Nonlinear geometrical responses in large deflection of un-symmetrically layered piezo-electric plate under initial tension

陳春福,李儀威
Mechanical Engineering
Engineering
cfchen@chu.edu.tw

Abstract

The nonlinear geometrical responses in large deflection of an unsymmetrically
piezo-electric layered plate under initial tension are
studied. von Karman plate theory for large deflection is utilized and extended to an un-symmetrically layered plate including a piezoelectric layer. The nonlinear governing equations are derived, first, in a non-dimensional form in terms of lateral slope and radial force resultant. These equations are solved using a numerical finite difference method with the aid of the clamped-ended boundary conditions of the problem and an iteration procedure, by taking the associated linear analytical solution of lateral slope as the initial guess. For a nearly monolithic plate under a very low applied voltage, the results agree well with available solutions for a singlelayered
case due to uniform lateral load in literature and thus the present approach is validated. For a two-layered un-symmetric plate made of typical silicon-based materials, the results show that piezoelectric effect seems to be apparent only up to a moderate initial tension and a moderate lateral pressure. Under this circumstance, the higher the applied voltage, the greater the central deflection; and hence the plate may transit to a membrane in a relatively low pretension condition. For a relatively high pretension or a severe lateral load, however, the piezoelectric effect becomes insignificant. Moreover, the effects of initial tension and lateral load may merge to become dominant, yielding nearly the same responses, regardless of the magnitude of the applied voltage.

Keyword：Large Deflection, Initial Tension, Piezoeletric Effect, von Karman Plate Theory, Finite Difference Method.