Study on the influence of cutting fluid on flat grinding process

Badea Lepadatescu, Flavia Fechete
Transylvania University of Brasov
Romania
lepadatescu@unitbv.ro, flavia.fechete@unitbv.ro

Abstract*: In the paper is presented a study regarding the influence of different factors on the roughness of machined surfaces obtained by manufacturing process of flat grinding. The workpieces that were used on the experimental tests were radial bearing ring with needles made of steel hardened to 60-64 HRC. It were taken into consideration factors like, the size of the machined surface, the traverse speed, the grain size of abrasive grinding wheels, cutting fluid.*

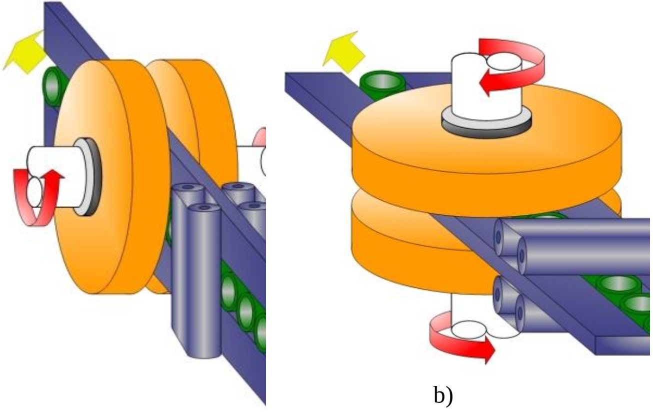
During the experiments was used the method of the Box-plot graphical representation that aims to observe and characterize the distribution of values obtained on these tests.

Keywords:*GRINDING PROCESS, CUTTING FLUID, SURFACE FINISH*

1. Introduction

Simultaneous flat grinding is a process of flat grinding in which the parts are machined simultaneously on both sides of the front of the abrasive bodies. The machining process has a high productivity, so these types of machines can not operate without automatic feeding systems and discharge of machined parts.

The machined parts are pushed into the grinding slot by a roller drive system and are guided by two linear supports. The two abrasive discs can be mounted with horizontal (Fig.1.a) or vertical axes (Fig.1b).



b)

a)

Fig.1 *Principle of operation of simultaneous flat grinding machines. a) Abrasive bodies with horizontal axes; b) Abrasive bodies with vertical axes.*

In the following we will refer only to the process of simultaneous flat grinding of the needle bearing rings (Fig.2), made of steel hardened to 60-64 HRC. The amount of material removed from workpiece faces depends on the speed of the abrasive wheels.

If asymmetrical parts are machined (ex. tapered roller bearing rings), in order to remove the same material from both sides, it is necessary to respect the relation (1):

$$\frac{n_1}{n_2} = \frac{S_1}{S_2} \tag{1}$$

where S_1, S_2 represent the areas of the two flat surfaces of the part which are machined simultaneously, and n_1, n_2 - the rotations of the two abrasive wheels which simultaneously cut the flat surfaces of the areas S_1 and S_2 respectively [1].

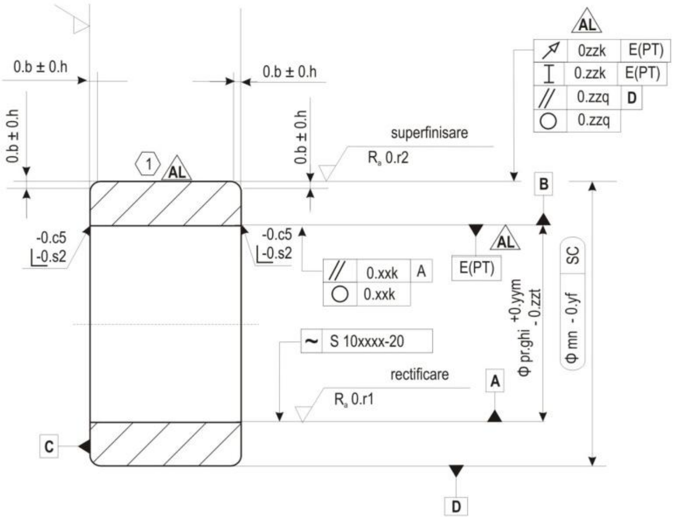


Fig.2 *Radial bearing ring with needles.*

2. Analysis of simultaneous flat grinding process performance

During the experiments the population was considered to consist of all the parts processed between two successive dressings of the abrasive wheels (around 40,000 pieces). Due to the large number of parts, not all of them can be measured. A sample was taken from the population: 5 pieces for every 5000 pieces. Next, the R_a and R_z roughness on both sides of the workpiece surfaces were measured. We will note with R_{amax} and R_{zmax} the highest value obtained by measuring R_a and R_z on both side of the machined parts.

It is found that the R_a roughness values decrease immediately after dressing abrasive wheels, and then remain constants. When the grinding wheels have worn out, the abrasive grains no longer cut but "break" the metal from the part. In this way the roughness of the parts increases rapidly[4]. The dispersion of the 55 measured values of R_{amax} roughness is represented in Fig.3. Note that the standard deviation is 0.003 and the arithmetic mean is 0.334.

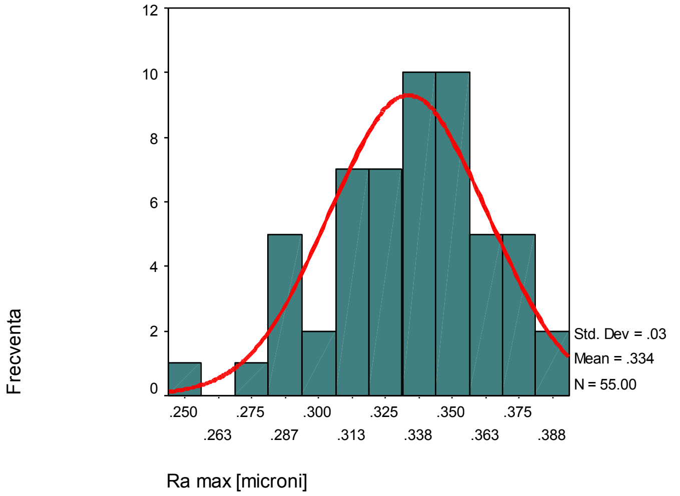


Fig.3 *Dispersion of roughness R_{amax} for parts between two dressings.*

3. The influence of the size of the machined surface on part roughness

In the following we will note with R_{AMIN17} and R_{AMAX17}, R_{AMIN18} and R_{AMAX18} , R_{AMIN19} and R_{AMAX19} respectively the roughness R_a measured on both sides of parts with diameter of 17 mm, 18 mm and 19 mm diameter [2]. The large number of measurements is observed (60 pieces for pieces with diameter of 17 mm and 19 mm respectively and 55 pieces for pieces with diameter of 18 mm) in order to draw conclusions with a high degree of generality.

Table 1 Descriptive statistics indicators

	N		Mean		Std. Deviation	Variance	Range	Minimum	Maximum
	Valid	Missing							
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic
RAMIN17	60	0	.27512	3.53E-03	2.73E-02	7.48E-04	.141	.226	.367
RAMAX17	60	0	.30755	4.45E-03	3.45E-02	1.19E-03	.170	.247	.417
RAMIN18	55	5	.30020	3.61E-03	2.68E-02	7.17E-04	.136	.217	.353
RAMAX18	55	5	.33385	3.98E-03	2.95E-02	8.71E-04	.136	.256	.392
RAMIN19	60	0	.29882	4.17E-03	3.23E-02	1.04E-03	.158	.214	.372
RAMAX19	60	0	.33323	4.20E-03	3.25E-02	1.06E-03	.163	.273	.436

The amplitude of the dispersions is between 0.136µm and 0.170µm.

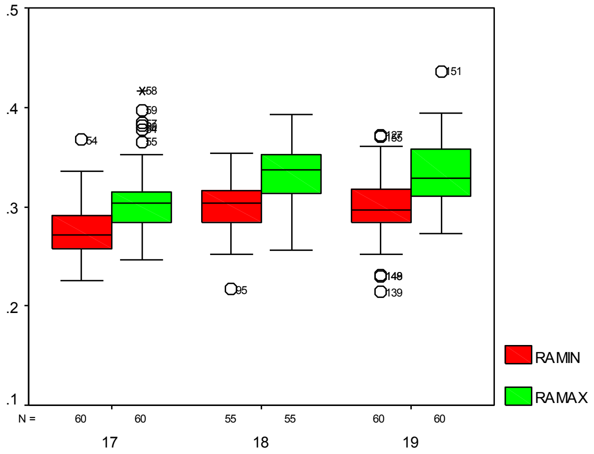


Fig.4 Box plot R_a for parts of diameter 17, 18, 19 mm.

From the analysis of Fig.4 is found that the size of the machined surface does not greatly influence the roughness of the machined surfaces [3].

4. The influence of the traverse speed on the part roughness

The same principle of population sampling was applied: 5 pieces were taken for every 5000 pieces processed. R_a roughness was measured on both sides and R_{amin} and R_{amax} values were obtained.

Table 2 Descriptive statistics indicators

	N		Mean		Median	Std. Deviation	Variance	Range	Minimum	Maximum
	Valid	Missing								
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
RAMIN8.1	35	70	.29569	6.98E-03	.29600	4.13E-02	1.70E-03	.178	.212	.390
RAMAX8.1	35	70	.33146	7.66E-03	.32800	4.53E-02	2.06E-03	.184	.242	.426
RAMIN8.7	30	75	.26010	5.77E-03	.25700	3.16E-02	9.99E-04	.138	.179	.317
RAMAX8.7	30	75	.28950	6.24E-03	.28450	3.42E-02	1.17E-03	.144	.211	.355
RAMIN9	40	65	.32860	8.03E-03	.32900	5.08E-02	2.58E-03	.213	.226	.439
RAMAX9	40	65	.36645	9.43E-03	.36400	5.97E-02	3.56E-03	.214	.253	.467

As expected, the increase of part’s feed rate, led to a certain increase in the roughness of R_a and to an increase of spreading values obtained.

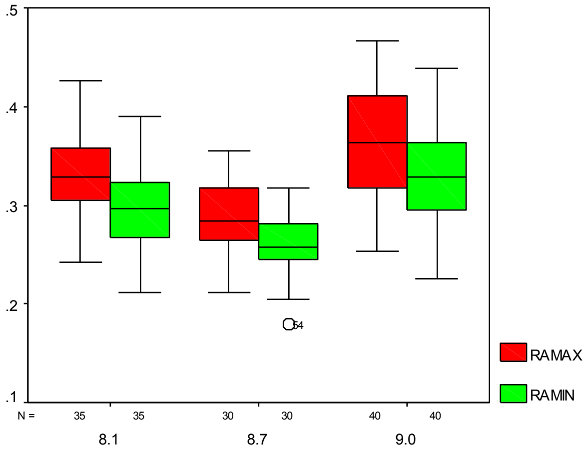


Fig.5 *Box-plot R_a depending on the feed rate of the parts.*

From the analysis of the dispersions represented in Fig.5 it is observed that the largest width is presented by the “box” obtained for the roughness of the pieces with diameter of 19mm.
In this case, the large number of measurements performed is noticeable: 35, 30, respectively 40, in order to obtain information with a high degree of certainty[6].

5. The influence of the grain size of abrasive grinding wheels on the machined parts roughness

Fig.6 and Fig.7 show the Box-plots of the roughness’s R_a and R_z for the machined parts with abrasive wheels of different grain sizes.

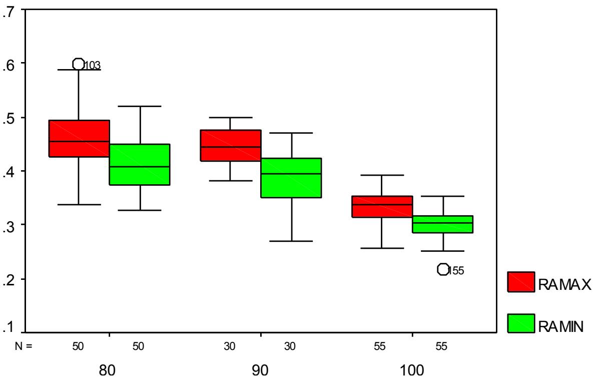


Fig.6 *Box-plot R_a roughness depending on abrasive grain size.*

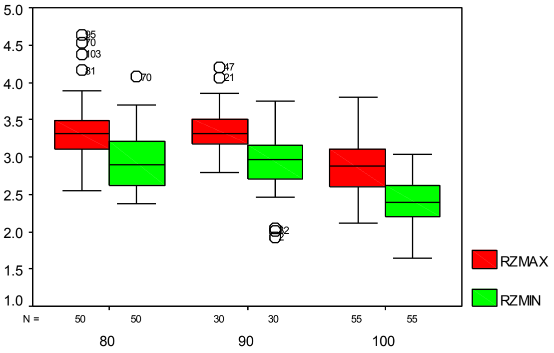


Fig.7 *Box-plot R_z roughness depending on abrasive grain size.*

Except for the abrasive wheels, the other cutting conditions were kept constant. It is found that as the grain size of the abrasive wheels is finer, the roughness Ra of the machined surfaces decreases accordingly [5].

6. The influence of the cutting fluid on the roughness of the machined parts

The roughness R_a and R_z of the parts were measured before and after changing the cutting fluid, using the same experimental design (after each 5000 machined parts, 5 pieces were measured).

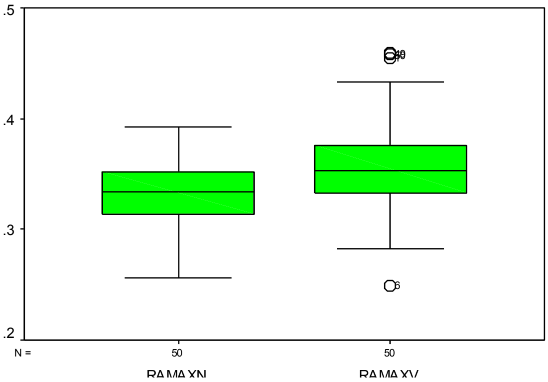


Fig.8 *Box - plot R_{amax} for old and new cutting fluid used.*

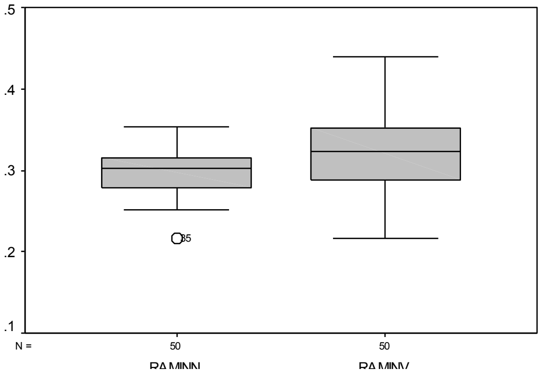


Fig. 9 *Box - plot R_{amin} for old and new cutting fluid used.*

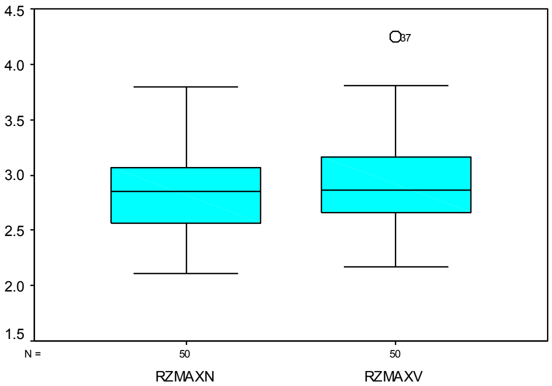


Fig.10 *Box - plot R_{zmax} for old and new cutting fluid used.*

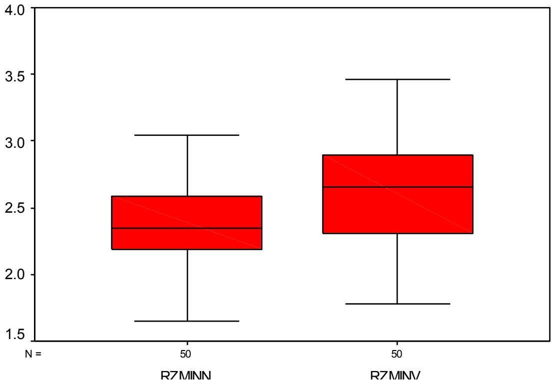


Fig.11 *Box - plot R_{zmin} for old and new cutting fluid used.*

7. Conclusions

1. The size of the machined surface, characterized by the variable diameter: 17mm, 18mm, 19mm (all parts have the same inner diameter) does not significantly influence the R_{amin} and R_{amax} roughness of the machined parts;
2. The traverse speed of the parts (8m / min, 8.7 m / min, 9m / min, 11m / min) does not have a great influence on the quality of the machined surfaces;
3. The size of the grain size of abrasive wheels greatly influences the quality of the machined surface. The larger the grain size, the higher the roughness of the machined parts. This is proof that the roughness of machined parts is the result of the overlapping marks left by the abrasive grains on the surface of the part.
4. The quality of the cutting fluid does not greatly affect the roughness of the machined parts. This is due to the stability of the machine tool-tooling system and the strict observance of proper cutting fluid management.

8. References:

[1] Awiszus, B., Matthes, K-J., Duerr, H., Bast, J. –Grundlagen der Fertigugstechnik, Seiten 125-130, Editura Hanser, 2006

[2] Beyer, P. –Hochproduktive Vit- CBN- Schleifwerkzeuge, *in SMM Fertigungstechnik, Nr.4- 2005, Seiten 60- 63.*

[3] Bock, R: Vorlesung Fertigungstechnik, Übung Zeitspanunsvolumen, Juni 2006

[4] K.D. Bouzakis, C. Karachaliou: Process Models in grinding, based on three dimensional description of the grinding wheel topomorphy, North American Manufacturing Research Conference Proceedings, May 19-22, 1985

[5] Brinksmeier, H., Koch, T. –Auswirkungen des mikrobiellen befalls von wassermischten Kühlschmierstoffen auf das Zerspanergebnis , Presentation bei Resourceshonende Metallbearbetung, Arbeitkreis Kuehlschmierstoffe, IWT, Bremen, Sept.2002

[6] Kleber, M. –Kuehlschmierstoffe: Analytisch-chemische Charakterisierung und Untersuchungen zur mutagenen Wirkung, *Inaugural- Dissertation zur Erlangung des Doktorgrades der Naturwissenschaften, Dortmund, 2000, Seiten 5- 20*