

Roughness of Surfaces Worked During Milling with Changes in the Direction of Mills

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Abstract— The purpose of this paper is to measure the roughness of the working surfaces during milling for X210Cr12 steel and 17Mn4 steel (according to DIN). All the machine characteristics (used cutting regime), the factors affecting the surface roughness rate for these two types of steel, the performance of the measurements and the analysis of the results are given in this paper.

Keywords: work surfaces, cutting tool, experiment, machine, processing regime, surface roughness

I. INTRODUCTION

In order to achieve high quality on the work surfaces, it is necessary to know the underlying causes of the roughness (of micro elevations or ripples). The quality of the work surfaces depends on a number of factors, which are closely related to the processing conditions, such as: processing regime, cooling mode, machine stability, geometric shape of the cutting tool, etc., which are mainly can be grouped as:

- swinging on machine-device-parts-instrument system,
- geometric parameters of the cutting instrument,
- processing regime elements.

II. CONDITIONS FOR CONDUCTING THE EXPERIMENT

A. Choosing the Material

Material which has been researched for measuring the parameters surface severity is X210Cr12 Steel and 17Mn4 Steel, according to DIN's dimensions.

DIN	C(%)	Si(%)	Mn(%)	Cr(%)	Mo(%)	Ni(%)	V(%)	Tjera(%)
X210Cr12	2.0 5	0.2 5	0. 30	11. 50	-	-	0.1 0	-

Table 1: The chemical composition of steel X210Cr12

C%	Si%	Mn%	P%	S%
0.22-0.6	0.35	0.8	0.045	0.045

Table 2: The chemical composition of steel 17Mn4

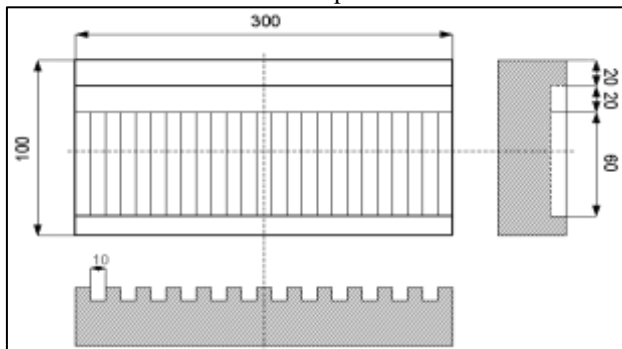


Fig. 1: The dimensions of the details for the two steels are the same

B. 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: $n_{max}=2400$ spin/min, $n_{ave}=2000$ spin/min, $n_{min}=1600$ 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).

Nr.	Size	Level Code	Max	Average	Minimal
			1	0	-1
1.	v (m/min)	X ₁	105.5	87.9	70.3
2.	f (mm/rev)	X ₂	100	80	60
3.	a (mm)	X ₃	1.5	1.0	0.5

Table 1: Characteristics of cutting regimes and used code level.

C. Selecting the Cutting Tool

For the processing of the sample, it's used an mill with four cutting edges, production of the firm FRA HSSE.

FRA HSSE	d ₁ [mm]	d ₂ [mm]	l ₁ [mm]	l ₂ [mm]	z
(z=4)	10	10	83,0	26.0	4

Table 2: Dimensions of the cutting tool



Fig. 2: The cutting tool

D. Selection of Milling Machine

The Sample is used in the mill machine CNN X.mill 900, production of German firm KNUTH.



Fig. 3: The machine by which the sample preparation was done.

E. 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.



Fig. 4: The measuring device for measuring the roughness of processed surface TALYSURF-INTRA

III. ACHIVED RESULTS

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).

Nr	Processing Regime			Surface Roughness		
	v (m/min)	f (mm/rev)	a (mm)	R _a [μm]	R _t [μm]	R _z [μm]
1.	70.3	60	0.5	1.904 6	15.372 8	10.997 8
2.	105.5	60	0.5	2.043 8	23.324 3	12.057 5
3.	70.3	100	0.5	1.513 7	15.248 8	8.9626
4.	105.5	100	0.5	1.549 8	15.503 2	9.5414
5.	70.3	60	1.5	2.200 4	17.310 8	12.392 3
6.	105.5	60	1.5	2.042 8	17.048 7	11.428 9
7.	70.3	100	1.5	1.602 7	13.491 3	9.6653
8.	105.5	100	1.5	1.610 8	14.612 1	9.8275
9.	87.9	80	1.0	2.036 8	16.802 5	11.685 0
10.	87.9	80	1.0	2.341 8	19.583 7	13.370 0
11.	87.9	80	1.0	2.139 9	18.687 7	12.709 2
12.	87.9	80	1.0	2.262 6	21.482 5	12.487 0

Table 3: Results achieved for steel X210Cr12

Nr	Processing Regime			Surface Roughness		
	v (m/min)	f (mm/rev)	a (mm)	R _a [μm]	R _t [μm]	R _z [μm]
1.	70.3	60	0.5	1.129 0	16.690 8	8.1717
2.	105.5	60	0.5	1.324 1	15.208 4	9.1737
3.	70.3	100	0.5	1.611 9	17.401 4	10.016 4

4.	105.5	100	0.5	1.864 8	18.471 5	11.495 8
5.	70.3	60	1.5	1.444 8	17.739 5	9.6277
6.	105.5	60	1.5	1.235 5	16.579 9	7.6629
7.	70.3	100	1.5	1.153 6	16.013 6	8.4145
8.	105.5	100	1.5	1.141 9	13.044 2	7.6807
9.	87.9	80	1.0	1.448 7	18.646 9	9.5054
10.	87.9	80	1.0	1.276 8	15.453 3	8.3761
11.	87.9	80	1.0	1.529 2	16.791 8	9.3849
12.	87.9	80	1.0	1.897 6	21.923 0	11.209 9

Table 4: Results achieved for steel 17Mn4, by changing the direction of the mills

IV. ANALYSIS OF RESULTS

With opposite direction milling the direction of the auxiliary movement of the workpieces being processed and the main movement of the milling machine are opposite. The section of the chip varies from the minimum at the beginning of the engraver blade entry point (tooth) to the material, to the maximum at the end of the material acquisition, respectively, until the engraver blade entry point (tooth) emerges from contact with the workpieces being processed. In this case, as a result of directing the main cutting force, the mill tends to raise the detail being processed by the machine's worktable, so in this case, the workpiece to be machined should be tightened to the machine of milling worktable. In addition, when the engraver blade entry point (tooth) exits the material, when the cutting force is maximal, results in vibration because of momentary discharge. On the other hand, during the entry of the engraver blade into the material, initially the engraver blade entry point (tooth) slides across the processed surface, then the material is crushed until the material layer reaches the required minimum thickness when the process of chipping begins. Due to the aforementioned slip and twist, the processed surface acquires a bright (polished surface that shines) appearance and is of poor quality.

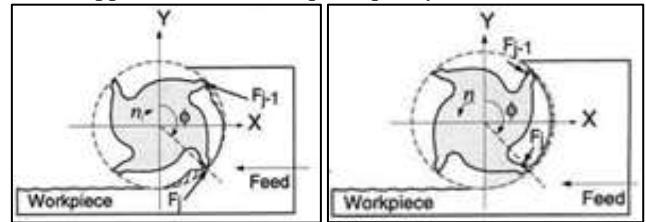


Fig. 5: Milling with the same direction and reverse

With same direction milling, the auxiliary movement of the workpieces being processed and the main rotation of the mill have the same direction. Here the chip section changes from the maximum, at the beginning of the engraving blade entry point (tooth) to the material, to the minimum, at the engraver blade entry point exit of the material. In this case, due to the direction of the main cutting force, the mill suppresses the workpieces toward the milling

worktable, resulting in the whole system being stable and rigid.

With opposite direction milling, the vibrations appear as the engraving blade enters the material, but there is a lack of pressing of the material when the engraving blade exits the material. For this reason, the processed surface does not have the excellent characteristic appearance, and is of very good quality, and in this aspect it has been found that the same direction milling is more suitable than the opposite direction milling. However, in the same way, in the same direction milling, in practice, same direction milling is much less used.

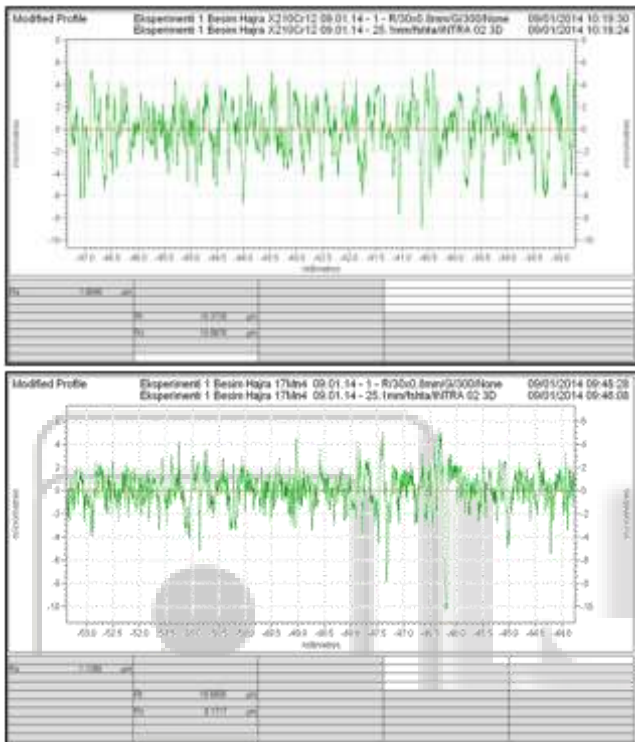


Fig. 6: Graphical representation for the experiment nr. 1

V. CONCLUSION

In support of the results obtained by means of relevant measurements and analyzes in the sample treated with cutting, surface roughness parameters such as: arithmetic mean profile deviations (R_a), maximum nonlinear heights (R_t) and, average altitudes of the plateaus (R_z). From the results obtained, we can see that the greatest impact on the increase of surface roughness is the cutting feet.

The cutting speed (v) has a great impact on the roughness of the machined surfaces. The higher the velocity the lower the height of the micro elevations, which means that as the cutting speed increases, the roughness on the work surfaces decreases.

Cutting feet (f) - The most influential factor in the magnitude of the surface roughness rate is the cutting feet. During the research it was established that the increase in feet (f) had an effect on the increase in severity.

Depth of cutting (a). Depth of cutting, based on the analysis of the results, in relation to the cutting feet and cutting speed, is less influential on the roughness of the working surfaces.

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