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Stability limits of milling considering the flexibility of the workpiece and the machine

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Abstract

High speed machining of low rigidity structures is a widely used process in the aeronautical industry. Along the machining of this type of structures, the so-called monolithic components, large quantities of material are removed using high removal rate conditions, with the risk of the instability of the process. Very thin walls will also be milled, with the possibility of lateral vibration of them in some cutting conditions and at some stages of machining. Chatter is an undesirable phenomenon in all machining processes, causing a reduction in productivity, low quality of the finished workpieces, and a reduction of the machine-spindle's working life.

In this study, a method for obtaining the instability or stability lobes, applicable when both the machine structure and the machined workpiece have similar dynamic behaviours, is presented. Thus, a 3-dimensional lobe diagram has been developed based on the relative movement of both systems, to cover all the intermediate stages of the machining of the walls. This diagram is different and more exact than the one that arises out of the mere superposition of the machine and the workpiece lobe diagrams. A previous step of rejecting resonance modes that are not involved in the milling at the bottom zones of the thin walls must be previously performed.

Finally, the proposed method has been validated, by machining a series of thin walls, applying cutting conditions contrasted with the limits previously obtained in the three-dimensional lobe diagram.

Keywords: Chatter; High speed milling; Low-rigidity parts; Machining vibrations; Stability lobes