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A Unified Approach for the Vibration of Laminated Composite Plates with Various Support Conditions Using Computed Static Modes

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Summary

Extensive research has been carried out in the area of vibration of plates, and many methods are now available in the literature, including, but not limited to, finite element methods, boundary element methods, classical Ritz approach, differential quadrature method, and the dynamic stiffness method, just to mention a few. Among these methods, the classical Ritz approach has the advantages of rapid convergence, smaller computational costs (due to smaller number of unknowns) and easy formulation and implementation. The method, however, suffers from the major drawback that simple yet efficient trial functions which can accommodate various complicated boundary conditions and, at the same time, generate frequencies with rapid convergences are not easy to formulate. As such, it is the objective of this paper to present a set of computed static modes, which are simple to formulate, easy to implement, and be able to generate frequencies with rapid convergence for various complicated boundary conditions in a simple and unified manner. To enhance the versatility of the method, a third-order plate theory is adopted so that the method can be applied to thick plates and laminated composite plates with significant shear flexibility.

Based on the idea of influence lines of reactions of a continuous beam, static modes of a continuous beam can be computed by releasing one of the support reactions each time, and a unit deflection is imposed thereat so that the corresponding deflected shape of the entire beam can be easily found. This process is repeated for all other supports and a set of computed static modes can be obtained. These computed modes possess the appropriate necessary C-1 continuity for a third-order plate theory and, more importantly, similar mathematical properties of the conventional Lagrangian shape functions used in finite element method, thus facilitating the boundary conditions to be treated in a manner similar to the conventional finite element method.

Using these modes in each of the two orthogonal directions of a shear deformable plate, rapid convergence of results can be demonstrated for plates with various support conditions and aspect ratio.

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