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EXPERIMENTALS ASSPECTS REGARDING MULTI-FLUTE TWIST DRILLS WEAR

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ABSTRACT

The problem of twist drills behavior in the cutting process, from the wearing point of view, is defining for the characterization of the quality of the tool. Another element which influences the quality of machined part is the machine-tool itself. In this paper was analyzed the process capability in case of boring with a HAAS machining center using multi-flute twist drills. The tests concerns about the holes position and diameter. The measurements were made using a coordinate measuring machine Tesa MicroHite 3D.

KEYWORDS: multi-flute helical drill, cutting, CNC machining

1. INTRODUCTION

The problem of twist drills behavior in the cutting process is defining for the characterization of the tool’s quality. Another element which influences the quality of the machined part is the machine-tool itself.

In this paper was analyzed the process capability in case of boring with a HAAS machining center using multi-flute twist drills. The machining center model is VM3, with 22.4 kW nominal power and a maximum revolution speed of 12000 rpm.

The tests consist in boring 45 holes with diameter of 16 mm in OL 37 steel plates.

The cutting parameters were:
- cutting speed 40 m/min;
- rotation speed 796 rpm;
- feed 0.1 mm/rot.

The measurements of the holes position and diameters were made in the measurements laboratory of the Manufacturing Engineering Department, using a coordinate measuring machine Tesa MicroHite 3D.

2. EXPERIMENTAL ASPECTS REGARDING DRILL WEARING

In order to establish the quality of machined parts using the HAAS machining centre and drills with three cutting edges, we performed tests in regards to the holes position and diameter.

The tests were performed in the same drilling conditions *(v, s, t)*, using the same cooling liquid.

2.1 Cutting tools and materials used experimental research of drill resistance

There were used a set of Rp3 high-speed steel twisted drills.

The tools were delivered to the Tool Factory Rîşnov, Romania. The twisted drills were sharpened after a hyperboloid surface, on the sharpening device designed in the Department of Manufacturing Engineering, Faculty of Mechanical Engineering, University of "Dunărea de Jos" Galați [18].

Fig. 1. Drills used for holes manufacturing

The thermal treatment was identical for all drills, performed in the normal technological feed of the Rîşnov Tool Factory.

The cutting edge resistance of drills was measured inside the Department of Manufacturing Engineering, Faculty of Mechanical Engineering, University of "Dunărea de Jos" from Galați.

The geometry of twist drills, measured after sharpening, highlighted the point angles κ_t=60°, and peripheral angle, respectively, of κ_p = 12°;

2.2. Materials

The Rp3 high-speed steel from which all the drills were made, has a chemical composition certified by the Rîşnov Tool Factory, table 1.

Table 1. Chemical composition of Rp3 high-speed steel [%]

C	Mn	Si	Cr	Mo
0.73	0.45	0.31	3.7	max. 0.6
W	V	Ni	P	S
18.2	1.3	0.4	0.025	0.02

In order to perform the tests, were used four plates with the dimensions of 350×350×50 mm from carbon steel of general use, OL37 (A570, according to AISI and ASTM specifications), with the chemical composition presented in table 3.

Table 2. Chemical composition OL37, [%]

C	Mn	Si	P	S	Cu
0.16	0.42	0.3	0.04	0.05	0.035

2.3. Equipment used in experimental research of twisted drill wearing

The tests were conducted at the Romanian-Belgian Company SIDEM, from Suceava County, using the vertical machining center CNC of the HAAS brand, model VM3, with a nominal power of 22.4 kW and a maximum rotation 12000 rot/min.

The specifications and the general limitations if uses of the vertical machining center Haas-VM3 are defined in table 3.

Table 3. Specifications and general limitations of use for the vertical machining center CNC Haas-VM3

Stroke	X=1016 mm	Y=660 mm	Z=635 mm
Drilling axis	Torque: 102 N·m	Power: 22,4 kW	Rotation: 12000 rot/min
Feed	- fast: 18 m/min - maximum processing: 12,7 m/min		
Temperature - running - storage	Minimum	Maximum	
	5°C	50°C	
	-20°C	70°C	
Noise	Minimum	Maximum	
	70dB	<85dB	

The machine has a Siemens system of command and a Fanuc 16i MB programming language. The machine’s program was designed so that it allows, at regular time intervals, visual inspection and usage measurement in the peripheral area of main cutting edges.

2.4. Holes processing

It was agreed that, for processing plates, there should be established a work plan, generically represented in figures 2.

In this case, it was considered the origin of the first hole at a distance of 13 mm on the direction of +X and +Y axis of the CNC machine.

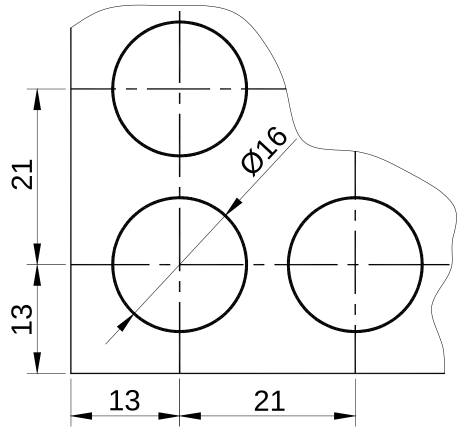


Fig. 2. Positioning sketch of boring on the plate

These preliminary data, along with the parameter specifications of the cutting regime, was part of the G code, transmitted to the machine. The holing depth was of 50 mm (hole drilled entirely), practically being in conformity with the specifications of the manufacturer, that, according to DIN 341, stipulates a drilling depth of $< 5 \cdot D$ (D – drill diameter).

3. EXPERIMENTAL VALUES AND RESULTS

In order to test the machining center capabilities, at boring with 16 mm helical drill we analyzed the diameters of the holes using statistical control sheets.

The tolerance limits for the machined holes diameter at drilling are $\Phi 16^{+0.415}_{+0.137}$ mm. So, the maximum diameter is 16.415 mm and the minimum diameter is 16.137 mm.

Were analyzed 45 holes and the measured data were registered in statistical control sheet. The 45 holes were grouped in 9 selections. For each selection was calculated the average diameter and the amplitude of the diameter errors. In equations (1) and (2) are presented the calculus for first selection.

$$D_{av} = \frac{\sum_{i=1}^{5} D_i}{5} = \frac{91.577}{5} = 16.315 \quad (1)$$

The amplitude is:

$$A = D_{max} - D_{min} = 16.354 - 16.264 = 0.09 \text{ mm.} \quad (2)$$

For the others selections the calculus are similarly.

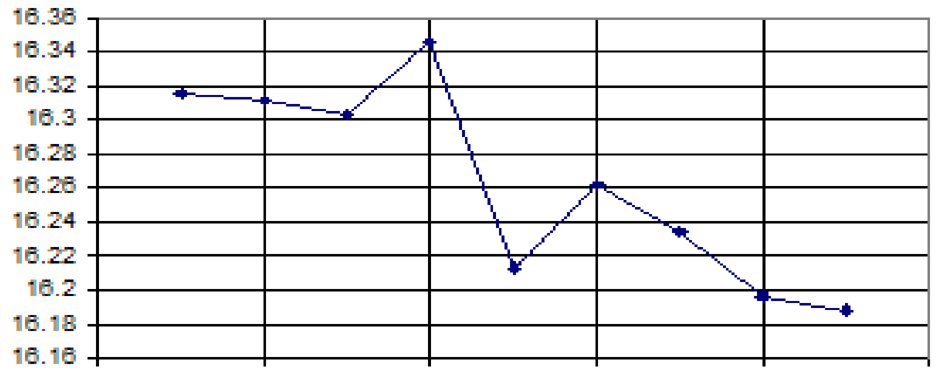
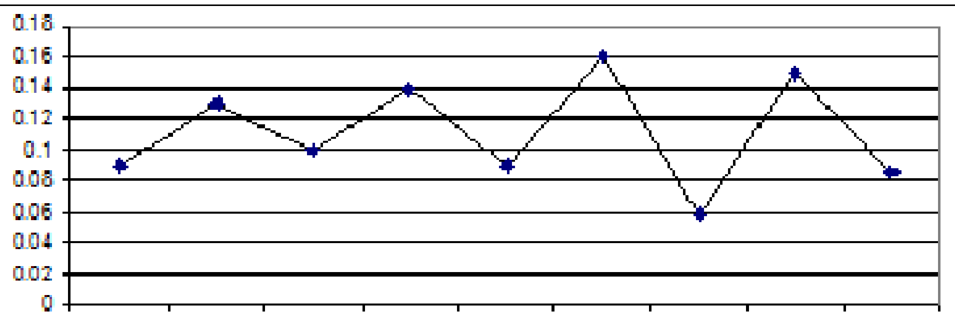
The average amplitude is calculated with:

$$A_{av} = \frac{\sum_{i=1}^{9} A_i}{9} = \frac{1.003}{9} = 0.111 \text{ mm.} \quad (3)$$

3.1 The statistical calculus sheet

Part: Drill plate
Process: drilling
Controled feature: hole diameter
Allowed dimension: Ø16 mm $^{+0.415}_{+0.137}$
Upper limit: D_{max} = 16.415 mm;
Lower limit: D_{min} = 16.137 mm;
Selection: 5 samples;
Interval between 2 probes: 2 hours.

Table 4. Statistical calculus sheet

Crt. no.											
I.	Average										
II.	Amplitude										
III	Measured characteristic value, D	1	16.338	16.269	16.373	16.4	16.212	16.369	16.237	16.286	16.223
		2	16.298	16.29	16.278	16.415	16.165	16.245	16.219	16.194	16.179
		3	16.264	16.3	16.288	16.276	16.255	16.238	16.216	16.137	16.147
		4	16.354	16.3	16.307	16.295	16.198	16.249	16.274	16.178	16.233
		5	16.323	16.399	16.273	16.349	16.235	16.208	16.226	16.184	16.157
IV	Sum		81.577	81.558	81.519	81.735	81.065	81.309	81.172	80.979	80.939
	Average		16.3154	16.312	16.304	16.347	16.213	16.262	16.234	16.196	16.188
	Amplitude		0.09	0.13	0.1	0.139	0.09	0.161	0.058	0.149	0.086
V	Control conclusion		C	C	O	O	C	O	C	C	C

In figure 3, is presented the distribution curve of the analyzed characteristic.

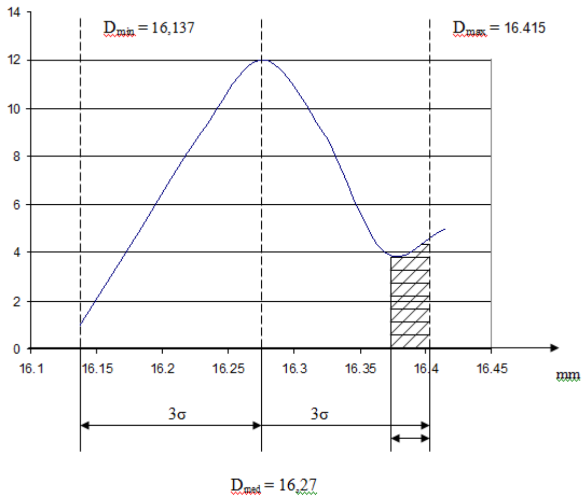


Fig. 3. Distribution curve of the measured characteristic (diameter)

4. CONCLUSIONS

Analyzing the diagram we may obtain the following conclusions:

1. Although the spreading of the diameter values:

$$6\sigma = 0.0096 \text{ mm} < A = 0.111 \text{ mm}. \qquad (4)$$

so, the process is precisely, due to the improper setting, the process is displaced;

2. In figure 3, the hatch zone of the diagram represents the reject probability.

3. It is possible to emerge some errors due to the machined surface roughness.

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