Studies Regarding the Specificity of the Abrasive Processes

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Abstract— In the paper are presented some aspects regarding the specificity of the abrasive processes compared to other machining processes and taking into account the main characteristics of superfinishing work parameters for radial ball bearing parts. Also, in this study are showed some test results regarding the performances obtained in increasing the surface finish, deviations from circularity and waviness after machining the ball bearings through superfinishing process for two types of workpieces.

Keywords—surface finish, abrasive processes, quality of machining, cost reduction

I. Introduction

In his "Abrasives for engineering purposes" D.Roşca [1] states that "regardless of the abrasive process considered (grinding, honing, superfinishing, etc.), the abrasive grain fixed in a body abrasive tool must have a relative movement with respect to the workpiece surface to be processed". As a result, we find the characteristic elements of abrasion process:

- a large number of cutting tools with undefined geometry consisting of a lot of abrasive grains acting simultaneously or successively;
- relative movement between the abrasive grains and the workpiece.
- Researchers have tried to study the abrasion process comparing it to the machining process with defined cutting tool geometry:
- for grinding were tried to find similarities to milling, each abrasive grain being considered as cutter tooth [2] (grinding wheel is a rotating body as milling, but possessing a small number of edges bordering abrasive grains embedded in the body);
- for superfinishing was assimilated broaching, each abrasive grain corresponding to a tooth of the broach [3], abrasive bar having a similar movement to broach, each abrasive grain moving on the trajectory on a previous grain.

But today, specialists in the field believe that abrasive process differs fundamentally from the other machining processes with defined tool cutting edges. One of the differences between abrasive process and other machining technology is the phenomenon of self-sharpening of abrasive body.

As the abrasive grit blades become dull and blunt, cutting forces grow properly and the grains are torn out from the body tool. If the cutting tool (grinding body) has a low hardness, abrasive grains are easily plucked from the body tool and gradually and continually fresh grains appears with sharp edges and abrasive process continues normally. If the cutting tool has a hardness too high, dull abrasive grains are retained for a longer time so that the abrasive grain gradually lose its capacity of cutting or complete clogging and the workpiece surface finish will have a poor quality.

Between other limitations from abrasive processes and milling or broaching process we can mention:

- Cutting edges of the abrasive grains located on the periphery of the abrasive body have an irregular layout and are not included, in general, to the same initial surface;
- The geometry of the abrasive grain is variable and varies from grain to grain, being possible cutting rake angles both positive and negative, within a very broad field;
- Cutting edges have irregular shapes and sizes.
- Grain sizes range in a great domain, from 10 - 1400μm;
- Cutting fluid penetration is difficult in the area of contact between the abrasive grain and workpiece surface because a small size of the contact surface between the abrasive body and workpiece ,a high speeds under which the cutting process and centrifugal forces "throws out" of the cutting fluid, an "obstacle" which has to overcome the cutting fluid to one point at the periphery of the workpiece.

In superfinishing, it can be stated [5] that the rake angle of the abrasive grain can turn into a relief angle after a reciprocate movement of the tool during machining process (Fig.1).

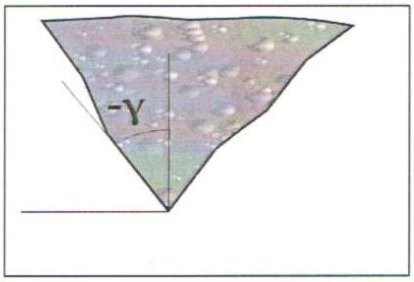

Fig. 1. Transition of the rake angle into relief angle

In the early processing, abrasive grain has sharp edges, but shortly grain radius increases due to wear and wear facet occurs which results in decreased of cutting productivity (Fig.2).

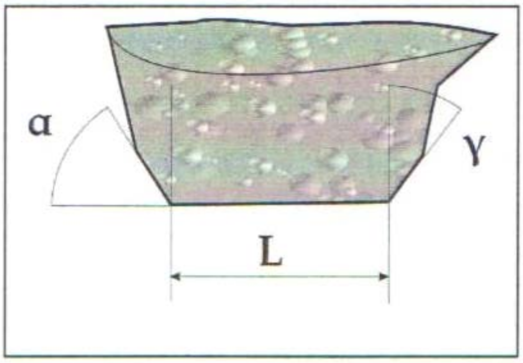

Fig. 2. The wear facet of an abrasive grain

During abrasion process is observed a phenomenon of lateral deformation of the workpiece surface, due to the penetration of the abrasive grain in the part body (Fig.3). These bumps may be expelled by the action of next abrasive grains.

Studying contact between the abrasive grains and the workpiece surface (Fig.4) is observed that there are three areas: the elastic zone I, the plastic zone II, and the cutting zone III. Research [3] has shown that the intensity of the lateral deformation has different values in the three areas, and the maximum value was obtained for the area II.

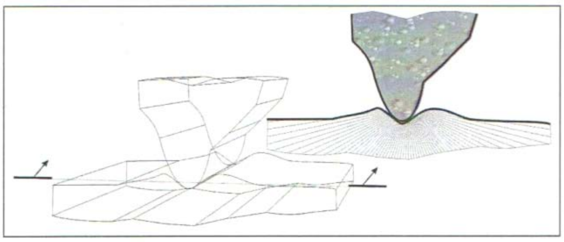

Fig. 3. The phenomenon of lateral deformation

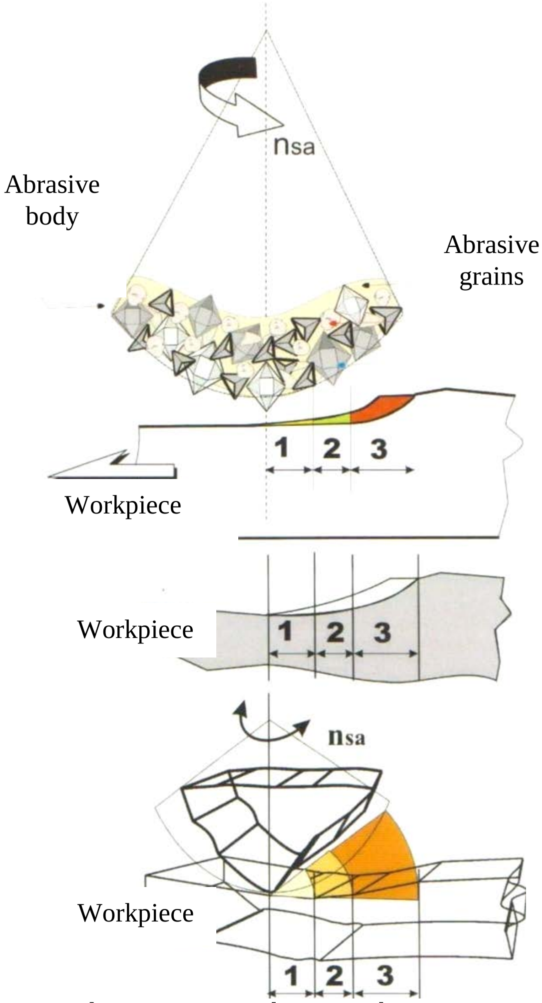

Fig. 4. The contact zones between abrasive grains and workpiece surface.

Cutting heat diffused into the workpiece during abrasion process has, in addition to dimensional changes that should not be neglected, the following effects on the workpiece surface: internal stresses that remain, changing the surface hardness, the formation of cracks on the surface (Fig.5), changing the structure of the surface layer piece rectified (Fig.6).

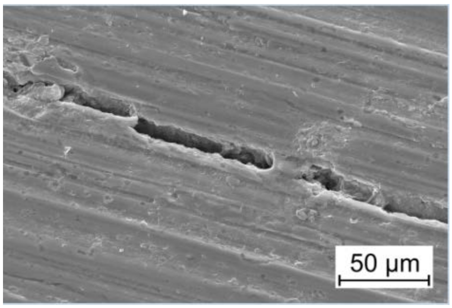

Fig. 5. Cracks that appear during abrasion process.

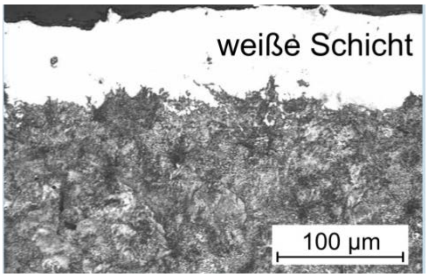

Fig. 6. Changing the structure after abrasion process.

II. Test Results Regarding the Superfinishing of the Ball Bearing Ring Groove

During the tests was used a superfinishing machine KM 150 which has two working stations for roughing and finishing machining, an oscillation frequency of 1200 double strokes per minute and a force of abrasive stone on the workpiece surface of 50 daN.

The principle of the superfinishing process of the ball bearing ring groove is shown in Fig.7.

To highlight the relationship between surface finish of the radial ball bearing ring grooves after superfinishing process, were measured the deviations of circularity, waviness and roughness for two groups of workpieces, 6209-10 and 6312-10 respectively.

It were used two abrasive tool, for roughing EK1 600-08-100 VKH S-Atlantic and for finishing SC 9 1000-1-65- VUB – Atlantic.

To exclude the influence of the blank material on the quality of superfinished part, measured workpieces were from a lot of parts processed on the same machine tool under the same conditions, previous operations (simultaneous surface grinding, centerless grinding, and grinding ring groove).

Measurement deviation from roundness and waviness was done with a device type Talyrond and roughness measurement was performed with a Talysurf device type.

Dispersions values deviation from circularity, waviness and roughness Ra were performed using SPSS program and are shown in the Figs. 8-10.

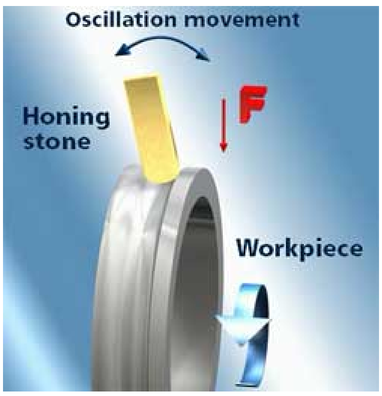

Fig. 7. The principle of the superfinishing process.

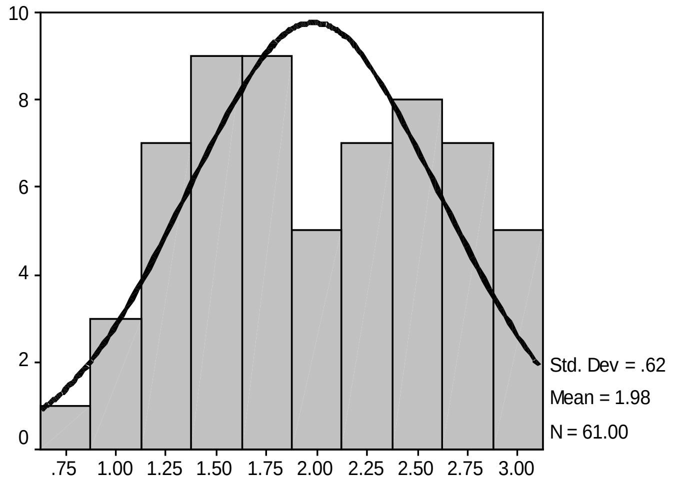

Fig. 8. Deviation from circularity (Piece nr. 6209-10).

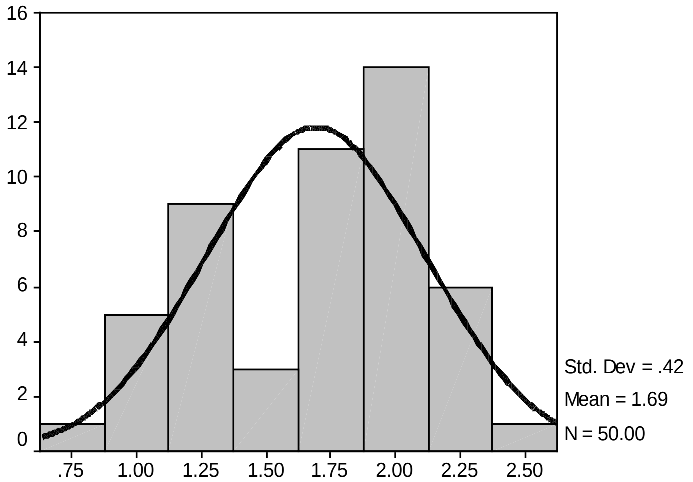

Fig. 9. Deviations from circularity (Piece nr. 6312-10).

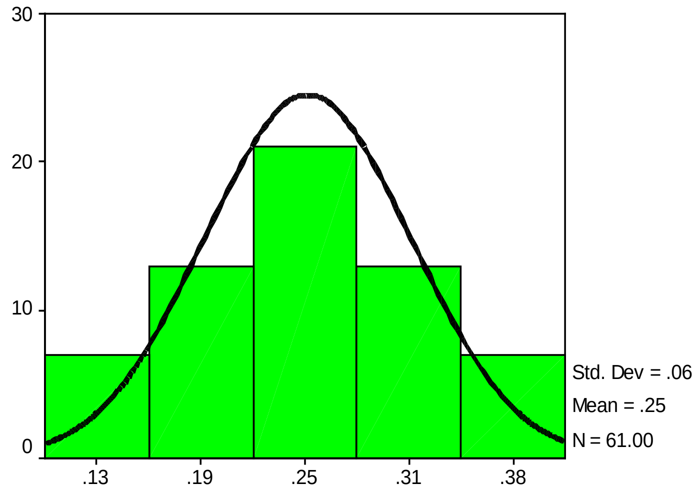

Fig. 10. deviations from waviness (piece nr. 6209-10)

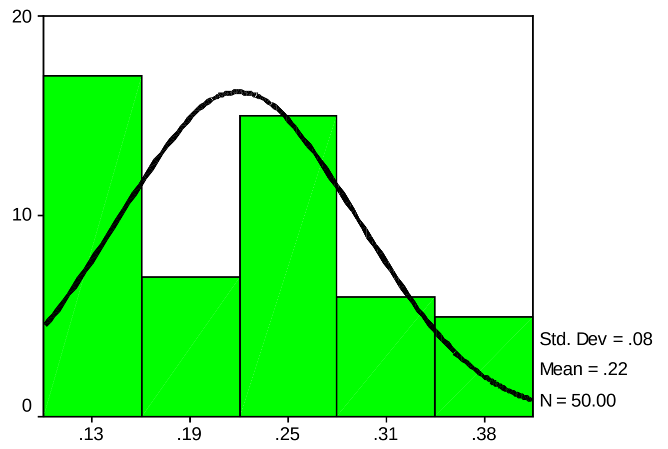

Fig. 11. Deviation from waviness (piece nr. 6312-10).

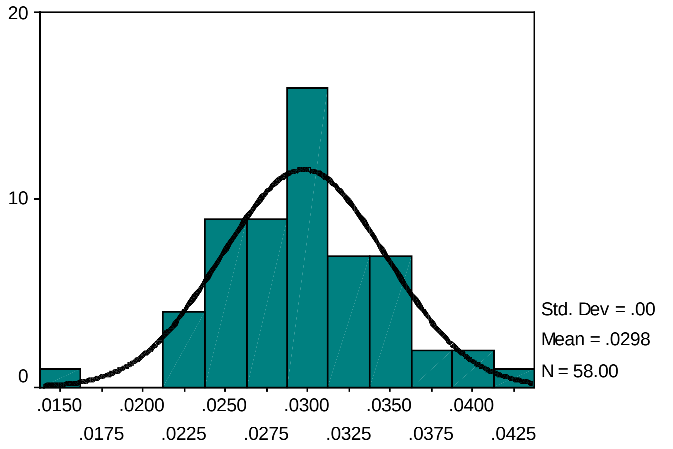

Fig. 12. Deviation from roughness (piece nr. 6209-10).

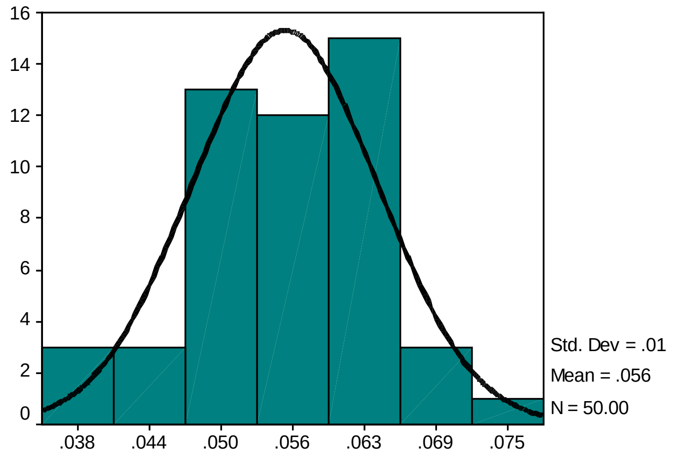

Fig. 13. Deviations from roughness (piece nr. 6312-10)

Analysis of correlation between the workpieces characteristics after superfinishing process show that there is a significant correlation between waviness and deviation of roundness, but there is no correlation between roughness and parameters characterizing the shape of the piece (Tables 1-2).

TABLE I. CORRELATIONS BETWEEN WORKPIECE PARAMETERS AFTER SUPERFINISHING (PIECE NR. 6209-10).

		N	Correlation	Sig.
Pair 1	AB.CIRC2 & OND2	61	0295	0.021
Pair 2	AB.CIRC2 & RA2	58	0.040	0.763
Pair 3	OND2 & RA2	58	0.027	0.838

TABLE II. CORRELATIONS BETWEEN WORKPIECE PARAMETERS AFTER SUPERFINISHING (PIECE NR. 6312-10).

		N	Correlation	Sig.
Pair 1	AB.CIRC2 & OND2	50	0.1	0.992
Pair 2	AB.CIRC2 & RA2	50	0.135	0.348
Pair 3	OND2 & RA2	50	-0.245	0.086

TABLE III. DESCRIPTIVE STATISTICS

Parameter	Characteristics' parameters	6209-10	6312-10
Deviation from circularity of ball bearing ring groove	N	61	50
	The arithmetic mean	1.98	1.69
	Standard deviation	0.62	0.42
Waviness of ball bearing ring groove	N	61	50
	The arithmetic mean	0.06	0.08
	Standard deviation	0.25	0.22
Roughness average of ball bearing ring groove	N	58	50
	The arithmetic mean	0.0298	0.056
	Standard deviation	0	0.01

In Table 3 were presented characteristic parameters of dispersions deviation from circularity, waviness and roughness for the two groups of pieces with numbers 6209-10 and 6312-10 with the outer diameter of 95 mm and 120 mm respectively.

It appears that there are not big differences between arithmetic mean and standard deviations for circularity deviation, waviness and roughness Ra average of the two groups of rings.

III. CONCLUSIONS

- Using the data processing program of data SPSS were drawn frequency diagrams for surfaces of the bearing rings after superfinishing process – deviation from circularity, waviness and roughness average of two groups of workpieces 6209-10 and 6312-10
- The characteristic sizes of descriptive statistics (arithmetic mean, standard deviation) do not differ in a much from those two groups of workpieces.
- The correlation tables show that there is a significant correlation between the deviation of circularity and waviness. One explanation would be that the waviness and deviation from circularity are obtained by

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"smoothing" of measurement results forming the real profile of the surface by applying different filters.

- Tables of correlations showed that there is not a significant correlation between the waviness and deviation of circularity. This shows that, in the circumstances of superfinishing, the rings are scratched of loose abrasive grains of abrasive bars and unfiltered properly by individual system of machine tool used. Scratches cause an increase in roughness average. Another limitation of the technological process is that there is no perfect control of radius of the ring groove obtained through grinding. The deviations from the correct form of the radius of the ring groove lead to the formation of "bumps" on this surface. Superfinishing stone cannot penetrate into all these areas, and therefore the area is insufficient superfinished and thus will have a higher waviness.

References

[1] D. M. Rosca, Abrasive tools used in machining, LUX LIBRIS Publishing House, Brasov, 1995.

[2] M. Cozmanca, S. Panait, and C. Constantinescu, Basics of cutting, „Gh. Asachi" Publishing House, Iasi, 1995.

[3] C. Buzatu, A. Nedelcu, I. Piukovici, and B. Lepădătescu, Working smoothing surfaces in mechanical engineering, LUX LIBRIS Publishing House, Brasov, 1998.

[4] G. Draghici, Manufacturing engineering, Technical Publishing House, Bucuresti, 1983.

[5] I. Sarbu, O. Pruteanu, and C. Carausu, "Static and dynamic stability study in superfinishing process," Paper presented to TMCR ´99, Iasi, 1999.

[6] C. Picos, Manufacturing engineering, Didactic and Pedagogic Publishing House, Bucuresti, 1974.

[7] J. Koehler, Randzonenbeeinflussung und Prozessueberwachung beim Aussenrundschleifen, Schaeffler Technologieplattform Schleifen, May 20, 2008, Bucuresti.