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CONTRIBUTION TO UNDERSTANDING AND MODELIZING VIBRATION ASSISTED DRILLING

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ABSTRACT

Drilling operation is mainly used in order to assemble parts with bolts in the aircraft industry. A drawback of this process is the formation of long chips when cutting metallic parts. Usually, the drilling operation is made with peck drilling cycle to evacuate the chip. This solution increases the operation time and therefore the operation cost. To address the issue of long chips, vibration assisted drilling has been developed to meet industrial needs in terms of productivity. The use of forced vibrations imposes the tool to go in and out of the material, cutting and generating smaller chips. This process is quite young and optimal cutting conditions have yet to be determined. To assess the quality one can expect from vibratory drilling, it is necessary to first understand the cutting mechanisms and the evolution of the cutting forces. To take into account the evolution of tool geometry and cutting velocity along the edge of the tool, thrust force in conventional drilling has already been modelled by representing the tool by several parts corresponding to each cutting mechanism: indentation at the centre of the tool, cutting along the cutting edges and a mix of these two mechanisms in a small region around the centre of the tool. When applied to vibration assisted drilling, the oscillation of the feed rate has to be considered. The repetitive accelerations and decelerations continuously modify the size of each zone and the thrust force they generate. The model presented here formulates the interaction of several zones of the tool with the material and explains the particular shape of the thrust force observed. The work presented in this paper is a part of a thorough study of the impact of vibratory drilling on hole quality. The models are identified and validated through an application on aluminium 7010.

RESUME

L'opération de perçage est principalement utilisée afin de permettre l'assemblage de pièces aéronautiques par rivets ou boulons. Une limitation de ce procédé est la formation de copeaux longs lors du perçage de matériaux métalliques. Généralement, des cycles de débourrage permettre de casser le copeau et faciliter son évacuation. Mais cette solution augmente les temps de perçage et donc les coûts de fabrication. L'utilisation d'une assistance vibratoire permet de fragmenter le copeau répondant ainsi aux problèmes de longs copeaux tout en conservant la productivité initiale. Ce procédé est jeune et les conditions de coupe optimales sont encore méconnues. Avant de qualifier la qualité des trous obtenus par ce procédé, il est nécessaire de comprendre les mécanismes de coupe en perçage assisté par vibrations.