ANNALS OF THE ORADEA UNIVERSITY
Fascicle of Management and Technological Engineering
ISSUE #1, MAY 2014, http://www.imtuoradea.ro/auo.fmte/

RESEARCH ABOUT 18CrNi5 STEEL MACHINABILITY BY CUTTING

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Abstract— There have been made experiments on 18CrNi5 steel by external cylindrical turning, collecting the resulted chips. In this paper the shapes and sizes of the resulted chips, explaining their correlation with channel dimensions on the front face of cutting tool, according to and chip deformation sections are analyzed. Also, the forms of resulted chips in relation with parameters of cutting process are explained.

Keywords— chips forms, chip section, 18CrNi15 steel, turning.

I. Introduction

THERE are many studies in the literature that aim different stages of the cutting process for different types of steels machined by turning. But, there are few studies which aim the chips forms as machinability indicators.

In [1] these forms of chips results after typical OL37 steel turning, details are given also in [2] have been studied.

In [3] a classification of form chips for C45 steel turning, using modern devices, with measuring of cutting forces is presented.

In [4] chips resulted from steel turning steel, depending on geometrical parameters of the cutting tool, using a cutting speed of 100 m/ min are analyzed.

In a documented thesis [5] analyzed the forms of chips, presenting all the factors that influence them and their influences are analyzed.

Roughness and cutting forces in hard turning of hot work steel X38CrMoV5-1 using mixed ceramic tools using cermets are studied in [6].

It was found that the largest component of the radial cutting force is the radial and roughness is comparable to that obtained in grinding.

In [7] the influence of feed on roughness and chips form for a medium steel and copper machined by turning are studied. Results and images of real surfaces are given.

The research presented in [8] is focused on the surface roughness variation in high speed fine turning of the austenitic stainless steel. Ra parameter and its variation with the feed have been measured. At the same time samples of chips at various feed values have been taken, analyzing their shapes and forms.

In [9] the influence of cutting tool geometry on surface roughness and chip forms are studied. The authors compare the calculated roughness with the actual roughness in turning of AISI D2 steel. Also, images of chips and resulted surfaces are presented.

In [10] complex studies about the forms and formation of chip in turning of 1045 steel are given.

Chip forms with noise produced on their recess and cutting forces have been correlated. About "chips reading" are given details in [11]. Various forms of chips through images of their forming on carbide cutter are examined. Also, the influences of various factors on the chips forms are studied and many conclusions that allow the process assessing according to resulted chips are established.

Contributions on chip formation on 100Cr6 (AISI 52100) hardened steel turning with a hardness of 760 HV are presented in [12]. Elements of chips obtained have been studied geometric and metallographic. Establish relationships between chip geometry and conditions are established.

II. Experimental Data

The external 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, for a shaft with diameter of Φ34 mm, Fig. 1. The part was made by 18CrNi5 steel.

Fig. 1. The shaft with diameter of Φ34 mm machined by turning

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

It was used following cutting feeds range, presented: 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.

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

III. RESULTED CHIPS FORMS

It is known that the chips forms define the phenomena occurring in the cutting area, and therefore, for the study of a material machinability is considered the shapes and dimensions of the resulted chips.

A first general observation is that all chips have wrinkles on the external face and are smooth on face away from the front face of the cutting tool, which is normally because the contact areas with the cutting tool are pressed and polished as opposed to the obverse faces, loose.

Accordingly with Fig. 3, for the sample 1 (f = 0.096 mm/rot), spiral chips very lengthy, straight, silver color, having a diameter of 7.32 mm, the pitch of the helix of 16.56 mm, having 0.27 mm thickness and 0.75 mm width are obtained.

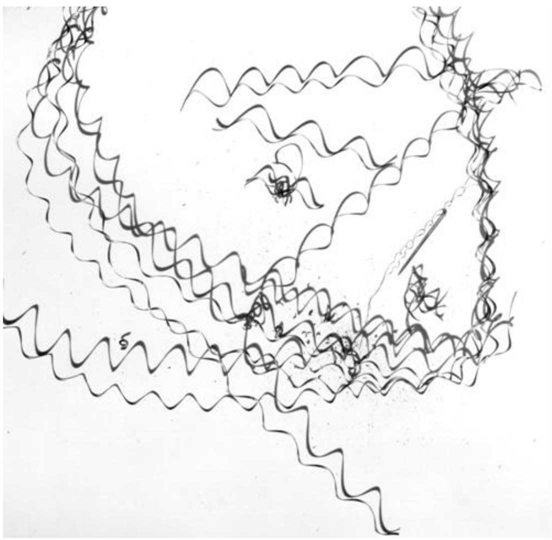

Fig. 3. The aspect of resulted chips after sample 1turning with feed f = 0.096mm/rot

For the sample 2 (f = 0.209 mm / rot) resulted long flow chips (Fig. 4), helicoidally, dark brown color, propeller with a helix of 8.6 mm outer diameter, 14.08 mm the propeller pitch, 0 44 mm thickness of and 0.89 mm width.

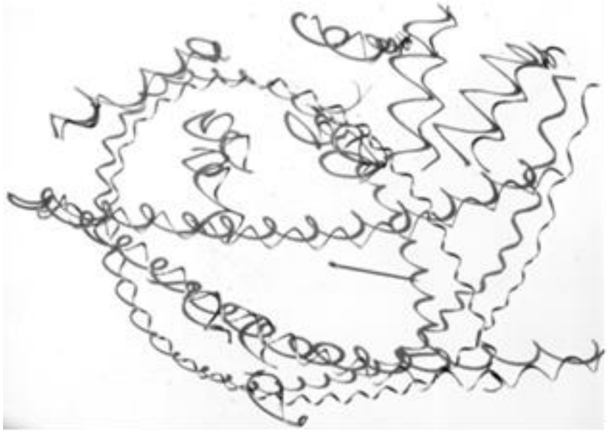

Fig. 4. The aspect of resulted chips after turning the sample 2 with feed f = 0.209mm/rot

At sample 3 (f = 0.302 mm / rot) resulted black color chips with helical shape (Fig. 5), with uneven diameters of helix between 4.9 and 7.6 mm, and for the other between 6 and 10 mm, with propeller pitch between 5.1 and 14 mm, a thickness of 0.45 mm and a width of 1.12 mm. Also, chips with aspect as commas, with a chip curl as Archimedes spiral, with a maximum diameter of 5.3 mm are appeared.

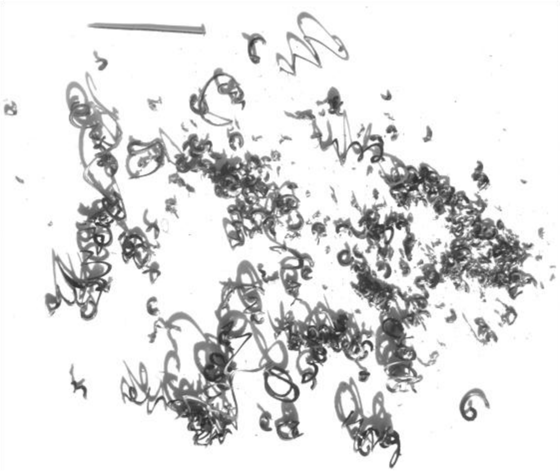

Fig. 5. The aspect of resulted chips after turning the sample 3 with feed f = 0.302mm/rot

For sample 4 machined with a fed value of f = 0.416 mm/rot, chips are short helicals (Fig. 6), with variable pitch between 3 and 7 mm, and a deformed chip curl at one end, with a maximum of 5 loops, black color, between 5 and 9 mm in diameter with thickness of 0.51 mm and width of 1.3 mm.

Also, comma-shaped chips appear similar spirals Archimedes, a little over a loopl with a maximum diameter of 8 mm.

Fig. 6. The aspect of resulted chips after turning the sample 4 with feed f = 0.416mm/rot

Chips resulted from sample 5 (f = 0.5 mm/rot) are long helicoidals (Fig. 7), dark gray color, with a diameter of 8.75 mm, 10.89 mm pitch of helix, thickness 0.65 mm and 0.91 mm width.

Also, appeared chips loosed from side cutting edge with length of 9.62 mm, 3.95 mm diameter and 4.52 mm propeller pitch; these helical chips were dark blue color.

Fig. 7. The aspect of resulted chips after turning the sample 5 with feed f = 0.5mm/rot

For sample 6 were obtained helical longs chips (Fig. 8), the pitch of the propeller 10.38 mm thickness 0.9 mm and width 1.16 mm; dark brown colors.

Some forms of long chips were straight, some of them bent at about 90^0 degrees, some of them had a semi-ellipse form.

It also appeared a splinter cuted by the side cutting edge blade having 2.94 mm diameter , 33.6 mm length and 4.66 mm pitch propeller.

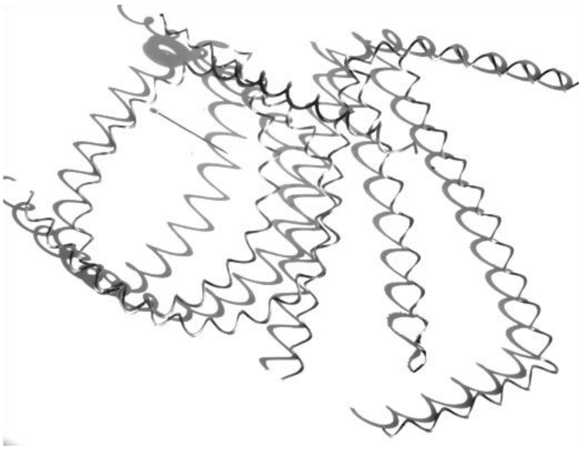

Fig. 8. The aspect of resulted chips after turning the sample 6 with feed f = 0.584 mm/rot

In order to monitor the size of the chips, a pin with a diameter of 0.76 mm and a length of 29 mm through them was photographed.

Based on performed research followings conclusions can be established:

- for samples 3 and 4 resulted chips were flowing but with a small number of curls when feed were on the average values of the experiment;
- the breaking of chips earlier than the long helicoidals is due to the shape and dimensions of the channel from front face of cutting tool that had a depth of 0.52 mm, which was closed to the size of the feed;
- for the other samples chips were flowing, at high feeds slightly sliding on channel of the front face, but for high feeds not fall from great feeds does not fall in the channel and it is not deformed;
- steel processed conveniently, although energy consumption is high due to the hardness of the material.

Based on performed research In Table I the obtained results obtained from the measurements for the depth of chips (experimental and theoretical) are presented.

TABLE I
EXPERIMENTAL (a) AND THEORETICAL (a1) DEPTH OF CHIPS

Sample	f (mm/rot)	a1 (mm)	a (mm)
1	0.096	0.27	0.095
2	0.209	0.44	0.209
3	0.302	0.45	0.3019999
4	0.416	0.51	0.4159999
5	0.5	0.65	0.4999999
6	0.584	0.9	0.5839998

In Table II the obtained results from the measurements for the width of chips (experimental and theoretical) are given.

TABLE II
EXPERIMENTAL (a) AND THEORETICAL (a1) WIDTH OF CHIPS

Sample	f (mm/rot)	b1 (mm)	b (mm)
1	0.096	0.75	0.095
2	0.209	0.89	0.209
3	0.302	1.12	0.3019999
4	0.416	1.3	0.4159999
5	0.5	0.91	0.4999999
6	0.584	1.16	0.5839998

From the Table I and Table II the followings can be noticed:

- theoretical chip depth is equal to the feed value, cutting tool having plan approach angle of 90^0;

- resulted experimental chip depth is always larger than the theoretical depth of chip because the chip expands its section and shrinks its length due to deformations that appear in the cuttting area;

- the theoretical width of the chip is equal to the feed value mainly due to plan approach angle of 90^0;

- experimental width of chip is also higher than its theoretical width due to increasing chip section;

- disruption is found in samples 5 and 6 turned with high feeds values because chips there is no longer deform into the groove of the cutting tool, sliding over it. Therefore the deformation of the chip is small.

IV. Conclusion

From the experimental and measured data followings can be established:

The studied material (18CrNi5 steel) conveniently processed, except energy consumption;

There are no influences of deposits on the cutting edge; they are small and just for smaller feed values.

Resulted chips indicated a normal flow, advantageous, without coils.

Chips sections are increased to the theoretical; deformation in the cutting area being high.

The colors of the chips indicated the temperature which was reached in cutting zone during the meta removal process.

The chips were shrinked in length and increased in section, due to the plastic deformation on the cutting zone, at the initial compression of the material in front of the cutting edge.

It can be appreciated the progress of cutting process by the shapes and sizes dimensiones of chips:

- long chips long, flowing, showing a continuous process without additional deformations on the top face of the tool;
- small chips indicates their breaking by the threshold on the front face of cutting tool, which means a more difficult process with additional energy consumption.

Sections chips are indications of their possible breaking channel face clearance: the large sections breakage occurs in small sections chips do not break the flow of the light.

For processing performed on automatic machines shoud be established the form of front face according to the theoretical section of the chip correlated with thickening and widening coefficients of chips.

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