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TURNING TOOL HOLDER WITH AN ORIENTED CENTER OF RIGIDITY FOR EFFECTIVE REDUCTION OF NEGATIVE SELF-OSCILLATIONS

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Abstract *The paper considers the topical issue of valuable scientific directions development for improving the lathe dynamic quality during high-performance rough turning. The given recommendation for the use of special lathes tool holder with an oriented position of the center of rigidity with confirming an experimental study results of the effectiveness use for increasing vibration resistance level.*

Keywords: vibration resistance, turning, machine tool dynamics.

Vibration resistance of machine tool during cutting process characterizes its ability to resist the occurrence of relative oscillations between cutter and machined workpiece surface, caused by the cutting process and external disturbance. So, increasing the vibration resistance of machine tool allows to increase cutting conditions with an acceptable level of relative vibrations. Loss of vibration stability during turning is mostly accompanied by the appearance and amplification of self-oscillations in lathe dynamic system due to: 1) the presence of a "coordinate links" between the elastic displacement of cutter and machined workpiece during cutting process; 2) nonlinear characteristics of the cutting force depending to the cutting speed; 3) the inertia of the cutting process. The negative consequences of appearance and amplification self-oscillations during cutting characterized by reduced stability and destruction of the cutting tool; decrease in quality of machined surface and processing accuracy; the occurrence of high-frequency noise which harmful to the human body.

Among the known methods of increasing the vibration resistance of machine tools during cutting, we can single out the following: 1) ensuring rational values of elastic parameters of the machine tools carriages elastic system, such as the orientation of the main axes of rigidity and rational ratio of the maximum and minimum rigidity coefficients 2) ensuring the condition of a positive value of the static characteristic for machine tools carriages elastic system spindles elastic system would lead to elastic displacement of cutter from the workpiece surface with decreasing value of cutting forces; 3) improving the dynamic quality indicators of machine tools dynamic system by reducing value of oscillations masses with increasing the damping ratio. Such well-known scientists as V.A. Kudinov [1], S. A. Tobias were engaged in the development of the theory of coordinate links, in whose studies it was indicated that in order to ensure the vibration resistance of the machine tools carriage elastic system rigidity parameters should be as large as possible in the cutting force action direction, and in other directions the rigidity should be less.

For existing machine tools, which, in terms of their technological capabilities, allow processing from both sides up to spindle axis, for example, a two-spindle lathe with CNC manufactured in Kyiv, model PAB-130, the increase in vibration resistance of processing is carried out by changing the position of the center of rigidity of the carriage elastic system by using additional specific tool holder.

A new design of the tool holder is proposed by author [2],[3] in which cutters triangular carbide plate is rigidly attached to elastic part of tool holders construction, and the rigid part with equipment body is installed on machine tools carriage instead of the based tool holder. The release and rigid parts of the tool holder are separated by a shaped groove in such a way that these parts remain interconnected by elastic hinges. In the design of the tool holder, the position of the coordinates of the center of stiffness of its elastic system is set due to the orientation of the axes of three interconnected elastic rotational pairs. To increase vibration resistance in the proposed design [4], the elastic elements are arranged in such a way that the axis of maximum rigidity of its elastic system in the direction of approaching the line of cutting force action.

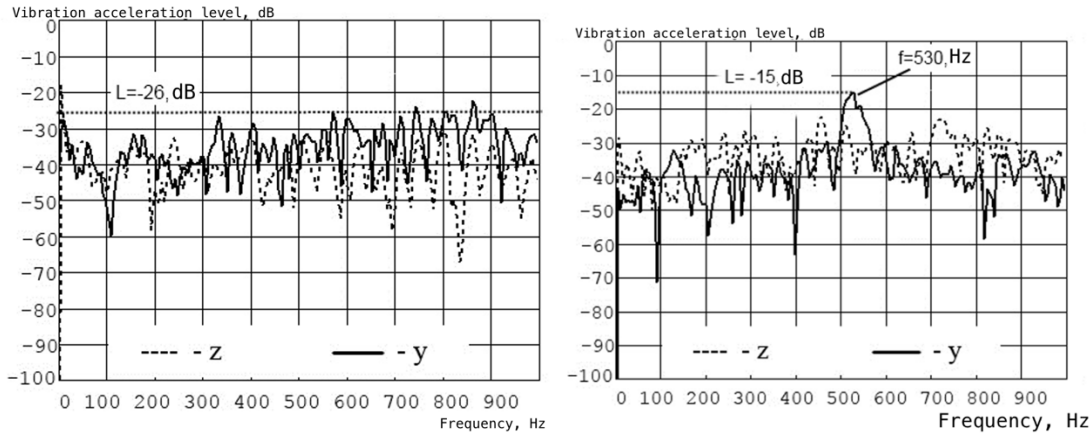

Fig.1 The vibro-acceleration level of the experimental stand carriage during machining

The experimental research of vibration level was carried out at the maximum permissible cutting conditions for roughing turning on experimental standing lathe: workpiece material - 5140 alloy steel; cutter turning - 3225 P10, workpiece diameter D = 120 mm; spindle speed rate n = 160 rpm; cutting speed V = 60 m/min; cutting depth t = 5 mm; feed S = 0.3 mm / rev; the cutting force value P = 4000 N. The results of the study are presented in the form of graphs of the frequency response of the relative level of vibration acceleration of the cutter during processing using the base tool holder (fig. 1) and the proposed tool holder with an oriented center of rigidity.

Comparing the obtained experimental characteristics, it can be seen that when using a basic lathes tool holder during machining, the appearance of self-oscillations along the y coordinate at the frequency of the dominating potentially unstable machine tools carriage dynamic system f = 530 Hz is observed. The use of the proposed special tool holder under the same cutting conditions has almost halved the relative level of vibrations of the cutter tool from L = -15dB to L = -26dB.

REFERENCES

1. Kudinov V.A. Dinamika stankov (Dynamics of machines), Moscow: Mashinostroenie, 1967, 360 p.
2. Vakulenko S.V. Lathe tool holder with the oriented position of the center of rigidity // X International congress “Machines, Technologies, Materials”, vol.2, ISSN 1310-3946, - Scientific-technical union of mechanical engineering, Varna, Bulgaria 2013. p. 128-131.
3. Vakulenko S., Analysis of known design solutions of increasing turning vibration stability // Zbiór artykułów naukowych recenzowanych. "Science, Research, Development Technics and Technology. #29 Gdańsk" Z 40 - Warszawa, 2020. - 72 p. - p. 30-36. ISBN: 978-83-66401-53-2.
4. Vakulenko S., Theoretical research of the cutting process dynamic characteristics // Zbiór artykułów naukowych recenzowanych. "Science, Research, Development Technics and Technology. #29 Gdańsk" Z 40 - Warszawa, 2020. - 72 p. - p. 39-44. ISBN: 978-83-66401-53-2.

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ІНСТРУМЕНТАЛЬНЕ ОСНАЩЕННЯ З ОРІЄНТОВАНИМ ЦЕНТРОМ ЖОРСТКОСТІ ДЛЯ ЕФЕКТИВНОГО ЗМЕНШЕННЯ АВТОКОЛИВАНЬ ПРИ ТОЧІННІ

Анотація *В роботі розглянуто актуальне питання розвитку одного з наукових напрямків, підвищення динамічної якості токарного верстата при високопродуктивній чорновій обробки. Наведена рекомендація використання спеціального інструментального оснащення з орієнтованим положенням центра жорсткості та основні підтверджуючі результати експериментального дослідження щодо ефективності його використання для підвищення рівня вібростійкості.*

Ключові слова: вібростійкість, токарна обробка, динаміка верстатів.

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