Numerical Analysis and Experimental Researches of the Influence of Technological Parameters Burnishing Rolling Process on Fatigue Wear of Shafts

Pawel Kaldunski[a)], Radoslaw Patyk[b)], Leon Kukielka[c)], Lukasz Bohdal[d)], Jaroslaw Chodor[e)], Agnieszka Kulakowska[f)]

Department of Mechanical Engineering, Koszalin University of Technology, Poland

[a)]Corresponding author: pawel.kaldunski@tu.koszalin.pl
[b)]radoslaw.patyk@tu.koszalin.pl
[c)]leon.kukielka@tu.koszalin.pl
[d)]lukasz.bohdal@tu.koszalin.pl
[e)]jaroslaw.chodor@tu.koszalin.pl
[f)]agnieszka.kulakowska@tu.koszalin.pl

Abstract. The paper presents the results of computer modelling using FEA and experimental researches of the influence of technological parameters of burnishing rolling process on resistance to fatigue wear of shafts. For solution of elaborate equation of motion the explicit method has been used. This allows to carries out the time analysis of the displacements, strains and stresses state's in workpieces. In addition, the numerical analyses have been carried out for the fatigue wear component after burnishing for low frequency loads. The results of the numerical analysis have been experimentally verified by researching the surface layer after burnishing. In addition the shafts have been tested on fatigue wear.

INTRODUCTION

The paper analyzes the problem of the influence of rolling burnishing depth on fatigue resistance of machined shafts. Increased resistance to fatigue wear is the primary purpose of the burnishing treatment. Resistance to fatigue wear is mainly due to the creation of a specific state of compressive stresses and the hardening of the surface layer of the object. From the literature it is known that using a burnishing surface texture density can be prepared and incorporated permanent compression stresses to about -1200 MPa. In practice, it is important relationship between the dimension of the depth of the deformation, caused by burnishing treatment. The increase in fatigue strength after a properly conducted burnishing process can be significant. For example, for structures with stress accumulation locations (stepped shafts), the increase in fatigue strength may be up to about 150 ÷ 200% compared to turning or grinding. The main purpose of the work is to determine the impact of the depth of implantation on fatigue strength. To achieve the goal, numerical analyzes and experimental studies of the effect of burnishing depth on usable properties of the product (durability) and technological properties of the product (surface roughness) were carried out.

NUMERICAL ANALYSIS OF THE PRODUCTION AND DEGRADATION PROCESS

Simulation of process burnishing shafts

The process of static axial roller burnishing was simulated using a three-bar head, which aims to improve the fatigue strength of the samples. The simulation was carried out using the Finite Element Method. The geometry needed to model the process consists of a sample in the shape of a shaft with a diameter of 20 mm and three discs

with a diameter of 50 mm and a thickness of 25 mm each. Figure 1 presents an example of the state of reduced stresses obtained after burnishing for the depth of burnishing a_n = 0.02 mm.

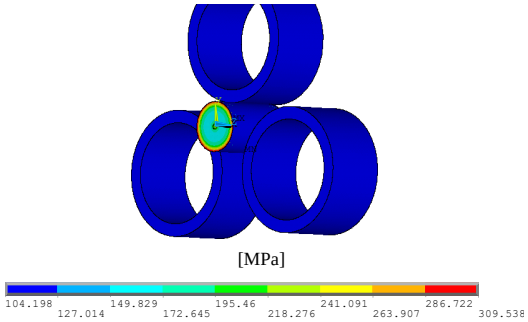

FIGURE 1. Reduced stress distribution map for the depth of burnishing a_n = 0.02 mm - general view

Simulation of the process cyclic bending shafts

The numerical model of the process of cyclic rotary bending of shafts has been developed in order to forecast useful properties (durability) after rolling burnishing with various technological parameters of the process. The layout of the position and sample results are shown in Figure 2.

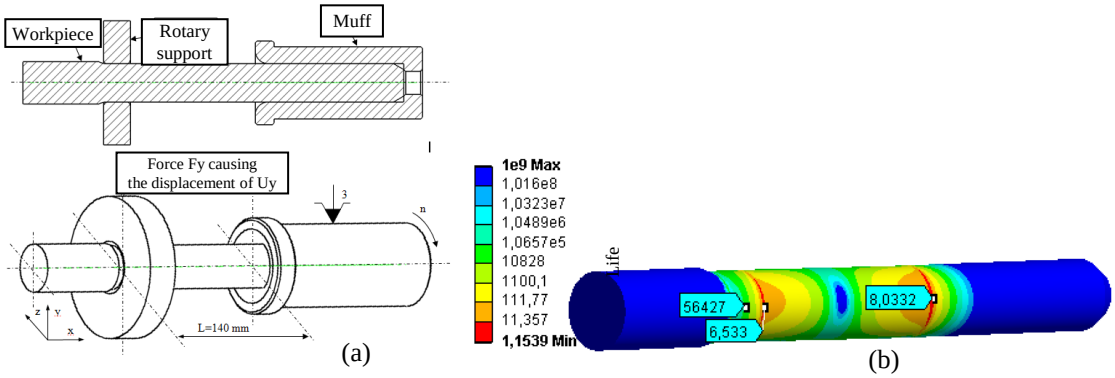

FIGURE 2. The concept of the position of the fatigue resistance wear (a) and the life calculated (b)

EXPERIMENTAL VERIFICATION

The results of numerical analyzes were verified experimentally. Exemplary results of experimental research are presented in Figure 3.

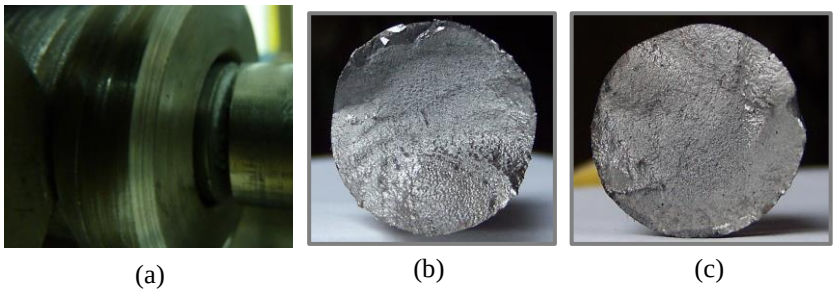

FIGURE 3. Photo scrap fatigue: a) general view, b) for burnishing depth an = 0.02 mm, c) for the burnishing depth and an = 0.03 mm