

The Vibration effect on the roughness surface of Ck35 steel during the turning operation

Ahmet Latifi, Astrit Shatri, Arsim Abazi, Ismet Ibishi

Abstract— Vibrations in the turning process are an important issue of instability in the metal cutting process. This phenomenon is characterized by violent vibrations, loud sounds, wear of the metal cutting tool and poor quality in the final surface.

Index Terms— Vibrations, turning, machine tool, cutting tool, surface roughness

I. INTRODUCTION

During the processing by chip removal appear some vibrations as consequence of force occurrences which have variable nature and which depend on the physical essence and the vibrations mechanisms. The Vibrations appearance, their amplitude and their frequency depend on the ratio between the vibrating forces and characteristics of the elastic system of the machine. The exciting forces can occur on the transmitting mechanism of the energy, on the cutting process, during the start or during the end of cutting.

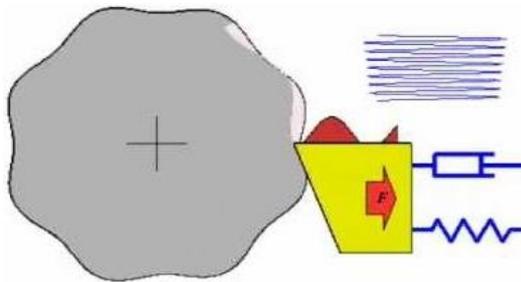


Fig. 1. The vibration impact on the final detail surface

Vibrations in the machine-cutting tool system are a well known fact which can cause a number of problems during the processing including the wear of the cutting tool, the wear of the axis of the cutting tool machine, the wear in the bearings on axis of the metal cutting tool, poor quality on the final surface, low quality of the product and high energy consumption. Vibrations can be classified in different ways due to many factors. For example, vibrations can be classified as free vibrations, violent vibrations and self-excitation vibrations based on the outsourcing energy resources. It is useful to identify the types of vibrations on the metal cutting machine.

Ahmet Latifi, Mechanical Engineering Department, University of Mitrovica, Mitrovica, Republic of Kosovo. Phone/ Mobile No; +37744192250

Astrit Shatri, Mechanical Engineering Department, University of Mitrovica, Mitrovica, Republic of Kosovo.

Arsim Abazi, Mechanical Engineering Department, University of Mitrovica, Mitrovica, Republic of Kosovo.

Ismet Ibishi, Mining Engineering Department, University of Mitrovica, Mitrovica, Republic of Kosovo. Phone/ Mobile No; +38649147180

II. CONDITIONS FOR CONDUCTING THE EXPERIMENT

1. Choosing the material – Material which has been researched for measuring the parameters surface severity and of the vibrations is Ck 35 Steel , according to DIN's dimensions Ø55 dhe l=550.

Tab. 1. The chemical composition of steel Ck 35

Signs DIN	C%	Si%	Mn%	P%	S%
Ck35	0.32-0.39	0.15-0.35	0.50-0.80	0.035	0.035

2. Selecting the cutting tool – For the processing of the sample, it's used an cutting tool holder 90 W20-T3K13 according DIN's 3705, production of the German firm KNUTH, and one cutting insert ISO6-P10 production of Swedish firm Sandvik Coroman type TCMT 161308-MR 2025 following characteristics: $\alpha=45^\circ$, $\gamma=90^\circ$, $\beta=60^\circ$, $r_\epsilon=1.2$ [mm].



Fig. 2. The cutting tool

3. Selection of cutting regimes – Preparation of the sample is conducted in the turning machine by the selected cutting regime: cutting speed, cutting feet and the depth of cutting. Based on the number of the machine rotations, sample dimensions, consulted text, chemical compositions and mechanical properties, these spindle speeds (numbers) are acquired:

$$n_{\max}=700 \text{ spin/min}, n_{\text{ave}}=500 \text{ spin/min}, n_{\min}=300 \text{ spin/min}.$$

For the sample preparation is used an experiment using three orthogonal factors with a measurement point plan and on the repeating on point zero four times (2^3+4).

Tab. 2. Characteristics of cutting regimes and used code level.

Processing Regime and Preparation of the Sample					
Nr.	Size	Level Code	Max	Average	Minimal
			1	0	-1
1.	v (m/min)	X1	120.89	86.35	51.81
2.	f (mm/rev)	X2	0.10	0.085	0.055
3.	a (mm)	X3	1.5	1.0	0.5

4. Selection of Turning Machine – The Sample is used in the turning machine TURNADO 230, production of German firm KNUTH.

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Fig 4. The machine by which the sample preparation was done.

5. Election of metering device – Measurement of the roughness surface parameters which is done in a computer device for measuring roughness TALYSURF INTRA of firm TAYLOR HOBSON, and vibration measurement in the turning process is done by the Comarator device for vibration measurement.



Fig. 5. The measuring device for measuring the roughness of processed surface TALYSURF-INTRA and the device of vibration measurement – Comperator

III. RESULTS AND DISCUSSION

For the sample preparation is used a three orthogonal factor with a point plan measurement and the repeating on point zero four times (2^3+4).

Tab. 3. Matrix coded plan of the first row with three factors.

Nr.	Level Kode			
	X ₀	X ₁	X ₂	X ₃
1.	1	-1	-1	-1
2.	1	1	-1	-1
3.	1	-1	1	-1
4.	1	1	1	-1
5.	1	-1	-1	1
6.	1	1	-1	1
7.	1	-1	1	1
8.	1	1	1	1
9.	1	0	0	0
10.	1	0	0	0
11.	1	0	0	0
12.	1	0	0	0

Tab. 4. Measuring achieved results during sample processing by turning machine tool TURNADO 230

Nr.	Processing Regime			Vibrations f [Hz]
	v(m/min)	f(mm/rev)	a (mm)	
1.	300	0.055	0.5	0.02
2.	700	0.055	0.5	0.01
3.	300	0.10	0.5	0.02
4.	700	0.10	0.5	0.01
5.	300	0.055	1.5	0.02
6.	700	0.055	1.5	0.02
7.	300	0.10	1.5	0.01
8.	700	0.10	1.5	0.02
9.	500	0.085	1.0	0.01
10.	500	0.085	1.0	0.01
11.	500	0.085	1.0	0.01
12.	500	0.085	1.0	0.01

Tab. 5. Determination of surface roughness by turning machine tool TURNADO 230

Nr.	Surface Roughness		
	R _a [μm]	R _l [μm]	R _z [μm]
1.	4.6111	33.6489	24.5047
2.	1.3559	11.0580	8.0578
3.	3.5355	32.8781	19.1978
4.	1.9867	22.5223	11.3695
5.	2.3990	27.1440	13.2927
6.	0.8460	17.6357	6.5433
7.	2.2480	16.7127	11.8266
8.	0.7560	12.9905	4.9619
9.	0.9578	13.4132	7.0038
10.	0.9074	16.4911	6.6580
11.	0.8772	14.8040	6.2349
12.	0.8505	12.5322	5.6206

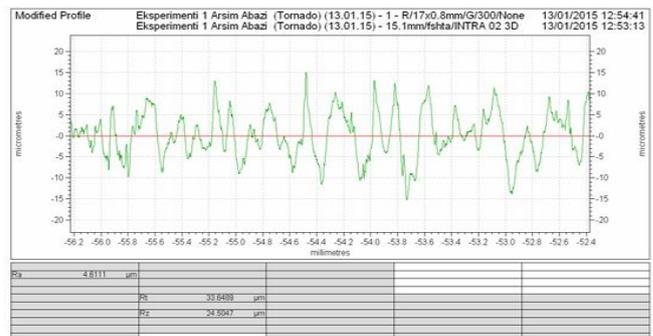


Fig. 6. Profilogram graphic interpretation for the first experiment

Based on the achievement of metering results during the research vibration impact on surface severity for CK35 steel, it has been reflected the impact of the factors which have been used for the experiment implementation, such as cutting speed, cutting step and cutting depth. *Cutting speed*-(v) has a great influence on vibration size and on the harshness of proceeded surface. The greater the velocity the less is the height of micro particles, which means that by increasing cutting speed decreases the processed surface harshness. During low-speed cutting (v=300 m/min) obtained results show that we have got more harshness, and this happens due to increased vibrations, and the plastic deformations on the cutting area are larger.

Cutting feet (f) – The most influential factor on the vibration size and on the surface harshness is the cutting feet. The research shows that the increased in feet has influenced on increasing harshness. During processing on maximal feet ($f=0.10$ mm/rev) have increased the severity of surfaces. This is because by increasing the cutting pace the cutting resistance grows, cutting temperature grows and this causes an increase in size of plastic deformation on the cutting area. During processing on low-speed ($f=0.055$ mm/rev) the results have shown that by reducing the pace it also reduces the severity of the surface.

Cutting depth (a)- The cutting depth, based on analysis results, related on cutting pace and cutting speed, is less influential on the severity of processed surface. By increasing depth ($a_{max}=1.5$ mm), we have gained values with major parameters of the processed surfaces because by increasing the cutting depth, the cutting resistance increases, the cutting temperature and the deformations increase as well. While on the other hand, by reducing the cutting depth ($a_{min}=0.5$ mm), the surface severity is reduced on the processed surface.

IV. CONCLUSION

Processed surface roughness depends on many factors, but for the research some factors have been adopted: cutting speed (v), cutting feet (f) and cutting depth (a). Physico-Chemical properties of material, altered structure through layers of processed surface and chip shape due to plastic deformation during the cutting process, geometry constant change of the cutting tool due to the wear, growth phenomenon and the appearance of the oxidation layers in the cutting edges, greatly affect the vibration and the processed surface. By this we conclude that the used factors in the experiment are just some of the indicators expressing their impact on vibrations and on the surface roughness. Considering the result analysis of obtained experimentally, during the research on vibration impact over processed surface harshness during the turning process for Ck35 steel according DIN standard, in the turning machine V-Turn, allows us obtaining scientific arguments which appear during the turning process.

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Ahmet Latifi is working in Mechanical Engineering Department at the Public University of Mitrovica (UMIB) in Republic of Kosovo. Research interests; Machine Elements and Engineering Mechanics,

Astrit Shatri is a student in Mechanical Engineering Department at the Public University of Mitrovica (UMIB) in Republic of Kosovo. Research interests; Machine Elements and Engineering Mechanics,

Arsim Abazi is a student in Mechanical Engineering Department at the Public University of Mitrovica (UMIB) in Republic of Kosovo. Research interests; Machine Elements and Engineering Mechanics,

Ismet Ibishi is working in Mining Engineering Department at the Public University of Mitrovica (UMIB) in Republic of Kosovo. Research interests; Continuum Mechanics, Machine Elements Design and Engineering Mechanics of Materials.