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PERFORMANCE IMPROVEMENT OF 3D PRINTED FUNCTIONAL PARTS THROUGH THE USE OF UNCONVENTIONAL CONTINUOUS FIBER REINFORCEMENTS

Abstract

The advent of additive manufacturing techniques has opened new possibilities in the field of rapid prototyping in many engineering fields including aerospace. The fabrication of functional parts requires the use of materials with high performance, so metallic materials are preferred over polymeric materials, which in addition to low mechanical capabilities show limitations in uses in harsh environments. However, the ability to employ continuous fiber reinforcements has also made it possible to consider polymeric materials for applications needing high performance, as fused deposition modeling techniques may now be used to create components with qualities that are comparable to those of metals. The combination of 3d printing techniques with the characteristics of composite materials has widened the design space in which the designer can range as the arbitrary deposition of continuous fiber reinforcements can lead to high optimization of the considered components. This paper presents the experimental study of the performances of 3d-printed composite components reinforced with continuous fiber. Classical and unconventional deposition layouts have been considered to compare the mechanical response and evaluate the impact of the use of innovative design solutions. Rectilinear and curvilinear fibers have been considered. Carbon fibers and Kevlar reinforcements have been used. The components have been tested under static and buckling loads, and where possible a numerical model has been developed to evaluate the possibility to develop a virtual representation of the phenomena. The findings show that components with spatially varying stiffness may be created, showing the potential for customizing the reinforcing method to provide the required stress field. In addition, the use of appropriate reinforcement methodologies has led to a substantial change in buckling behavior showcasing how the use of curvilinear fibers can lead to an improved response of composite structures.