11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

A COMPUTATIONAL FRAMEWORK FOR POLYCONVEX LARGE STRAIN ELECTROMECHANICS. APPLICATIONS.

R. Ortigosa*, Antonio J. Gil and J. Bonet.

Civil and Computational Engineering Centre, College of Engineering Swansea University,
Singleton Park, SA2 8PP, United Kingdom

Key words: *Piezoelectricity, Polyconvexity, Large strains, Electroactive polymers, Boundary Element Method.*

In this paper, we present some applications of a new computational framework for the analysis of large strain electromechanics. More specifically, we consider two important smart materials, i.e, piezoelectric and electroactive polymers (EAPs), which are used in a vast range of interesting engineering fields. In particular, they have been recently used for morphing wing control in unmanned aerial vehicles [1] and for the precise shape control of scale space antennas.

In these type of applications, these materials appear in the form of thin patches mounted directly to a relatively thin structure. Therefore, suitable beam/shell models can be applied for their reliable numerical simulation. We present a variational formulation for beam/shells in which the classical beam/shell strain measures [2] are not used. Instead, the formulation for a continuum degenerate beam/shell model is developed in which material objectivity is guaranteed by the definition of an energy function depending on the right Cauchy-Green deformation tensor and on a Lagrangian electric variable. The energy function is defined as a polyconvex combination of both strain and electric variables [3].

The influence of Maxwell vacuum stresses in these applications is also analysed in this paper. We present an approach in which the influence of the surrounding vacuum is included in a surface integral through the Boundary Element Method [4]. We propose a modified version of the resulting boundary integral in order to remove possible singularities of the integrands containing the fundamental solution of the associated Laplace's equation.

REFERENCES

[1] D. Cadogan, T. Smith, F. Uhelsky, M. MacKusick. Morphing inflatable wing development for compact package unmanned aerial vehicles. AIAA No. AIAA-2004-1807,

45th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 2004.

[2] J. C. Simo and L. Vu-Quoc. A three-dimensional finite-strain rod model, part II: computational aspects. *Computational Methods in Applied Mechanics and Engineering.*, Vol. **58**, 79–116, 1986.

[3] J. Bonet, A. J. Gil, R. Ortigosa. A computational framework for polyconvex large strain elasticity. *Computational Methods in Applied Mechanics and Engineering*, under review.

[4] D. K. Vu and P. Steinmann. On 3-D coupled BEM-FEM simulation of nonlinear electro-elastostatics. *Computational Methods in Applied Mechanics and Engineering.*, Vol. **58**, 79–116, 1986.