Fracture energy for orthogonal cutting in unidirectional CFRP at different cutting directions

ABSTRACT

A unidirectional carbon fibre reinforced polymer (CFRP) laminate is a composite material made up of strong parallel carbon fibres incorporated in a polymer matrix such as epoxy to provide high stiffness and strength in the fibre direction of the laminate. Unfortunately, the interlaminar or intralaminar plane of this material has a low resistance to damages as the fracture toughness of a unidirectional CFRP laminate is related to the energy dissipation during the orthogonal cutting. The aim of this study is on cutting a unidirectional CFRP along the longitudinal or transverse directions, characterizing orthogonal cutting forces and the related fracture energy. Orthogonal cutting is performed using braised carbide tools for a range of cutting depth of 10-100 μm with a rake angle of 30° to quantify the cutting forces and to observe the fracture mechanisms. The fibre orientations have a significant impact on surface bouncing-back. For some fibre orientations, the energy balance model is applicable, deducting the reasonable value of fracture toughness due to high normal force (F_t). Fibre subsurface damage and cutting forces during cutting are found to be strongly influenced by the cutting depth. The input energy of cutting is released in form of new surface energy, fibre breakage, high bending energy, and chip fracture energy.