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SURFACE QUALITY RELATED TO TURNING TOOLS

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ABSTRACT

Surface quality is one of the important criteria to be considered for proper functioning of many machine parts.

The study of the surface quality produced during the machining process with the different operation conditions will lead to better and satisfactory control over the degree of finish.

In the present work, an experimental study of the relation between the surface quality and the cutting conditions, tool geometry and tool material is presented. Brass was used as a work material. The combined effects of the cutting conditions on the surface quality of the machining surfaces were discussed.

It was found that the feed rate and nose radius have major effect on the surface quality. A relationship between nose radius and feed rate indicated that the nose radius should be three times or more of the feed rate. However, it should be remembered that if the nose radius is too large, it may cause chatter.

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INTRODUTION

The removal of metal by an edged cutting tool generally requires one or more roughing cuts to remove the excess metal and then a finishing cut to bring the workpiece to a given size and establish the correct surface roughness. The effect of various factors on the surface finish can be summarised as follows[1]:

i- Increase in cutting speed, improves surface finish,
ii- Increase in feed rate, deteriorates surface finish,
iii- Increase in depth of cut, deteriorates surface finish,
iv- Increase in rake angle, improves surface finish,
v- Increase in nose radius, improves surface finish.

Numerous investigations have been carried out to study and analyse these factors. Damir et al.[2]studied the effect of tool geometry, feed and cutting speed on the resulting surface roughness using brass and carbon steel specimens. Their results showed that the surface roughness for brass was not effected with increasing the cutting speeds for small values of depth of cut. However the an increase in cutting speeds improves the surface roughness of carbon steel. This trend in agreement with the phenomenon of the built-up edge reported by [3],[4] and [5].

Selvam and Radhakrishnom [6], Shuster [7]and Taylor[8]studied the effect of cutting conditions and tool wear on the resulting surface roughness in turning.

EXPERIMENTAL WORK

In the present experimental investigation, testpieces of brass were used. The variables which have the largest effect on surface finish are presented in Table 1.

The experiments were carried out on a centre lathe, type (MARTIN KM 230). The testpieces were prepared in form of a bar of 155 mm length and 35 mm diameter. For each testpiece five cutting lengths of 20 mm each were used. A mark was made between the cutting lengths to identify each feed. Each space between two marks is going to be machined with a given value of feed. Two sets of twelve testpieces each were machined using high-speed steel and carbide-tipped tools. The dimensions and the cutting angles of the cutting tools were the same.

The surface roughness degrees of the machined surfaces were measured using profilograph, model "Forster 5.815". Arithmetical mean surface roughness (R_a) was taken as, measure for the roughness degree.

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RESULTS AND DISCUSSION

Figs.1(a and b), indicate the variation of surface roughness (R_a) and feed rate (s) with different cutting speeds (v) and tool nose radii (r) for high-speed steel and carbide-tipped tools, respectively. Assuming linear relationship, the fitted equations are evaluated and given in Table 2. These relations can be represented by the straight line equation as follows[9].

$$R_a = b + m\,s$$

The following remarks are made :

A-Correlation Coefficient (C_c):

The values of the correlation coefficient are calculated for each of the 24 sets of conditions and are given in Table 2. The obtained (C_c) values are very high, they vary between 0.852 and 0.876. These values are due to strong linear relationship between (R_a) and (s).

B-Fitted Relations:

The "best" fitted equations obtained by the least-squares method are given in Table 2.

i) Constant Parameter (b):

The value of b in the equations 1 to 24 represents the arithmetical mean value of surface roughness (R_a) at zero feed rate, i.e. at the start of the cutting operation. From Table 2 it can be seen that at a given cutting speed, and various values of nose radius, the value of b decrease with increasing the nose radius, cutting speed and tool hardnees. This trend is the same for high-speed steel and carbide-tipped tools.

ii) Rate Parameter (m):

The rate parameter (m) measures the rate of change of the arithmetical mean surface roughness (R_a) with the increase of the feed rate (s). The numerical values of m in all equations are found to decrease with the increasing the nose radius (r), cutting speed (v), and tool hardness (T_h). The rate parameter (m) for the 0.35 mm nose radius is about 15 times for high-speed steel tool and 10 times for carbide-tipped tool then that at the nose radius varied between 0.7 to 2.8 mm. This means that at a 0.35 mm nose radius, the value of m is considerably high which is similar to the cutting by a sharp tool.

CONCLUSIONS

1- The best value of the arithmetical mean surface roughness

	Nose radius ranges, r, mm 0.35 to 0.7	0.7 to 2.8
a) An increase of tool hardness, Th	35 %	30 %
b) An increase of cutting speed, v	15 %	10 %
c) A decrease of feed rate, s	40 %	25 %
d) An increase of nose radius, r	70 %	30 %

2- The best surface quality was found to occur at the following operation conditions :

a) Cutting speed, ranged from 100 to 150 m/min for high-speed steel and carbide-tipped tools.

b) Nose radius, used at 1.4 to 2.8 mm for high-speed steel and carbide-tipped tools.

c) Feed rate, varied between 0.08 to 0.31 mm/rev and 0.08 to 0.62 mm/rev for high-speed steel and carbide-tipped tools, respectivelly.

3- With largest nose radii of 2.8 mm chatter in the machine tools was not occurred.

4- Relationship between nose radius should be average 3 and 4 times of the feed rate for high-speed steel and carbide-tipped tools, respectivelly.

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NOMENCLATURE

a = Depth of cut, mm
b = Constant parameter, µm
C_c = Correlation coefficient,
m = Rate parameter, µm/mm/rev
r = Nose radius, mm
R_a = Arithmetical mean surface roughness, µm
s = Feed rate, mm/rev
T_h = Tool hardness,
v = Cutting speed, m/min

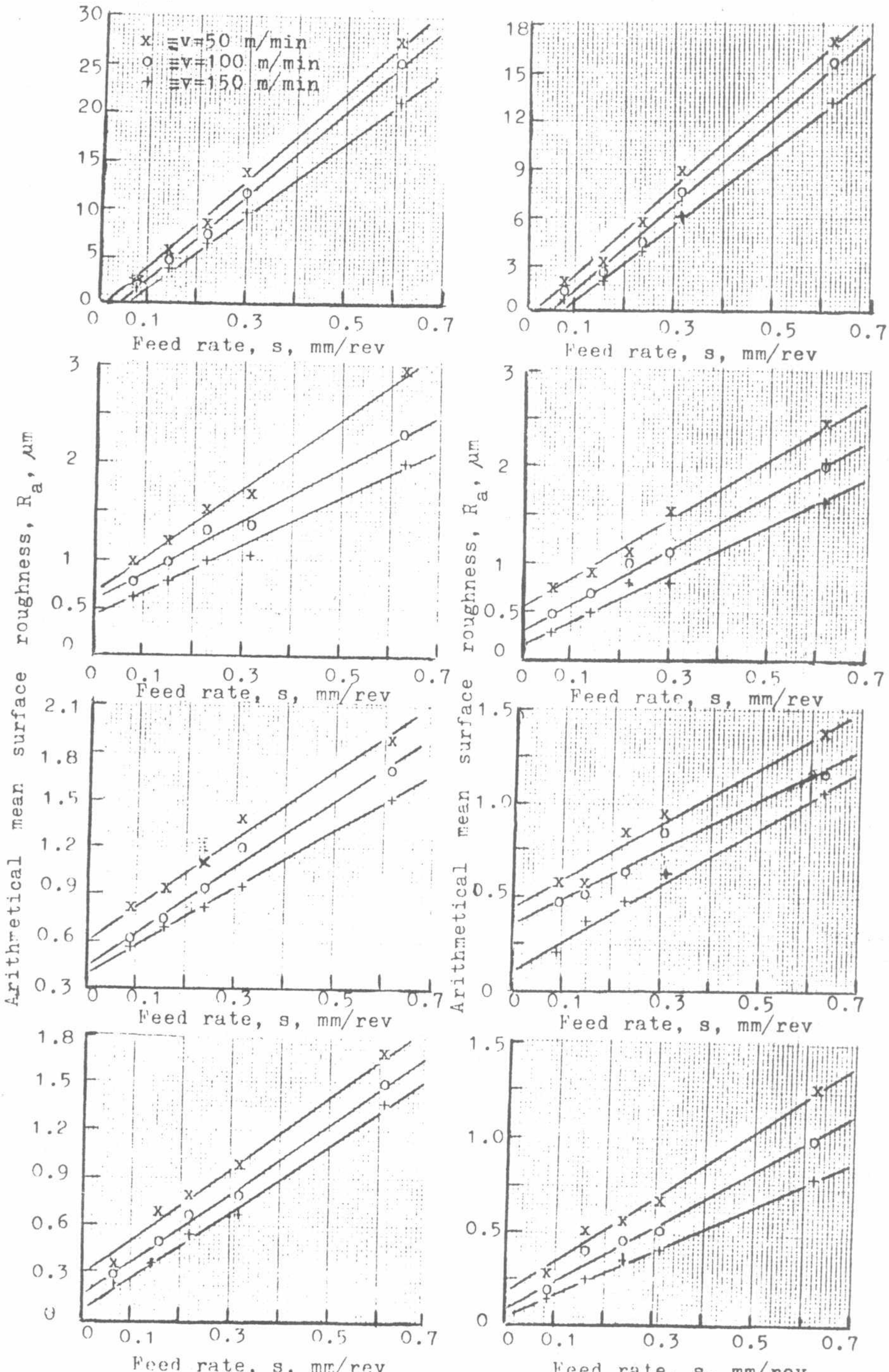
Table 1: Identification Table.

Factor	Level	Value
Feed rate,s	5	0.08, 0.15, 0.23, 0.31, 0.62 mm/rev
Nose radius,r	4	0.35, 0.70, 1.40, 2.80 mm
Cutting speed,v	3	500 , 100 , 150 m/min
Cutting tools.	2	High-speed steel , Carbide-tipped
Depth of cut,a	1	1 mm

Table 2: Calculated values of the correlation coefficient and the fitted relations for cutting tool materials.

Cutting speed v, m/min	Nose radius r, mm	Cutting tool materials			
		High-speed steel tools		Carbide-tipped tools	
		Correl. coeff. C_c	Fitted relations $R_a =$ b + m s	Correl. coeff. C_c	Fitted relations $R_a =$ b + m s
50	0.35	0.871	=0.92+38.27s (1)	0.884	=0.74+23.81s(13)
50	0.70	0.874	=0.88+ 2.87s (2)	0.872	=0.65+ 2.47s(14)
50	1.40	0.873	=0.82+ 1.52s (3)	0.870	=0.53+ 1.19s(15)
50	2.80	0.870	=0.36+ 2.01s (4)	0.873	=0.29+ 1.37s(16)
100	0.35	0.873	=0.91+34.77s (5)	0.874	=0.63+20.88s(17)
100	0.70	0.876	=0.75+ 2.13s (6)	0.871	=0.39+ 2.25s(18)
100	1.40	0.868	=0.63+ 1.53s (7)	0.854	=0.42+ 1.15s(19)
100	2.80	0.867	=0.28+ 1.65s (8)	0.864	=0.20+ 1.08s(20)
150	0.35	0.873	=0.66+29.43s (9)	0.867	=0.61+17.27s(21)
150	0.70	0.858	=0.56+ 1.93s(10)	0.857	=0.29+ 1.83s(22)
150	1.40	0.852	=0.56+ 1.36s(11)	0.867	=0.24+ 1.24s(23)
150	2.80	0.875	=0.19+ 1.66s(12)	0.864	=0.11+ 0.97s(24)

where R_a is measured in um and s in mm/rev.



Figs.1(a and b): Variation of the arithmetical mean surface roughness on the feed rate at different nose radius, cutting speed and tools.