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Influence of forces acting on side of machine on precision machining of large diameter holes

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Abstract. One of the most important factors that increase efficiency, durability and reliability of rotating units is precision installation, preventive maintenance work, timely replacing of a failed or worn components and assemblies. These works should be carried out in the operation of the equipment, as the downtime in many cases leads to large financial losses. Stop of one unit of an industrial enterprise can interrupt the technological chain of production, resulting in a possible stop of the entire equipment. Improving the efficiency and optimization of the repair process increases accuracy of installation work when installing equipment, conducting restoration under operating conditions relevant for enterprises of different industries because it eliminates dismantling the equipment, sending it to maintenance, the expectation of equipment return, the new installation with the required quality and accuracy of repair.

1. Introduction

Loading and unloading nodes, and grinding raw mills have internal devices of the cone type or sludge worm. The load from the incoming and outgoing material is to protect the inner surface of the axle from damage and wear. Seats for trubochnika and cone are traces of deformation and hardening, and the axles have wear and deformation of the inner cylindrical surface. Inserts wear due to abrasion of fine material and blows significant pieces of the input material. In the raw mills are mainly plug-in elements are deformed due to the ingress of large foreign material and grinding mills abrasion occurs due to the contact with a hard clinker. In this process, trubochnik wear and reduced wall thickness. To the mill shell constantly acting dynamic forces that conduct will cause vibrations that are transmitted to the axles and inner elements [1-6].

2. The main part

Under the action of shocks and vibrations, the housing of the axle is the stress-compressed vertically and stretched horizontally. As a result, the plug-in element is deformed. Moving the element in the resulting gap leads to the fact that it gets raw, and under the action of variable loads is the destruction of the Seating surfaces of the axle and the insertable element. In this process, the shape of the Seating surfaces and after repair to establish a new standard, it is impossible. Connection design of the bottom with the drive shaft characterized by the fact that the mating part has large dimensions and a large mass. For normal operation this connection is necessary to ensure accurate handling of splines mating parts and the splines of the clutch and precise Assembly of parts. Failure to comply with these terms of effort when the mills are distributed to the slots is uneven, overloaded the splines wear out quickly,

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accompanied by a vibration in the drive mechanism and the discharge end of the unit.

Designed side machine 3 for holes of large diameter. Side machine is mounted on a plate 5, which is attached to the force table 1. The whole structure is mounted on the side of the spare part, the process control is performed by using the remote 2. The required depth of cut will be determined and set manually, longitudinal feed – automatic. The recoverable part is rotated from the Assembly with its own drive. If necessary, execution of surfacing works, instead of the cutting tool is possible to install for surfacing welding machine or device for grinding abrasive tool. The disadvantage of this special side of the machine is the presence of displacements of the cutting tool relative to the axis of rotation of the restoring parts. These phenomena occur due to the fact that the housing of the rotating Assembly with his large weight and length and has deflection and vibration. Due to the fact that the recovered item based on a spherical reference nodes, then the deflection of the housing unit changes the position of the axis of rotation of this part and offset it relative to the cutting tool. Most often in industry there is a need for processing the boot of the axles of the grinding mills. During the boot process of the material of the wearing surface of the axle. Usually the axles have a length of two meters and a diameter up to 1800mm and repair such surface can be a special auxiliary machine module [7, 8].The design of this module allows to process the inner surface of the large rotation diameter and length. Machining accuracy depends on the quality of the reference node.

A method of processing holes of large diametrically is that the bearing support is installed auxiliary machine module with a spherical base, the machine has two rollers, which is set recoverable deflagrate.

Side the machine is in its construction is slab, the length of which greatly exceeds the depth of the processed holes. The plate is installed the machine, which because of its considerable mass causes deformation of the plate. In addition, under the action of cutting forces, an additional deflection and potential vibrations from the system side of the machine – based device - tool – recoverable detail due to varying cutting forces, arising due to spotty hardness and of various sizes pass.

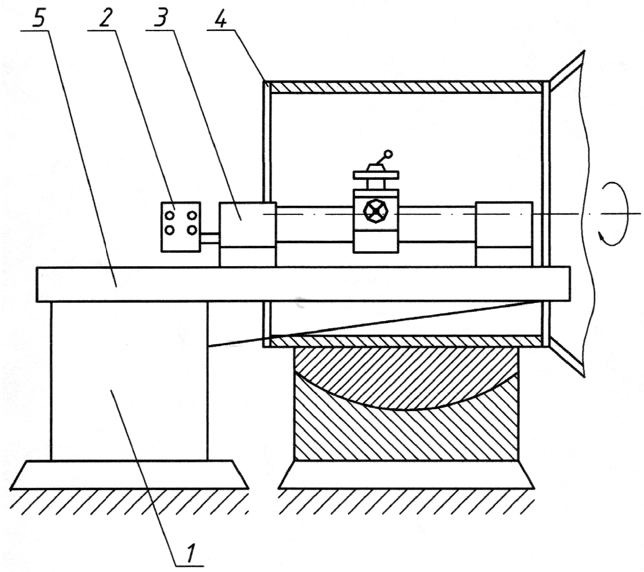

Figure 1. The scheme of installation of the special auxiliary machining module for processing the inner surface of the axle:1 – power table; 2 remote control; 3 – machines; 4 – axle; 5 – plate

The plate can be considered as a beam clamped at one end, and the load from the cutting force moves along the beam.

To determine the movement written in the matrix form of integral for Mora j precinct in determining the displacements depend only upon bending in one plane [9]:

$$K_P = \int_l \frac{\overline{M}_K \times M_P \times d_X}{E \times Yj} = \overline{M}^T_{jK} \times A_j \times M_{jP} \quad , \tag{1.1}$$

where $\overline{M}^{\tau}_{jk}$ is the transpose of the column isolated moments on j the site,

$$\overline{M}^T_{jK} = \left[M^{Л}_{jk}, M^{C}_{jk}, M^{П}_{jk} \right];$$

A_j - the diagonal flexibility matrix for j the site:

$$A_j = \frac{l_j}{6EI_0} \begin{bmatrix} a^{Л}_{ij} & 0 & 0 \\ 0 & 4a^{C}_{ij} & 0 \\ 0 & 0 & a^{П}_{ij} \end{bmatrix} \tag{1.2}$$

Here $a_{ij} = \frac{I_0}{I_{ij}}$ – relative give (I_0 –any fixed moment of inertia as main, I_{ij} – the moment of inertia in i the cross section of the element l_j);

M_{jP} – freight matrix – column i the site

$$M_{jP} = \begin{bmatrix} M^{Л}_{jP} \\ M^{C}_{jP} \\ M^{П}_{jP} \end{bmatrix} \tag{1.3}$$

In these formulas, the indices $Л, C, П$ indicate that the values correspond to left, middle and right parts of the element section l_j .

The matrix multiplication in equation (6.1) coincides with the evaluation of the integral Mora using the formula of Simpson [9].

Summing up the final calculations for all n– areas of the system, have:

$$\Delta_{KP} = \sum_{j=1}^{n} \overline{M}^T_{jK} \times A_j \times M_{jP}. \tag{1.4}$$

This expression can be written in block form:

$$\Delta_{KP} = \left[\overline{M}^T_{1K}, \overline{M}^T_{2K}, ..., \overline{M}^T_{K} \right] \times \begin{bmatrix} A_1 & 0 & ... & 0 \\ 0 & A_2 & ... & 0 \\ ... & ... & ... & ... \\ 0 & 0 & ... & A_n \end{bmatrix} \times \begin{bmatrix} M_{1P} \\ M_{2P} \\ ... \\ M_{nP} \end{bmatrix}. \tag{1.5}$$

For the displacement vector $\overline{\Delta}_P$, components $\Delta_{1P}, \Delta_{2P}, ..., \Delta_{mP}$ have [9]:

$$\overline{\Delta}_P = \overrightarrow{M}^T \times A \times \overrightarrow{M}_P. \tag{1.6}$$

If j the site $EI_j = const$, the diagonal matrix (1.2) give becomes:

$$A_j = \frac{l_j}{6EI_j} \begin{bmatrix} 1 & 0 & 0 \\ 0 & X & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

In the process of processing the inner surface of the large-sized shaft because of the differences in allowances on the treated surface and spotted the hardness of metal cutting forces are constantly changing, the result of which may cause forced oscillations of the system. Efforts to fluctuations change in time $P(t)$ and cause the system $S_{дин}$, and its relation to the same static factor from the power $P_{\max}$ is called the dynamic coefficient [9]:

$$K_d = S_{дин} / S_{ст}.$$

When considering oscillations under the action of variable forces $P(t)$ auxiliary machine module can be viewed as a system. Under the force of $P(t)$ the system will deviate from the equilibrium position, but under the influence of the stiffness will return to the equilibrium position.

Thus, if we accept that the mass deviation m the magnitude y on it except power $P(t)$ will act in a restoring force P^*, seeking to return to the starting position $(P^* = -cy)$; the force of inertia $I = -m\ddot{y}$ and the resistance force $R_C(t)$, we get the equation:

$$m\ddot{y} + cy + R_C(t) = P(t).$$

3. Conclusion

Reasoning Equations for the bending and vibration of plate side of the machine, which allow the application of numerical control to adjust the movement of the cutting tool when machining holes of large diameter. Research and testing of auxiliary machines showed that they provide for the treatment of large rotating parts under operating conditions without dismantling. [10-13].

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