ABSTRACT

The work described in this dissertation is concerned with the static and dynamic behaviour of plates having material inhomogeneity or geometrical discontinuity subjected to various in-plane compressive or tensile edge loading. From a stability viewpoint, this problem involves a complex non-uniform pre-buckle stress state. The equations governing the dynamic behaviour of this class of problems are derived using Lagrange's Principle. The equations for the special cases of static stability, free vibration with or without load are obtained from the general equation of dynamic behaviour by setting certain quantities to zero.

The investigation is mainly analytical in nature and is carried out by the finite element method. The formulation is based on the Mindlin's plate theory. An eight noded isoparametric element is employed, which can account for the transverse deformation and rotary inertia. The stiffness matrix, stress stiffness matrix, mass matrix and load vectors of the element are derived by the Principle of Stationary Potential Energy. They are evaluated using the Gauss quadrature numerical integration technique. The element matrices are assembled in skyline form to get the global matrices. The equations governing the static equilibrium are solved by the Gauss elimination method, which decomposes global stiffness matrix into diagonal and off-diagonal matrices. The eigenvalues are determined by Subspace iteration scheme. The convergence studies for the numerical computations are carried out in all the cases and comparisons are made wherever possible. The computer coding is done in FORTRAN language.

Results are presented for buckling, vibration and parametric instability behaviour of plate having internal flaw or opening, considering various parameters like, position and nature of load; position, extent and size of damage; size and shape of cut-out; plate aspect ratio and boundary conditions. Results are discussed in detail and the conclusions are made highlighting the important findings and the scope for further research.

The experiments on the dynamic instability behaviour of rectangular sheet specimens containing different opening shapes are carried out and the results are presented for two typical centrally located openings: (1) Circular hole, (2) rectangular slot with round ends. The dynamic instability regions for different static and dynamic load factors are obtained and the results discussed.

Organisation of the thesis: The thesis is divided into seven chapters and appendices. Chapter 1 contains the general introduction, review of literature and aim and scope of the present study. In Chapter 2, the governing equations for plates with flaws or cut-outs are derived using the Lagrange's Principle. The finite element formulations including solution techniques are described in Chapter 3. In Chapter 4, salient features of computer programme developed are outlined. The numerical results are presented in Chapter 5. Chapter 6 deals with the experimentation, which highlights the methodology adopted along with some sample results. Conclusions and scope for future work are highlighted in Chapter 7. Appendix contains (i) introduction to dynamic instability and (ii) sample output data generated by the mesh generating routine.

Key words: Inhomogeneity, flaw,damage, cut-out, stress analysis, vibration, stability,buckling, parametric instability, dynamic instability, non-uniform loading, finite element method, mechanical properties.