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A Review on vibration technique used in order to defined the condition of the structure

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***ABSTRACT*: The aim of this paper is diagnosis of various vibration based crack detection technique by various researches. For detection of damage in a fiber reinforced composite. Many developments have been carried out in order to try to quantify the effects produced by dynamic loading. Examples of structures where it is particularly important to consider dynamic loading effects are the construction of tall buildings, long bridges under wind-loading conditions and buildings in earthquake zones, etc. Damage in structure alters its dynamic characteristics. It results in reduction of natural frequencies and changes in mode shapes, stiffness of the beam. An analysis of these changes makes it possible to determine the location and depth of cracks. There due to such importance of this analysis a brief review of this area is required, therefore in this paper a brief review on this technique is conducted**

1. INTRODUCTION

Beams are fundamental models for the structural elements of many engineering applications and have been studied extensively. There are many examples of structures that may be modeled with beam-like elements; for instance, long span bridges, tall buildings, and robot arms, beams as well as the presence of cracks in the structural components can have a significant influence on the dynamic responses of the whole structureThere are many techniques to evaluate the problem of a cracked beam such as numerical, analytical, and experimental. FEM (Finite Element Method) is a common technique to obtain the stiffness matrix of the cracked beam element. During last few decades, intensive research on the detection of crack using the vibration based techniques has been done. In this present paper number of literatures published so far have been surveyed, reviewed and analyzed. This paper focus on various cost effective reliable, numerical and experimental techniques developed by various researchers for vibration analysis of cracked beams.The maintenance management was taken up as a serious issue only after the dynamic industrial revolution dur8ing the Second World War (Vyas&Pophaley, 2010). Rapid modernization and the increasing need for high yielding productivity have led to finer development and use of hi-tech and complex machines and equipment's. Therefore, high cost capital is involved in the production shop floor and the occurrence of incipient and frequent failures may result in production downtime and huge losses for the enterprise. Hansen I.H, in his paper, referred that maintenance cost can be the second largest part of organizational budget, next to only energy costs (Hansen, 2006).

2. VIBRATIONS ANALYSIS TECHNIQUE

In today's times 80% of the parameters measured likely to be, vibrations based. Hence, Vibrations monitoring and analysis is also one of the most widely used technique in condition based maintenance and rely a lot on instrumentation Machine vibrations stack a lot of information about the condition of a machine. Measurement and analysis of the vibration response gives a lot of information with relevance to fault conditions in different types of machines.

3. VIBRATION ANALYSIS

Free vibrational characteristics of layered circular plates are considered by Venkatesan and Kunukkasseril (1978). The equations incorporating shear deformation and rotatory inertia are developed for the asymmetric motion. For axisymmetric motion, exact closed form solutions are obtained. Timothy and Nayfeh (1996) developed the analysis and numerical calculations for the exact free vibration characteristics of simply supported, rectangular, thick, multilayered composite plates and assumed that each layer of the composite plate is of arbitrary thickness, is perfectly bonded to adjacent layers, possesses up to orthotropic material symmetry and that its material crystallographic axes are oriented either parallel or perpendicular to the plate's boundaries. Exact formal solutions are obtained for the individual layers which are, in turn, used to relate the field variables at the upper and lower layer surfaces. The solution is carried through by the successive application of appropriate interfacial continuity conditions between adjacent lamina.

4. HISTORICAL PROSPECTIVE

Beams are fundamental models for the structural elements of many engineering applications and have been studied extensively. There are many examples of structures that may be modeled with beam-like elements, for instance, long span bridges, tall buildings, and robot arms. The vibration of Euler–Bernoulli beams with one step change in cross-section has been well studied. Jang and Bert (1989) derived the frequency equations for combinations of classical end supports as fourth order determinants equated to zero. Balasubramanian and Subramanian (1985) investigated the performance of a four-degree-of-freedom per node element in the vibration analysis of a stepped cantilever

5. LITERATURE REVIEW

Murat et al. explained that, in which the finite element analysis and component mode synthesis methods are used together, the beam is separated into parts from the crack section. Numerous techniques, such as non-destructive monitoring tests, can be used to veil the condition of a structure. Novel techniques to identify structural defects should be explored. A crack in a structural element alters its stiffness, dynamical performance and damping properties. The mode shapes and natural frequencies of the specimen hold information relating to the location and dimension of the crack. Vibration analysis allowing online inspection is an attractive method to identify cracks in the structures. These sub-structures are joined by using the flexibility matrices taking into account the interaction forces derived by fracture mechanics theory as the inverse of the compliance matrix found with stress intensity factors and strain energy release rate expressions. To reveal the accuracy offered method, a number of numerical examples are given for free vibration analysis of cantilever beams with transverse nonpropagating open crack. Numerical results showing good agreement with the results of other possible studies, address the effects of the depth and location of the cracks on the natural frequencies and mode shapes of the damaged beam. Modal characteristics of a cracked beam can be employed in the crack recognition process.

Rao et al. UK in Vibration Analysis of Beam analyze the vibration characteristics of beams. All real physical structures, when subjected to loads or displacements, behave dynamically. The additional inertia forces, from Newton's second law, are equal to the mass times the acceleration. If the loads or displacements are applied very slowly then the inertia forces can be neglected and a static load analysis can be justified. Hence, dynamic analysis is a simple extension of static analysis. Many developments have been carried out in order to try to quantify the effects produced by dynamic loading. Examples of structures where it is particularly important to consider dynamic loading effects are the construction of tall buildings, long bridges under wind-loading conditions and buildings in earth quake zones, etc.

Behzad et al.proposed new techniques for vibration analysis of a cracked beam in A new approach for vibration analysis of a Cracked beam. In this paper the equations of motion and corresponding boundary conditions for bending vibration of a beam with an open edge crack has been developed by implementing the Hamilton principle. A uniform EulerBernoulli beam has been used in this research. The natural frequencies of this beam have been calculated using the new developed model in conjunction with the Galerkin projection method. The crack has been modeled as a continuous disturbance function in displacement field which could be obtained from fracture mechanics. The results show that the natural frequencies of a cracked beam reduce by increasing crack depth. There is an excellent agreement between the theoretically calculated natural frequencies and those obtained using the finite element method.

Huang et al. Vibration Analysis of Beams with and without Cracks Using the Composite Element Model. Beams are fundamental models for the structural elements of many engineering applications and have been studied extensively. There are many examples of structures that may be modeled with beam-like elements, for instance, long span bridges, tall buildings, and robot arms. The vibration of Euler–Bernoulli beams with one step change in cross-section has been well studied. The correctness and accuracy of the proposed method are verified by some examples in the existing literatures. The presence of cracks in the structural components, for instance, beams can have a significant influence on the dynamic responses of the whole structure; it can lead to the catastrophic failure of the structure. To predict the failure, vibration monitoring can be used to detect changes in the dynamic responses and/or dynamic characteristics of the structure. Knowledge of the effects of cracks on the vibration of the structure is of importance. Efficient techniques for the forward analysis of cracked beams are required.

Chasalevriset al. studied the dynamic behavior of a cracked beam with two transverse surface cracks. Each crack is characterized by its depth, position and relative angle. A local compliance matrix of two degrees of freedom, bending in the horizontal and the vertical planes is used to model the rotating transverse crack in the shaft and is calculated based on the available expressions of the stress intensity factors.

Ranjanet al. presented to model an inclined open edge crack in a cantilever beam and analyse 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.

Orhan et al. studied the free and forced vibration analysis of a cracked beam was performed in order to identify the crack in a cantilever beam. Single- and two-edge cracks were evaluated. Dynamic response of the forced vibration better describes changes in crack depth and location than the free vibration in which the difference between natural frequencies corresponding to a change in crack depth and location only is a minor effect.

Kausharet al.explained that, detection of the crack presence on the surface of beam type structural element using natural frequency is discovered. First two natural frequencies of the cracked beam have been obtained experimentally and used for detection of crack location and size. Obtained crack locations and size are compared with the actual results and found to be in good agreement. All structures are prone to damage, may be due to over-stressing in operation or due to extreme environmental conditions or due to any accident. Crack present in the specimen may grow during service and may result in the component failure once they develop beyond a critical limit. It is desirable to investigate the damage occurred in the structure at the earlier stage to protect the structure from possible failures. Thus, Vibration Based Inspection (VBI) can be a effective method for crack detection.

Prasad et al. explained that, the method of multiple cracks detection in moving parts or beams by monitoring the natural frequency and forecasting of crack location and depth using Artificial Neural Networks (ANN). Detection of crack properties like depth and location is vital in the fault diagnosis of rotating machine components. For the theoretical analysis, Finite Element Method (FEM) is used wherein the natural frequency of beam is calculated whereas the experimentation is done by using Fast Fourier Transform (FFT) analyzer. In experimentation, simply supported beam with one crack and cantilever beam with two cracks are considered. The experimental results are validated with the results of FEM (ANSYS) software. This formulation can be extended for various boundary conditions as well as varying cross sectional areas.

Sayyad et al. explained that, to develop suitable methods that can serve as the basis to detection of crack location and crack size from measured axial vibration data. Cracks develop gradually through time that lead finally to catastrophic failure. Therefore, crack should be monitored regularly with more care. This will lead to more effective preventive measure and ensure continuous operation of the structure and machine. Damage in structure alters its dynamic characteristics. The change is characterized by change in modal parameters, that is, modal frequencies. Thus, vibration technique can be suitably used as a non-destructive test for crack detection of component to be tested. This method for detection of crack from measurement of natural frequencies of cracked free–free beam for axial vibration is developed. Analysis of this approximate model results in algebraic equations, which relate the natural frequencies of beam and crack location. These expressions are applied to studying the inverse problem, that is, identification of crack location from frequency measurements.

Ranjan et al. explained that, A crack in the vibrant structures can lead to premature failure if it is not detected in early stages. The failure rate increases as the crack growth increases due to the structure becomes weaker. Therefore, crack detection and type of crack is a key issue. The existence of cracks which affect the performance of structure as well as the vibration characteristics such as; natural frequencies, mode shapes, stiffness and modal damping. This paper presented model an inclined open edge crack in a cantilever beam and analyzes the model using a finite element analysis, as well as experimental approach. When the natural frequency increases, the crack location also increases. At particular crack location of a beam, the amplitude is minimum with respect to other beams having varying crack location.

6. CONCLUSION

Many of researcher used different non-destructive techniques for detection of crack in vibrating structure. According to the researcher, presence of crack alters the dynamic characteristics of structure. This change in dynamic source used as a information source. Researchers done lot of work on effect of crack depth, crack location and crack inclination on natural frequency and mode shape. Researcher used transfer matrix method as an input data. Physical properties, boundary condition, crack depth, crack inclination,crack inclination ,orientation and number of cracks greatly influence the dynamic response of the structure. Some have used wavelet analysis for detection in vibrating structure.It has been observed that the change in frequencies is not only a function of crack depth, and crack location, but also of the mode number. When the position of the crack is at that point where amplitude of vibration is zero there is no change in natural frequency in spite of change in crack depth. Natural frequency changes drastically when crack is on that point where amplitude of vibration is maximum.

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