Analytical Geometrical Responses in Large Deflection of Simply Supported Piezoelectric Layered Plate under Initial Tension

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Abstract

The analytical geometrical responses in large deflection of a simply supported and layered piezoelectric circular plate under initial tension due to lateral pressure are presented. The approach follows von Karman plate theory for large deflection with a consideration of a symmetrically laminated case including a piezoelectric layer. The related nonlinear governing equations are derived in a non-dimensional form and are simplified by neglecting the arising nonlinear terms, yielding a modified Bessel equation or a standard Bessel equation for the lateral slope. The associated analytical solutions are developed by imposing the simply supported edge conditions of the problem. For a 3-layered nearly monolithic plate under a low pretension and a low applied voltage upon the piezoelectric layer, the results agree well with those obtained by using the classical plate theory for a single-layered plate under pure mechanical loading, and thus the developed approach is validated. Typical 3-layered piezoelectric plates are then implemented and the results show that, no apparent edge effect was found for the present problem. In additions, a piezoelectric effect appears

to be present only up to a moderate initial tension. For a relatively high pretension,
the tension effect tends to be dominant, resulting in nearly the same results for the
geometrical responses, regardless of the magnitude of the applied voltage.

Keyword : large deflection, piezoelectric layered plate, initial tension, von karman