INFLUENCE OF THE WORKING PARAMETERS AT PLANE GRINDING UPON THE SURFACE ROUGHNESS, UPON THE GRINDING FORCES AND UPON THE WEAR ANGLE OF THE GRINDING WHEEL

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1. EXPERIMENTAL EQUIPMENT, WORKPIECE MATERIAL AND DIMENSIONS

1.1. The Grinding Machine

The tests were performed on a Churchill surface grinding machine. The crossfeed and downfeed were changed with ratchet mechanisms thus required wheel downfeeds and table crossfeeds could be quickly and accurately achieved. The table velocity was variable over the range zero to 10.5 m/min, choosing suitable values.

The electric motor driving the wheel spindle was of 5,8 H.P.

1.2. The Grinding Wheel

The same wheel was used throughout the work. Its specifications were 38 A 46 H 8 VBE and it was manufactured by NORTON Co LTD, having a 175 mm diameter.

1.3. Material and Workpiece Dimensions

The workpieces were manufactured from En 8 steel. The properties are given in BS 970:1955. The dimensions were 100x50x13 – the 13 dimension not being important for the tests.

2. EXPERIMENTAL PROCEDURES

Before any grinding tests were commenced, the wheel spindle and table motors were switched on for thirty minutes, in order to ensure the normal working conditions of lubricant and bearing temperatures, especially on the spindle bearings.

The workpiece was set always in the same position on the magnetic table of the grinding machine after each measuring of the surface finish and with the 100 mm dimension in the direction of table movement.

The spindle speed was constant at 2300 rot/min, which result in a peripheral wheel speed of 21 m/sec for a wheel of 175 mm diameter.

The table (workpiece) velocity was established using an electrical pick-up device. The 100 mm long pick-up contact was so positioned that the signal was produced only during the wheel-workpiece contact. In this way the time taken for the 100 mm long workpiece to pass beneath the wheel could be measured and the corresponding table velocity could be easy calculated for the cutting time.

The dressing of the wheel was done after each change in the values of cutting parameters. For this purpose a single point diamond was used which was set on the machine table and feeded across the surface of the rotating wheel. A downfeed of 0.05 mm was used and a crossfeed of 0.1 mm/rot. The last two passes across the wheel surface were performed without downfeed. All tests were performed dry.

3. PROCEDURES FOR SURFACE FINISH MEASUREMENTS, TEST RESULTS, CONCLUSIONS

The establishment of the surface finish, after each test, was done as follows:

With cutting parameters (crossfeed, downfeed and table velocity) well established, six passes were carried out on the surface of the workpiece for each pair of values. The surface finish was measured in five locations, after each pass – see diagram in Fig. 1. These five measurements were used to establish an average value of surface finish for each pass. It was observed that after 2-3 passes approximattely, for the same values of cutting parameters, the surface finish become steady, so if surface finish is plotted against the number of passes the general appearance of the curve is as shown in Fig. 2.

The surface finish measurements were carried out on the TALYSURF 4 surface profile measuring equipment.

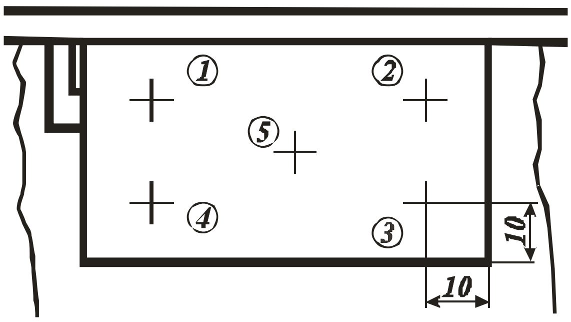

Figure 1. The locations for surface finish measurement

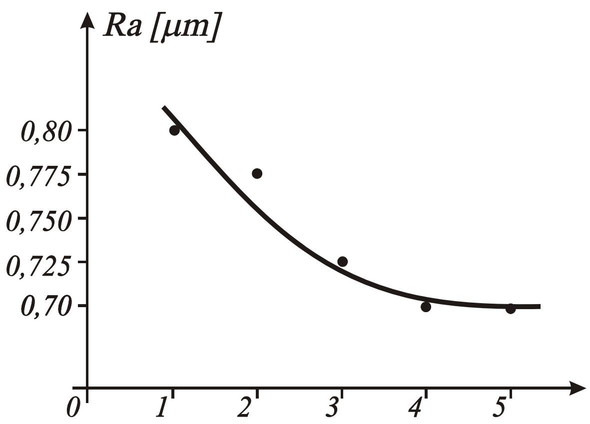

Figure 2. Steady state of the surface finish (***Ra*** vs. measuring points)

Two series of tests were performed. The first under conditions of constant metal removal rate and the second under conditions which resulted in different metal removal rate.

During surface grinding the metal removal rate is the product of the wheel crossfeed per pass, the wheel downfeed and the workpiece (table) velocity. The first series of tests was performed with one of the above three parameters and the product of the other two constant. For example, at constant crossfeed, the downfeed was doubled when the workpiece speed was halved.

The manner of the variation of these parameters and the results which were obtained are shown in Table 1.

Fig. 3 to 5 inclusive shows, in graphical form, the results given in table 1.

During the second series of tests, the parameters mentioned above namely crossfeed, downfeed and workpiece speed, were systematically tested for different metal removal rates. The results of these tests are presented in tabular form, Table 2, and in graphical form as Figs. 6 to 8 inclusive.

The result obtained in this work will be compared with the results of other authors.

Empirical formulae and theoretical aspects has been presented by several authors for the purpose of surface finish study.

Several equations has been presented, as follows:

1. K. Sato

$$h = \frac{1}{8R}\left(\frac{v}{V}\right)^2 a^2 + \frac{b^2}{4d_0}\left(\frac{X}{E}\right)^2 ; \tag{1}$$

2. Yang and M.C. Shaw

$$h = \left[\frac{v}{2Vrn\sqrt{D}}\right]^{2/3} ; \tag{2}$$

3. M.C. Shaw

$$h = \frac{t^2}{16d} = \frac{v}{4Vnr}\sqrt{\frac{1}{Dd}} , \tag{3}$$

where, h – mean scratch depth, $R=D/2$ – wheel radius, v – workpiece speed, V – wheel circumferential speed, a – distance between two succesive abrasive grits, b – scratch width, d_0 – grain diameter, X – crossfeed, E – wheel width, r – mean width to depth ratio of individual grinding scratches, n – number of cutting points per unit area of wheel surface.

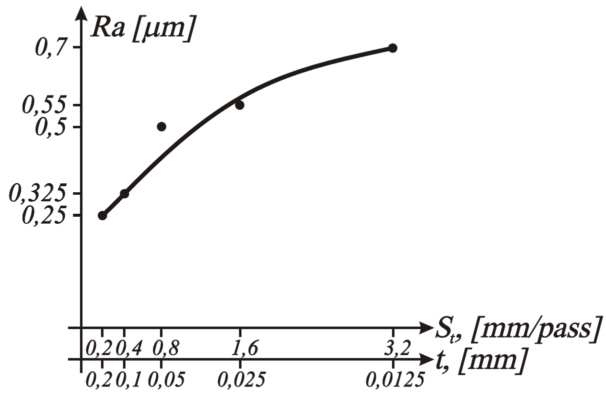

Figure 3. Influence of the crossfeed and the downfeed on the surface finish (***Z, v*** – constants)

Table 1

Pos	No	Crossfeed s_t (mm/pass)	Downfeed t (mm)	Table velocity v (m/min)	Metal removal rate $Z=tvs_t$ (mm^3/sec)	Surface finish Ra (µm)
A	1	0.2	0.2	2.6	1.73	0.25
	2	0.4	0.1			0.325
	3	0.8	0.05			0.5
	4	1.6	0.025			0.55
	5	3.2	0.0125			0.7
B	1	0.2	0.05	10.5	1.73	0.25
	2	0.4		5.25		0.425
	3	0.8		2.6		0.475
	4	1.6		1.3		0.5
	5	3.2		0.65		0.9
C	1	0.8	0.0125	10.5	1.73	0.7
	2		0.025	5.25		0.625
	3		0.05	2.6		0.55
	4		0.1	1.3		0.325
	5		0.2	0.65		0.275

Table 2

Pos	No	Crossfeed s_t (mm/pass)	Downfeed t (mm)	Table velocity v (m/min)	Metal removal rate $Z=tvs_t$ (mm^3/sec)	Surface finish Ra (µm)
D	1	0.2	0.025	5.25	0.43	0.09
	2	0.4			0.86	0.16
	3	0.8			1.73	0.425
	4	1.6			3.46	0.75
	5	3.2			6.92	1.257
E	1	1.6	0.025	10.5	6.92	1.00
	2			5.25	3.46	0.7
	3			2.6	1.73	0.5
	4			1.3	0.86	0.4
	5			0.65	0.43	0.3
F	1	0.8	0.0125	5.25	0.86	0.35
	2		0.025		1.73	0.425
	3		0.05		3.46	0.8
	4		0.1		6.92	1.25
	5		0.2		13.94	1.5

Fig. 3 shows the effect of crossfeed and downfeed on the workpiece surface roughness under constant metal removal rate and workpiece speed conditions.

It can be seen the surface roughness increases with the increase of crossfeed and the decrease of downfeed.

According to Sato, Eq. (1), with the increase of crossfeed, the surface roughness, which is a function of the scratch depth, increases. In the same time with the decrease of downfeed the surface roughness increases. This aspect do not agrees with M.C. Shaw. But it is well known that keeping the others parameters constant (wheel speed, workpiece speed etc.) an increase in the downfeed produces an increase in the underformed chip thickness which have an immediately effect in increasing surface roughness. These seems not to agree with the results obtained in this work. While the downfeed decreases the crossfeed increases in such a way that the product of crossfeed-downfeed remains constant. We may consider that the results which have been found are suitable. Fig. 3 shows that the crossfeed has a greater influence on the surface roughness than the downfeed. Also Fig. 3 indicates that the surface roughness increases 2.8 times while the crossfeed increases 16 times and in the same time the downfeed decreases 16 times.

Fig. 4 shows the effect of crossfeed and workpiece speed in the workpiece surface roughness under constant downfeed and metal removal rate conditions. It can be seen that also the surface roughness increases with the increase of the crossfeed and the decrease of the workpiece speed.

The fact that with the increase of crossfeed also increases the surface roughness, agrees with

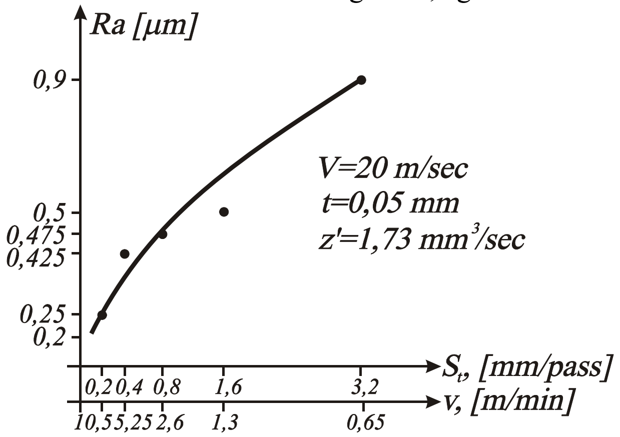

Figure 4. Influence of the crossfeed and the table velocity on the surface roughness (***Z, t*** – constants)

Eq. (1). Corresponding to Eqs. (1), (2) and (3), with the increase of the workpiece speed the surface roughness increases but the results obtained in this work show that the situation is inverse. But the decrease of the workpiece speed takes place in the same time with the increase of the crossfeed and this has a greater influence on the surface finish than the workpiece speed. It can be observed that the surface finish increases 3.2 times while the crossfeed increases 16 times and the workpiece speed decreases in the same time 16 times.

Fig. 5 shows the influence of workpiece speed and downfeed on the workpiece surface roughness under constant crossfeed and metal removal rate conditions.

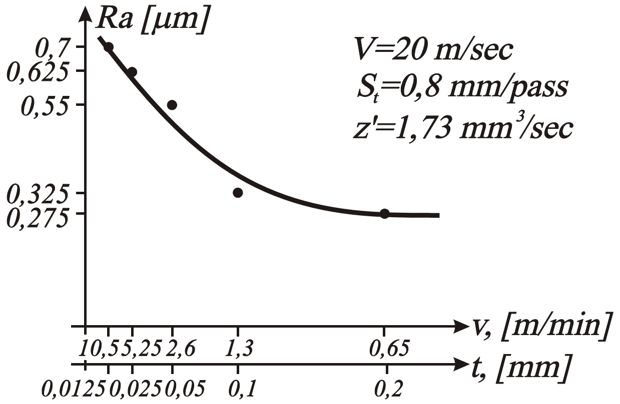

Figure 5. Influence of the table velocity and the downfeed on the surface roughness (***Z, s_t*** – constants)

It can be seen that the surface roughness increases with the increase or workpiece speed and the decrease of downfeed.

The increase of the surface roughness with the increase of the workpiece speed agrees with Eqs. (1), (2) and (3). Also the increase of the surface roughness with the decrease of downfeed agrees with Eq. (3), although considering the relation between underformed chip thickness and downfeed. This means that the workpiece speed has a greater influence on the surface roughness that the downfeed. It can be noticed that surface roughness increases 2.54 times while the workpiece speed increases 16 times and the downfeed decreases 16 times.

Generally it can be said that this influence of the cutting parameters on the surface roughness takes place in the following order, from more to least significance: crossfeed, workpiece speed and downfeed.

Fig. 6, 7 and 8 show the effect of the crossfeed, table velocity and downfeed respectively, under variable metal removal rate conditions. In fig. 6 and 7 there can be seen the increase of the surface roughness with the increase of the parameters namely crossfeed and table velocity, which agrees with Eqs. (1), (2) and (3).

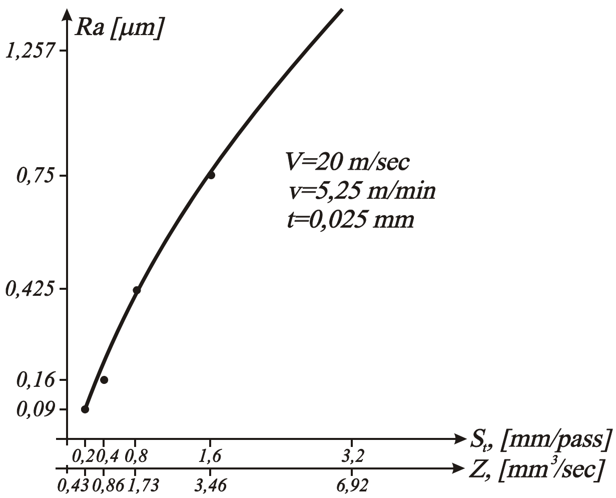

Figure 6. Influence of the crossfeed on the surface roughness (***t, v*** – constants; **Z** – variable)

Interesting is the variation of surface roughness with the downfeed (Fig. 8). With the increase of downfeed, a considerable increase of surface roughness takes place. Taking into account that increasing downfeed increases underformed chip thickness, therefore increases surface roughness, the results obtained in this work underline this variation. There also can be seen that surface roughness increases 13.85 times while

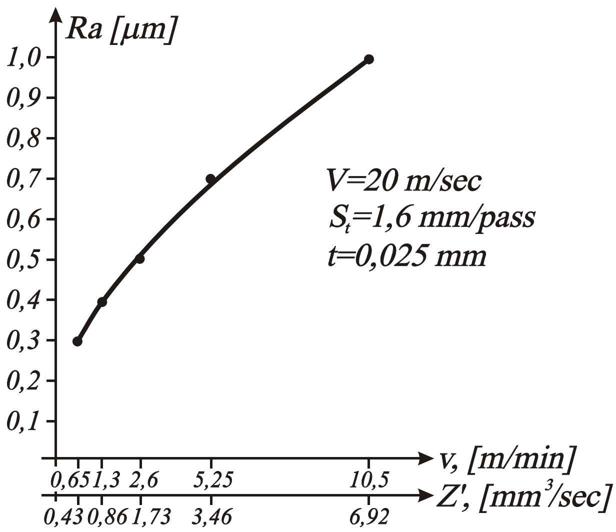

Figure 7. Influence of the table velocity on the surface roughness (***t, s_t*** – constants; ***Z*** – variable)

crossfeed increases 16 times, therefore an increaseabout 5 times more than in Fig. 3, meaning that the influence of downfeed is quite great. The surface roughness increases 3.33 times while table velocity increases 16 times, there fore an increase about 1.35 times than in Fig. 5 meaning that the influence of downfeed is quite little. A very important increase can be observed in Fig. 8, i.e. 4.27 times while the downfeed increases 16 times.

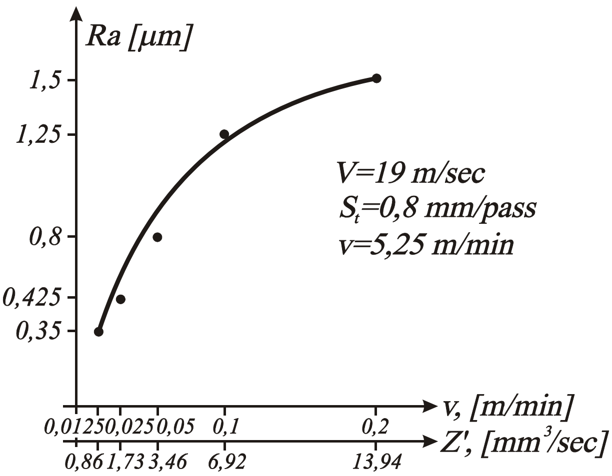

Figure 8. Influence of the downfeed on the surface roughness (***s_t, v*** – constants; ***Z*** – variable)

In these tests, under variable metal removal rate, the influence of the cutting parameters on the surface roughness takes place in the following order: crossfeed, downfeed and table velocity.

The influence of crossfeed is of first importance, who can be seen in both constant and variable metal removal rate conditions.

4. THE APPARATUS USED FOR FORCE MEASUREMENTS, TEST RESULTS

The arrangement of the equipment emploied to measure and record grinding forces during surface grinding is shown schematically in fig. 9.

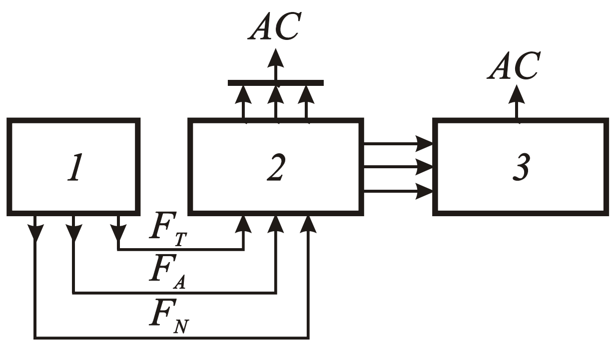

Figure 9. The equipment emploied to measure and record grinding forces

A three-component force dynamo-meter was located on a magnetic table which was then fastened to the grinding machine table. The dynamometer output leads of which there were three, were fed to a multichannel ultraviolet recorder via charge amplifiers.

The force components measured were: F_x – the tangential component F_T, F_y – the axial component F_A, F_z – the normal component F_N.

It is to remark that on the tests carried out the axial force F_A has not a value which may takes into consideration, even at the biggest values of the cutting parameters.

Two series of tests were performed. The first series was conducted under conditions of constant metal removal rate while the metal removal rate varied during the second series.

4.1. Constant Metal Removal Rate

The manner of variation of the cutting parameters as well as the results are shown in Table 3.

Using the results given in Table 3 graphs were plotted as follows.

In Fig. 10 is shown the variation of the normal and the tangential forces as a function of crossfeed and downfeed for the table velocity and metal removal rate constants. It can be seen that forces increase with increased crossfeed, although at the same time downfeed decreases.

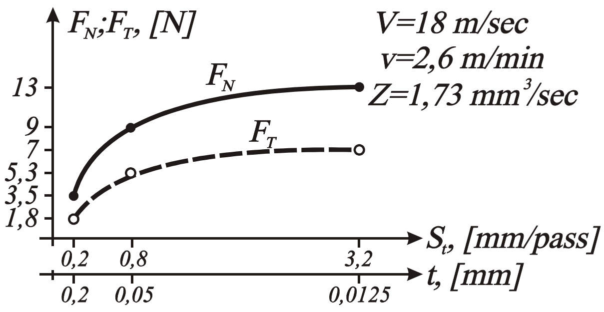

Figure 10. The variation of the F_N and F_T forces as a function of the crossfeed and downfeed (v, Z – constants)

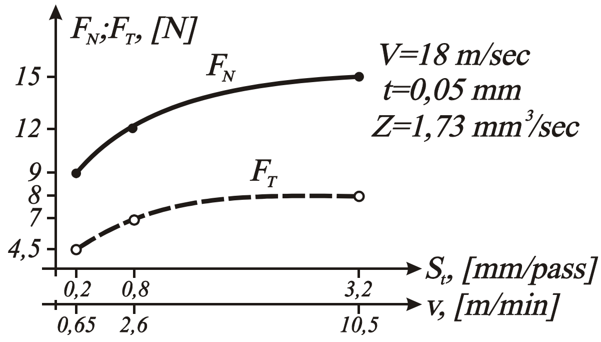

Figure 11. The variation of the $\mathbf{F_N}$ and $\mathbf{F_T}$ forces as a function of the crossfeed and table velocity (**t, Z** – constants)

In Fig. 11 there is shown the variation of the normal and tangential forces as a function of crossfeed and table velocity for constant downfeed and metal removal rate conditions. In this case the cutting forces increased with increases crossfeed although the table velocity decreases.

In Fig. 12 there is shown the variation of the normal and tangential forces as a function of downfeed and table velocity for constant crossfeed and forces decrease, although downfeed increases. The cutting forces appear to be influenced by the grinding parameters in the following order – from most to least significance: crossfeed, table velocity and downfeed.

Table 3

Pos	No	Crossfeed s_t (mm/pass)	Down-feed t (mm)	Table velocity v (m/min)	Metal removal rate, Z, (mm³/sec)	Cutting forces (N) F_N	F_T	Ratio F_N/F_T	Surface finis R_a (µm)
A	1	0.2	0.2	2.6	1.73	3.5	1.8	1.94	0.25
	2	0.8	0.05			9.0	5.3	1.7	0.5
	3	3.2	0.0125			13.0	7.0	1.84	0.7
B	1	0.2	0.05	10.5	1.73	9.0	4.5	2.0	0.25
	2	0.8		2.6		12.0	7.0	1.7	0.475
	3	3.2		0.65		15.0	8.0	1.87	0.9
C	1	0.8	0.0125	10.5	1.73	16.0	10.0	1.6	0.7
	2		0.05	2.6		8.0	5.3	1.5	0.55
	3		0.2	0.65		4.5	3.0	1.5	0.275

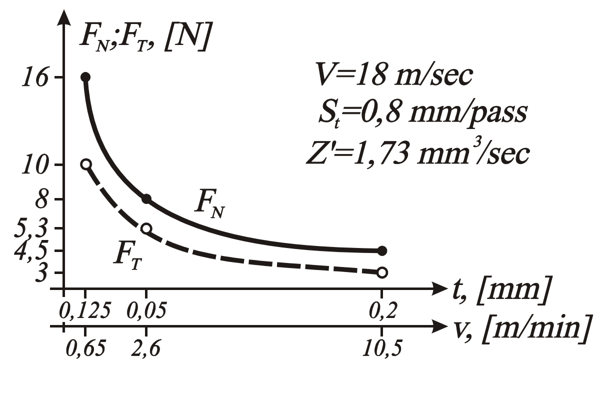

Figure 12. The variation of the F_N and F_T forces as a function of the downfeed and table velocity (***S_t*, *Z*** – constants)

If is during comparison between the aspects of these curves and that for the surface finish [4], which correspond to the same parameters, that a very close likeness is observed.

In R.P. Lindsay and R.S. Hahn's paper [5] between ***Z*** and F_N is a liniar relationship of the form:

$$Z = \lambda F_N,$$

where λ is a proportional factor (mm³/N.sec). On the basis of this relationship it would must for constant Z the cutting forces to be constant with change the cutting parameters. In these tests this indications seems not to be perfectly valid (see Figs. 10, 11 and 12).

In Figs. 13, 14 and 15 are plotted surface finish versus the normal force for the cutting parameters like in Figs 10, 11 and 12. In these graphs was drawn a linear dependency with a quite good approximation. With increased forces, surface finish values increased.

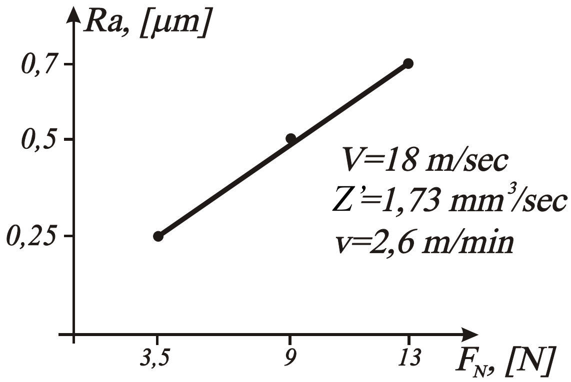

Figure 13. The influence of the normal force on the surface finish (***v***, ***Z*** – constants)

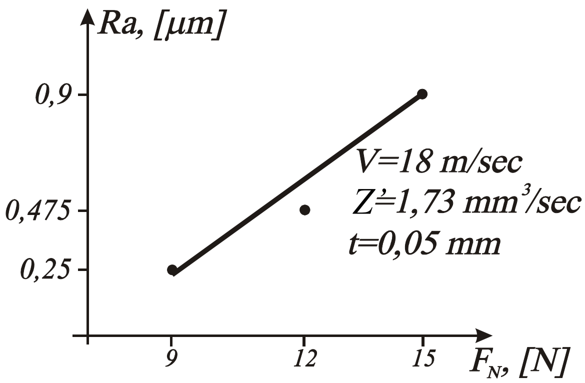

Figure 14. The influence of the normal force on the surface finish (**t**, **Z** – constants)

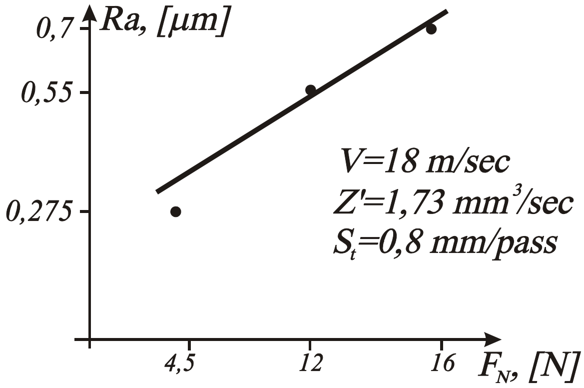

Figure 15. The influence of the normal force on the surface finish (***S**~t~*, ***Z*** – constants)

4.2. Variable Metal Removal Rate

The manner of variation of the cutting parameters as well as the results obtained are shown in Table 4.

In Figs. 16, 17 and 18 are shown the variation of the cutting forces F_N and F_T as a forces and metal removal rate increase as does any one grinding parameter on the other two remain fixed.function of the crossfeed, table velocity and downfeed respectivelly. It can be seen that cutting

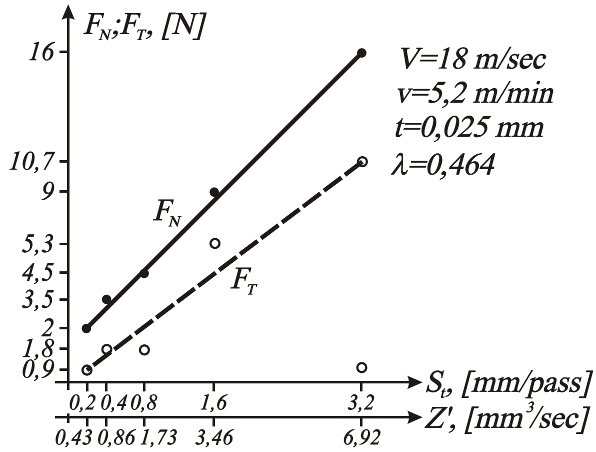

Figure 16. The variation of the F_N and F_T forces as a function of the crossfeed ***(t, v*** – constants; ***Z*** – variable)

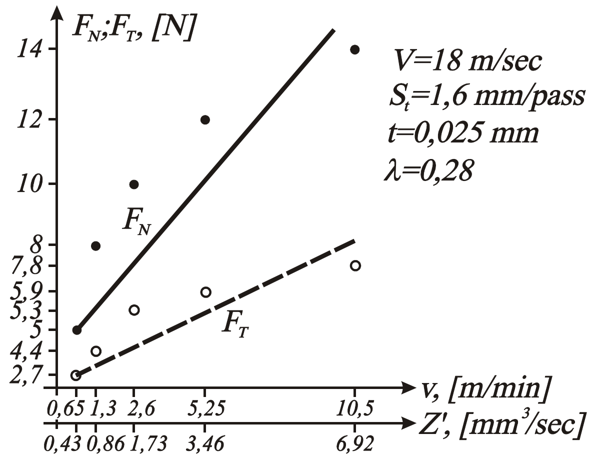

Figure 17. The variation of the F_N and F_T forces as a function of the table velocity (S_t**,** ***t*** – constants; ***Z*** – variable) (***t, v*** – constants; ***Z*** – variable)

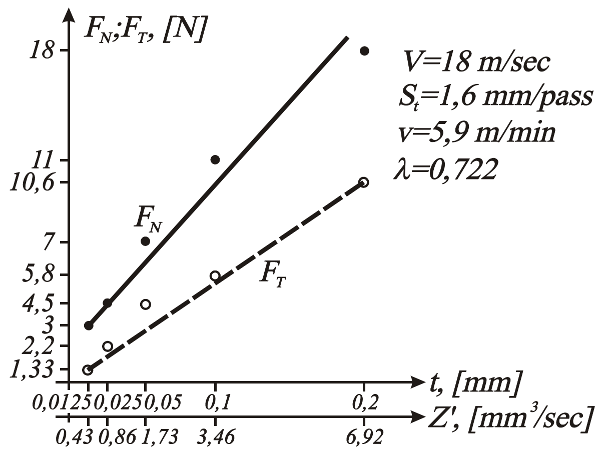

Figure 18. The variation of the F_N and F_T forces as a function of the downfeed (S_t**,** ***v*** – constants; ***Z*** – variable)

With a fairly good approximation the dependency between cutting forces and metal removal rate can be considerate linear. The relationship between forces and metal removal rate (when table velocity was varied) may be considered to be almost linear.

Paper [5] shows that λ changes with change of the wheel speed. The present test results indicate that ***λ*** is also a function of table velocity.

In Figs. 19, 20 and 21 are shown the variation of the surface finish as function of the normal force, observing that increased normal force is associated with increased surface finish.

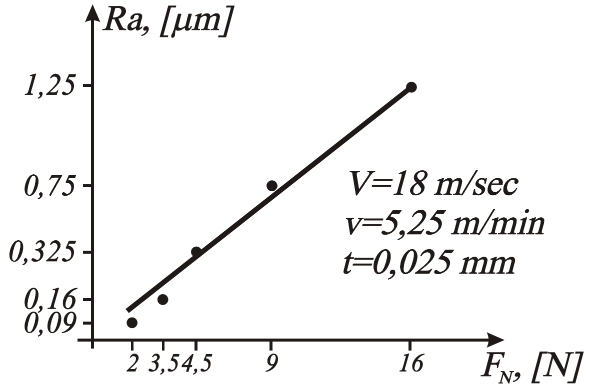

Figure 19. The influence of the normal force on the surface finish (***t, v*** – constants; ***Z*** – variable)

It can be observed that ***λ*** also varies with downfeed and crossfeed.

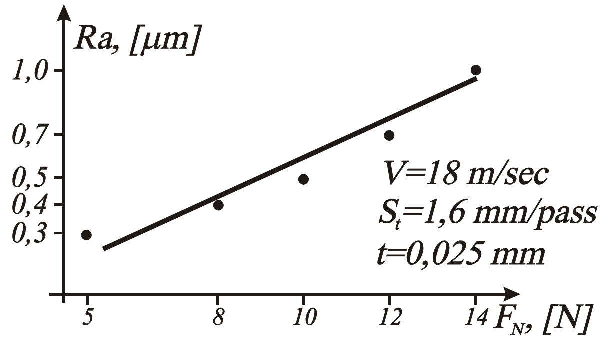

Figure 20. The influence of the normal force on the surface roughness (***S_t, t*** constants; ***Z*** – variable)

Table 4

Pos	No	Crossfeed s_t (mm/pass)	Down-feed ***t*** (mm)	Table velocity ***v*** (m/min)	Metal removal rate, ***Z***, (mm^3/sec)	Cutting forces (***N***) F_N	F_T	Ratio F_N/F_T	Surface finis R_a (μm)
	1	0.2			0.43	2.0	0.9	2.2	0.09
	2	0.4			0.86	3.5	1.8	1.95	0.16
D	3	0.8	0.025	5.25	1.73	4.5	1.8	2.5	0.325
	4	1.6			3.46	9.0	5.3	1.7	0.75
	5	3.2			6.92	16.0	10.7	1.5	1.25
	1			10.5	6.92	14.0	7.8	1.8	1.00
	2			5.25	3.46	12.0	5.9	2.03	0.7
E	3	1.6	0.025	2.6	1.73	10.0	5.3	1.9	0.5
	4			1.3	0.86	8.0	4.4	1.8	0.4
	5			0.65	0.43	5.0	2.7	1.85	0.3
	1		0.0125		0.86	3.0	1.33	2.2	0.35
	2		0.025		1.73	4.5	2.2	2.04	0.425
F	3	0.8	0.05	5.25	3.46	7.0	4.5	1.55	0.8
	4		0.1		6.92	11.0	5.8	1.9	1.25
	5		0.2		13.94	18.0	10.6	1.7	1.5

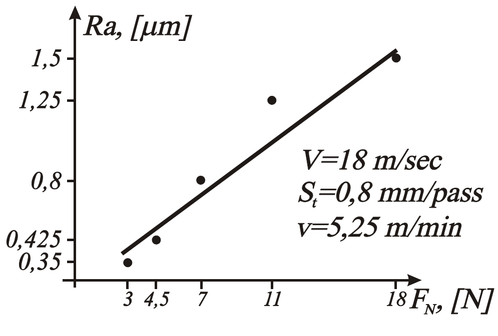

Figure 21. The influence of the normal force on the surface roughness (**S, v** – constants; **Z** – variable)

5. WHEEL WEAR AND LEADING EDGE MEASUREMENTS, TEST RESULTS

The equipment emploied to measure wheel wear during surface grinding is shown schematically in fig. 22. The workpiece 2 was settled down always in the same position on the magnetic table of the surface machine 1. A blade 3 was clamped at one end of the magnetic table. The blade was positioned higher than workpiece with 0.02…0.03 mm. After each pass on the workpiece surface, corresponding to a metal removal of 250 mm^3, the wheel profile was reproduced (in inverse form) on the blade by feeding the latter slowly against the wheel. For a given set of grinding parameters five depth increment were re-moved from the workpiece, the wheel profile being recorded after each complete surface pass.

The blade profile was determined with the aid of Talysurf equipment.

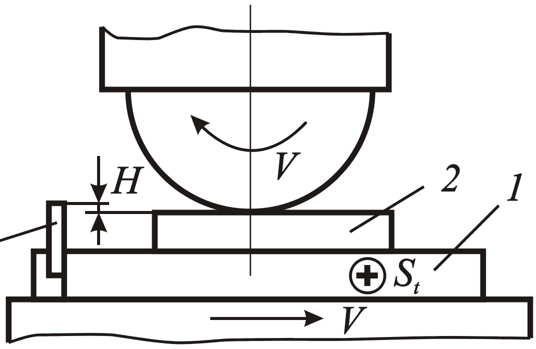

Figure 22. The equipment employed to measure wheel wear during surface grinding

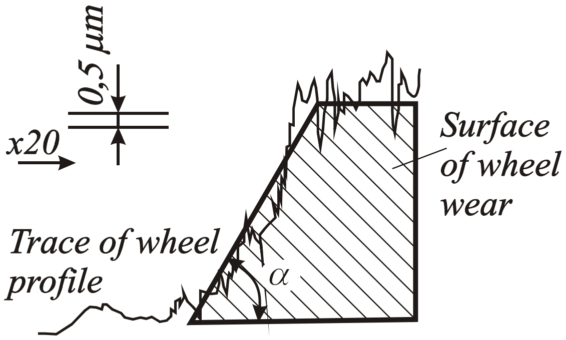

Figure 23. An example of a profile recording of leading edge angle (the hatched surface is the wheel wear)

Fig. 23 shows an example of a profile recording of leading edge angle. This show the angle and the wheel wear (the hatched surface).

Two series of tests were carried out. The first serie with constant metal removal rate, but the second serie with variable metal removal rate conditions. The results are shown in Tables 5, 6 and 7.

References [6], [7], [9], [10] presents informations which indicates that in the case of surface grinding, after a certain amount of metal has been removed, a stable angle is formed on the leading edge, Fig. 24.

Initially, after normal dressing a fairly breakdown of the leadingedge of the wheel occurs and a stable angle on the leading edge begins to form (the straight line AC). Wheel wear then takes place to the active cutting face AC. The presence of this angle reduces the downfeed to a value which is self-imposed and automatically adjusted as a function of cutting parameters, especially crossfeed and on the other hand, as fonction of the factors which limit the cutting capacity of the wheel: grit, bond strength, or porosity. In papers above mentioned it is assumed that the cutting action on AD and CH is negligible. All the cutting taking place on the wear land AC. The surface finish is produced by the grits situated at the junction of the angle and the whel face (point A). Also this leading edge does not alter the metal removal rate which is mentained as a product of downfeed, table velocity and crossfeed, although the effective downfeed will be the straight line AF, i.e. $t_e = S_t tg\alpha$ a value somewhat less than the applied downfeed.

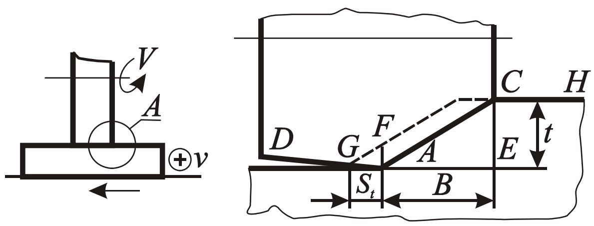

Figure 24. The forming of the leading edge angle

According to Purcell's experiments [6] after 95 mm^3 of metal removal an angle starst to form and after 390 mm^3 metal removal the angle is fully formed and stable.

It is stated in the same paper that doubling the crossfeed doubles the value of B (see fig. 24). This means that or constant downfeed doubling the B value, halves the angle α, whereas doubling workpiece speed, increase the value of B by a factor of four; this means that the angle α will be reduced by a factor of four.

Present results will be compared with Purcell's affirmations.

Table 5

Crossfeed S_t mm/pass	Pos.	Metal removed M, mm^3	Metal removal rate, mm^3/sec	Wheel wear W, mm^3	Leading edge angle α	Average leading edge angle, α_{av}	Grinding ratio $G = \frac{M}{W}$
0.2	1	250	0.43	0.875	23'15"	23'42"	1400
	2	500			23'43"		
	3	750			23'32"		
	4	1000			24'15"		
	5	1250			24'00"		
0.4	1	250	0.86	1.45	14'12"	13'30"	862
	2	500			12'39"		
	3	750			13'42"		
	4	1000			13'30"		
	5	1250			14'00"		
0.8	1	250	1.73	1.64	3'30"	5'00"	756
	2	500			3'30"		
	3	750			5'20"		
	4	1000			6'20"		
	5	1250			7'00"		
1.6	1	250	3.46	1.83	3'15"	3'24"	700
	2	500			3'12"		
	3	750			3'48"		
	4	1000			3'25"		
	5	1250			3'30"		
3.2	1	250	6.92	2.45	0'10"	0'42"	520
	2	500			0'15"		
	3	750			0'15"		
	4	1000			1'12"		
	5	1250			1'30"		

V=20 m/sec; v=2.6 m/min; t=0.05 mm; n=2300 rot/min; D=165 mm

Table 6

Table velocity v, m/min	Pos.	Metal removed M, mm^3	Metal removal rate, mm^3/sec	Wheel wear W, mm^3	Leading edge angle α	Average leading edge angle, α_{av}	Grinding ratio $G = \frac{M}{W}$
0.65	1	250	0.43	2.63	2'48"	1'48"	475
	2	500			1'30"		
	3	750			1'30"		
	4	1000			1'30"		
	5	1250			1'42"		
1.3	1	250	0.86	2.41	4'06"	3'06"	520
	2	500			3'30"		
	3	750			3'30"		
	4	1000			3'30"		
	5	1250			1'15"		
2.6	1	250	1.73	1.64	3'30"	5'00"	756
	2	500			3'30"		
	3	750			5'20"		
	4	1000			6'20"		
	5	1250			7'00"		
5.25	1	250	3.46	2.06	5'18"	4'12"	607
	2	500			3'30"		
	3	750			5'12"		
	4	1000			3'30"		
	5	1250			3'30"		
10.5	1	250	6.92	1.45	1'45"	1'18"	862
	2	500			1'30"		
	3	750			1'00"		
	4	1000			1'00"		
	5	1250			1'00"		

S_t =0.8 mm/pass; t=0.05 mm ; V=20 m/sec; n=2300 rot/min; D=165 mm

Table 7

Crossfeed S_t mm/pass	Table velocity V, m/min	Pos.	Metal removed M, mm^3	Metal removal rate, mm^3/sec	Wheel wear W, mm^3	Leading edge angle α	Average lea-ding edge angle, α_{av}	Grinding ratio $G = \frac{M}{W}$
0.2	10.5	1	250	1.73	1.34	21'36"	21'45"	940
		2	500			22'07"		
		3	750			21'15"		
		4	1000			21'20"		
		5	1250			22'30"		
0.4	5.25	1	250	1.73	1.45	8'57"	9'02"	850
		2	500			8'46"		
		3	750			9'05"		
		4	1000			8'24"		
		5	1250			9'30"		
0.8	2.6	1	250	1.73	1.64	3'30"	5'00"	770
		2	500			3'30"		
		3	750			5'20"		
		4	1000			6'20"		
		5	1250			7'00"		
1.6	1.3	1	250	1.73	1.87	1'08"	1'12"	650
		2	500			1'00"		
		3	750			1'16"		
		4	1000			1'32"		
		5	1250			1'18"		
3.2	0.65	1	250	1.73	5.75	0'32"	0'40"	215
		2	500			0'48"		
		3	750			0'36"		
		4	1000			0'42"		
		5	1250			0'45"		
t=0.05 mm; V=20 m/sec; n=2300 rot/min; D=165 mm								

Fig. 25 shows the effect of the crossfeed on the leading edge angle α for constant table velocity and downfeed (that is a variable metal removal rate) conditions.

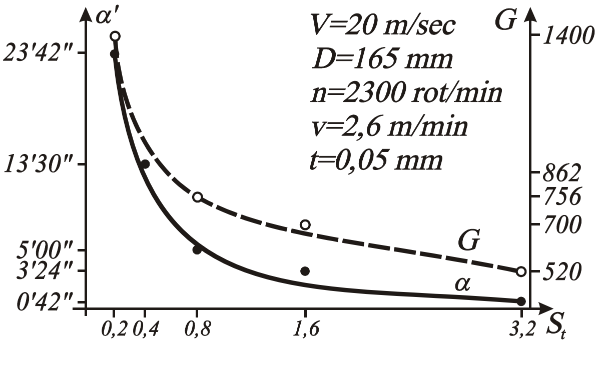

Figure 25. The influence of the crossfeed on the leading edge angle and grinding ratio (***v***, ***t*** – constants; ***Z*** – variable)

Taking into consideration the fact that $tg\alpha = t / S_t$ for constant downfeed increasing crossfeed, the angle α will decrease. The result s obtained agree with this relationship as well as Purcell's affirmations that doubling the crossfeed, the leading edge angle will be halved. In these results the effective downfeed is t_e=0.001 mm (the initial value of downfeed is 0.05 mm).

Using the results presented in Table 6 the graph was plotted in Fig. 26 which shows the effect of workpiece speed on the leading edge angle under constant crossfeed and downfeed (this means variable metal removal rate) conditions.

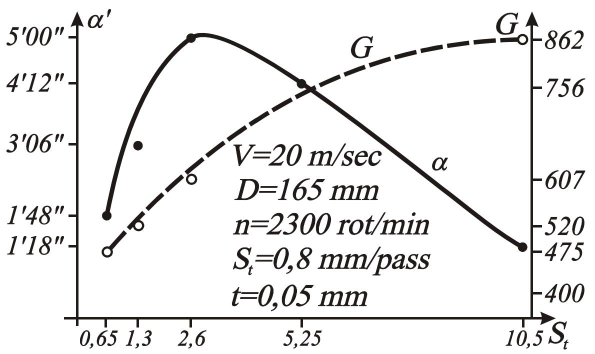

Figure 26. The influence of the table velocity on the leading edge angle and grinding ratio (***S_t***, ***t*** – constants; ***Z*** – variable)

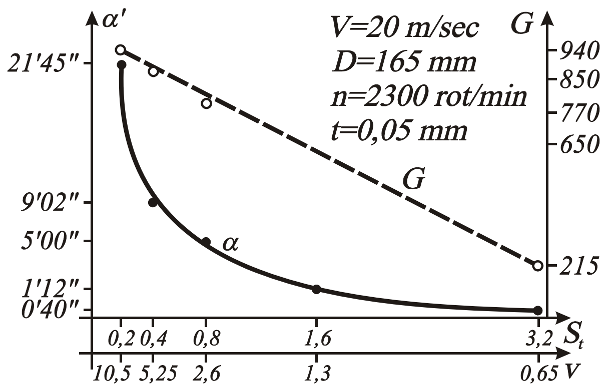

Figure 27. The influence of the table velocity and crossfeed on the leading edge angle and grinding ratio (***t, Z*** – constants)

6. CONCLUSIONS

It can be seen that for a workpiece speed less than 2,6 m/min decreasing the workpiece speed, decrease the leading edge angle α (instead to increase as in [6] and [8] papers). Also the leading edge angle decreases about two times only instead of four times. For workpiece speeds greater than 2.6 m/min the results agree with those outlined in other publications.

In Benerjee's paper [8] the variaton of leading edge angle α as a function of the workpiece speed was carried out for workpiece speed between 9 to 21 m/min. In present work the experiment was carried out for workpiece speed between 0.63 m/min to 10.5 m/min. It can be observed that for workpiece speed more than 2.6 m/min up to the domain of workpiece speed variation in [8], the form of the curve is the same.

Fig. 27 shows the influence of workpiece speed and crossfeed on the leading edge angle α under constant downfeed and metal removal rate conditions.

Because the influence of the crossfeed is much stronger that of workpiece speed, in the same time with the increase of the crossfeed the leading edge angle α decreases. This aspect agrees with [6], [7] and [8].

Figs. 25, 26 and 27 also indicate the manner of variation of the grinding ratio G with the grinding parameters.

Assuming that the cutting action takes place on the wear land only [8], the wheel wear was evaluated by the area under the trace obtained (the hatched surface in Fig. 23) times the wheel circomference.

Corresponding to Figs. 25 and 26 the grinding ratio G decreases when the crossfeed increased. These results agree with [11] but do not agree with [9] where the situation is exactly inverse. When the workpiece speed increases, Fig. 26, the grinding ratio increases. These results do not agree with [9] and [11] papers, where inverse is the situation.

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