CHIPS FORMS AND THEIR IMPORTANCE ON INNER CYLINDRICAL TURNING WITH SMALL CUTTING FEEDS

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Abstract: Forms and chips size are very important, especially in the automatic processing, because they can disrupt the process of cutting by breaking and blocking tools. This paper presents an experiment on the shapes and dimensions of chip obtained by the inner cylinder turning with small cutting feeds. Chips resulted by small cutting feeds are small; the chips are broken because they are small sections, so they break easily. Wit increasing the cutting feed in the small cutting feeds domain, there is observed an increasing of the maximum diameter of the chip because of plastic deformations. It establishes a polynomial for calculating the maximum diameter of the chips.

1. INTRODUCTION.

On turning inner cylinder, chip shapes and sizes are very important. In this case chips are not directly dangerous to worker as they encounter internal walls of the piece and do not reach the worker. They may cause disorders of the tool but if it is crowded between the cutting edge and part can block the cutting process, and leading to accidents.

At the processing on automatic machines that are not permanent surveillance off-grade chips can cause accidents due to poor stocking their, tool breakage and disruption of next phases.

These issues have been noted and studied by us since 1971 [1]. Today, this problem has become again a concern of many researchers, especially for current automated.

In [2] is investigated the splinters resulted in turning steel with a cutting speed 100 m/min. Evaluation criterion is the length of resulted chips. It shows the influence of cutting conditions (material, tools, system, and machine) on chip forms. Thus, in [3] is studied the acoustic emissions from the cutting area, then process the results of fuzzy and neural algorithms in order to establish the desired shapes prior to chips, according to tool-part-machine interaction. In [4] is studied the chip forms of the cutting in conjunction with noise emissions from the cutting zone. Carry out a computer program that leads system so as to obtain desired shapes of chips. In [5] the importance of knowing the chips forms in process of automation processing is performed. A study about the feasibility of an algorithm for predicting the chip forms at turning is presented

2. EXPERIMENTAL RESEARCH.

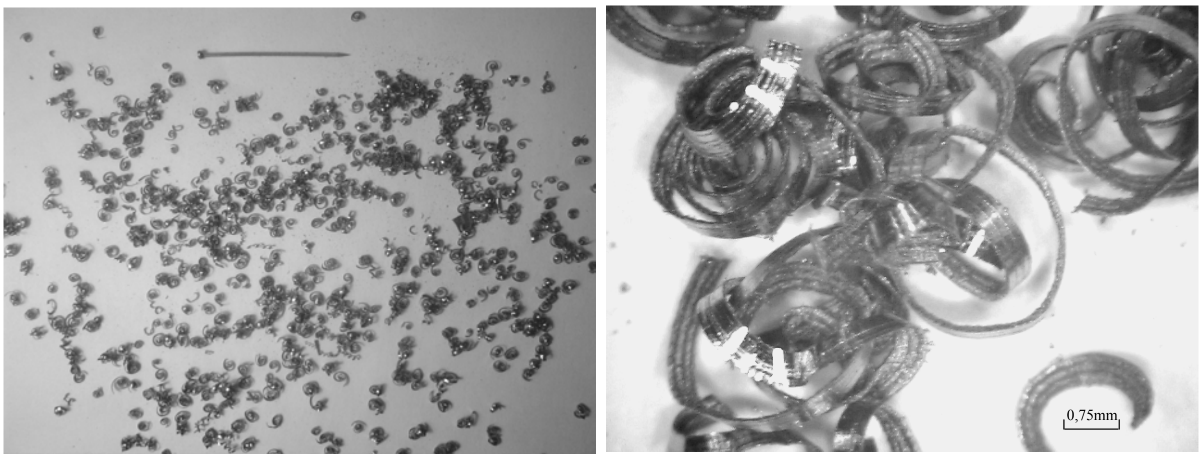
The turning has been made on a centre lathe type SNB 400, on to a bushing with internal diameter of 60 mm, with a rate of cutting of 53,4 m/min and cutting depth of 0,3mm. Carbide-tipped tools type P10 was used. The part was made by OL37 steel. It was used cutting feeds range. The cutting feeds range used were: 0,053; 0,059; 0,075; 0,083; 0,088; 0,096 mm/rot.

Processed surfaces on shaft in a microscope Type I.O.R. using a web cam from a digital microscope Type 4 in 1 PC Link E, Eastcolight, have been studied. Scales used are different, so some pictures have noted with standard dimension and the other is a bold image of 0,745 mm thick - taken as a scale factor.

Chips resulted during experimental testing were collected and studied as shapes. These forms are the results of the phenomena of plastic deformation from the cutting zone and cutting tool geometry. If the chip is long, it means that cutting process performs evenly and do not appear disturbance. Here chip is broken because its length in console. If the chip is short, it means that cutting process suffered interruptions caused by tool geometry and vibrations.

3. EXPERIMENTAL RESULTS

When processing with a cutting feed of f = 0,053 mm/rot, the chips are the form shown in fig. 1.a. They are small, with propeller-shaped turns with one-two chip curls. Also, curlings appear as Archimedes spirals. In fig. 1.b chips thicknesses are observed, quite uniforms and longitudinal flutes on both sides of the chips.



a. ***b.***

Fig.1 – Chips forms resulted at turning with a cutting feed of f = 0,053 mm/rot

In fig.2.a the chips obtained at turning with a cutting feed of f=0,059 mm/rot are presented.

a. ***b.***

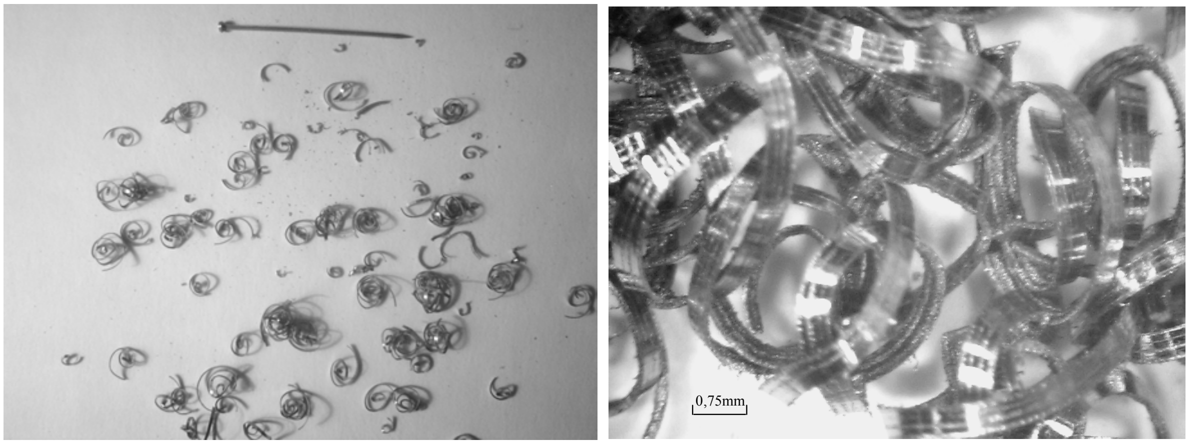
Fig.2 – Chips forms resulted at turning with a cutting feed of f = 0,059 mm/rot

From the fig.2.a it can be shown that here. Chips are of two categories: some like Archimedes spirals, others with 4-5 helical turns.

They are seen more clearly in fig. 2.b. Also, it can be observed the flutes on both sides and thickness.

When processing with a cutting feed of f = 0,075 mm/rot, the chips are the form shown in fig. 3.a. It can be observed that are generally Archimedes spiral type, with large diameters.

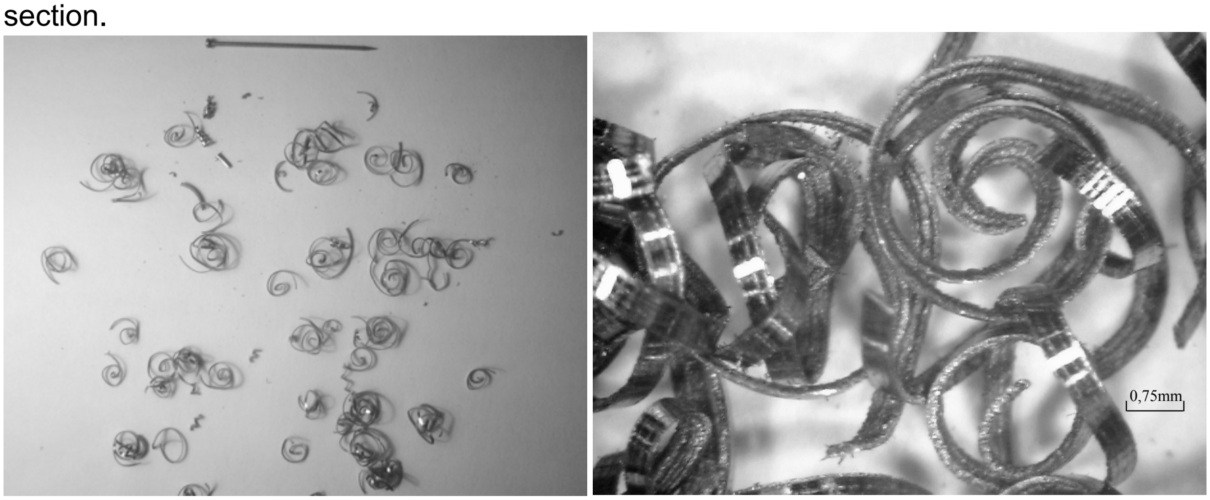
From the fig.3.b it can be noticed that the area which has been in contact with the cutting tool (fig. 3.b) is more uniform and specular and the flakes, too.



a. ***b.***

Fig.3 – Chips forms resulted at turning with a cutting feed of f = 0,075 mm/rot

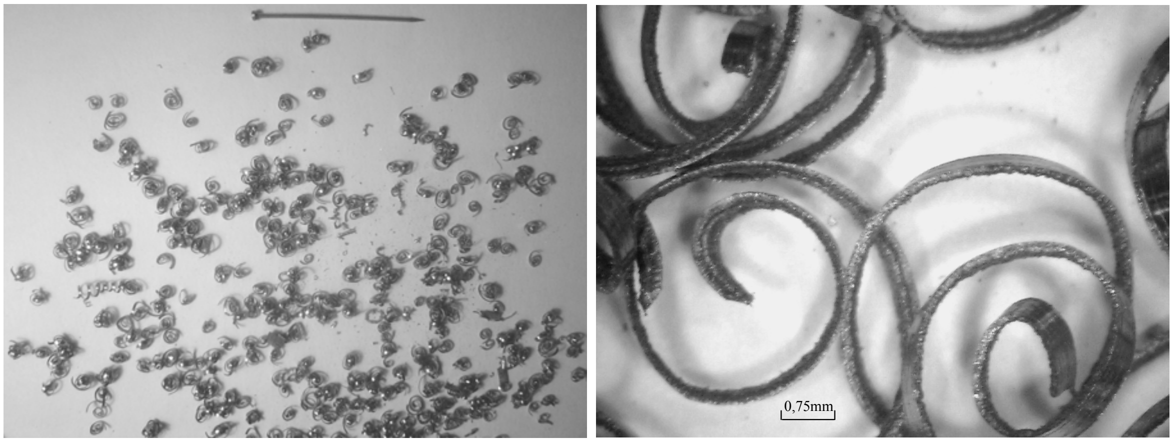
At f = 0,083 mm / rot were obtained chips like Archimedes spiral (fig. 4.a) but with deviations from a flat surface.
Archimedes spiral sequences appear namely unbroken chips, because there was increased chip thickness. Thickness is uniform (fig. 4.b), and finding flakes in cross section.



a. ***b.***

Fig.4 – Chips forms resulted at turning with a cutting feed of f = 0,083 mm/rot

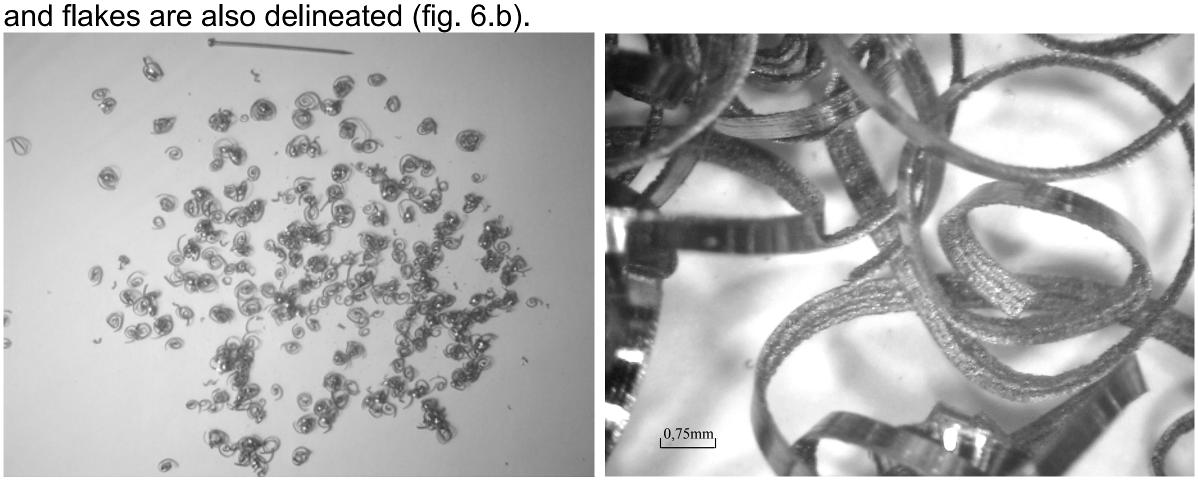
Chips presented in fig.4.a have been obtained by turning with cutting feed of f=0,088mm/rot, and they are very unordered shapes formed from Archimedes spirals propeller continued with one or two curls. Propellers appear longer. In fig. 5.b uniform thickness of the chips are observed.



a. *b.*

Fig.5 – Chips forms resulted at turning with a cutting feed of f = 0,088 mm/rot

In the fig.6.a shapes of resulted chips obtained at turning with a cutting feed of f = 0,096 mm/rot are presented. It can be observed that these chips consist of two opposite spirals Archimedes, linked, and the simple Archimedes spirals, too. Thickness of chips is uniform and flakes are also delineated (fig. 6.b).



a. *b.*

Fig.6 – Chips forms resulted at turning with a cutting feed of f = 0,096 mm/rot

Following conclusions about forms and dimensions of resulted chips at turning with small cutting feeds can be established:

- chips have small lengths, which is advantageous because they jump from the cutting area, avoiding conglomerations and interlocking.
- they are not dangerous for machine and tool, but at processing on the general purpose machines become dangerous for the worker, if he has no protecting spectacles;
- for automatic machines these chips are advantageous because they do not block the work area, where the multiple tools are in action.

4. EVALUATION OF MAXIMUM DIAMETER OF CHIPS

From the above results it was found that the chips result generally with helical forms, or spirals, having varying diameters.

Maximum diameters were measured with establishing the following values (x=f, y= maximum diameter):

- initial data:

i= 1 x= .053 y= .23 (1)
i= 2 x= .059 y= .41 (2)
i= 3 x= .075 y= .48 (3)
i= 4 x= .083 y= .5 (4)
i= 5 x= .088 y= .54 (5)
i= 6 x= .096 y= .45 (6)

- polynomial approximation:

y= 5.329969 +(-362.5566)*x+(8799.489)*x^2+(-87313.66)*x^3+(307236)*x^4 (7)

- statistical data are:

Source: sum squares =5.360651E-02; degrees of freedom = 4; average squares = 1.340163E-02
Residue: sum squares =6.543398E-03; degrees of freedom = 1; average squares =6.543398E-03
Total: sum squares = 6.014991E-02; degrees of freedom = 5; coefficient of correlation= .9440419 standard error estim.= 8.089128E-02

- approximation errors checking:

x= .053 ydat= .23 ycalc= .2574802 Er= 11.94789 % (8)
x= .059 ydat= .41 ycalc= .3606477 Er= 12.03715 % (9)
x= .075 ydat= .48 ycalc= .5210352 Er= 8.549001 % (10)
x= .083 ydat= .5 ycalc= .5135422 Er= 2.708435 % (11)
x= .088 ydat= .54 ycalc= .4912167 Er= 9.033956 % (12)
x= .096 ydat= .45 ycalc= .4660721 Er= 3.571577 % (13)

In fig. 7 the graphical dependency of the diameter of chips variation upon the cutting feed value obtained by statistical processing is presented. From the fig. 7 it can be noticed that appear great jumps in diameter for small values of cutting feeds, then an approximately linear increase followed by a decrease in the maximum adopted cutting feed which indicate the non-uniformity of the cutting process for small cutting feeds.

For small values of cutting feed chip deformation is large, so the diameters increase and for large cutting feeds values, shrinkage is greater and diameters decrease.

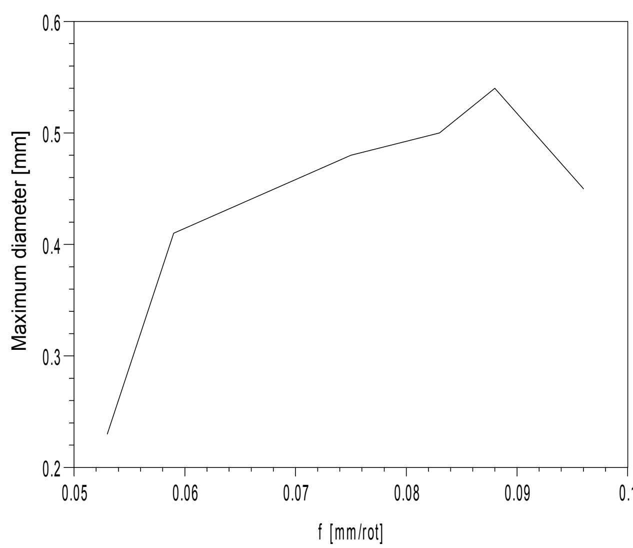


Fig.7 Dependency of chip diameter upon cutting feed

Also, from the fig. 7 it can be noticed that appear jumps in diameter which indicate the non-uniformity of the cutting process for small cutting feeds, the cutting edge radius is close to the size of the cutting feed and depth of cut.

5. CONCLUSIONS

- Resulted chips obtained by turning with small cutting feeds have small dimensions and sections; they are broken because sections are small, so they break easily.
- The usual forms of these chips are cylindrical propellers or Archimedes spirals.
- With increasing the cutting feed, in the small cutting feeds domain, an uniform increasing of the maximum diameter of resulted chips, because of large plastic deformations due to small cutting feeds is observed.
- Non-uniforms variations of maximum diameter for great cutting feeds, but still in range of small cutting feeds values, can be explained by the small difference between the cutting feed and the tool cutting edge radius.

REFERENCES:

[1] Popescu, I. - Contributii la stabilirea formelor aşchiilor rezultate la strunjirea aliajelor de aluminiu. In: "Constructia de masini", nr. 2/1971, ISSN 0573-7419 pg. 99-104, 1971.
[2] Mahashar, A. J., Murugan, M. - Influence of chip breaker location and angle on chip form in turning low carbon steel. In: International Journal of Machining and Machinability of Materials, Vol. 5, No. 4, , pp. 452-475(24), 2009.
[3] Sukvittayawong, S., Inasaki, I. – Identitication of Chip Form in Turning Process. In: Journal JSME international journal. Ser. 3, Vibration, control engineering, engineering for industry, 34-III(4) pp.553-560, 2008.
[4] Ralston, P.A.S., Stoll, K.E., Ward, T.L. - Fuzzy logic control of chip form during turning. În: Computers & Industrial Engineering,Vol. 22, Issue 3, pp. 223-230, 1992.
[5] Chiu, W.K., Yu, K.M., Man, K.H. - Chip form modelling and chip-forming animation in oblique cutting. În: International Journal of Computer Integrated Manufacturing,vol. 20 , Issue 8, pp: 781-793, 2007.