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Geometric Model to Study the Mechanism of Machining and Predict the Damage Occurring During Milling of Unidirectional CFRP

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Abstract : The applications of composite materials in aerospace, sporting and automotive industries need high quality machined surfaces and dimensional accuracy. Some studies have been done to understand the fiber failure mechanisms encountered during milling machining of CFRP composites but none are capable of explaining the exact nature of the orientation-based fiber failure mechanisms encountered in the milling machining process. The objective of this work is to gain a better understanding of the orientation-based fiber failure mechanisms occurring on the slot edges during CFRP milling machining processes. The occurrence of damage is predicted by a schematic explanation based on the mechanisms of material removal which in turn depends upon fiber cutting angles. A geometric model based on fiber cutting angle and fiber orientation angle is proposed that defines the critical and safe zone during machining and predicts the occurrence of delamination. Milling machining experiments were performed on composite samples of varying fiber orientations to verify the proposed theory. Mean fiber pulled out length was measured from the microscopic images of the damaged area to quantify the amount of damage produced. By observing the damage occurring for different fiber orientation angles and fiber cutting angles for up-milling and down-milling edges and correlating it with the material removal mechanisms as described earlier, it can be concluded that the damage/delamination mainly depends on the portion of the fiber cutting angles that lies within the critical cutting angle zone.

Keywords : unidirectional composites, milling, machining damage, delamination, carbon fiber reinforced plastics (CFRPs)
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