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STRENGTHENING MACHINE PARTS BY ROLLING WITH FLEXIBLE ROLLERS

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Abstract. Through theoretical and experimental research, it has been shown that, taking into account the rigidity of the machine tool-tool-part system and the stabilization of the running-in forces, it was possible to achieve optimal running-in modes and, as a result, expand the range of running-in and rolling-out parts.

Keywords: strengthening, stiffness, surface plastic deformation, running-in, rollers.

Improving the quality and reliability of machines and their components is one of the most important and primary tasks of the modern stage of machine-building development. This problem can be solved by developing effective methods of strengthening machine parts and increasing their durability.

The use of thermal or chemical-thermal hardening methods in the manufacture of large parts is limited by their overall dimensions and weight. The most affordable, and often the only possible method of hardening such parts, is the treatment of surfaces by plastic deformation with the help of rolling with rollers.

Spherical or toroidal rollers are most widely used for strengthening rolling of metal parts of rotation of large diameters, when a high degree of plastic deformation requires a significant depth of its penetration.

To eliminate the waviness, it is proposed to stabilize the rolling force on the roller, which changes with each revolution of the roller due to the variable-sign frictional force arising from the radial impact of the roller. The frictional force in the roller assembly can be reduced by an order of magnitude by replacing the sliding bearings with rolling bearings or using a spring housing in the rolling device to reduce the rigidity of the machine-tool-part technological system.

The implementation of the optimal run-in mode is related to the capabilities of the machines used. One of the conditions for this is the possibility of creating and stabilizing the working effort of the required amount. In the sense of maintaining the optimal running-in mode, the danger is not so much a decrease in rigidity as its instability.

For example, when turning the ends of the shaft on lathes, in addition to the stiffness of the caliper, the stiffness of the system is significantly affected by the stiffness of the front and rear headstocks. It is considered that as the caliper moves from the front headstock to the rear, the stiffness decreases by 40-60%.

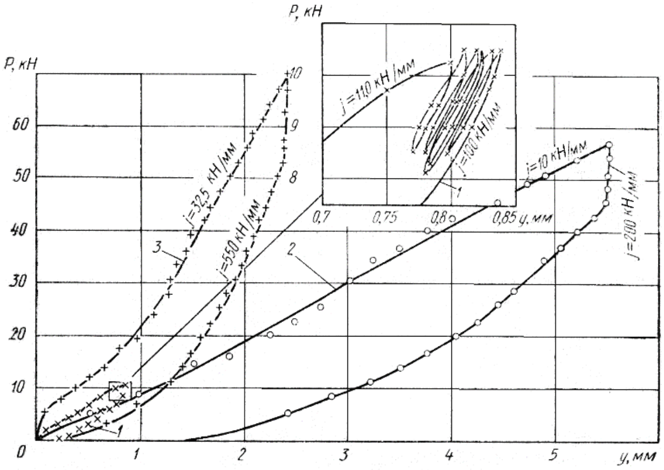

Fig. 1 – **Dependence of the press-out of the lathe support on the radial force at the height of the centers**: 1 - 286 mm; 2 - 500 mm; 3 - 1250 mm

In Fig. 1 shows experimental dependences of deformation on radial force for three lathes of different sizes, where it is shown that stiffness does not increase monotonically in all cases when the number of forces increases. Exceeding a certain amount of effort leads to general stretching of the sleeve and a corresponding decrease in stiffness as a result of the interaction of adjacent efforts.

Necessary for the stabilization of the working force of rolling, the reduction of the rigidity of the technological system is achieved by using tools with spring elements. In Fig. 2 shows a single-roller device with a spring housing for rolling the shaft.

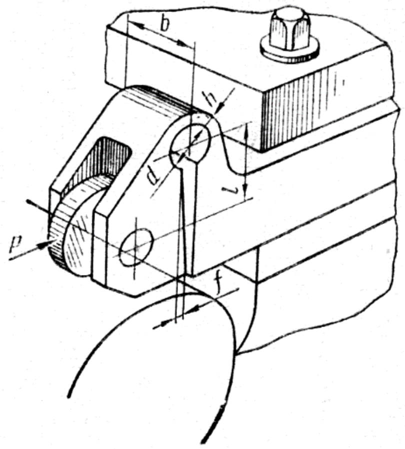

Fig. 2 – **Universal one-roller device with a spring body**

Taking into account the work of the system on the unloading branch of the stress-compression curve (see Fig. 1), an even greater effect than 5 times can be expected. A slight beating of the part, errors in its shape and other violations of the initial conditions of deformation are compensated by the corresponding displacements of the roller due to insignificant fluctuations of the working effort of rolling within the limits of the elastic deformation of the body of the device. A fundamentally similar design of the heads, but with spring loading, is used to roll out the axial channels in the crankshafts of diesel engines. The angles of the cones of the support rings in these heads differ by 2°. This gives the balls additional rotation in the plane of the axial section of the rolling hole during operation and increases the service life of the heads. Planetary multi-roller devices with conical rollers resting on a conical core have been most widely used in practice. Although the constancy of the angle of rollers with a rectilinear forming gives them advantages over ball hard heads, the need to prepare rolled-in parts within narrow tolerances to maintain optimal tension is a serious obstacle to their widespread use for processing large-diameter parts.

Indeed, if tension fluctuations within the limits of 0.1 mm are allowed, then holes with a diameter of up to 260 mm should be processed for rolling according to 8 quality, and for larger diameters (from 260 to 500 mm) according to 7 quality accuracy, regardless of the accuracy required by the conditions of operation of the parts. The creation of a practical design of heads of reduced radial stiffness with rollers of a rectilinear profile remains an urgent problem, the solution of which depends on the expansion of the nomenclature of rolling parts.

The developed technology and devices for rolling non-rigid parts with rollers are introduced into production at OJSC «Nikolaevsky Aluminum Plant».

List of sources used

1. Ryzhak V. Investigation of the stiffness of rolling holes / O. Zubiekhina-Khaiiat, V. Artyukh, V. Ryzhak, V. Teleshchak // MATERIALS of the 15th International Scientific and Practical Conference of Young Scientists, Postgraduate Students and Students «Promising Techniques and Technologies» 2019». Mykolaiv, September 25-27, 2019. C.38–40.
2. Tolgarenko M. Research on the accuracy of parts after rolling with rollers / V. Artyukh, O. Lymar, M. Khramov, O. Zubiekhina-Khaiiat, M. Tolgarenko // MATERIALS of the 15th International Scientific and Practical Conference of Young Scientists, Postgraduate Students and Students «Promising Engineering and Technologies – 2019». Mykolaiv, September 25-27, 2019. C.28–30.
3. Zubiekhina-Khaiiat A.V. Mathematical modeling of the process of rolling body rools with needed rollers / A.V. Zubiekhina-Khaiiat, D.D. Marchenko // International Scientific Journal «Problems of tribology». – Volume 24 № 3 / 93 – 2019. Khmelnytskyi, KhNU, «Problems of tribology».– 2019. C. 45 – 50. ISSN 2079 – 1372.
4. Vladimirov O. Methods and technologies for improving the quality and reliability of parts using surface plastic deformation / O. Vladimirov, O. Ponomarenko, O. Mudryi, B. Butakov, O. Zubiekhina-Khaiiat // MATERIALS OF THE 31ST STUDENT SCIENTIFIC AND THEORETICAL CONFERENCE «YOUTH PARTICIPATION IN THE DEVELOPMENT OF THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE», March 20-22, 2020. Mykolaiv, MNAU. 2020.
5. Pavlyuk S. Stiffness of the machine tool-tool-part system and its influence on the running-in process during surface plastic deformation / S. Pavlyuk, O. Dulger, D. Koshmak, O. Zubiekhina-Khaiiat // MATERIALS OF THE 31ST STUDENT SCIENTIFIC AND THEORETICAL CONFERENCE «YOUTH PARTICIPATION IN THE DEVELOPMENT OF THE AGRO-INDUSTRIAL COMPLEX OF UKRAINE», March 20-22, 2020. Mykolaiv, MNAU. 2020.

Анотація. За допомогою теоретичних і експериментальних досліджень показано, що з урахуванням жорсткості системи верстат-інструмент-деталь, стабілізації зусиль обкатування, вдалося досягти оптимальних режимів обкатування та як наслідок цього розширити номенклатуру обкатуваних і розкатуваних деталей.

Ключові слова: зміцнення, жорсткість, поверхневе пластичне деформування, обкатування, ролики.