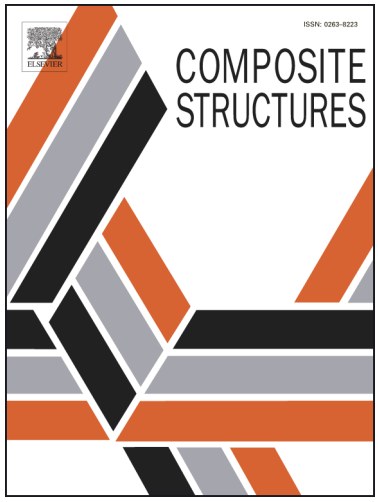

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Analysis of Low Velocity Impacts on Sandwich Composite Plates using Cubic Spline Layerwise Theory and Semi Empirical Contact Law

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Abstract

The theoretical and numerical framework for the simulation of impacts on thick sandwich composite plates is presented. It encompasses three new elements: 1) A three-dimensional layerwise theory, which approximates the in-plane and transverse displacements through the thickness using third-order Hermite spline polynomials that captures the high inhomogeneity of all interlaminar stresses present in the thick sandwich laminate. 2) The integration of the layerwise theory into a time domain plate spectral finite element with nodes collocated to Gauss-Lobatto-Legendre integration points, which provides a consistent semi-diagonal mass matrix and high-order spatial approximation in the plane of the structure, thus enabling high spatial convergence and fast explicit time integration of impact events. 3) A semi-empirical contact law that is derived from analytical expressions and validated with indentation experiments and numerical results, to provide the coupling between the impactor and target structure. Numerical simulations of the transient impact response obtained by the present method are correlated with 3D continuum finite element impact models and experimental results to quantify accuracy and computational speed. It is demonstrated, that the simulation of impacted sandwich composite plates requires integration of all three previous elements to obtain accurate and fast results.

Keywords

Elastoplastic contact models; Time domain spectral elements; Layerwise mechanics; Sandwich structures; Impact dynamics

1. Introduction

Sandwich composite structures typically consist of two thin or moderately thick fiber reinforced composite face sub-laminates bonded to a restrained thick polymer foam or

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