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MULTISCALE ANALYSIS OF FIBRE-REINFORCED COMPOSITES VIA A COMPONENT-WISE APPROACH

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The progressive damage analysis of fibre-reinforced composite structures is currently a challenging task due to the complex damage and failure mechanisms exhibited by such materials. The complexity is further increased due to the significant computational expense associated with high-fidelity computational modelling of composite structures. The objective of the current work is the development of a virtual test platform which addresses the issue of computational costs without compromising on the accuracy of the solution.

The present work is based on the Carrera Unified Formulation (CUF), which is a generalised framework for the development of higher-order structural theories for beams, plates and shells [1]. The kinematic field is improved via the use of expansion functions across the cross-section and through the thickness of 1D and 2D structural models, respectively, resulting in 3D displacement and stress fields that approach 3D-FEA in terms of accuracy, while avoiding the associated computational costs. The multiscale analysis is based on the high-fidelity 1D micromechanical analysis toolbox, where the CUF Component-Wise (CW) approach enables the explicit modelling of the constituents [2]. Progressive failure at the microscale is modelled using the crack band theory, while matrix inelasticity is modelled via the J2-plasticity theory. The micromechanical framework is extended to a fully nest multiscale framework where CUF models are used at both scales. The use of the computationally efficient micromechanical toolbox in the multiscale framework translates to significant reduction in the overall analysis time [3, 4].

The highlighted developments constitute a part of the virtual test platform based on the CUF for the multiscale analysis of composite structures. Numerical assessments are performed to demonstrate the capability of the framework to provide accurate solutions in a computationally efficient manner.

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