MS1S_11752

XXI International Congress of Theoretical and Applied Mechanics
Warsaw, Poland, August 15–21, 2004

A Geometrically Non-Linear Finite Shell Element with Piezoelectric Layers

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A geometrically non-linear total-Lagrangian finite element method is presented to investigate composite shells with integrated piezoelectric layers. The displacement field assumption is based on the first order Reissner-Mindlin theory and the strain-displacement relations for the mid-surface are valid for small strains but moderate rotations. Special attention is given to properly defining the electrical field quantities in material coordinates. By means of several benchmark problems certain phenomena are observed. Comparing the finite element solutions with analytical results based on beam theory it is concluded that the clamping effect is not negligible. For sensing purposes of the piezoelectric layers it is shown that the effect of the induced membrane strains is even larger.

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