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THE EFFECT OF CUTTING PARAMETERS ON SURFACE ROUGHNESS IN HIGH SPEED MACHINING

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ABSTRACT
In this study, the effect of cutting parameters on surface roughness during high speed machining of carbon steel has been investigated. The cutting parameters considered include cutting speed and feed per tooth. The cutting experiments are carried out using two milling tools, diameter 20 and 40 mm. The results show that, both of cutting parameters has deeply effect on the surface roughness. Investigations also show that the better surface roughness is obtained during machining with the tool diameter of 40 mm.
Keywords: high speed machining, surface roughness, cutting parameters, carbon steel

1. INTRODUCTION
Among the most effective and efficient modern manufacturing technologies, high speed machining is employed to increase productivity while simultaneously improving product quality and reducing manufacturing costs. Due to their higher productivity and throughput, high speed cutting technologies and especially high speed milling are commonly use in many industrial sector, such as defence, aerospace, aircraft, automotive as well as in die and mould manufacturing for the machining of work with high material removal rates [1]. Research on high speed machining involves a wide variety of work materials ranging from easy-to-cut aluminium alloy [2] to difficult-to-cut hardened steels [3, 4] and advanced aerospace materials [5, 6]. The significance for high speed milling is in the increase of quality of machined surface. Thus, it is necessary to have a deeper knowledge about the optimum operation conditions, which will permit us to assure a good surface roughness. An experimental approach is taken this study. First, the experimental setup is introduced. Then, the effect of cutting parameters on surface roughness in high speed face milling of carbon steel is explained.

2. EXPERIMENTAL SETUP
In order to achieve the stated objective, the experiments are carried out using carbon steel G70 to investigate the effect of cutting parameters on surface roughness. Experiments are conducted on the Faculty of Mechanical Engineering in Sarajevo. The machining system VBS is used in the experiments, figure 1. VBS system is constructed by the adaptation of the stiff universal milling-drilling machine, by building modern high speed components which have primary characteristics: flexibility, high productivity and modularity. The process of the machining system set-up was accompanied by a number of expert and non-standard practices as well as investigations regarding the rigidity and vibrations that played an important role in the selection of the mounting [7]. During implementation of the experimental investigations the two milling tools with exchangeable inserts of hard metal used as the cutting tool, manufacturer SANDVIK Coromant. The cutting tools are clamped to the motor spindle HSM by a tool interface HSK 40E, and it is produced in Technical office of Sandvik Coromant in Germany by submission of the authors of this study. Experimental investigations conducted in high speed face milling, with the following parameters:

- *Tool diameter of 20 mm*: cutting speed from 500 to 1500 m/min and feed per tooth from 0,05 mm to 0,15mm. Depth of milling and width of milling are 0,30 mm and 12 mm, respectively.
- *Tool diameter of 40 mm*: cutting speed from 750 to 3000 m/min and feed per tooth from 0,05 mm to 0,15mm. Depth of milling and width of milling are 0,30 mm and 24 mm, respectively.

Cutting tests carried out under dry machining conditions. A new cutting edge for each machining experiment is used. For measuring of surface roughness, the modern device Perthometer Concpet is used. The examined steel was the carbon steel G70. The mechanical properties and the chemical composite of the examined steel are given in table 1.

Figure 1. Experimental machining system VBS

Table 1. Mechanical properties and chemical composite of the carbon G70 steel

Mechanical properties		
Tensile strength (N/mm^2)	Yield strength (N/mm^2)	Hardness HRc
734,71	506,13	30

Chemical composite, %							
C	Si	Mn	Cr	S	P	Cu	Ni
0,68	0,25	0,78	0,10	0,02	0,02	0,08	0,03

3. RESULTS AND DISCUSSION

The effect of cutting speed on surface roughness during high speed down-cut and up-cut face milling of the carbon steel are done in figures 2, 3, 4, 5, 6, and 7.

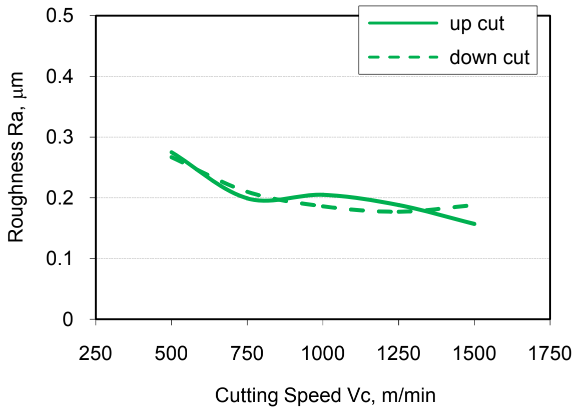

Figure 2. The effect of cutting speed on roughness for f=0,05 mm/t–tool diameter of 20 mm

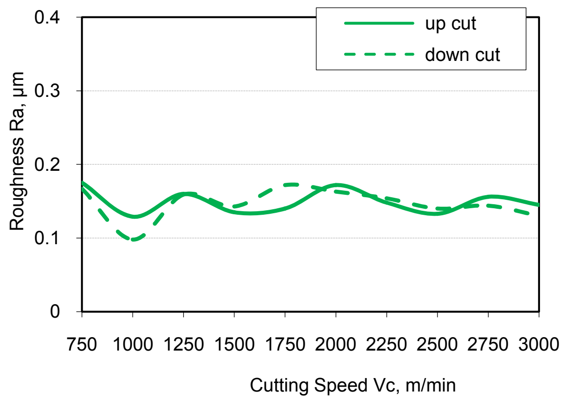

Figure 3. The effect of cutting speed on roughness for f=0,05 mm/t – tool diameter of 40 mm

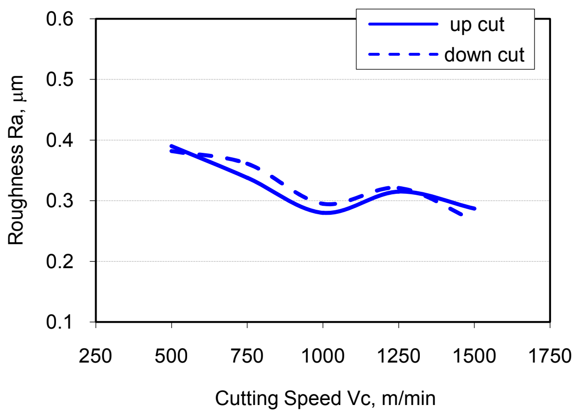

Figure 4.The effect of cutting speed on roughness for f=0,10 mm/t – tool diameter of 20 mm

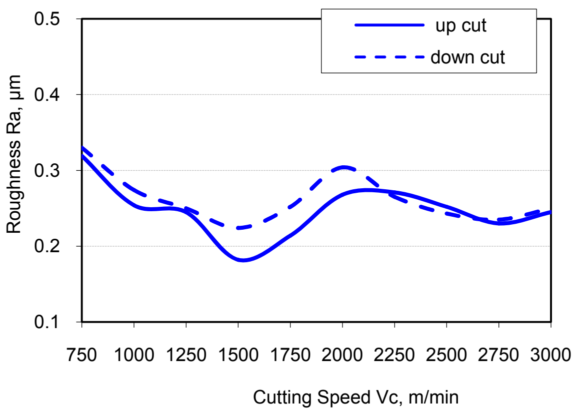

Figure 5.The effect of cutting speed on roughness for f=0,10 mm/t – tool diameter of 40 mm

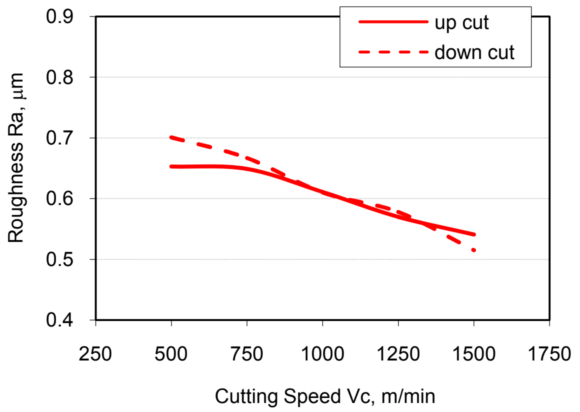

Figure 6. The effect of cutting speed on roughness for f=0,15 mm/t – tool diameter of 20 mm

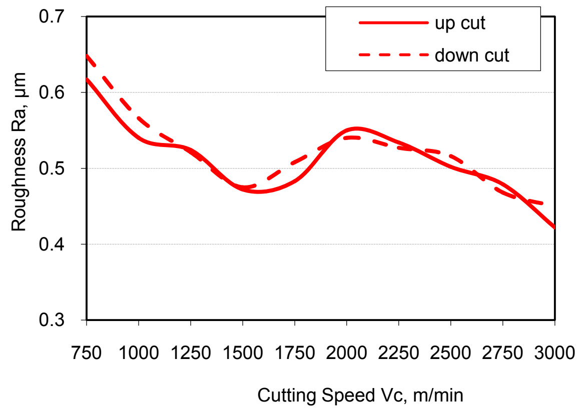

Figure 7. The effect of cutting speed on roughness for f=0,15 mm/t – tool diameter of 40 mm

According to diagrams in figures 2, 3, 4, 5, 6 and 7, the surface roughness decreases with the increase of cutting speed during high speed face milling. In some cases, the roughness remained constant after reaching a specific cutting speed and further increases had no effect on the roughness.

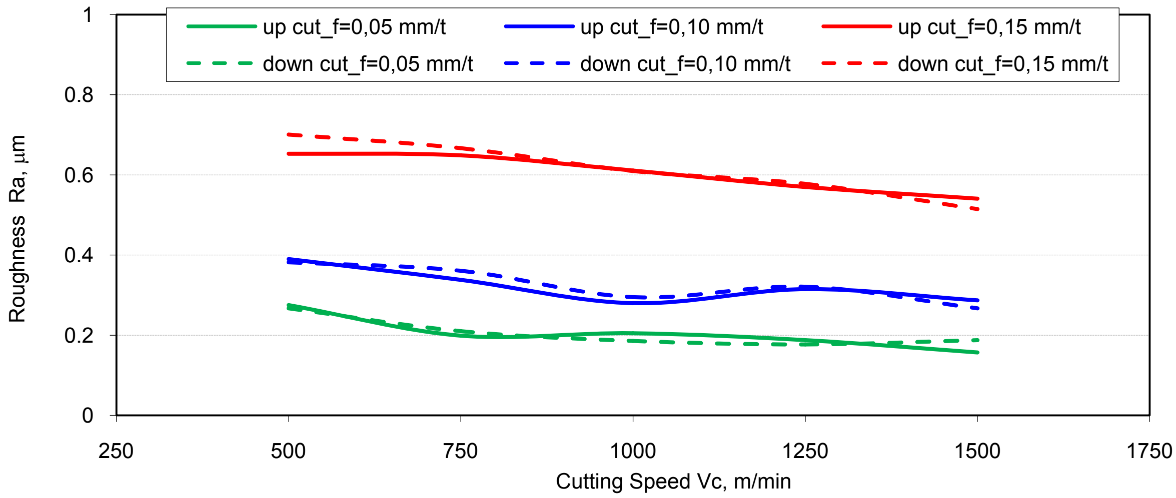

Figure 8. The effect of feed per tooth on surface roughness -tool diameter of 20 mm

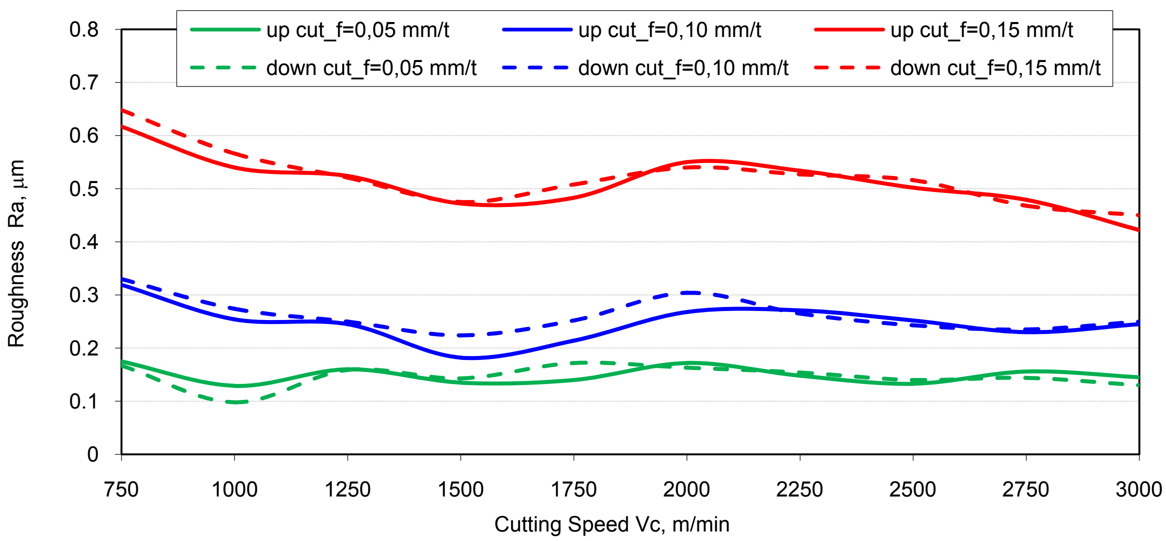

Figure 9. The effect of feed per tooth on surface roughness -tool diameter of 40 mm

Figures 8 and 9 show that the feed per tooth has deeply effect on surface roughness. Surface roughness increases with the increase of feed per tooth. The effect of the diameter of milling tool on surface roughness during down-cut high speed milling of carbon steel is shown in figure 10.

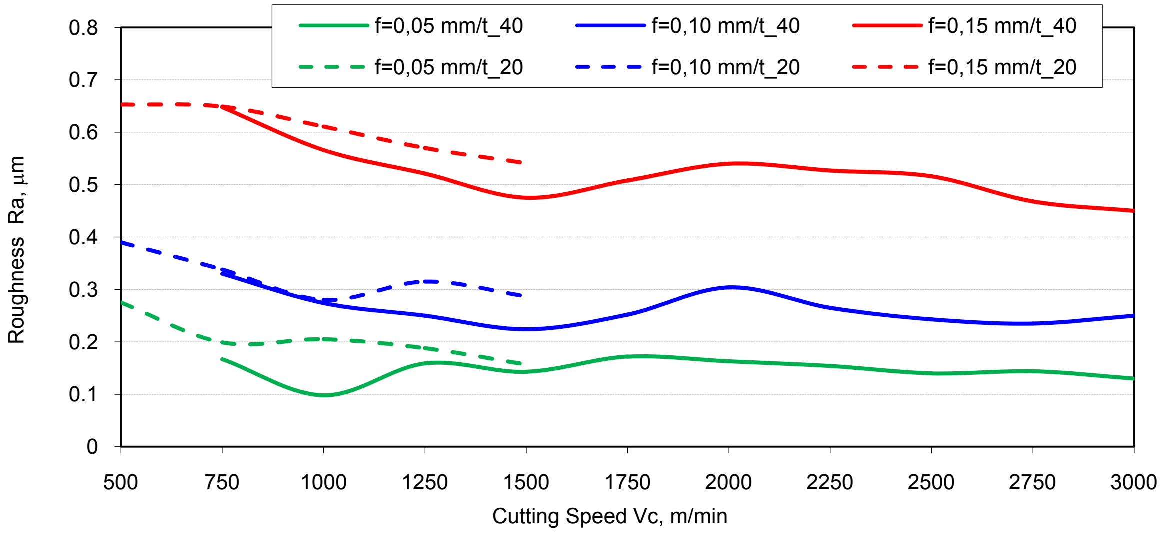

Figure 10. The effect of the diameter of cutting tool on surface roughness during down-cut milling

4. CONCLUSION

According to the reported results it is possible to derive the following conclusions:

- The surface roughness decreases with the increase of cutting speed during high speed face milling.
- Investigations also show that the feed per tooth has deeply effect on the surface roughness during highspeed milling of examined steel. The roughness increases with the increase of feed per tooth.
- Furthermore, it is concluded that milling direction (down-cut and up-cut) has no influence on roughness of machined surface for examined material used in the experiment.
- Also can been concluded that the better surface roughness are obtained during machining with the tool diameter of 40 mm.
- By machining system VBS, which is located on Faculty of Mechanical Engineering in Sarajevo, it has been gained excellent conditions for research of phenomena inherent during high speed milling.

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5. REFERENCES

[1] Dudzinski D., Molinari A., Schulz H.: Metal Cutting and High Speed Machining, Kluwer Academic/ Plenum Publishers, ISBN 0-306-46725-9, New York, 2002.,

[2] Siems S., Dollmeier R., Warnecke G.: Material behaviour of aluminium alloy 7075 and AISI 1045 steel in high speed machining, Trans. NAMRI/SME 28, 101-106, 2000.,

[3] Kulenović M., Begić Đ., Čekić A.: Investigation of Surface Roughness in High Speed Face Milling of Hardened Tool Steel X38CrMoV5-1, 11th International Scientific Conference on Production Engineering – CIM2007, Biograd, Croatia, 2007.,

[4] Quan Y.M., Wang C.Y., He Z.W.: Experimental investigation on the high speed machining of hardened steel, Adv. Mater. Manufact. Sci. Technol. Mater. Sci. Forum 471-472, 339-343, 2004.,

[5] Ezugwu E.O., Bonney J.: An overview of the machinability of aero-engine alloys, Journal of Material Processing Technology 134, 233-253, 2003.,

[6] Fang N., Wu Q.: A comparative study of the cutting forces in high speed machining of Ti-6Al-4V and Inconel 718 with a round cutting edge tool, Journal of Material Processing Technology 209, 4385-4389, 2009.,

[7] Kulenović M., Goja Ž., Čekić A., Halilagić Đ.: Development of the experimental system for investigating the phenomena in high speed milling, DAAAM International Scientific Book, Vienna, Austria, 2004.