Abstract

The work presented in this dissertation describes buckling, postbuckling, postbuckled vibration, dynamic instability, nonlinear dynamic instability analysis of plates and cylindrical shell panels under non-uniform (parabolically or linearly varying) in-plane mechanical edge loadings. The mathematical model adopted in the present investigation is based on a higher-order transverse shear deformation theory of shallow cylindrical shell panels that includes the von Kármán-type geometric nonlinearities and initial geometric imperfections.

Initially the governing equations of composite plates and shell panels subjected to time dependent non-uniform in-plane loads ($\bar{N}_{xx} = N_s + N_t \cos pt$) are derived. In the present study both static (N_s) and dynamic ($N_t \cos pt$) part of the load is assumed to vary in a similar manner. As the applied edge load is non-uniform, in the first step, only the static part (N_s) of the in-plane load is applied and correct stress distribution within a plate are evaluated by solving the plate membrane problem. Superposing the stress distribution due to static and dynamic load, the final stress distribution within the plate is obtained. Subsequently, using the above evaluated stress distribution, the partial differential equations governing the plate dynamic instability are formulated via Hamilton's variational principle. Adopting Galerkin's approximation, the governing partial differential equations are converted into a set of ordinary differential (Mathieu type) equations describing the plate/panel dynamic boundaries. Adopting Fourier series method, periodic solution to Mathieu equations are sought and the *instability regions* are determined by solving the associated eigenvalue problem. By neglecting the inertia terms and the time dependent in-plane loads, the governing partial differential equations are converted into a set of nonlinear algebraic equations by adopting Galerkin's method. They are solved using Newton-Raphson method in conjuction with the arc-length method to *obtain equilibrium paths*. Neglecting nonlinear terms in the above equations, a set of homogeneous linear algebraic equations are obtained. Solving the associated eigenvalue problem, the *buckling loads* are evaluated.

The buckling loads, postbuckling equilibrium paths, postbuckled vibration frequencies and dynamic instability regions are reported for various edge boundary conditions and different non-uniform edge loadings for isotropic and three layered

cross-ply *[0/90/0]* composite plates and shell panels. The influence of nonlinearity (*w/h*) on the dynamic instability region is also investigated.

Keywords: Buckling, Postbuckling, Dynamic instability, Galerkin method, Non-uniform in-plane loading.