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Optimization of machining performance in deep hole boring: A study on cutting tool vibration and dynamic vibration absorber design

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A B S T R A C T

In the realm of precision engineering, particularly in deep hole boring processes, tool vibration emerges as a critical determinant of machining performance. This investigation elucidates the genesis of self-excited vibrations within deep hole boring operations and delineates the underlying mechanisms of cutting tool vibration. A focal point of this study is the optimal alignment of the boring bar to mitigate vibrational impacts, thereby enhancing surface finish quality and extending tool longevity. Central to this analysis is the employment of a Dynamic Vibration Absorber (DVA) aimed at attenuating cutting tool vibration. The deployment of DVA necessitates precise identification of modal parameters, namely the equivalent stiffness (K) and mass (M) of the cutting tool. This research juxtaposes various scholarly methodologies to amalgamate theoretical calculations with simulation approaches, thereby acquiring accurate modal parameters. Utilizing Matlab software, the vibration amplitude of the boring bar under varying spring stiffness scenarios was examined. Results indicate a direct correlation between increased stiffness and reduced amplitude, particularly when the frequency ratio 'g' ranges between 0.5 and 1.1. Consequently, a stiffer DVA configuration is posited as more effective in vibration reduction. Furthermore, the study conducted frequency sweep experiments on a damping boring bar, utilizing a vibration excitation platform. These experiments revealed the existence of an optimal stiffness value for the DVA, thereby underscoring the significance of stiffness matching in vibration mitigation strategies.

A R T I C L E I N F O

Keywords:
Deep hole boring;
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