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A feed direction cutting force prediction model and analysis for ceramic matrix composites C/SiC based on rotary ultrasonic profile milling

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ABSTRACT

Ceramic matrix composites have immense applications in the aerospace, aircraft, and automobile industries. Belonging to this class, carbon-fiber reinforced ceramic matrix composites (C/SiC) are used for critical applications due to their superior properties. However, these materials have also stringent properties of heterogeneity, anisotropy, and varying thermal properties that affect machining quality and process efficiency. So, developing a cutting force prediction model and analyzing machining parameters is an essential need for the accurate machining of such materials. In this study, a mechanistic-based feed direction cutting force prediction model for rotary ultrasonic profile milling of C/SiC composites is developed and validated experimentally. The experimental and simulation results closely match each other. The mean error and standard deviation were recorded as 1.358 % and 6.003, respectively. The parametric sensitivity analysis showed that cutting force decreased with increased cutting speed, whereas it increased with increased feed rate and cutting depth. The proposed cutting force model for rotary ultrasonic profile milling of C/SiC composites is robust and can be applied to predict cutting forces and optimize the machining process parameters at the industry level.

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