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CONTRIBUTION TO SET UP THE REGRESSION PROCESS FUNCTIONS FOR THE QUALITY OF THE EXTERIOR REVOLUTION SURFACES OF LATHED TEMPERED STEEL PARTS

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Abstract: In this paper the authors present th methodology for determining the regression process function for the pitch of knobs Sm_{ISO} and the other quality indxes Ra_{ISO}, Rz_{ISO}, Ry_{ISO}. After analyse done on a central pivotant experimental orthogonal plane, the authors established a regression $S = b \,.\, Ra^{m1} \,.\, Rz^{m2} \,.\, Ry^{m3}$.

1. INTRODUCTION

The study of surface's quality is done using regression process functions obtained by experiments. The researches done with RUL 1 steel aim to obtain functions that express correctly the links between the output figures represented by the quality indexes Ra, Rz, Ry and the average pitch of local knobs S (SR ISO 468:1997). The regression analyse looked for a significant link between the above figures, in order to have a clear image of the lathe process for the RUL 1 tempered steel.

The researches were done to identify the possibility to replace the grinding process with lathing on classical lathes, knowing that grinding produce non-recoverable splinters that pollute the industrial area of cities.

2. THE METHOD USED TO OBTAIN THE REGRESSION PROCESS FUNCTIONS

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
Length feed, s [mm/rev]	Xi2	0,057	0,125
Chip nose radius, r_ε [mm]	Xi3	0,5	1,5
Cutting rate, v [m/min]	Xi4	35	50

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). 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 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 process function obtained by the regression calculation with Fisher test check for constants $F_{mcal} = m_i^2/S_{mi}^2 < F_{tab}(1,\infty)$ and for the suitable links between the values of the indexes Ra, R_z, R_y and the pitch of knobs S. Table 4 presents the results of the regression analyse, calculated after processing and measurements.

Table 4. The results of the regression analyse.

RUL1	b	m_1 (Ra)	m_2 (Rz)	m_3 (Ry)
mi	0,741937	1,358876	2,051798	-1,66448
smi	0,319066	0,324999	0,566449	0,453663
Sey	0,064733			
$Ftab(1,\infty) < Fbcal$	3,84			
$Fbcal = b_i^2/S_{bi}^2$	5,4	17,48	13,118	13,46
Significance	Significant	Significant	Significant	Significant
Fcal > Ftab	6,194675 > 4,07			
ssreg	0,077873			
ssrezid	0,016761			

The mathematical relation of the regression process function experimentally determined in the polytrophic shape is:

$$S = 0,741937 \cdot Ra^{1,358876} \cdot Rz^{2,05} \cdot Ry^{-1,66448} \quad (1)$$

Relation (1) shows that there is a mathematical link between the values of the surface's quality parameters. Among these parameters, the maximum value of roughness R_z is the factor with the highest influence over the average pitch of local knobs. The mathematical model proposed is adequate for processing the RUL 1 steel, used for bearing manufacturing.

4. CONCLUSIONS

Individual values of the quality indexes Ra, Rz, Ry and S does not offer a complete image of the surface's quality, especially of the mathematical links between them. As the product competitiveness on the market increases, it must take into consideration the quality of the machine parts surfaces put in contact and the relative motion between them.

The present standards give us relations between the quality indexes of the surfaces. So, the technological engineer must obtain such process functions in order to keep under control the lathe process for bearing rings, considering also that presently it is a tendency to replace the grinding processing with the lathe processing.

The control devices allow us to measure a lot of quality indexes, facilitating the experiments whose results could be used then to simulate the technological processes.

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