A PERTURBATION METHOD FOR BUCKLING AND VIBRATIONS OF IMPERFECT STRUCTURES

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A perturbation theory for the large amplitude vibration analysis of general, statically loaded imperfect structures is presented. The method is based on a perturbation expansion for both the frequency parameter and the dependent variables. The theory developed forms an extension of earlier work in [1] and [2], and makes it possible to investigate the dependence of the natural frequencies of structures on finite vibration amplitudes, initial geometric imperfections, and a nonlinear static deformation (orthogonal to the axisymmetric fundamental state).

In the present analysis, this perturbation theory is applied to the nonlinear (large amplitude) vibration problem of composite cylindrical shells including edge effects. The starting point of the analysis are the Donnell-type differential equations of a circular cylindrical shell. An axisymmetric fundamental state is included in the formulation. The first-order state problem constitutes an eigenvalue problem for the unknown eigenfrequencies and vibration modes. The associated higher order state problems are response problems with coefficients that depend on the solution of the first-order state problem.

Koiter's initial post-buckling and imperfection sensitivity theory deals with the dependence of the load parameter on the deflection and imperfection amplitudes in the case of static buckling problems. In [3], Koiter's theory has been applied to the buckling of composite cylindrical shells. The theory developed in the present paper is related to the work described in [3]. The perturbation approach has been applied to the single mode nonlinear vibrations of composite shells in [4].

In the current work the extension to a multi-mode analysis is presented. Characteristic results of the buckling and nonlinear vibration analysis of isotropic and anisotropic shells are shown, in order to illustrate the capabilities of the computational modules developed.

References

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