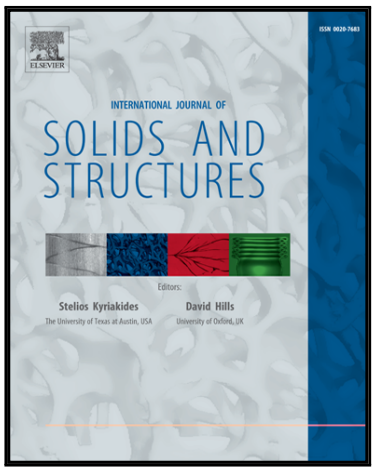

Prediction of outer-ply matrix crack density at saturation in laminates under static and fatigue loading

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Prediction of outer-ply matrix crack density at saturation in laminates under static and fatigue loading

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Abstract

The onset of dominant damage mode transition from matrix cracking to induced delamination in laminates containing outer-ply matrix cracks is experimentally and analytically investigated. Stress states of a $[\theta_m^{(o)}/\theta_n^{(i)}]_s$ laminate containing staggered outer-ply matrix cracks with or without induced delaminations are derived implementing a developed unit-cell based analysis in the framework of variational principles. A damage mode competition criterion is implemented to predict crack density at saturation which is argued to be a characteristic damage state (CDS) independent from loading conditions. Several carbon/epoxy specimens of type $[\theta_m/0_n]_s$ are prepared with different off-axis ply orientation, θ, and thickness. Optical microscopy is used to identify matrix crack density during both static and fatigue loading with different loading conditions. The analytically predicted crack densities at saturation are shown to be in acceptable agreement with experimental observations and saturated crack density is confirmed to be a characteristic damage state (CDS) identical during both static and fatigue loading.

Keywords: Saturation matrix crack density, Induced delamination, Characteristic damage state, Staggered crack distribution pattern, Fatigue

1. Introduction

Several experimental observations [1–3] have reported consecutive occurrence of matrix cracking and induced delamination as the first and second

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