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STUDY ON EFFECT OF CRACK INCLINATION AND LOCATION ON NATURAL FREQUENCY FOR INCLINED EDGE CRACKED BEAM USING FREE VIBRATION

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Abstract –

Damages like inclined crack in vibrating component can initiate catastrophic failures. The presences of cracks change the physical characteristics of a structure which in turn alter its dynamic response characteristics. Therefore there is need to understand dynamics of cracked structures. Crack inclination, depth and location are the main parameters for the vibration analysis. So it becomes very important to monitor the changes in the response parameters of the structure to access structural integrity, performance and safety. This paper focuses on the vibration analysis of a beam with fixed free (Cantilever) boundary condition and investigates the mode shape and its frequency. The existence of inclined crack in a structural element leads a local stiffness that changes its vibration response. Finite Element Analysis (ANSYS) has been accomplished to derive the vibration signatures of the inclined cracked cantilever beam.

Key Words: ANSYS, Crack Depth, Inclined crack, Mode shape, Modal Natural Frequency

1.INTRODUCTION

Damages like inclined crack in vibrating component can initiate catastrophic failures. The presences of cracks change the physical characteristics of a structure which in turn alter its dynamic response characteristics. Therefore there is need to understand dynamics of cracked structures. Crack inclination, depth and location are the main parameters for the vibration analysis. So it becomes very important to monitor the changes in the response parameters of the structure to access structural integrity, performance and safety. Cracks in a structural element in the form of initial defects within the material or caused by fatigue or stress concentration can reduce the natural frequencies and change the vibration mode shapes due to the local flexibility introduced by the crack. Understanding the dynamic characteristics of cracked structures is of prime importance in structural health monitoring and non-destructive damage evaluation because the predicted vibration data can be used to detect, locate, and quantify the extent of the cracks or damages in a structure.

Classification of Crack

Based on geometries, cracks can be broadly classified as follows::

Transverse crack : These are cracks perpendicular to beam axis. These are the most common and most serious as they reduces the cross section as by weaken the beam .They introduce a local flexibility in the stiffness of the beam due to strain energy concentration in the vicinity or crack tip.

Longitudinal cracks : These are cracks parallel to beam axis. They are not that common but they pose danger when the tensile load is applied at right angles to the crack direction i.e. perpendicular to beam axis.

Open cracks : These cracks always remain open .They are more correctly called “notches”. Open cracks are easy to do in laboratory environment and hence most experimental work is focused on this type of crack

Breathing crack : These are cracks those open when the affected part of material is subjected to tensile stress and close when the stress is reversed.

Many researchers to develop various techniques for early detection of crack location, depth, size and pattern of damage in a structure. Some nondestructive methodologies for crack detection have been use in global. However the vibration based method is fast and inexpensive for crack/damage identification. Hence it is possible to use natural frequency measurements to detect cracks.

Abdul Salam *et. al*, has presented simplified formula for the stress correction factor in terms of the crack depth to the beam height ratio, f(a/h). The natural frequencies of the cracked beam are determined numerically by solving the characteristic equation of the beam.[1] Abhijit Naik and Pawan Sonawane studied on vibration based Crack/damage diagnosis techniques presented by various researchers for cracked structures. These methods use “finite element analysis techniques, together with experimental results, to detect damage in a fiber reinforced composites, laminated composites and non composite structures for its vibration analysis.[2] Dayal. R. Parhi, Prases. K. Mohanty, Sasmita Sahu and Amiya Kumar Dash have presented analytical as well as experimental methods to locate and quantify the size of damage in beam type structure from vibration mode.[3] Kaustubha V. Bhinge *et. al*, tried to establish a systematic approach to study and analyze the crack in cantilever beam. It is addresses 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.[4] Ranjan K. Behera, Anish Pandey, Dayal R. Parhi in their research work has developed the theoretical expressions to find out the natural frequencies and mode shapes for the cantilever beam with two transverse cracks.[5] In the present investigation a number of literatures published so far have been surveyed, reviewed and analyzed. Most of researchers studied the effect of single crack on the dynamics of structures. However

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