Prediction of Surface Quality in Roller Burnishing Processes Using FEM-Based Applications

A. Kulakowska[1,*], L. Bohdal[2] and K. Olewińska[2]

[1,2,3]Department of Mechanical and Energy Engineering, Koszalin University of Technology, Koszalin, Poland
e-mail: agnieszka.kulakowska@tu.koszalin.pl
e-mail: lukasz.bohdal@tu.koszalin.pl
e-mail: kinga.pakmur@gmail.com

KEYWORDS: *Numerical Analysis, Surface Quality Forecasting, Burnishing Rolling.*

Applications developed in FEM systems enable comprehensive time-dependent analysis of deformation states (displacements and strains) and stresses occurring in an object composed of a workpiece and a burnishing tool. They allow flexible modification of model parameters such as geometry, loading conditions (e.g., indentation depth), friction conditions, process time, and material properties (including nonlinear plasticity models dependent on strain and strain rate). The application developed by the author meet advanced practical requirements and can be successfully used for simulating real burnishing processes. Increasing technical and economic demands, along with the development of new materials, necessitate the creation of new theoretical models and their implementation in numerical software. These applications are used for modeling and simulation of burnishing processes. The model assumes a three-dimensional state of stresses and strains. The applications enable full analysis for a wide range of input data, including: arbitrary geometry of the workpiece (e.g., shaft, sleeve, cone) and tool (e.g., sphere, polyhedron), various materials with complex plastic behavior models, diverse surface geometries resulting from prior machining processes, deviations and surface irregularities with defined profiles, different friction conditions in the contact zone, arbitrary tool displacements over time, arbitrary initial and boundary conditions.

The first step involves defining the geometry of the workpiece and the tool. The analyses primarily use three-dimensional models, assuming the tool to be either rigid or elastic. The simulation program allows the introduction of various surface profiles, including different angles and deviations of surface irregularities. An important feature of the application is the ease of modifying geometry, refining the mesh, and optimizing the model, which enables accurate representation of real burnishing process conditions. To confirm these capabilities, both experimental studies and numerical analyses were carried out. They involved surfaces prepared for burnishing by turning, made of C45 steel, characterized by surface irregularities with different apex angle θ, while the spacing of the irregularities was s=1 mm.

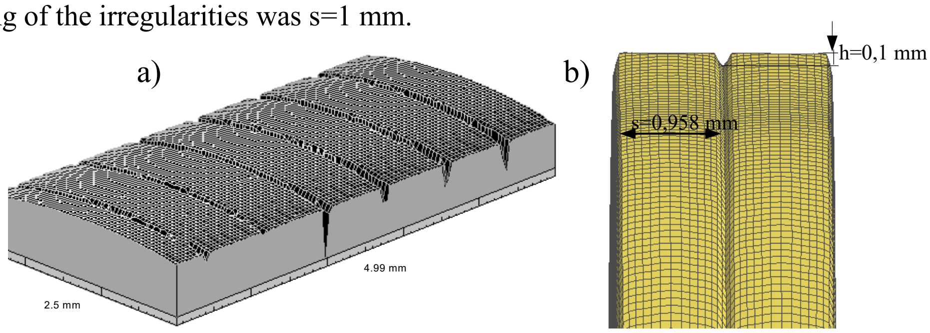

Figure 1. Continuous axonometric view of the surface after burnishing with visible secondary indentations (a), computer simulation result (b).

[1] Jerez-Mesa, R.; Travieso-Rodriguez, J.A.; Lluma, J.; López de Lacalle, L.N. Numerical–experimental approach for ball burnishing process on complex surfaces.*Precision Engineering*, 2021, 67, 231–243

[2] Kluz, R.; Antosz, K.; Trzepiecinski, T.; Bucior, M. Modelling the Influence of Slide Burnishing Parameters on the Surface Roughness of Shafts Made of 42CrMo4 Heat-Treatable Steel. *Materials* 2021, 14, 1175. https://doi.org/10.3390/ma14051175.