Nonlinear Study of Large Deflection of Simply Supported Piezoeletric Layered-Plate under Initial Tension

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Abstract

The nonlinear problem of large deflection of a simply supported piezoelectric layered plate under initial tension is studied. The approach follows von Karman plate theory for large deflection for a symmetrically layered isotropic case including a piezoelectric layer. The thus derived nonlinear governing equations for the lateral slope and radial force resultant are solved using a numerical finite difference method with the aid of an iteration scheme, by taking the associated linear analytical solution as an initial guess. The case of a nearly monolithic plate under a very low applied voltage across the piezoelectric layer was implemented, first. The results for are found to correlate well with available solutions for a single-layered case under pure mechanical loading and thus the present approach is validated. For three layered symmetric plates made of typical silicon based materials, various initial tension and lateral pressure are considered, and different applied voltages up to a moderate magnitude are implemented. No edge effect was observed, in contrast to the cases of clamped plates in literature. In additions, varying the layer moduli seems to have an insignificant effect upon the structural responses of the layered plate. On the other hand, the piezoelectric effect tends to be apparent only in a low pretension condition. For a relatively large pretension, the effect of initial tension becomes dominant, yielding nearly unique solutions for the structural responses, regardless of the magnitudes of the applied voltage and the lateral pressure.

Keyword：None