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Application of the Local Cohesive Zone Method to Numerical Simulation of Composite Structures under Impact Loading

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Abstract

A novel technique for efficient modelling of progressive delamination in large-scale laminated composite structures is presented and applied to the simulation of two dynamic events involving axial crushing of tubes and transverse impact loading of plates. During the transient analysis, continuum elements that are prone to delaminate are adaptively split through their thickness into two shell elements with cohesive elements planted between them. The numerical results using this adaptive placement of inter-laminar cohesive zones combined with a continuum modelling approach for capturing the intra-laminar damage modes in the composite are compared to the available experimental data as well as to the results obtained using the conventional application of the cohesive zone method, where the discrete cohesive interfaces/elements are introduced prior to the analysis.

Keywords:
LS-DYNA, adaptive element-splitting, delamination, adaptive cohesive zone, axial tube crush, transverse plate impact

1. Introduction

Composite materials are increasingly being used in advanced structural components which may experience axial or transverse dynamic loading conditions during their service life. Failure of these materials involves evolution of various damage mechanisms, such as fibre breakage and matrix cracks (Zobeiry, Vaziri, and Poursartip (2015), Green et al. (2007)), where the debonding of adjacent laminate layers, also known as delamination, is considered to be one of the most dominant damage mechanisms affecting the structural performance of composite laminates. Delamination will usually lead to a reduction in structural stiffness, notably in

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