Effects of Irregular Tool Geometry and Machining Process Parameters on the Wavelength Performance of Process Damping in Machining Titanium Alloy at Low Cutting Speed

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ABSTRACT
In machining titanium alloy as difficult-to-cut or hard materials, productivity is limited because of low heat conductivity at high spindle speed. Process damping is a damping mechanism during the machining process that can be exploited to improve the limited productivity in machining titanium alloy at low cutting speed. In the present study, experiments are performed to evaluate the wavelength performance of process-damped milling under irregular tool geometries such as uniform, variable helix, variable pitch, and variable helix/variable pitch. The effects of radial immersion, feed rate, depth of cut, and surface velocity as process parameters are also studied. By using flexible workpiece conditions, all tools are tested in machining titanium alloy at low speed to encourage the process damping phenomena. The wavelength performances are calculated on the basis of the chatter frequency domain analysis extracted from the acceleration signal in the time domain during the cutting process. The effect of irregular tool geometries shows that variable helix and variable pitch tools have the best wavelength performance compared with regular and other irregular tools. The effect of process parameters reveals that the radial depth of cut can also improve the process damping wavelength compared with regular tools. Irregular milling tool geometries with spindle speed and feed rate parameters can be used to suppress the chatter by exploiting the process damping behavior, thus improving machining productivity.

KEYWORDS: Titanium; Process damping; Wavelength performance; Variable helix; Helix angle; Cutting force coefficient

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