THE ASPECTS REGARDING TECHNOLOGICAL PARAMETERS INFLUENCES ABOVE PRECISION AND PROFILE ERROR OF SHAFTS GROOVE OBTAINED USING COLD PLASTIC METHOD

АСПЕКТЫ ОТНОСИТЕЛЬНО ВЛИЯНИЯ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ НА ПОГРЕШНОСТЬ ТОЧНОСТИ И ПРОФИЛЯ НАЗА ВАЛОВ ПОЛУЧЕННЫХ ПРИ ПРИМЕНЕНИИ ХОЛОДНОГО ПЛАСТИЧЕСКОГО МЕТОДА

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Abstract/ Конспект: This paper present some aspects of technological parameters above precision of some measured values and grooves profile obtained using cold plastic procedure. There are presented matricial models for exterior diameter of obtained groove shafts, dimension over teeth and radial error. Also are presented metallographic analyses of that two stainless steel used.

KEYWORDS: PRECISION, PROFILE, GROOVES, COLD PLASTIC

1. Introduction/ Введение

High rate of development in machine building technologies, are in direct connection with implementation of the newest methods for metal process. One of this method is cold plastic act, method which does not remove material from shaft. These methods, based on cold plastic deformation of metals, consist in procedure like rolling with rolls or balls, embrace procedures like rolling with rolls or balls, surface hardening with pellets jet, pinch rolling, e.g.

Cold plastic procedures start to be more and more used, due to their advantages in connection with material savings and productivity but also due to the procedure capacity to obtain complex shapes, without overdue expenses in proportion with that productivity but also due to the procedure capacity to obtain complex shapes, without overdue expenses in proportion with that on the classical method with elimination of metallic material. Groove shafts with triangular profile obtained using cold plastic method using MURF 32 machine tool.

2. Matricial pattern of the experimental results/ Картина Матрициал экспериментально результатов

Using Fisher criteria we conclude dependencies equation between entrance parameters (table 1) and measured parameters.

Table 1: The levels of initial parameters

<table>
<thead>
<tr>
<th>Input factor</th>
<th>Dx</th>
<th>Fixad</th>
<th>Lx</th>
<th>Nmes</th>
<th>Td</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 level</td>
<td>75-OL50 90-OLC15</td>
<td>On chuck</td>
<td>Without cooling cutting</td>
<td>750</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>2 level</td>
<td>82-OL50 97-OLC15</td>
<td>Between centers</td>
<td>With cooling cutting</td>
<td>1500</td>
<td>30</td>
<td>120</td>
</tr>
</tbody>
</table>

During experimental tests we used following mathematical model:

\[ z = M \left[ [a_1, a_2, \ldots, a_m] [e_1, e_2, \ldots, e_n] [e_1, e_2, \ldots, e_n] [e_1, e_2, \ldots, e_n] \right] \left[ [t_{c}, t_{c}, \ldots, t_{c}, 1] [t_{c}, t_{c}, \ldots, t_{c}, 1] [t_{c}, t_{c}, \ldots, t_{c}, 1] [t_{c}, t_{c}, \ldots, t_{c}, 1] \right] \]

where: Zt is the theoretical answer of system; M is the general average of answers and can be calculate like ration between values sum of answers and experimental number done; [Fi] is the vector of level Fj factor and this is the column matrice with zero elements and one element is equal by 1 on "i" line accordingly factor level taken into account; \( E_{Fj} \) is the medium effect of system answer for Fj factor on j level and can be calculate diminishing from system average of answer the general average M; \( [I_{Fj} \] are the interactions between Fi and Fj factors and can be calculate by relation: \( I_{Fj} = M - E_{Fj} \)

To find out matricial relationship, we used software in QBasic programming language; this software saves the results into a format that could be read by a graphical editor (ACAD V.14) who transform entrance data into a vectorial draw. Using the draws generated we was able to establish the influence of the exit parameters considering entrance ones. This influence is represented by straight lines which represent variation of a parameter up to the general average value of the experiment.

Entrance parameters which used for input in this software were: Ns number of variables; Nexp number of experiments; Nmax maximum number of levels.

For some of the measured parameters, using OL50 and OLCl5 steel brand for obtaining groove shafts, we deduce following matricial models:

- for outer diameter

\[
\begin{bmatrix}
D_{OL50} + 0.0012 \cdot [-3.4112, 3.4112, 0.8878 - 0.8878, \ldots, 0.8878, \ldots, -0.8878, -0.8878] \\
D_{OLC15} + 0.0019 \cdot [3.0469, 3.0469, 0.8981, 0.8981, \ldots, 0.8981, \ldots, 0.8981, 0.8981]
\end{bmatrix}
\]

The outer diameter of the groove shaft obtained using cold plastic procedure is strongly influenced by half-finished diameter (Dx) used, then by hydraulic pressure (P); the others parameters have a negligible influence above outer diameter of the final product. The interaction of the half-finished diameter and hydraulic pressure has a direct influence above outer diameter. Also number of reviews and hydraulic pressure has an influence above outer diameter too. This one could be explained by the fact that material deforming is different when we have only one crossing by of the tool over the shaft (when outer diameter of the half-finished is smaller) comparing with that one when we have at least two crossing over of the tool over the shaft, case when outer diameter is larger, with corresponding level of the hydraulic pressure used for rolling tools.

To be able to obtain an outer diameter larger, the outer diameter of the half-finished should be at 2nd level (with the maximal value of the diameter) and hydraulic pressure at the 1st level (minimal pressure). The maximum influence that we could
have, within interaction between hydraulic pressure and number of cross over of the tool, is when tothing process is finished by one interaction of the rolling tool.

It is well known that cold plastic method is recommended to be executed from one crossing by of the tool with interest to obtain a tight as possible tolerance field, so the interaction hydraulic pressure-number of crossing by of the tool have an influence above quota over sprocket.

In the case of cold plastic process of the OLC15 steel brand we have diameter of the half-finished and number of crossing by of the tool as independents parameters; interaction between half-finished and number of crossing by of the tool is obvious. Interaction between half-finished diameter and machine tool speed is explained by the fact that to a higher diameter and a lowered speed, could be obtained higher values of the quota over sprocket, at lower cold plastic deformation speed, distortion of the metal grains is more profound and uniform. The interaction between clamping of the half-finished and cooling-greasing liquid, are generated by the clamping errors. Also, without this liquid, could appear peeling phenomena.

In the case of quota over sprocket (N) for groove shaft made from OL50 steel brand, fastening of the half-finished (Fixsf), as independent parameter, have a decisive influence. Hydraulic pressure ($P_a$) and numbers of cross over of the tool (Nt) have a low influence. The influence of the interaction between half-finished diameter (Dsf) and his clamping could be explained by the errors that appear during clamping and orientation process. If, during production process, we have cooling-greasing liquid, we could obtain a higher precision, which means serried tolerance for quota over sprocket.

Deformation level of the half-finished material is influenced by the hydraulic pressure; this level is higher for maximum pressure and, if we use cooling-greasing liquid, we could explained interaction between this liquid and hydraulic pressure. At the same time could be obtained a better surface quality and precision at low pressing speed, which, correlative with hydraulic pressure, have a direct influence the value of quota over sprocket. (the interaction between hydraulic pressure and speed).
On the obtaining of matricial pattern stage, for radial error, was considered maximal value of the radial; to decrease this should be act over the clapping method of the half-finished (for clapping between points was obtained the lowered values of the radial slapping, flowing 6-7 precision category). Also, as independent factor, we have hydraulic pressure and as an effect of hydraulic pressure) when thickness of the deformed layer is higher. Of the machine tool, de forming effect of the tool is time prolonged of the deformed layer is smaller. On decreasing the revolution speed we have a decrease of the cold plastic deformation rate so thickness of the deformed layer is smaller. On decreasing the revolution speed of the machine tool, deforming effect of the tool is time prolonged compared with situation with higher revolution speed (also higher hydraulic pressure) when thickness of the deformed layer is higher.

Average effects of the entrance parameters above radial slapping are presented in figure 5 and 6.

![Figure 5: Entrance parameters above quota over radial slapping (B_r) for OL50](image)

![Figure 6: Entrance parameters above quota over radial slapping (B_r) for OLC15](image)

Metallographic sample are presented in figure 7 for OL50 (a- top of the groove, b- side of the groove, c- bottom of the groove, d- base material).

We could conclude after we analyze these metallographic samples:

- structure of cold plastic deformation layer is different from basis material, being more smooth, because using this procedure of processing, crystals lose their globular shape and are more elongate into processing direction;
- processing of these grooves using cold plastic deformation lead to shape modification and crystalline grains dimensions (ferrite), changing spatial orientation and fine structures of these; also appear modifications at the cementite and oxide enclosure level;
- elongation of the grains is more accentuate where we have greater deformation (at the bottom of grooves) and less accentuate on the side area (for OL50); could be observed some turbulence at the bottom of the grooves which correspond as direction with direction of processing chose. This turbulence could constitute development center of material faults from weakening resilience point of view. The value of microdurity measured in these area are similar with that one measured on the side of the groves, so these turbulence will not modify high-tensile bottom groove;
- for OLC15 could be observed a breaking up of the small grains, more pronounced to the top of the groove, with small angles in the new crystalline network, we obtained so called mosaic structure, so we have lower values of microdurity;
- in the case of cold plastic processing made from OL50 we could observe larger lead away from the groove shape that from same one using OLC15.

3. Conclusion/ Заключение

The outer diameter of groove shaft process thru cold plastic method is highly influenced by half-finished diameter (D_0) used, than by hydraulic pressure (P_h), the other parameters have an insignificant influence above the outer diameter of the final product.

On the quota over sprocket (N) for OL50 groove shaft a decisive influence has the clapping procedure (Fix_OLC), as independent parameter.

Analyzing superficial microstructure we concluded that crystalline network modification is less in the deep of the material, up to the basis material proprieties. There is a concentration of the pearlitic grains into the superficial layer.

4. References/ Справки

[7] NEDELCU Dumitru, Pruteanu Octavian “Some theoretical considerations concerning cold plastic deformation of material for forming exterior grooves”,

$$P_{OLC15} = 0.2731 \cdot [0.1231 - 0.1231] + 0.0460 - 0.0460 \cdot P_h + N_s \left[ 0.0423 - 0.0009 \right] P_h + \left[ 0.0981 - 0.0981 \right] \cdot P_h$$
Fig. 7 Metalographic sample for groove shaft from OL50

Fig. 8 Metalographic sample for groove shaft from OLC15

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