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ISHAM PANIGRAHI
SYNOPSIS

It is being observed that dynamic behavior of structures and machine components changes due to presence of crack in them. The change in dynamic behavior has been utilized as one of the criteria of fault diagnosis for structures and machine components. Now a day, with the development of high speed machineries and light weight rising structures, fault diagnosis using the dynamic behavior of different components of the system has gained paramount importance. It has also been realized that the presence of crack in structures or in machine member leads to operational problems as well as premature failure.

A number of investigators round the world are working on the dynamic characteristic of structures with crack. Major characteristics of the structure which undergo change due to presence of crack are the natural frequency, the amplitude response due to vibration, the mode shape and damping factor. Scientific study on the changes in these characteristics are being widely utilized for the identification of crack in buildings, bridges, framed structures, machine tools, automobile engine parts and biomechanics.

In the present investigation, a number of literatures published up to date have been surveyed, reviewed and analyzed. It was felt that, the results presented by the investigators have not been utilized so far in a scientific way for practical application. Although the information on some aspect are available but not exhaustive for real application, therefore an attempt has been made to investigate the dynamic behavior of basic structures like beams systematically. The investigation has been carried out in four steps. (1) Analysis of dynamic behavior of beam with open transverse crack, (2) Analysis of dynamic behavior of beam with breathing transverse crack, (3) Application of Artificial Neural Network (ANN) to predict crack position and its severity and (4) Analysis of dynamic behavior of beam with crack subjected to moving mass.

In these investigations, the presence of transverse crack in the structure has been considered. The crack introduces new boundary conditions for the structure at the crack location. These boundary conditions are derived from the strain energy equation using Castigliano’s theorem. Presence of crack also reduces the stiffness of the structure which has been derived from the stiffness matrix. For dynamic behavior of beam with a transverse crack, Euler’s beam theory with modified boundary conditions have been used to find out the theoretical expressions for the natural frequencies and the modes for the
beam. For all the theoretical expressions as derived for dynamic characteristics of structure with a crack, respective numerical analysis was taken up with suitable numerical models with the help of the computer. The numerical methods results in graphical representation have been presented in corresponding sections in order to draw different conclusions of the present investigation.

In order to establish the authenticity of theories developed in the different sections, experiments have been conducted in varied specimens in line with the numerical models adopted in different sections. Experimental, finite elements and analytical results have been compared and are presented in graphical form in the corresponding sections.

From the present investigations the following generalized conclusions are made.

(i) Crack in structure makes an appreciable difference in dynamic response. The natural frequencies changes with depth of crack and location along the length of beam. The mode shapes and amplitude response are affected too

(ii) The deflection pattern of cracked beam got affected by weights of moving mass and its velocities

These findings can be utilized in various industrial applications like railway bridges, over head cranes, conveyers and pipes for fluid supply. Beside it can be used for long rotating shaft used in drilling rigs, for high speed centrifuges, for turbine rotors and for off shore structures. In general fault detection in structures can be more specific with the help of this information. The present study may be extended in order to provide information about the failsafe life span of complicated structures with cracks used in actual practice.