Vibration measurement based technique for non-destructively assessing the integrity of structure has certain advantages over the common NDTs, like online conditioning monitoring etc. It is tedious and time consuming job to apply common NDTs to large structures like long pipelines, rail tracks, aircraft structures, engineering components, etc.

An analytical method, which provides the theoretical basis for crack detection using two natural frequencies of uncracked and cracked beam, has been developed for application to uniform beams. The crack is modeled as a spring and is placed at the root of the crack. With this type of modeling the crack location can be predicted accurately. In deriving these theories few important assumptions are made like, the structural member is assumed to behave linearly, the structural properties are assumed to be a time invariant.

Analytical solution methods are being verified through ANSYS FEM package and experimentation. The lowest two frequencies are generally sufficient for analysis and smaller frequencies are easier to measure experimentally. So in the finite element analysis, the subspace iteration procedure can be conveniently employed. The subspace iteration calculates few natural frequencies in the given range with efficiently and accurately.

For crack size an integrated approach is used, which integrates the elastic spring concept and continuum damage concept, has come out with undefined function
that provides a relation between frequencies changes, crack location and crack size in the beam. This function can be obtained from the knowledge of the mode shape of the uncracked structure. Thus method is versatile and can be applied to various beam structures.

The literature survey has implied the frequency as most suitable parameter for vibration analysis of cracked structures, although research is in progress for other parameters like displacement parameter etc. The non-destructive evaluation of structure by vibration measurement has a tremendous scope for application. To make it widely applicable more research is needed.

In this thesis a method for detection of crack from measurement of natural frequencies of cracked beam for transverse as well as longitudinal vibration is study. For identification of crack location and crack depth ratio, it was shown that data on the variation of the first two natural frequencies is sufficient.

The crack is simulated by an equivalent spring, connecting the two segments of the beam. Analyses of this approximate model results in algebraic equation, which relates the natural frequencies of beam and crack location. These expressions are applied to studying the inverse problem i.e. identification of crack location from frequency measurements. For crack size an integrated approach is used, which gives a relation between frequencies changes, crack location and crack size in the beam.

The error in prediction of crack location by theoretical analysis is less than 15% and in experimental analysis is less than 20%. The proposed method is confirmed by comparing it with results of ANSYS FEM results and experimental results. The proposed method is found to be both simple and accurate.


9.2 SCOPE FOR FUTURE WORK

On analytical side, the approach can be further extended for assessment of multiple discrete cracks, inclined edge crack etc. Also the approach can be extended for composite beam, varying cross-section beams like circular, T- section and I-section etc. The study can further be extended for stepped beam and tapered beam.

Experiments can be done to assess single, multiple discrete cracks in varying cross-sectional beams like stepped or tapered beams for various boundary conditions like cantilever, simply supported beam etc. The approach for the analysis of 3-D frames, trusses for e.g. bridges or towers etc, is to be experimentally verified for practical implementation.