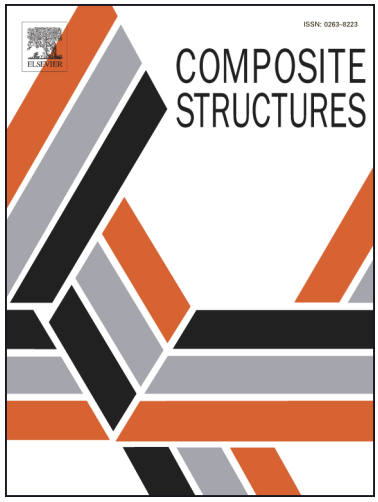

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An Efficient Multiscale Computational Formulation for Geometric Nonlinear Analysis of Heterogeneous Piezoelectric Composite

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Abstract: In this contribution, an efficient multiscale computational formulation is developed for the geometric nonlinear analysis of heterogeneous piezoelectric materials. In this formulation, the relations between the microscopic heterogeneous properties and macroscopic behaviors of the piezoelectric composite are established by the numerically constructed displacement and electric potential base functions. The heterogeneous and complex microstructure can be equivalent to a simple macroscopic piezoelectric coarse element through those constructed multiscale base functions. Then the equivalent tangent stiffness matrix and internal force vector of the macroscopic coarse element are deduced based on the co-rotational approach, which can describe the motion of macroscopic coarse element clearly and efficiently. Thus the original electro-mechanical coupling geometric nonlinear problem could be solved iteratively on the macroscopic scale, which will save a tremendous amount of computing time and cost. After all the macroscopic calculations, the microscopic mechanical and electrical responses could be retrieved and calculated from the macroscopic solutions by using the above-mentioned multiscale shape functions. To verify the validation and high-efficiency of the proposed multiscale computation formulation, several typical numerical examples are carried out. All the computation results indicate that the developed multiscale formulation not only could provide high precision solutions but also has high efficiency.

Keywords: Piezoelectric composite; Smart material; Geometric nonlinear analysis;

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