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A Perturbation Method for Nonlinear Vibrations of 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 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. An extension to a multi-mode analysis is presented for perfect structures. The perturbation theory developed is applied to the nonlinear (large amplitude) vibration problem of anisotropic cylindrical shells including edge effects. The starting point of the analysis are the Donnell-type differential equations of an anisotropic circular cylindrical shell. Characteristic results of the buckling and nonlinear vibration analysis of isotropic and composite shells are shown, in order to illustrate the capabilities of the computational modules developed.

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