analysis of Eluer-Bernoulli beam is manipulated to give the relationship between the stiffness & location of crack.

S.P.Mogal[13] the author has presented vibration analysis of cracked cantilever beam and verified theoretical result with ansys result. If the crack is presence natural frequency is reduced. Pankaj Charan Jena[14] the author has presented fault detection in a single cracked beam has been worked out. The identification of location and the depth of crack in a beam containing single transverse crack is done through theoretical and experimental analysis respectively. It has come to noticed that a crack in a beam has great effect on dynamic behavior of beam. The strain energy density function also applied to examine the few more flexibility produced to because of the presence of crack. The difference of mode shapes of cantilever beam, simply supported beam and Clamped – Clamped beam in between the first three modes of cracked and un-cracked respectively beam with its amplified view at the zone of the crack locale are studied. The theoretical analyses are carried out of the crack structure.

Kaustubha V. Bhide[15] the author has presented the inverse problem of assessing the crack location and crack size in various beam structures. The study is based on measurement of natural frequency, a global parameter that can be easily measured at any point conveniently on the structure. In theoretical analysis the crack is simulated by a spring, connecting the two segments of the beam. The catachrestic equation obtained from the vibration analysis of Eluer-Bernoulli beam is manipulated to give the relationship between the stiffness & location of crack.

P.K. Sharma[16] the author has use ANSYS software package for finite element analysis of both crack and un-crack cantilever beam taking input file as a CAD design developed in CATIA. Experiments is done for total 10 models of crack beam having different cross section. The presence of crack leads to changes in some of the lower natural frequencies. The proposed approach has been verified by comparing results obtained from theoretical method and finite element analysis. The concept of vibration can be applied to identify the crack location.

Ezekiel Kingsley C[17] the author has presented a method on the use of the amplitude of higher harmonic components of excited frequency of vibration for the detection of crack, its location and size. A cantilever beam has been considered for the study and Finite Element (FE) model was developed. Acceleration responses when excited at the first mode were calculated for healthy case and crack at different locations.

Jialai Wang[18] has presented damage detection technique using irregularity profile of a structural mode shape. The mode-shape of a cracked beam is first obtained analytically by using a general function. Its irregularity profile is then extracted from the mode shape by a numerical filter. The location and size of the crack in the beam can be determined by the peak value appearing on the irregularity profile. The successful detection of the crack in the composite
beam demonstrates that the irregularity-based method is capable of assessing both the location and size of the crack and can be used efficiently and effectively in damage identification and health monitoring of beam-type structures. A. Dixit[19] the author has presented damage magnitude which relates the strain energy, to the damage location and magnitude. The strain energy expression is calculated using modes and natural frequencies of damaged beams that are derived based on single beam analysis considering both decrease in mass and stiffness. The method is applicable to beams, with notch like non-propagating cracks, with arbitrary boundary conditions. The analytical expressions derived for mode shapes, curvature shapes, natural frequencies and improved strain energy based damage measure, are verified using experiments. The damage measure was shown to be extremely sensitive to the damage as both the discontinuity in stiffness and also the curvature are contained in the damage measure. A limitation of the damaged measure was that it depended on accurate measurement of damaged mode shapes. Irshad A Khan[20] the author has presented presence of cracks a severe threat to the performance of structures and it affects the vibration Signatures. Natural frequency increases and Mode shape decreases as the crack depth increases. Experiment are also conducted, results of experiment having good correlation with results of finite element analysis.

II. CONCLUSIONS

It has been if the natural frequency and mode shape change that parameter crack size and location respectively. Some researchers have considered composite structures in their study to analyse the effect of various parameters like crack location, crack size, crack depth, crack inclination on the dynamic behaviour of structures subjected to vibration. Researchers are presently focusing on using the concept of fuzzy Logic and genetic Algorithm, Artificial Neural Network (ANN) as an effective tool for vibration analysis of damaged structures. Various models have been developed by researchers using various theories and concepts to study the dynamic characteristics of damaged vibrating structures having various types of crack like Transverse, Longitudinal, Slant, Gaping, Surface, Subsurface, breathing, open edge crack and internal cracks.

REFERENCES


