Isogeometric analysis for 3D stress predictions of composite beam structures

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ABSTRACT

Full-field stress responses are often required to satisfactorily predict the performance of composite structures in service. This work represents a fresh attempt at exploring the prospects of Isogeometric analysis (IGA) using Non-Uniform Rational B-Splines (NURBS) for the analysis of composite beam structures. Due to the smoothness characteristics, NURBS possess desirable properties that allow for robust applications in structural mechanics [1]. The primary goal of this paper is to demonstrate the potential of NURBS in satisfactorily capturing 1D kinematics of composite beam structures for 3D stress predictions. Application of advanced beam theory based on Unified formulation (UF) of the structure as represented by 2D Serendipity Lagrange Expansion (SLE) of the beam cross-section [2] combined with 1D description of the beam axis in accordance with low-order NURBS representation is implemented in this work. Several examples regarding static analysis of symmetric, non-symmetric and sandwich laminates with different stacking sequences and through-thickness configurations are performed. The results are benchmarked against finite element solution and good agreement was achieved. It is observed that while the IGA has better bandwidth properties and numerical conditioning which influence computational efficiency, it has comparable accuracy to the finite element solution.

keywords: Composite beam structures, Isogeometric analysis (IGA), Non-Uniform Rational B-Splines (NURBS)

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