Modeling the kinematics of material flow in the cutting process as a basis for optimizing tool geometry to limit the formation of burrs on the cut surface of components

Ł. Bohdal[1],*A. Kułakowska[1]

[1] Department of Mechanical and Energy Engineering, Koszalin University of Technology, Koszalin, Poland
e-mail: lukasz.bohdal@tu.koszalin.pl

KEYWORDS: *Cutting process, Modeling, FEM, Tool geometry* .

The paper presents the results of physical modeling and numerical simulations of the mechanical cutting process, focused on analyzing the kinematics of material flow and identifying factors affecting the quality of the cut surface. It was demonstrated that in complex metal forming processes, characterized by multiple degrees of freedom of the material, an intuitive approach to tool design is insufficient, and that visualization and process modeling play a key role.

Physical modeling enabled the identification of regions of strong geometric and material nonlinearities depending on the geometry of the cutting tool. A simulation model of the cutting process was developed, allowing for the analysis of displacement, strain, and stress states as a function of time, taking into account load history as well as variable process parameters such as tool geometry, friction conditions, and material properties.

The conducted analyses showed a significant influence of cutting tool geometry on the mechanics of material flow, including the formation of sticking and sliding zones, areas of deformation, and the energy consumption of the process. Conditions for process realization were determined that enable the reduction of cutting resistance and unfavorable phenomena such as excessive material hardening or the formation of flash.

Based on the obtained results, directions for optimizing the geometry of cutting tools were proposed, enabling the reduction of burr formation and improvement of the cut surface quality of metallic materials. The research results provide a basis for the development of new tool designs and can be applied in the design of cutting technological processes with increased efficiency and product quality.

a) b)

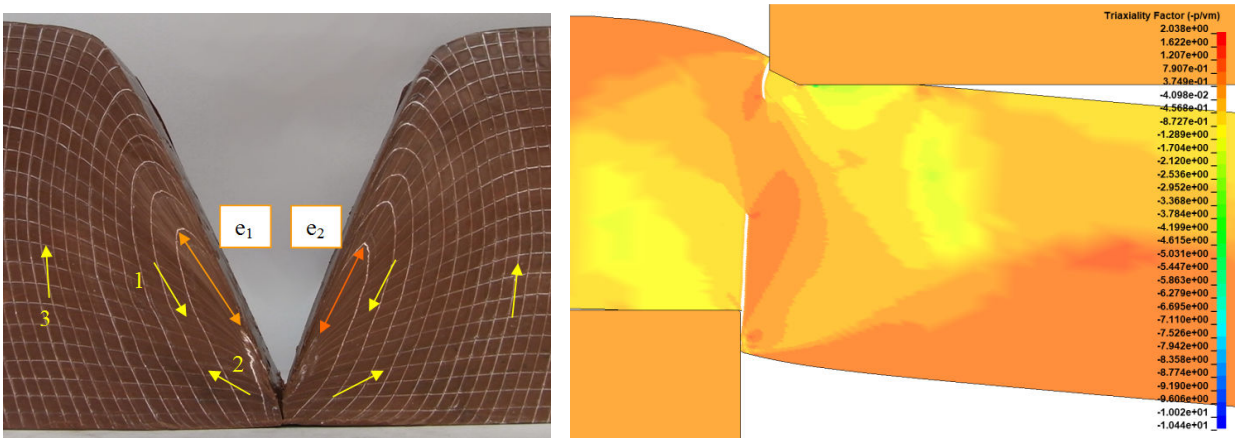

Figure 1. Example of physical modeling of cutting process (a), numerical modeling (b)