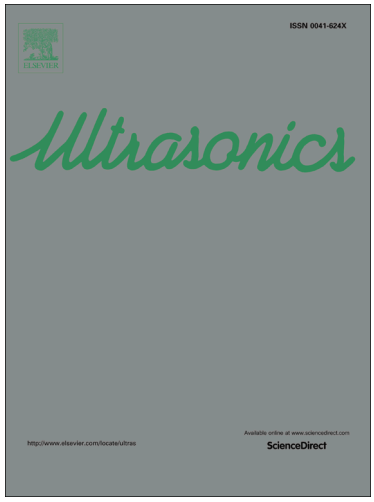

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Experimental and Numerical Study of Ultrasonically-Assisted Drilling

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Abstract

In this study, 3D finite element simulation of ultrasonically-assisted drilling is carried out to analyze the effect of ultrasonic vibrations on common difficulties existed in conventional drilling. Influence of harmonic movement of drill bit on the formation of built-up edge is experimentally evaluated and also discussed by investigation of heat generation on the tool faces in simulation. At the end, it was revealed that intermittent movement of drill bit in vibration method causes the total time of heat transfer between workpiece and drill bit to be reduced resulting lower built-up edge formation compared to conventional drilling. Moreover, linear motion of cutting tool in the feed direction results in the increase of chip strain and consequently damage value which causes to generation of broken chips.

Keywords: Drilling; Ultrasonic; FE simulation; BUE; Force; Chip curling.

1. Introduction

Conventional drilling (CD) process generally produces high cutting force. An increase in this value reduces tool life and surface quality [1]. Formation of built-up edge (BUE) could relatively be one of the reasons that intensifies cutting force generation. Due to embedding of dill bit in workpiece, heat localization is produced in the cutting zone. Thus, increase of temperature results in greater frictional force causing generation of built-up edge and tool wear acceleration [2]. Bhowmick and Alpas [3] indicated a large formation of BUE in dry drilling causes torque and thrust force to be increased. To overcome these problems, frictional contact in tool-chip interface should be decreased. Accordingly, various efforts are being carried out in related industries. These include reducing the material removal rate, using a proper coating, and utilization of cutting fluids [4]. One more strategy is modification of drilling kinematics. In an appropriate manner, ultrasonic vibrations can generate an additional movement to the cutting tool in the feed direction [5-7]. This periodically interrupted cutting results in a range of improvements in drilling process, in which it was experimentally analyzed by some researchers. Barani