Mechanical Behaviour of Glass Fibre-Reinforced Polymer/Polyvinyl Chloride Foam Cored Sandwich Structures

Abstract

This study focuses on the fabrication and analysis of the mechanical behavior of unidirectional (UD) glass fibre-reinforced polymer (GFRP) face sheet and polyvinyl chloride (PVC) foam core sandwich structures fabricated by a vacuum-assisted resin infusion method (VARIM). These sandwich structures are commonly used in marine and wind turbine blade applications. To date, relatively little knowledge about the functional behavior of UD GFRP compared to composites reinforced with bidirectional mats is available for day-to-day applications. The effects of the face sheet orientation, face sheet thickness, and core thickness on the mechanical behavior of the specimens were examined. The UD fibres were oriented in cross-ply (0/90), angle-ply (+45/−45), and quasi-isotropic orientations. Various mechanical properties such as tensile, flexural, flatwise compression, and edge wise compression tests were examined. Characterization of the tensile properties of the face sheet showed that the cross-ply orientation had a higher strength than the angle-ply and quasi-isotropic orientations. The flexural load-carrying capacity of the cross-ply face sheet orientation was superior to the other orientations. The increase in the core thickness changed the flexural failure mode from face yield and core shear to core indentation. Flatwise compression (FWC) was tested to determine the core characteristics of the sandwich structure, and the peak loads of 4.90, 1.81, and 3.90 kN were obtained for 10-, 15-, and 20 mm core thicknesses, respectively. Edgewise compression (EWC) exhibited stable end crushing for thinner face sheet, whereas thicker face sheet showed core crushing and buckling. When the face sheet thickness was increased from 1.5 mm to 3 mm in the EWC, the buckling load increase ranged from 2.53% to 44.83% for core thicknesses 10-, 15-, and 20 mm, respectively.