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Abstract

Composite pyramidal-truss core sandwich panels, in which the lattice core is strengthened by reinforced frames between dispersive nodes, were manufactured via water-jet cutting and interlocking assembly. The coefficients of thermal expansion and outgassing (mass loss) ratios of the composite laminates were determined. Subsequently, the effect of vacuum thermal cycling on the compression and shear performance of the composite sandwich panels with pyramidal-truss cores was studied using theoretical and experimental methods. In particular, the out-of-plane compression stiffness and strength, as well as the shear stiffness and strength of the structures subjected to vacuum thermal cycling, were predicted using theoretical equations. The compression and shear performance improved initially and then deteriorated with an increase in the vacuum thermal cycling-time. The observed failure modes depended on the number of vacuum thermal cycles. In addition, the catastrophic response of the composite sandwich panels with pyramidal-truss cores was investigated, and their possible failure modes (including the crushing and localized buckling of composite struts) were complemented with results of analytical modeling. The truss cores collapsed mainly due to crushing and localized-buckling processes, caused by matrix outgassing and debonding of the interface between the carbon fibers and epoxy resin, after prolonged thermal cycling.

Keywords: A. Carbon fiber/epoxy composite; B. Composite sandwich panels with pyramidal truss cores; C. Vacuum thermal cycling; D. Mechanical properties;

1. Introduction

There is a growing trend in the application of polymer matrix composites in various industrial fields, mainly due to their low weights, high specific strengths, high specific stiffnesses, and low

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