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DEVELOPMENT OF SURFACE ROUGHNESS IN HARD TURNING OF 100CR6 USING MIXED CERAMIC CUTTING TOOL WITH WIPER GEOMETRY AND CONVENTIONAL GEOMETRY

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ABSTRACT

Hard turning has been applied in machining since the early 1980s. There is an effort to substitute finish grinding by hard machining, because of machining by cutting tool with defined geometry. For machining of hardened steels (up to 45 HRC) are used two different cutting materials. PCBN are used the most for discontinuous machining of hardened steel (up to 63 HRC) and mixed ceramic tools, which are used in the experiment. This paper reports a development of surface roughness parameters when using wiper tool geometry of mixed ceramic tool and conventional geometry of mixed ceramic tool in hard turning. Roughness parameters (Ra, Rz, Rsk, Rku, RSm, Rdq) are measured when changing the feed, depth of cut and cutting speed are constant.

KEY WORDS

hard turning, mixed ceramic tool, tool geometry, surface roughness parameters

INTRODUCTION

Hard machining (hard turning) is a lathe machining process of hardened steels with hardness higher than 45 HRC. Machining hardened materials, mainly steels, is one of the leading removal methods of producing parts in such manufacturing branches as automotive, bearing, hydraulic and die and mold making sectors. This technology has also some disadvantages in comparison to grinding operations, f. e. production of the white layer, surface roughness, dimensional accuracy (1).

Surface integrity is very important to solve when taking into consideration workpiece functional properties. Surface quality is recognizing by the surface roughness, which plays an important role in many areas and it is a factor of great importance in the evaluation of machining accuracy (2). Low surface roughness means high surface finish.

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Very important steps for successful implementation of hard turning are selection of suitable cutting parameters for a given cutting tool, workpiece material and machine tool (3).

Many experiments achieved that the wiper geometry has a significant effect on the surface integrity and it can help to improve surface quality. The main difference between conventional geometry and wiper geometry is in the shape of the minor cutting edge (Figure 1). The aim of this article is to investigate the effect of the wiper mixed ceramic insert on the surface roughness in finishing by hard turning of hardened steel (100Cr6).

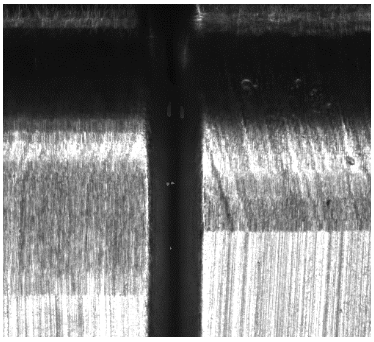

Fig. 1 *Comparison of the shape of the minor cutting edge, left – wiper, right – conventional geometry*

EXPERIMENTAL INVESTIGATIONS

Cutting conditions

Workpiece material used for this experimental study was hardened steel 100Cr6 with Rockwell´s hardness 62±1 HRC. This workpiece was turned using mixed ceramic tool with radius 0,8 mm and coated by TiN by Sandvik Coromant company. Hard turning (Fig. 2) was performed using cutting speed 100 m/min. Depth of cut was constant with value 0,25 mm. Feed was changing from 0,05 until 0,5mm for conventional geometry and for wiper geometry too. Used values are shown in the table 1. These cutting conditions are recommended from the producer, first two values and last two values of the feed rate are critical values, the aim was to find out, how are these two insert geometries behaving in the cutting process.

FEED RATE´S VALUES USED IN THE EXPERIMENT

Table 1

Nr.	1	2	3	4	5	6	7
Feed f (mm)	0,05	0,08	0,1	0,2	0,3	0,4	0,5

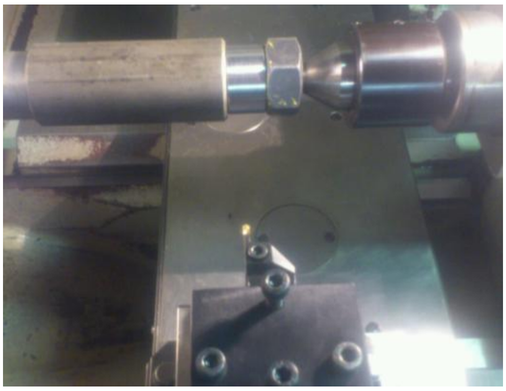

Fig. 2 *Hard turning*

The experimental part is performed on the workpiece (Fig. 3), which is turned using wiper insert geometry (1/2 of the workpiece) and conventional insert geometry (1/2 of the workpiece) with cutting speed 100 m/min, depth of cut 0,25 mm and all the feeds from the table 1. For hard turning was used lathe SUI 500.

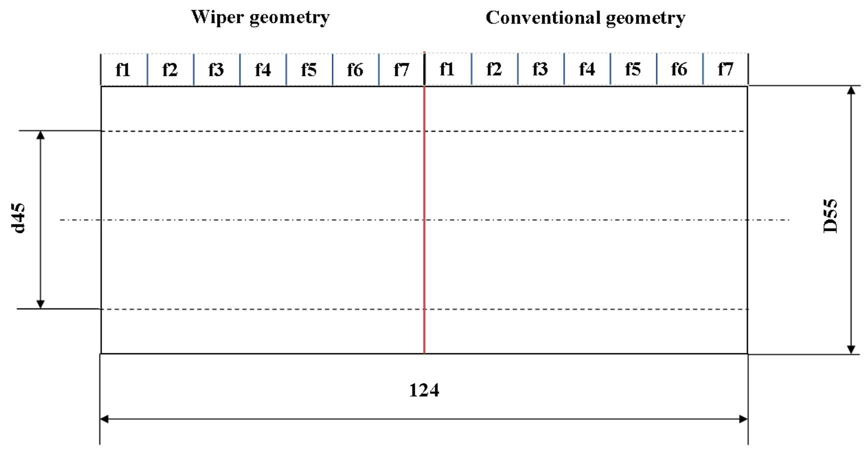

Fig. 3 *Workpiece and experimental plan, d – internal diameter, D – external diameter*

Measurements of surface roughness

Different surface roughness parameters were measured for three times, average values were used for the evaluation. Measurement of the surface roughness parameters was performed on Surfcom 1900SD3 from Carl Zeiss company.

EXPERIMENTAL RESULTS

Roughness profile was recorded for every part of the workpiece when feed was changed.

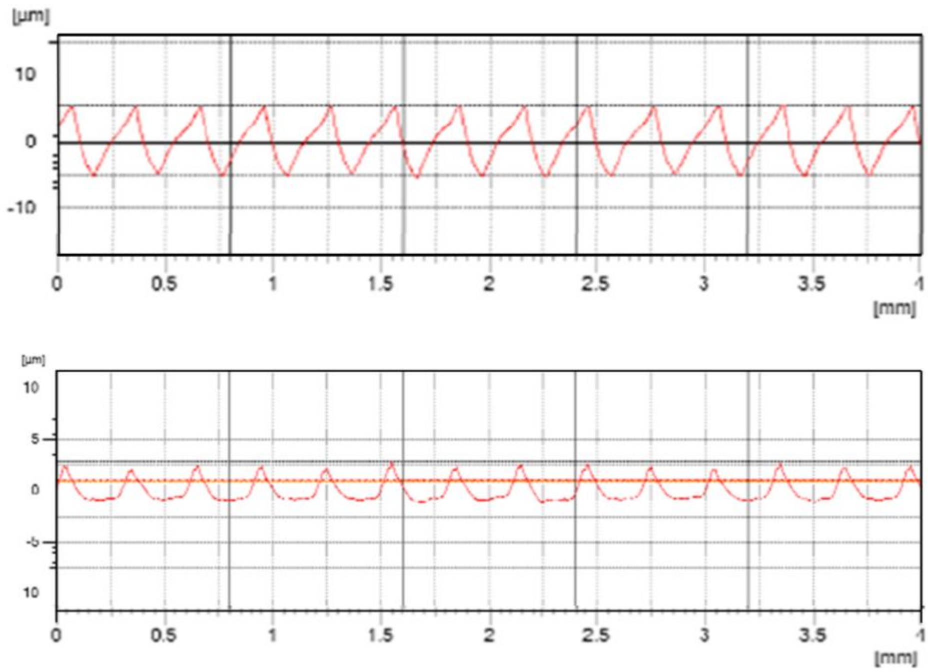

Fig. 4 *Roughness profile,* v_c *= 100 m.min*$^{-1}$*,* a_p *= 0,25 mm, f = 0,3 mm,*
upper – conventional geometry, lower – wiper geometry

In the figure 4 are examples of the profiles, which have different amplitude when using the same cutting conditions for both geometries. Using of wiper geometry helps to obtain better surface.

Roughness parameters Ra, Rz, Rsk, Rku, RSm, Rdq were measured for both used insert geometries. Values for conventional geometry are shown in the figures 5 and 6.

There is an evident difference between measured roughness values when comparing roughness obtained using conventional geometry with values obtained using wiper geometry except parameter RSm (The Mean width of profile elements). These values are almost the same for both geometries.

Typical for wiper geometry is longer minor cutting edge, which width determines range of feed´s values, when surface roughness is not changing. It can be summarized when using the same cutting parameters for hard turning that it is possible to achieved more than two times lower values of roughness parameters Ra and Rz with wiper than conventional geometry when using the same cutting conditions (Figure 5).

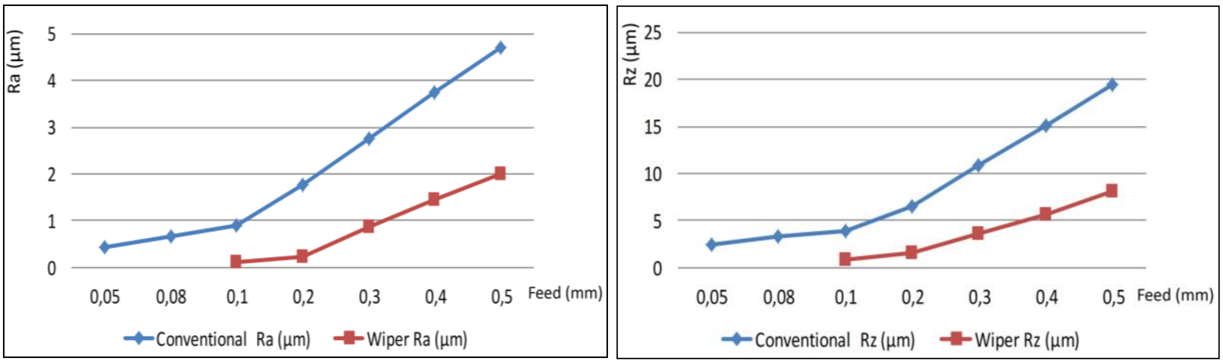

Fig. 5 *Graphs of the surface roughness parameters Ra and Rz*

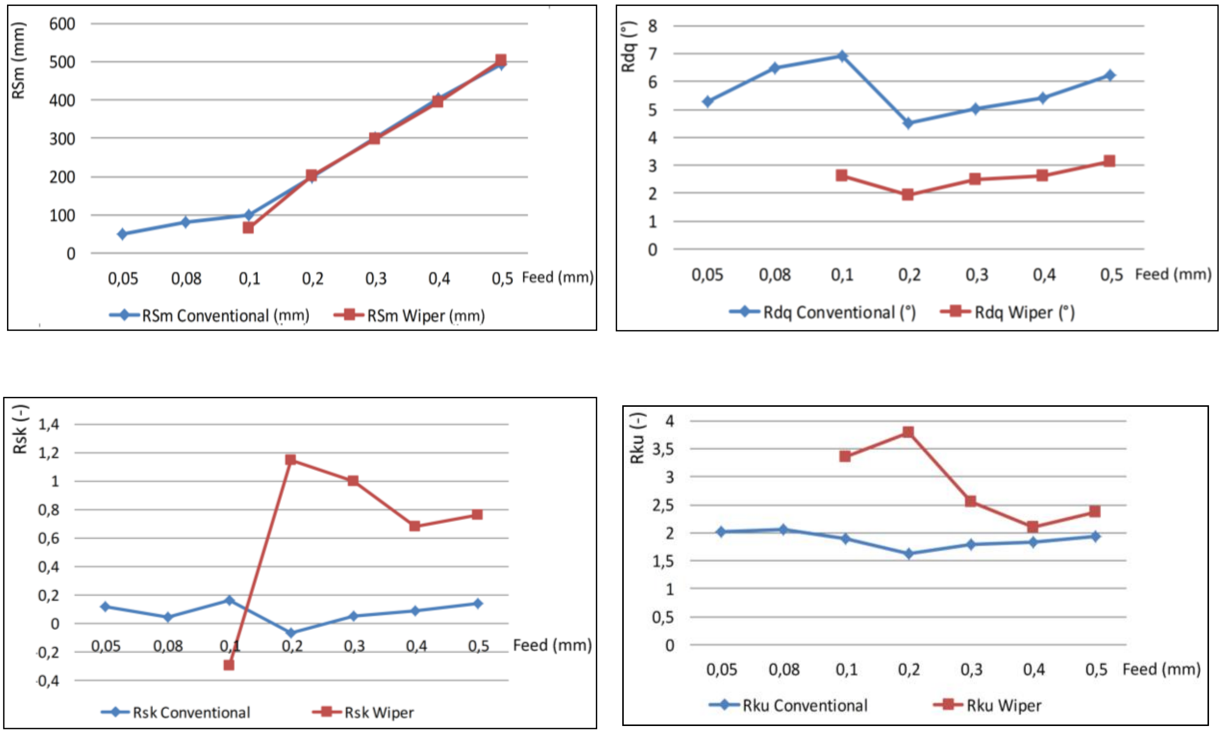

Fig. 6 *Graphs of the surface roughness parameters RSm, Rsk, Rku, Rdq*

Other roughness parameters (Fig. 6) have different character than parameters in the Fig. 5. RSm has very similar values for both geometries. Rsk talks about skewness (asymmetry) of the roughness profile. Conventional geometry is giving more symmetric workpiece profile. On the other hand profile has more valleys, when using wiper geometry, because of its longer minor cutting edge, which is removing peaks.

Rku (kurtosis of the roughness profile) parameter achieved higher values for wiper geometry than conventional. Root mean square slope of the roughness profile Rdq has lower values for wiper insert geometry in comparison to conventional geometry. The reason is again shape of the minor cutting edge, which eliminates peaks from the profile, and the slope is not so steep.

CONCLUSION

There are many different factors influencing surface accuracy and quality, one of them id feed, which is dealing with in this article.

According to this experiment it is possible to sum that insert geometry very influence surface quality, especially surface roughness parameters. There is an opportunity to use wiper geometry (which is different from the conventional geometry in the shape of the minor cutting edge), when needed better surface quality, but it is necessary to take into consideration higher cutting force components when dealing with energy consumption of the process.

Profile figures show us, how exactly is quality of the surface changing depending on feed.

Evaluation and the measurement of cutting tool components and cutting tool wear for conventional and wiper geometry will be aim of the other experimental work of these authors.

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