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RESEARCH ABOUT ROUGHNESS AFTER TURNING FOR 18CrNi5 STEEL

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***Abstract*—** In this paper the results of experimental research for roughness resulted after external turning of an 18CrNi5 steel shaft are presented. Roughness parameters Ra, Rz, Rq have been measured. After exprimental results a good roughness are obtained, because the deformation on the cutting zone is small, 18CrNi5 steel having high mechanical properties. Deposits on the cutting edge occur only for very small cutting feeds values and affects less the roughness parameters. Also, conclusions will show that with increasing of cutting feed, roughness parameters nonlinear increased.

***Keywords*—** Ra parameter, roughness, 18CrNi5 steel, turning.

I. INTRODUCTION

OVER the time numerous studies on the resulted roughness after the turning of different materials, in particular steel have been made [1,2].

Thus, in [3] roughness processing of hardened steel AISI 4340, following the influence of cutting parameters on surface roughness is studied. Factorial experimental program and results charts are presented.

In [4] the roughness resulted after cutting a martensitic stainless steel using cubic boron nitride tools are studied. Also, in Thamizhmanii [4] the relative roughness depending on parameters of cutting process and system vibrations is presented. They used very high cutting speeds. Also, tool wear have been aimed. Diagrams about roughnes variations and an image related to tool wear are presented.

In [5] the possibility of obtaining a roughness Ra<0.8 μm after cylindrical turning of steel AlSI 1045, using tools with based inserts based on glass cloth is analyzed. Followings parameters were measured: R_a, R_{zD}, R_{3z}, R_q, R_t, R_a/R_q, R_q/R_t, R_a/R_t.

In [6] were developed statistical models of surface roughness criteria at straight turning of a X38CrMoV5-1 steel treated at 50 HRC, machined by a mixed ceramic tool (insert CC650). A factorial program of 27 experimental samples, with three values for each variable (the variables considered: cutting speed, feed and depth of cut) have been used.

In [7] optimization of surface roughness at steel 28 Ni Cr Mo V59 turning, using as restrictions productivity and tool life is presented. The cutting process parameters (speed, feed and depth) using an experimental program with 9 samples have been modified. The sets of values that ensure the optimum roughness are obtained.

In [8] surface roughness in the turning process of duplex stainless steel code 1.4462 (DIN EN 10088-1), austenitic ferritic with 50% austenite, with hardness of 293 HB have been determined. The influence of cutting parameters, namely cutting speed, feed and depth of cut onto surface roughness after DSS turning process have been established. Surface roughness was evaluated by polynomial functions of 2 degree. Experimental programs were used with 9 samples.

In [9] the surface roughness on EN 36 steel shafts using carbide and cobalt tool have been evaluated. They were used four sets of values for speed, feed and depth of cut, by measuring the Ra parameter, represented in the diagrams.

In [10] Taguchi method is used, leading to 16 samples, measuring surface roughness by turning of AISI 8660 steel using ceramic cutting tools. The main cutting parameters such as cutting speed, feed rate, depth of cut in addition to tool's nose radius, using a statistical approach have been investigated The obtained results indicated that the feed rate had the greatest influence on the surface roughness.

In [11] the influence of speed, feed and depth of cut on surface roughness and cutting force in turning mild steel are studied. Experimental programs with 27 samples have been used. Diagrams and 2 degree polynomial relationships have been obtained.

In [12] surface roughness in finish turning of steel EN-19, modifying spindle speed, feed rate, depth of cut, pressurized coolant jet and rake angle, are determined. An experiment using 27 samples have been studied.

II. EXPERIMENTAL DATA

A shaft with diameter of Φ34f7 has been external turned. The shaft was made from 18CrNi5 steel. It was used following cutting feeds range, presented in Fig. 1: sample 1 – f =0.096mm/rot; sample 2 f=0.209 mm/rot; sample 3 – f = 0.302 mm/rot; sample 4 – f = 0.416 mm/rot; sample 5 – f=0.5 mm/rot; sample 6 - f= 0.584 mm/rot.

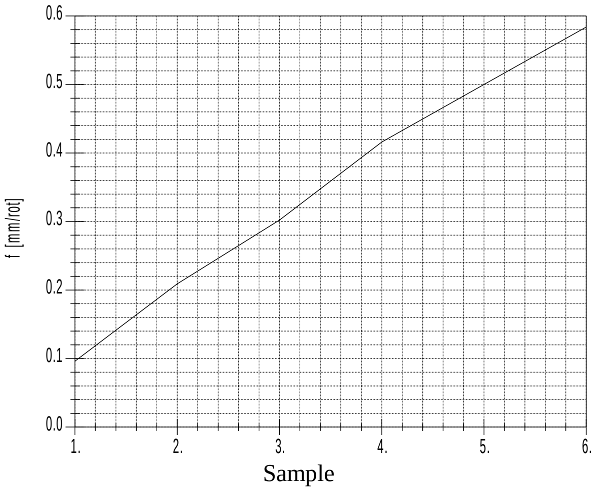


Fig. 1. Cutting feeds range for each sample

The turning has been made on a centre lathe type SNB 400, with speed of 500 rot/min, rate of cutting of 25 m/min and cutting depth of 0,5mm. Carbide-tipped tools type P20 was used, Fig. 2. The geometry of cutting tools used for turning are following: groove 12,67 x 4,95 mm with a depth of 0.52 mm, $\chi_r = 90^0$; $\chi_r' = 10^0$; $\alpha_n = 20^0$; $\gamma_n = 25^0$.

Fig. 2. The geometry of cutting tools

During processing, shaft has been fixed in lathe chuck and running centre.

The roughness was measured with an electronic roughness tester Mitutoyo, Japan, SJ-201 P.

Pictures of micro- irregularities of measured profiles and following values of roughness parameters (ISO 4287-2001) have been provided by Mitutoyu roughness tester:

- *Rz - average maximum height* which represents the vertical distance between the highest peak and the lowest valley of the unfiltered profile, within a sampling length lp:

$$\mathbf{Rz = Zp\ max + |Zv\ max|} \quad (1)$$

where: Zp max is maximum height of profile peaks element measured within sampling length lp; Zv max is maximum depth of profile valleys element measured within sampling length lp. It states that Rz differ from former Rz of previous standards (which refers to the average of the absolute values of the top 5 heights of profile peaks element and 5 depths of profile valleys elements within the sampling length);

- Ra - average roughness height or arithmetic mean average surface roughness height value is an arithmetical mean from absolute values of profile deviations in a range of sampling length.

The formula for determination of Ra is:

$$Ra = \frac{1}{l_p}\int_0^l |z(x)|dx$$

$$l = l_p \quad (2)$$

$$Ra \cong \frac{1}{n}\sum_{i=1}^{n} |z_i|$$

where:

z(x) – profile function;

z_i – profile discrete deviation value in M system equal to distance between any point of profile and mean line measured along a normal plotted to mean line via this point;

n – number of measured discrete deviations along profile sampling length;

- Rq - root mean square roughness is the geometric average height of roughness-component irregularities from the mean line measured within the sampling length, lp:

$$Rq = \sqrt{\frac{1}{l}\int_0^l z^2(x)dx} \quad (3)$$

where $l = l_p$.

III. Results

It has been measured the roughness on each step of shaft. In Fig. 3 the profile of micro-roughness for sample 1 of shaft is presented (on abscissa are millimeters and on y-coordinate micrometers).

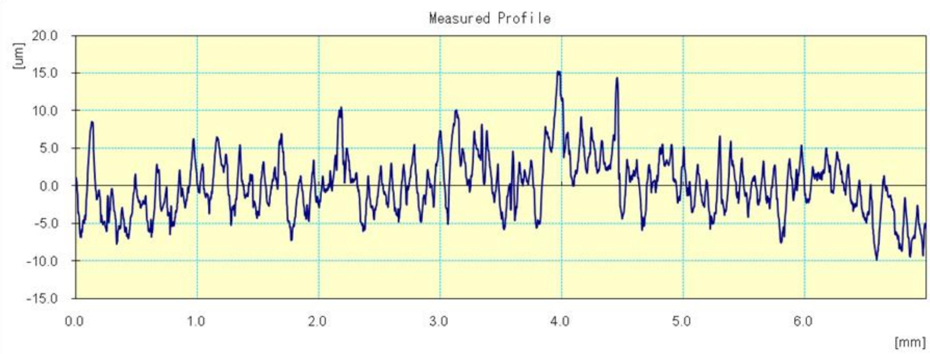


Fig. 3. The profile of micro-roughness for sample 1

In Table I the values of roughness parameters printed by Mitutoyu apparatus certificate are presented.

TABLE I
THE VALUES OF ROUGHNESS PARAMETERS

Appparatus readings		Apparatus characteristics	
Work Name	Sample	Nomenclature	Data
Measuring Tool	SurfTest SJ-201	Standard	ISO1997
Operator	Mitutoyo	Evaluation length	7.0 mm
Comment	Ver4.00	Cut-Off	2.5mm

Values of roughness parameters

Symbol	Value
Ra	2.61
Rz	21.55
Rq	3.36

In Fig. 4 an image obtained on microscope of geometrical micro-irregularities is shown.

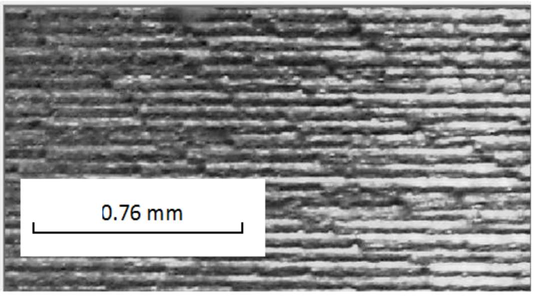
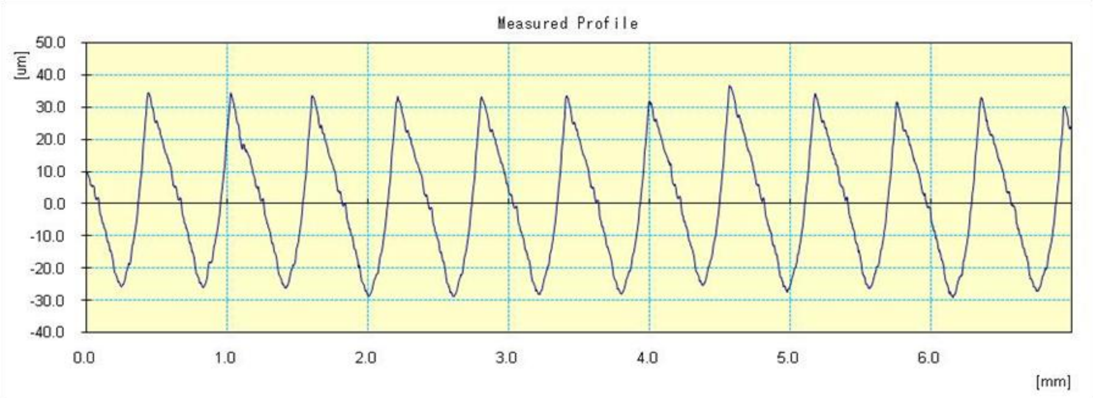


Fig. 4. Geometrical micro-irregularities for sample 1 machined with 0.096mm/rot feed

In Fig. 5 the profile of micro-roughness for sample 6 of shaft machined with 0.584 mm/rot feed is presented.



Ra	15.75 um
Rz	65.96 um
Rq	18.34 um

Fig. 5. The profile of micro-roughness for sample 6 of shaft machined with 0.584 mm/rot feed

In Fig. 6 an image obtained on microscope of geometrical micro-irregularities for sample 6 machined with 0.584 mm/rot is shown.

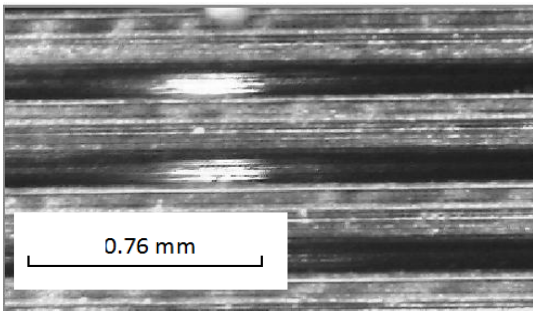


Fig. 6. Geometrical micro-irregularities for sample 6 machined with 0.584 mm/rot feed

In Table II the resulted roughness for samples 2, 3, 4 and 5 after turning with different values of feed are presented.

From the values of resulted roughness presented in Table II it can be noticed that with increasing of feed value increase the value of resulted roughness for all roughness parameters.

TABLE II
THE VALUES OF ROUGHNESS PARAMETERS FOR SAMPLES 2, 3, 4 AND 5

Sample	Feed (mm/rot)	Ra (μm)	Rz (μm)	Rq (μm)
2	0.209	4.78	33.12	5.95
3	0.302	5.24	35.12	6.33
4	0.416	7.40	48.69	8.92
5	0.5	13.27	59.70	15.50

IV. ANALYSIS OF EXPERIMENTAL RESULTS

Following conclusions have been established:

1) *at small values of cutting feeds, the height and pitch of irregularities are small;*
2) *with increasing of feed values increase the heights and pitchs of micro-irregularities, too;*
3) *viewing under microscope of micro-irregularities indicate the obtaining of small pitches at using small cutting feeds;*
4) *in range of small cutting feeds, some disturbances ratio geometrical roughness appear because of*

phenomena from plastic deformation in cutting area.

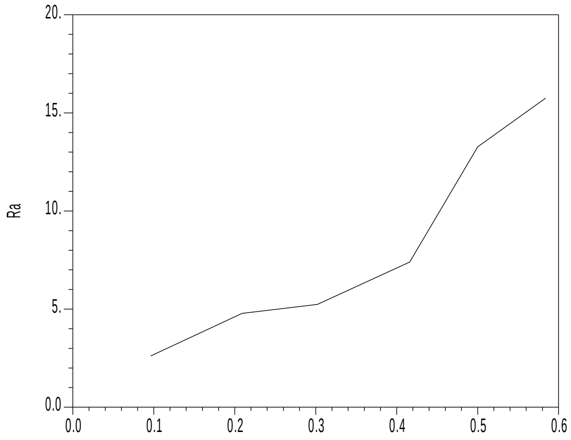


Fig. 7. The variation of Ra parameter with cutting feed

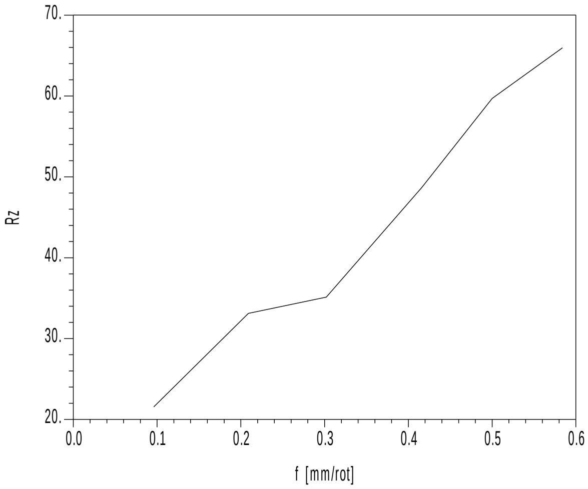
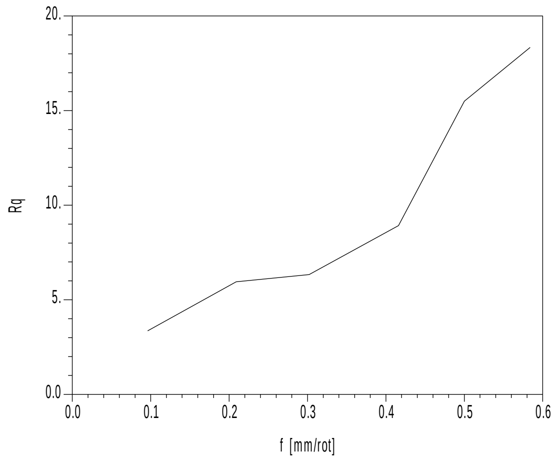


Fig. 8. The variation of Rz roughness parameter with cutting feed values

Fig. 9. The variation of Rq roughness parameter with



cutting feed values

Variations for roughness parameters are presented in Fig.7 (Ra=F(f)), Fig. 8 (Rz=F(f)) and in Fig. 9 (Rq=F(f)).

From the previous figures it can be noticed that all parameters of measured roughness increases with feed increasing, but the increasing is not linear due to the complex phenomena of the cutting area.

V.CONCLUSION

Roughness obtained at turning of this steel is similar to that obtained in other hard carbon steels.

Deformation of the material during machining is small, resulting in small values of the roughness, and the situation is advantageous.

The influence of deposits on the cutting edge is observed only in very small feeds range.

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