ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

THE STUDY OF PROCESSING MAIN MANUFACTURING PARAMETERS' INFLUENCE OVER THE QUALITY OF SURFACES LATHED ON TEMPERED STEEL PARTS

BANU Ilarion, NICOLAE Viorel
University of Pitesti, viorel.nicolae@upit.ro

Keywords: quality, lathe, regression process function.

Abstract: In this paper the authors established regression process functions of type $R_z, R_a, R_y, S = t^x \cdot s^y \cdot r_\varepsilon^q \cdot v^z$, useful for estimate the quality obtained by processing the RUL 1 tempered steel.

1. INTRODUCTION

One of the basic demands for the new products launched on the market is represented by the quality level. Because the clients are more and more exigent with the producers, the manufacturers must give a distinct attention to quality. A part of general quality is represented by the quality of lathe processing surfaces.

As presented before [1, 5], the analyse of the manufacturing parameters effect over the quality indexes shows that only a part of them has a significant effect to be considered and studied. This paper brings some contributions to establishing some regression process functions for lathe processing the RUL 1 tempered steel, used for bearing manufacturing.

2. THE METHOD USED TO OBTAIN THE REGRESSION PROCESS FUNCTION

As resulted from the studies done, the shape of the regression process is of polytrophic type, obtained using the smallest squares method. For the multiple linear progression it was used the logarithmic relations.

In order to obtain the process functions, it was used a factorial experimental plan reduced on two levels ($2^{4-1} = 8$) for the input selected figures used currently for lathe process. The input figures selected on two levels are: cutting depth t, length feed s, nose radius r_ε and rate of cutting v (Table 1). The output figures are: R_a, R_z, R_y and the average pitch of local knobs S.

Table 1. The input figures.

Levels			
Independent variables	Code	-1	+1
Natural figures			
Cutting depth, t [mm]	Xi1	0,5	1,5
Length feed, s [mm/rev]	Xi2	0,057	0,128
Chip nose radius, r_ε [mm]	Xi3	0,5	1,5
Cutting rate, v [m/min]	Xi4	35	50

Table 2 presents the results of the measurements done.

Table 2. The measurements results.

Experiment	Ra [μm]	Rz [μm]	Ry [μm]	S [μm]
1	2	3	4	5
1	9,25	6,27	20,1	38,38
2	7,32	3,96	9,96	31,14
3	5,45	5,7	15,6	18,5
4	3,5	6,45	11,48	24
5	3,44	7,78	11,6	27,66
6	2,24	8,21	9,0	35
7	1,71	11,46	13,78	21
8	1,81	7,25	8,89	20,8

3. SETTING AND ANALYSING THE REGRESSION PROCESS FUNCTIONS FOR RUL 1 TEMPERED STEEL

Table 3 presents the statistics used for lathe processing of RUL 1 tempered steel with 54 HRC. The process was done using: cutter with removable plate of GC325 type; angle $\gamma = 0^o$; angle of clearance $\alpha = 5^o$; setting angle $\chi_1 = \chi_2 = 45^o$; parallel lathe SN400; no cooling lathe process.

The parameters were measured by feeling the surface using a feeler with diamond that fitted on the digital measurement device Surtronic 4 (manufactured by Rank Taylor Hobson Limited). The experiments were done within the Machines Engineering Technologies laboratory from University of Pitesti.

Table 3. The statistics used for lathe processing of RUL 1 tempered steel.

se1,se2,...,sen	The standard error values for coefficients m1, m2,..., mn.
seb	The standard error value for constant b.
r2	The determination coefficient; it compares the estimated and actual values of y. Values between 0 and 1. If it equals 1, there is a perfect correlation within sample (there is no difference between estimated and actual values of y). If it equals 0, the regression equation could not estimate the value for y.
sey	The standard error for the estimated y.
F	The F statistics of the observed F value. It is used to determine if the relation between dependent and independent values is by chance.
df	The degrees of freedom, used to find the critical values F from the statistic table.
ssreg	The square regression sum.
ssresid	The residual regression sum.

The results obtained by processing the data for process functions R_a, R_z, R_y are:

- For R_a roughness (Table 4)

Table 4. The coefficients and statistics obtained for R_a roughness.

m4= -0,42529	m3= -0,92547	m2= -0,69028	m1= -0,29963	b = 4,20027
se4 = 0,174077	se3 =0,055989	se2 =0,077806	se1 =0,069799	seb =0,296597
r2 = 0,992254	sey = 0,03706	-	-	-
F= 96,07169>6,39	df = 3	-	-	-
$F_{tab}(1,\infty)$=2,6	ssreg = 0,527793	ssresid = 0,00412		-
F_{m4cl}=5,97	F_{m3cl} = 273,22	F_{m2cl} = 78,65	F_{m1cl} = 18,36	F_{bcl} = 196
Significant	Significant	Significant	Significant	Significant

The process function for the quality index R_a could be estimated with the polytrophic inferred using Table 4:

$$R_a = 4{,}2 \cdot t^{-0{,}29963} s^{-0{,}69028} r_\varepsilon^{-0{,}92547} v^{-0{,}42529} \quad (1)$$

- For R_z roughness (Table 5)

Table 5. The coefficients and statistics obtained for R_z roughness.

m4=0,781238	m3=0,402175	m2=0,200123	m1= -0,21666	b = 0,21829
se4=0,07303	se3 =0,023489	se2 =0,032642	se1 =0,029282	seb =0,12443
r2 =0,994197	sey =0,015548	-	-	-
F=128,4991	df =3	-	-	-
$F_{tab}(1,\infty)=2,6<F_{micl}$	ssreg =0,124247	ssresid= 0,000725	-	-
F_{m4cl}=12416	F_{m3cl} = 302,45	F_{m2cl} = 39	F_{m1cl} =58,81	F_{bcl} = 3,1
Significant	Significant	Significant	Significant	Significant

The process function for the quality index R_z could be estimated with the polytrophic inferred using Table 5:

$$R_z = 0{,}21829 t^{-0{,}21666} s^{0{,}2} r_\varepsilon^{0{,}04} v^{0{,}781238} \quad (2)$$

- For R_y roughness (Table 6)

Table 6. The coefficients and statistics obtained for R_y roughness.

m4=0,477686	m3=-0,24425	m2=0,019631	m1= -0,50651	b = 2,54834
se4=0,150629	se3 =0,048447	se2 =0,067326	se1 =0,060397	seb =0,256646
r2 =0,971642	sey =0,032068	-	-	-
F=25,69773	df =3	-	-	-
$F_{tab}(1,\infty)=2,6<F_{micl}$	ssreg =0,105706	ssresid=0,003085	-	-
F_{m4cl}= 10,14	F_{m3cl} = 104	F_{m2cl} = 0,1;(s)	F_{m1cl} = 69	F_{bcl} = 98,6
Significant	Significant	Non-significant	Significant	Significant

The process function for the quality index R_y could be estimated with the polytrophic inferred using Table 6:

$$R_y = 2{,}54834 \cdot t^{-0{,}050651} s^{0{,}019631} r_\varepsilon^{-0{,}24425} v^{0{,}477686} \quad (3)$$

It could be noticed that the exponent of the process feed is non-significant and it could be erased from relation (3), because it does not influence the quality of the processed surface.

- For the average pitch of local knobs S (Table 7)

Table 7. The coefficients and statistics for the average pitch of local knobs S.

m4=0,544611	m3=-0,04326	M2=-0,57956	m1=0,083868	b =0,8106
se4=0,133535	se3 =0,042949	Se2 =0,059685	se1=0,053543	seb =0,22752
r2 =0,974379	sey =0,028429	-	-	-
F=28,52319	df =3	-	-	-
$F_{tab}(1,\infty)=2,6<F_{micl}$	ssreg =0,092209	ssresid=0,002425	-	-
F_{m4cl}= 16,64	F_{m3cl} = 1,00; (r_ε)	F_{m2cl} = 96,49	F_{m1cl} = 2,45	F_{bcl} = 12,67
Significant	Non-significant	Significant	Non-significant	Significant

The process function for the quality index R_z could be estimated with the polytrophic inferred using Table 7:

$$S = 0{,}8106 \cdot t^{0{,}083868} s^{-0{,}57956} r_\varepsilon^{-0{,}04326} v^{0{,}544611} \quad (4)$$

It could be noticed that the exponents of the cutting depth and the plate nose radius are non-significant and they could be erased from relation (4) because they does not influence the quality of the processed surface.

3. CONCLUSIONS

It could be noticed that:

- for the R_a roughness model, the order of parameters influence is: r_ε, s, v, t;
- for the R_z roughness model, the order of parameters influence is: v, t, s, r_ε;
- for the R_y roughness model, the order of parameters influence is: v, r_ε, t, s;
- for the average pitch of local knobs S model, the order of parameters influence is: v, s, t, r_ε.

So, the influence of the above parameters over the quality indexes is diverse. In order to set all these quality indexes at the values demanded by the quality monitors they must be correlated by the technological engineers during process design and then during fabrication process.

The quality indexes could be set to technical-economical optimal values by simulation, using process functions like those described in this paper and then promoted to practice.

BIBLIOGRAPHY

1. BANU, I.- *Tehnologii de superfinisare cu scule abrazive, modele matematice şi rezolvări asistate de calculator*, Teză de doctorat, Universitatea "Transilvania" din Braşov, 1999;
2. BANU, I. - *Unele contribuții cu privire la stabilirea funcțiilor de proces de calitatea suprafețelor la prelucrarea de superfinisare a fontei nodulare Fgn 700-2*, Revista "Construcția de maşini", 1999 (51), nr.3.
3. BANU, I. - *Contribuții cu privire la stabilirea funcțiilor de proces la superfinisarea fontelor cenuşii,* Revista "Construcția de maşini", 2000 (52), nr.10.
4. BANU, I. - *Unele contribuții privind modelarea matematică a frecării la superfinisarea cu scule abrazive*, Revista "Construcția de maşini", 2002 (54), nr.11.
5. BANU, I., NICOLAE, V. - *Study of main turning process parameters influence on the surface quality of the parts mode of Fgn 700 – 2 hardened iron*, International Conference TMCR 2006, Iasi, May, 25th – 27th, 2006.
6. BANU, I., NICOLAE, V. - *Contribution to establishing the regression process functions for the quality for the exterior revolution surfaces of the parts made of Fgn 700 – 2 iron, cutting processed*, International Conference TMCR 2006, Iasi, May, 25th – 27th, 2006.
7. HEUGHEBAERT, J.C. - *Methodologie des planes d'experiences*, ENSCAT 61-17-56-56.
8. ALEXIS, J. - *Metoda Taguchi în practica industrială - planuri de experiențe*, Editura Tehnică, Bucureşti, 1999.