A Review paper on detection of Crack developed in Cantilever Beam by Using Various Techniques

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Abstract - The aim of this paper is to discuss various vibration based crack detection technique by various researches for crack detection. Crack and damage in cantilever beam method used to compare by finite element analysis and experimental modal analysis. Static as well as dynamic response characteristics of structure are greatly affected by cracks. Crack in a beam changes the natural frequency, mode shape & stiffness of the beam. To determine the location and depth of cracks we have to analysis the changes occur in structural characteristics.

Key Words: Cantilever beam, Vibration Analysis, free vibration, natural frequencies, Finite element Method.

1. INTRODUCTION

In modern era cantilever beams are used in major structures. Applications of cantilever beams are wide in civil, mechanical, naval, and aeronautical engineering. Response of structure varies according to time and load histoty. As structure becomes older it get damage and weak. For safety point of view damage analysis is an essential step for health growth of industries. During operation, structures are subjected to degenerative effects that may cause structural defects such as cracks which, as time progresses, lead to the catastrophic failure or breakdown of the structure. To avoid the unexpected or sudden failure, earlier crack detection is essential.

Various nondestructive methodologies for crack detection have been researched worldwide. However the vibration based method is fast and inexpensive for crack/damage identification.

In this paper different experimental technique used by various researchers for vibration analysis of cracked cantilever beams is highlighted.

In this paper the beam subjected to vibration and its effect on various parameters like crack size, crack location of beam also has been reviewed.

2. LITERATURE REVIEW

P. K. Jena [1] has used Multi cracked slender Euler Bernoulli beams and identifies the cracks through the knowledge of changes in the natural frequencies and their measurements. In this method crack is modeled by rotational spring. The spring model of crack is used 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 changes occur in mode shapes are observed at the area of crack location.

Ranjan K. Behera [2] explained that, the vibrant structures can lead to premature failure due to a crack if it is not detected in early stages. As the crack growth increases, the structure becomes weaker and failure rate increases. Therefore, key issue is a type of crack and crack detection. In his research experimental approach as well as finite element package is used for the analysis of open edge crack in a cantilever beam. The experiments are carried out using specimens having inclined edge cracks of different depths, positions and crack inclinations to validate the FEA results achieved. For examining the transverse vibration acceptable crack inclination angles is up to 45 °. It has been seen by examples that the determination of the crack location is more precise than the determination of the crack size.

Aniket S. Kamble [3] explained is research by using vibration measurements and evaluated first three natural frequencies, curves of crack stiffness are plotted and the intersection of the three curves indicates the crack location and size. Cantilever beam with single crack are compared between ANSYS and FFT results. Both FEM and FFT results show that the adequate accuracy and high sensitivity for small cracks. The estimated error of the crack location increases with the increase in crack depth.

Saidi abdelkrim [4] has analyzed the vibration behavior of concrete beams both experimentally and using FEM software ANSYS subjected to the crack under free vibration cases. Dynamic characteristics are very different of damaged and undamaged materials. It is essential to know the dynamics of cracked structures as vibrating parts can leads to catastrophic failures.

S.P.Mogal [5] has presented vibration analysis is carried out on a cantilever beam with two open cracks to study the response characteristics. In first phase local compliance matrices of different degree of freedom have been used model transverse cracks in beam on available expression of stress intensity factor and strain energy release rate. The results obtained numerically are validated with results obtained from simulation (FEM). The simulations have been done with the help of ANSYS software.

Murat Kisa,[6] has introduced methods for numerical modeling of the free vibration of cantilever beam having multiple open and non propagating cracks. In this study, It is revealed that the knowledge of modal data of cracked beams forms an important aspect in finding the structural failure.

Kaushar H. Barad [7] has done analysis of cantilever beam by using natural frequency .For identification of damage first two natural frequencies parameters of the cracked beam were obtained experimentally and used for detection. Observed crack locations and size were compared with the actual results and found to be in good alike agreement. The effect of the natural frequency on the damage parameters was also discussed. By this study we came to know that the natural frequency was greatly affected by crack depth and crack location. Result shows that it was clearly observed that the crack of a particular size present near the fixed end minimizes the natural frequency significantly greater than the crack of that size present closer to the free end. Tthe smaller crack to depth ratio has less effect on the normalized natural frequency than that of higher ratio.

3. MATERIALS AND METHODS

Various methods are used on different materials fot Vibration analysis. Materials like Aluminum, Mild steel, concrete is followed by different researchers by their methods such as experimental, finite element analysis, Artificial Neural Networks, Wavelet analysis, MATLAB, ANSYS, numerical model analysis, and numerical, experimental methods.

4. DISCUSSION

Different non-destructive techniques is used by many researchers for detection of crack in vibrating structure . According to the researcher, the change in dynamic characteristics of structure is due to presence of crack. This modification in dynamic source used as an information source. Researchers have different explanations 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 inclination, orientation, crack depth and number of cracks greatly influence the dynamic response of the structure. Some have used wavelet analysis for detection in vibrating structure.

For identification of crack in beam structure many researchers worked on the genetic algorithm, Fuzzy logic techniques and Artificial Neural Network. Researchers used concept like strain energy, stress intensity factor and fracture mechanics for detection of crack in cantilever beam.

5. CONCLUSION

It is observed that detection of crack location, crack size in cantilever beam depends on natural frequencies and mode shapes. Studied of analysis by different researches are based on dynamic behavior of structure by varying crack inclination, crack location, and crack depth. Analyzing vibration system are done by using different techniques by Researchers. As advancement of technology is taking place researcher using artificial neural network (ANN), genetic algorithm and fuzzy logic techniques for damage detection in structure. Researcher developed various theories and concept like transverse crack, longitudinal crack, breathe, slant crack, open crack, surface crack etc to identify dynamic characteristics of structure.

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