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Investigation of vibration effects and tool shape on edge chipping phenomenon occurring during rotary ultrasonic drilling

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Abstract

Rotary ultrasonic drilling (RUD) is non-conventional so called hybrid manufacturing process for hole drilling into materials with specific properties such as brittle materials and composites. RUD is a combination of grinding process by tool with diamond particles on active surface that simultaneously performs axial vibrations with frequency at the ultrasound level. During the hole drilling, the hole bottom thickness decreases and the change in the distribution of the structural parameters (mass, stiffness) of the workpiece occurs. The workpiece structure is exposed to ultrasonic excitation and therefore is subjected to the transition through the various vibration states. These vibration states are considered as one of the important effects that leads to appearance of the edge chipping phenomenon. Although intensive research in this application area is still ongoing, the impact of ultrasonic vibrations as well as the influence of the shape of the contact surface of drilling tool on this phenomenon is still insufficiently analysed. The effects different contact surfaces of drilling tools on the stress-strain states and prediction of edge chipping phenomenon occurring during RUD are analysed in this paper.

Keywords: rotary ultrasonic drilling, vibration, edge chipping, cutting force, finite element method, numerical simulation, stress-strain state

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