MATERIAL PROPERTIES FOR MODELING VIBRATION ASSISTED MACHINING

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The vibration-assisted machining adds high frequency motion and additional forces to an already very complex machining process. To incorporate vibration assisted machining into modern manufacturing processes it will be necessary to simulate the process with models and to help demonstrate the advantages and disadvantages of these added complexities. To model any machining process in a predictive environment it is necessary to have an understanding of the effect of material properties on the process parameters. The material property traditionally needed for machining models is the shear flow stress of the material appropriate for the particular process. Because machining is a very high strain-rate process, and machining usually involves elevated temperatures, the flow stress as a function of strain-rate and temperature becomes important. The material test method most commonly used for obtaining high strain rate properties of metals is the split Hopkinson pressure bar, or also called a Kolsky Bar.

The Kolsky Bar approach of determining appropriate dynamic material properties is presented in this paper with an emphasis on the strain rate effects on flow stress. If the strain rate of a machining process is affected by a vibrating tool, can a change in flow stress due to strain rate effects explain the machining performance enhancement of vibration-assisted machining? This paper provides some examples of strain rate effects on the flow stress of steel and aluminum that will be useful in modeling vibration assisted machining. The strain-rate effect has been investigated using the NIST Pulse Heated Kolsky Bar, and the method with some representative results will be presented in this paper.

As an interesting historical note: some of the earliest use of the finite element method for modeling machining processes—now becoming widely used industry—was from the precision engineering community (John Strenskowski's work at NCSU in the 1970s).