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AN OVERVIEW OF VIBRATION ANALYSIS OF CRACKED SIMPLY SUPPORTED BEAM WITH NONLINEAR PARAMETERS

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ABSTRACT

The objective of this paper is to update its readers the various vibration based Crack diagnosis techniques presented by various researchers for a cracked structures. These methods use "theoretical finite element analysis techniques, together with experimental results, to detect damage in different types of beam like cantilever, fixed-fixed beam, simply supported beam. 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 position and depth of cracks.

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KEYWORDS: Beam, Crack Detection, Vibration analysis, FEA, Natural frequency, Mode shapes, Cantilever, Fixed-Fixed beam, Simply Supported Beam.

INTRODUCTION

A beam is an elongated member, usually slender, intended to resist lateral loads by bending [1]. Structures such as antennas, helicopter rotor blades, aircraft wings, towers and high rise buildings are examples of beams. These beam-like structures are typically subjected to dynamic loads. Therefore, the vibration of beams is of particular interest to the engineer. For beams undergoing small displacements, linear beam theory can be used to calculate the natural frequencies, mode shapes, and the response for a given excitation. However, when the displacements are large, linear beam theory fails to accurately describe the dynamic characteristics of the system. Highly flexible beams, typically found in aerospace applications, may experience large displacements. These large displacements cause geometric and other nonlinearities to be significant. The nonlinearities couple the (linearly uncoupled) modes of vibration and can lead to modal interactions where energy is transferred between modes [2].

This investigation focuses in the study of the vibration analysis of cracked simply supported beam subjected to free excitation at the base. The objective of the study is to identify the effect of non-linearity's on the natural frequency and mode shapes of cracked simply supported beam by theoretical, numerical and experimental methods.

VIBRATION ANALYSIS OF CRACKED CANTILEVER BEAM WITH NON-LINEAR PARAMETERS AND HARMONIC EXCITATION.

Mr. R. S. Pawar [3] has presented Experimental Static Analysis of A Cantilever Beam With Nonlinear Parameters. The beam-like structures are typically subjected to dynamic loads. In this paper classical problem of deflection of a cantilever beam of linear elastic material, under the action of a uniformly distributed load along its length (its own weight), is experimentally and numerically analyzed. Paper presents the differential equation governing the behavior of this system and shows that these equations are difficult to solve due to the presence of nonlinear term. The experiment described in this paper is an easy way to introduce the concept of geometric nonlinearity in mechanics of material. Finally numerical result is carried out by ANSYS program and compared with the experimental results. Comparative static analysis of cantilever beam for mild steel material is carried out. The numerical results from Finite Element analysis showed in general a good agreement with the experimental static values.

NEW ANALYTICAL METHOD FOR VIBRATION ANALYSIS OF A CRACKED SIMPLY SUPPORTED BEAM

J.Fernad Ndez-Sad Ez [4] has formulated approximate calculation of the fundamental frequency for bending vibration of cracked beam. A simplified method of evaluating the fundamental frequency for the bending vibrations of cracked Euler Bernoulli beams is presented. The method is based on the well-known approach of representing the crack in a beam through a hinge and an elastic spring, but here the transverse deflection of the cracked beam is constructed by adding polynomial functions to that of the uncracked beam. With this new admissible function, which satisfies the boundary and the kinematic conditions, and by using the Rayleigh method, the fundamental frequency is obtained. This approach is applied to simply supported beams with a cracked section in any location of the span. For this case, the method provides closed-form expressions for the fundamental frequency. Its validity is confirmed by comparison with numerical simulation results. In all the cases considered in this paper, the results are very close to those obtained numerically by the finite-element method.

EXPERIMENTAL MODAL ANALYSIS OF BEAMS WITH DIFFERENT MATERIALS

Dr. Ravi Prasad et al. [5] proposed a work on a Modal analysis for process of describing a structure in terms of its natural characteristics which are the frequency, damping and mode shapes –its dynamic properties. The change of modal characteristics directly provides an indication of structural condition based on changes in frequencies and mode shapes of vibration. This paper presents results of an experimental modal analysis of beams with different materials such as Steel, Brass, Copper and Aluminum. The beams were excited using an impact hammer excitation technique over the frequency range of interest, 0-2000 Hz. Response functions were obtained using vibration analyzer. The FRFs were processed using NV solutions modal analysis package to identify natural frequencies, damping and the corresponding mode shapes of the beam.

EXPERIMENTAL MODAL ANALYSIS AND EFFECT OF CRACK ON MODAL PARAMETER OF A CANTILEVER BEAM

Ranja Behra [6] has analyzed Aluminium cantilever beam specimen with & without crack having inclined crack at different crack location & crack depth experimentally on FFT & validation is done by finite element method. It is found that in first mode shape the amplitude decreases with increase in location from fixed end but in second and third mode shapes the amplitude increases with increase in location from fixed end at constant crack depth and constant crack inclination angle of the cracked cantilever beam. Moreover at particular location in the beam amplitude decreases with increase in crack depth in case of first mode shape, but amplitude increases with increase in crack depth in case of second and third mode shapes of the cracked beam at constant crack inclination angle.

FINITE ELEMENT ANALYSIS OF SIMPLY SUPPORTED BEAM

P.Yamuna [7] published a paper on vibration analysis of beam with varying crack location The objective of this study is to analyze the vibration behavior of a simply supported beam using FEM software ANSYS subjected to a single triangular crack under free vibration. Material properties of steel are considered for the simply supported beam. Besides this, information about the variation in location and depth of cracks in cracked steel beams is obtained using this technique. It can be found that at symmetric positions of the crack position of the beam the lowest fundamental frequencies have almost equal value. This shows that the dynamic response of crack at symmetric locations of the beam is similar.

VIBRATION ANALYSIS OF CRACKED SIMPLY SUPPORTED BEAM WITH NON-LINEAR PARAMETERS UNDER FREE EXCITATION.

Ms.P.P.Gangurde, Prof.R.S.Pawar [8] in this method Theoretical, Numerical and Experimental Analysis of a cracked simply supported beam subjected to free excitation with nonlinear parameters. Theoretical study of vibration analysis of simply supported beam with cracks considering linear system and evaluation of natural frequency and mode shapes for free vibration. Numerical and Experimental Analysis of a cracked simply supported beam to identify the nonlinearities & their effects on load deflection.

CONCLUSION

By the literature review it is seen that, compare with previous old systems of vibration analysis of simply supported beam this method identifies the nonlinearities & effects on load deflection characteristics of simply supported beam. In this method Numerical verification of vibration analysis of cracked simply supported beam with non-linear parameters and evaluation of natural frequency and mode shapes with ANSYS software for free vibration are done & the experimental validation of results obtained by theoretical and numerical method with the help of FFT Analyzer for Free vibration of cracked simply supported beam with nonlinear parameters gives better result than previous old systems. The same work can be done with different boundary conditions.

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