PROGRESSIVE DAMAGE ANALYSIS OF COMPOSITE STRUCTURES VIA THE ONE-DIMENSIONAL CARRERA UNIFIED FORMULATION

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This paper presents a progressive damage model of composite structures based on refined one-dimensional models. The damage model is implemented in conjunction with the Carrera Unified Formulation (CUF) [1]. In the CUF framework, the governing equations and finite element matrices are given via a few fundamental expressions, namely the fundamental nuclei, which are independent of the order of the structural model. The 1D models are built using expansions of the displacement field above the cross-section. Within the CUF framework, the Component-Wise refined beams are used to model every component of an engineering structure via Lagrange Expansion (LE) elements independently of their geometry, e.g. 2D transverse stiffeners and panels, and of their scale, e.g. fibre/matrix cells [2]. The CUF allows the use of any order 1D structural models in a unified manner. A three-dimensional orthotropic elastic constitutive model with continuum damage based degradation is implemented. A stress-based failure envelope is predicted using Hashin's criteria for uni-directional composites [3]. The progression of damage is controlled by a linear damage evolution law and is based on fracture energy dissipation. A Newton-Raphson based iterative scheme is used to solve the non-linear problem. Damage propagation in laminated composite structures is obtained using highly accurate 3D displacement, strain, and stress fields given by 1D CUF.

Keywords: CUF; Progressive damage; Composite beams, Hashin 3-D Criteria

References

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