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CALCULATION OF THE DYNAMIC ADJUSTMENT ERROR OF THE CUTTING EDGE WITH THE SURFACE TO BE PROCESSED

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Annotation

In mechanical engineering, the detection of errors that occur during the processing of shaped surfaces of parts remains by far the most important task. Before processing the shaped surfaces, it will be necessary to study the working surfaces of the stamping molds. This article presents methods for determining the geometric parameters of the surface when processing stamping molds on shaped surfaces, in particular, information about the structure of the cutting zone of shaped surfaces, the penetration of the bit into the cutting zone and the control conditions in the cutting zone.

Keywords: Strength parameters, diagnostics, models, cutting area, strength, durability, stamping, stamping form, cutting parameters.

Introduction

CNC B workbenches are carrying out extensive scientific and research work on studying the effect of the forces acting on the cutting tools on the quality of the details, accuracy and the wear resistance of the cutting tools through diagnostic systems during the mechanical processing of the complex-shaped details. In this direction, among other things, research on increasing the service life of cutters on the basis of reducing the amount of cuttings during the processing of complex-shaped details, on the basis of reducing the effect of radial forces affecting the processing surface is considered a priority. At the same time, the development of

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adaptive software for automatic selection of force diagnostic features and calculation of their limit values, taking into account the reliability of the state of the cutting tool, remains one of the urgent tasks of today.

Materials and Methods

In the field of engineering and technology, ensuring the geometric parameters of details and their accuracy indicators is of particular importance in increasing the quality and service life of machinery and automotive products. At the same time, increasing the physical and mechanical properties of the metal surface layer is one of the important tasks. In this regard, in the research centers of developed countries, including the USA, Russia, England, Germany, Japan, and other countries, special attention is paid to the development of technologies that ensure dimensional bending of cutting tools during operation and increase accuracy indicators during mechanical processing of complex surface details.

The tasks of the second group, based on the research of the mathematical model of the controlled process, are to develop methods for constructing diagnostic tests in the analysis of the technological process; build an optimal diagnostic program that allows you to determine the state of the process.

In the tasks of the third group, the following questions are solved: development of rules for the construction of diagnostic systems and the choice of methods of their implementation by means of measurement; the speed and reliability of the diagnostic device and system, the reliability and completeness of the diagnosis for the increase of information, the analysis-economic efficiency and other indicators are checked. It is determined that the diagnostic system is related to the technological process.

The composition and principle of operation of the diagnostic system largely depends on the choice of the diagnostic method and the type of mathematical model used, and it serves to develop the algorithm of the diagnostic system and its technical application.

The issues considered in the diagnosis allow to assess the state of the technological process over a period of time. Estimating its next future state is a task of technical forecasting and is expressed in the following order: by monitoring the process of changing quality indicators or by monitoring individual parameters of the object at a certain time interval, predicts their future size at a certain time. The information necessary to solve the problem of predictability is obtained during the state control of the technological process. Depending on the nature of the specific

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task that is being solved for prediction, the types of control with the prediction of the subsequent quality indicators or the time of failure of the object differ.

Results

The developed control program produces a process surface below the nominal surface. The cutting force, the flexibility of the cutter, the cutting force to form the actual surface must be within the deviations.

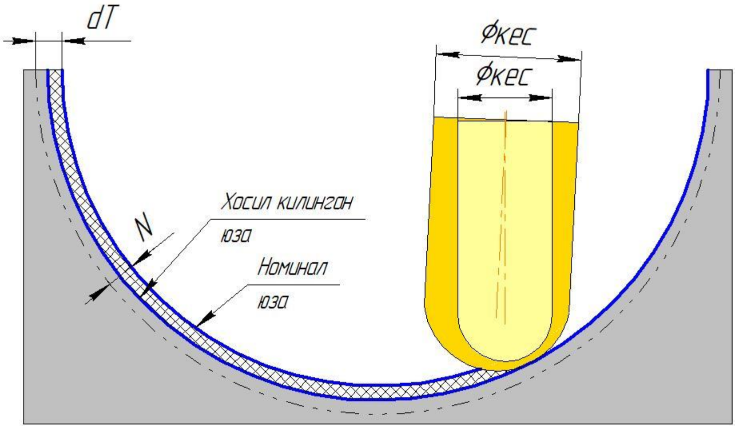

Figure 1. Real surface formation drawing.

Due to the lack of a calculation method of control of processing accuracy during milling of shaped surfaces, it is carried out by the method of tests. In this regard, it is necessary to analytically determine the parameters of the filler.

We assume that the resulting real surface is at a distance of shape deviation from the nominal surface. Then:

$$D_{хақ} = D_{тех} + 2_{\Delta}N + \frac{\Delta T}{2} \Rightarrow D_{тех} = D_{хақ} - 2_{\Delta}N - \frac{\Delta T}{2} \quad (1)$$

here:

$D_{хақ}$.- the diameter of the cutter used; $D_{тех}$.- The diameter of the tool used to design the program in the CAM system; ΔT- exclusion.

Therefore, in order to determine the amount of correction of the cutting tool, it is necessary to know the amount of elastic displacements in any part of the processed surface depending on the geometry of the cutting surface and to bring its value to a constant value.

ΔN determination of elastic displacements is carried out according to the formulas:

$$\Delta N = \frac{\Delta X \frac{dZ}{dX} + \Delta Y \frac{dZ}{dY} + \Delta Z}{\sqrt{\left(\frac{dZ}{dX}\right)^2 + \left(\frac{dZ}{dY}\right)^2 + 1}} \quad (2)$$

Here: ΔX, ΔY, ΔZ-- values of elastic displacements along the corresponding axes;

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$\frac{дZ}{дX}, \frac{дZ}{дY}$,-, With respect to the X and Y arguments Z=Φ(X, Y) partial derivatives of the function (tangents of the deviation angles of the treated surface).

The values of elastic displacements are determined by the following expressions:

$$\Delta X = \frac{P^{X}_{\text{пол}}}{J_x};\ \Delta Y = \frac{P^{Y}_{\text{пр}}}{J_y};\ \Delta Z = \frac{P^{Z}_{\text{ос}}}{J_z}\ (3)$$

here:

$P^{x}_{\text{пол}}$, $P^{y}_{\text{пр}}$, $P^{z}_{\text{ос}}$- projections of the generated cutting force on the coordinate axes of the machine.

$$P^{x}_{\text{пол}} = P^{\Sigma}_{Z} \cdot sin\Psi - P^{\Sigma}_{Y} \cdot cos\Psi;\ P^{y}_{\text{пр}} = P^{\Sigma}_{Z} \cdot cos\Psi - P^{\Sigma}_{Y} \cdot sin\Psi;\ P^{z}_{\text{ос}} = P^{\Sigma}_{X}, (4)$$

J_X, J_Y, J_Z - stability of the technological system along the axes.

The main part of the elastic deformations in the final milling process is the cutting tool, so we only consider the milling strength. The calculation is done by expression.

$$J_{\text{фр}} = \frac{3EJ_{\text{пр}}}{l^3}\ (5)$$

here:

E-module of elasticity of the first type; l-instrument rise.

Since the value of the axial elastic displacement of the cutting tool is zero

$$J_{\text{пр}} = J_x = J_y = \frac{\pi D^4}{64} \approx 0{,}05D^4 = 0{,}8R^4_{\text{фр}} \Longrightarrow J_{\text{фр}} = J_x = J_y = \frac{2{,}4ER^4_{\text{фр}}}{l^3}\ (6)$$

Then the expression takes the form:

$$\Delta N = \frac{\left(\left(P^{\Sigma}_{Z} \cdot \sin\Psi - P^{\Sigma}_{Y} \cdot \cos\Psi\right)\frac{dZ}{dX} + \left(P^{\Sigma}_{Z} \cdot \cos\Psi - P^{\Sigma}_{Y} \cdot \sin\Psi\right)\frac{dZ}{dY}\right)\frac{l^3}{2{,}4ER^4_{\text{фр}}}}{\sqrt{\left(\frac{dZ}{dX}\right)^2 + \left(\frac{dZ}{dY}\right)^2 + 1}}\ (7)$$

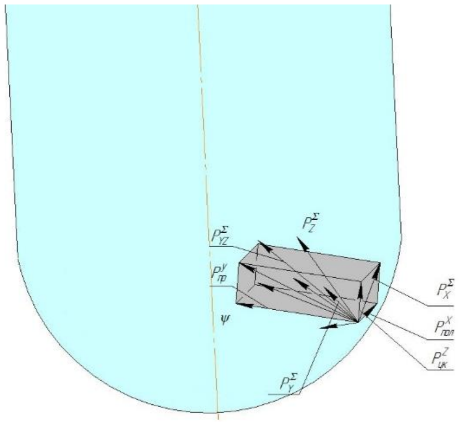

Figure 2. Decomposition of the forces acting on the teeth of the finger mill.

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Substituting formulas into this expression, we get:

1) For surface treatment during the first pass:

$$\Delta N_{C1}=\left(\left(0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(15{,}87S_{\text{тиш}}\sqrt{\frac{t}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)sin\Psi-0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(5{,}24S_{\text{тиш}}\sqrt{\frac{t}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)cos\Psi\right)\frac{dZ}{dX}+\left(0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(15{,}87S_{\text{тиш}}\sqrt{\frac{t}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)cos\Psi+0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(5{,}24S_{\text{тиш}}\sqrt{\frac{t}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)\sin\Psi\right)\frac{dZ}{dY}\right)\cdot\frac{l^3}{2{,}4ER_{\text{фр}}^4}\frac{1}{\sqrt{\left(\frac{dZ}{dX}\right)^2+\left(\frac{dZ}{dY}\right)^2+1}}\quad(8)$$

2) For surface treatment in the second and last passes

$$\Delta N_{C2}=\left(\left(0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(15{,}87S_{\text{тиш}}\sqrt{\frac{I_{\text{пр}}}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)sin\Psi-0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(5{,}24S_{\text{тиш}}\sqrt{\frac{I_{\text{пр}}}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)cos\Psi\right)\frac{dZ}{dX}+\left(0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(15{,}87S_{\text{тиш}}\sqrt{\frac{I_{\text{пр}}}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)cos\Psi+0{,}252\sigma_i R_{\text{фр}}(\varphi_{\text{в}}-\varphi_{\text{н}})\left(5{,}24S_{\text{тиш}}\sqrt{\frac{I_{\text{пр}}}{2R_{\text{фр}}}}+I_3 tg\left(80+\lambda-2arcsin\frac{1}{K}\right)\right)\sin\Psi\right)\frac{dZ}{dY}\right)\cdot\frac{l^3}{2{,}4ER_{\text{фр}}^4}\frac{1}{\sqrt{\left(\frac{dZ}{dX}\right)^2+\left(\frac{dZ}{dY}\right)^2+1}}\quad(9)$$

The error in the dynamic adjustment size is given in the expressions so that the largest value is generated when the previously untreated surface is processed. Therefore, the selection of the amount of filler for the dimensions of the cutting tool should be made for this part, and the change in the error value in other parts can be compensated by changing the cutting conditions.

Conclusion

- CNC machines are one of the main means of automating multipass operations in the milling of shaped surfaces, the effectiveness of which depends on the completeness and correctness of using the software control capabilities;
- variation of cutting force in black and finishing processing in a wide range is characterized by multi-pass milling; there are reliable calculation methods and normative recommendations, and in addition, the influence of various performance

factors on the number of each transition and cutting methods is not taken into account;

-milling of surfaces has a significant effect on accuracy, and errors in elastic deformations of the technological system are observed in the conditions of black, semi-clean processing;

Recommendations should be made for cutting tool wear under clean and finish machining conditions.

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