

Inter-Complex Dependence of Production Technique and Preforms Construction on the Failure Pattern of Multilayer Homo-Polymer Composites

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Abstract : The thermoplastic-based fibre composites are acquiring a market sector of conventional as well as thermoset composites. However, replacing the thermoset with a thermoplastic composite has never been an easy task. The inherent high viscosity of thermoplastic resin reveals poor interface properties. In this work, a homo-polymer towpreg is produced through an electrostatic powder spray coating methodology. The produced flexible towpreg offers a low melt-flow distance during the consolidation of the laminate. The reduced melt-flow distance demonstrates a homogeneous fibre/matrix distribution (and low void content) on consolidation. The composite laminate has been fabricated with two manufacturing techniques such as conventional film stack (FS) and powder-coated (PC) technique. This helps in understanding the distinct response of produced laminates on applying load since the laminates produced through the two techniques are comprised of the same constituent fibre and matrix (constant fibre volume fraction). The changed behaviour is observed mainly due to the different fibre/matrix configurations within the laminate. The interface adhesion influences the load transfer between the fibre and matrix. Therefore, it influences the elastic, plastic, and failure patterns of the laminates. Moreover, the effect of preform geometries (plain weave and satin weave structure) are also studied for corresponding composite laminates in terms of various mechanical properties. The fracture analysis is carried out to study the effect of resin at the interlacement points through micro-CT analysis. The PC laminate reveals a considerably small matrix-rich and deficient zone in comparison to the FS laminate. The different load tensile, shear, fracture toughness, and drop weight impact test) is applied to the laminates, and corresponding damage behaviour is analysed in the successive stage of failure. The PC composite has shown superior mechanical properties in comparison to the FS composite. The damage that occurs in the laminate is captured through the SEM analysis to identify the prominent mode of failure, such as matrix cracking, fibre breakage, delamination, debonding, and other phenomena.

Keywords : composite, damage, fibre, manufacturing

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