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Experimental and Numerical Investigation on the Bond Strength of Self-Sensing Composite Joints

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Abstract

Laboratory experiments demonstrate that a novel carbon nanotube (CNT)-based sensing layer embedded in the bondline of an adhesively bonded structural joint can detect and monitor deformation and damage progression of the adhesive layer. In this study, experimental and numerical investigations were performed to identify any effect of an embedded CNT-based sensing layer on the bond strength of that joint. To evaluate the mechanical behavior of such a bondline configuration, two sets of single-lap specimens, with and without sensing layer, were prepared and tested to determine the bond strengths of the respective types. Two-dimensional digital image correlation (2D DIC) was utilized to estimate the load-displacement response of the test specimens. Three-dimensional cohesive surface finite element models of the test specimens, with and without the sensing layer, were created and validated using the experimental measurements. It is shown that the embedded CNT-based sensing layer does not influence the bond strength of the single-lap joint.

Keywords: *Adhesive joint, composite, debonding, cohesive zone modeling, experimental testing, carbon nanotube sensing layer, fracture mode mixity.*

Introduction and Motivation

Most structures are composed of various members connected by structural joints and are the critical load-carrying paths in a structure. Adhesive joints are becoming increasingly popular

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