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Influence of spatial tool inclination on delamination when milling CFRP

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Abstract

When end milling long carbon-fibre-reinforced plastic (CFRP), delamination, mainly fibre protrusions can occur at the top layers of the machined edges. It was observed that the spatial inclination of the tool axis significantly influences delamination and has not yet been investigated in detail. The fibre cutting angle used so far for the description of the separation process only refers to the cutting velocity in the laminate plane.

The spatial position of the cutting edge and the effective velocity with respect to the fibre axis of a unidirectional ply depend on the tool engagement angle and the inclination of the tool axis. Hence, a three-dimensional description of the geometrical and kinematic relationships has been established in this work for the first time. To determine the effect on delamination the model is compared to milling experiments with various tool axis inclinations towards and perpendicular to the feed direction, denoted by lead and tilt angle.

The results show that fibre protrusions can be avoided if the cutting velocity is at least partially directed into the laminate plane and if the cutting edge is located partially above the fibre to be cut. The geometrical and kinematic model is applicable to any machining operation, to materials with unidirectional fibre reinforcement and to non-crimped fabrics with unidirectional top layers.

Keywords: CFRP; Milling; Delamination; Modeling

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