MECHANICAL BEHAVIOR OF Z-PINNED COMPOSITE LAMINATES USING CARBON FIBERS

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Abstract. Composite laminates are more vulnerable to through-thickness loads than to in-plane loads. To overcome this weakness, through-thickness reinforcement is widely considered as an efficient way to improve the resistance of laminated composites against out-of-plane failures. However, through-thickness reinforcements, especially carbon z-pins which are popular for reinforcement, create resin-rich regions around the pins and warp the alignment of the fibers, and this causes the degradation of in-plane stiffness and strength of the composite laminates. In this study, carbon-epoxy composite laminates were reinforced by carbon z-pins to make up for their susceptibility to delamination. The main objective of this study is to investigate the effect of z-pin reinforcements on the mechanical properties of composite laminates produced by various manufacturing methods. Three different manufacturing methods were examined, namely, the normal ultrasonically assisted z-fiber (UAZ) process, a new z-pinning technique without ultrasonic equipment, and a modified UAZ process. Test results demonstrate that the modified UAZ method places the z-pins in better position; therefore, it provides higher effective moduli than other methods. The tested effective moduli of the z-pinned composite laminates are also compared with numerically predicted results using a homogenization method. The predicted effective moduli agree well with the test results.

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