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Analytical modeling of ultrasonic burnishing process: Evaluation of active forces

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Abstract

In our recently published work [26], mechanic of forces acting during burnishing process has been identified. The process was modeled based on slab method theorem and effect of burnishing parameters on horizontal and vertical forces were identified. However, the present work is an analytical approach to find effect of ultrasonic vibration parameters and pass number considering elastic rebound of work surface. In the proposed methodology effect of different parameters such as feed rate, ball diameter, depth of burnishing, vibration amplitude and pass number on the burnishing force. The comparison with experimental results allows to affirm that the model is a useful tool to predict the value of burnishing force in both the horizontal and vertical directions.

Keywords: Burnishing; Analytical model; Ultrasonic assistance; Elastic surface rebound; Confirmation

1. Introduction

Burnishing is a mechanical surface treatment process which is used most commonly to enhance the surface quality of the engineering components by removing microcracks and voids remained from previous production process. Also, it improves the fatigue life of the parts by inducing compressive residual stress to the work surface. The surface of the burnished parts is even being work hardened due to plastic deformation caused by compression and burnishing action of tool. It causes microstructure refinement and improvement in mechanical properties and fatigue life [1].

Different studies have been carried out for analyzing the burnishing process by use of experimental, numerical and analytical approaches. In this case, Rodriguez et al. [2] performed experimental and numerical approaches to study surface characteristics, hardness and residual stress after ball burnishing process. They found that inducing ball burnishing process significantly enhances surface properties and residual stress values. El-Taweel and El-Axir [3] performed experimental study based on response surface methodology to analyze

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