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Large deformation multi-scale analysis of thin nanocomposite shell structures

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In this work a formulation for non linear multi-scale analysis of thin shells is presented and a modeling scheme is proposed in a FE2 method's context. The shells may undergo large deformations and exhibit heterogeneous micro-structures consisting of nonlinear materials and cohesive interfaces. Appropriate use of an attached coordinate system, for the projection of the strain measures, enables the elimination of large rotations from the kinematic constraints that are imposed at the Representative Volume Element (RVE), simplifying this way the boundary value problem (BVP) to be solved at the micro-structural level. This way, the BVP formulation refers to the local coordinate system of the RVE in which the imposition of the plane stress condition becomes totally independent from the current orientation of the midsurface of the shell. Emanating from Hill's averaging theorem, which is satisfied by use of appropriated averaging relations, the principle of virtual work is formulated in the attached auxiliary system basis, where a consistent tangent stiffness matrix is analytically derived. The resulting methodology is assessed against popular benchmarks for thin shells and allows for a straight forward integration of Kirchhoff-Love shells under large deformations in existing FE2 codes. The simulation possibilities originating from this formulation[are countless and are related to the wide applicability of the Kirchhoff Love theory in many fields of engineering.

REFERENCES

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