AP19175058 “Numerical modeling of cutting difficult-to-machine materials in the conditions of machine-building enterprises of the Republic of Kazakhstan” – p.m. Donenbayev B.S.

Relevance

Mechanical treatment remains the main type of forming of parts. High requirements for accuracy, roughness and surface quality require the need to improve the technology of machining and preparing production, especially when machining parts made of difficult-to-machine materials in the conditions of machine-building enterprises of the Republic of Kazakhstan. Difficult-to-machine materials include large-sized parts and modern wear-resistant materials.

In the domestic industry, the following plants mainly specialize in the manufacture and restoration of large-sized parts: the Almaty Heavy Machinery Plant JSC (AZTM) and the Petropavlovsk Heavy Machinery Plant JSC (PZTM).

To study the problems associated with manufacturing large-sized parts, a study was conducted in the conditions of the AZTM JSC.

As a result of the conducted studies of the state of issues related to the technology of processing and ensuring quality indicators of large-sized parts in the conditions of the AZTM JSC, a number of problems were identified: time costs for installation, alignment, fastening and removal of a large-sized part; the need to manufacture additional tooling; the occurrence of vibrations that negatively affect the accuracy of processing and the durability of the cutting tool, leading to high consumption of the cutting tool.

When machining modern materials, the choice of parameters for machining modes is additionally complicated due to their absence.

The efficiency of machining difficult-to-machine materials can be increased by numerical modeling of processing processes in software packages for engineering calculations. This requires the development of a new methodology of modeling machining processes. The development of such a methodology allows obtaining data on deformations, stresses, temperature, and the distribution of cutting force values in the processing zone.

The analysis of the obtained results makes it possible to select optimal cutting modes and tool geometry in terms of increasing tool life and the quality of the machined surface.

The practical significance of the results of this study will be directly applied to solve urgent problems of socio-economic and scientific-technical development of domestic machine-building enterprises of the Republic of Kazakhstan.

Project objective

The objective of the project is to increase the tool life and the quality of the machined surface of difficult-to-machine materials.

Expected and achieved results

Achieved results

Experimental studies of high-speed milling were performed on a vertical machining center (V-Center P76) with CNC in the conditions of the Gidro Stanko Servis LLC. Figure 1 shows the vertical machining center (V-Center P76) with CNC.

Figure 1 – Vertical machining center (V-Center P76) with CNC

Samples of heat-resistant high-alloy steel 15Kh12VMF were prepared for machining. Figure 2 shows photographs of samples for high-speed milling made of steel 15H12VMF.

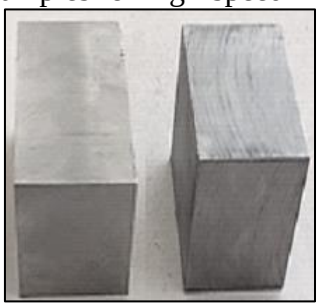
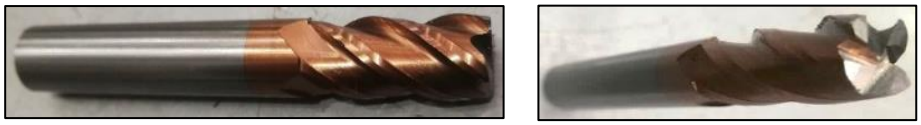


Figure 2 – Samples for high-speed milling from 15X12VMF steel

For the experimental studying of the high-speed milling process of 15H12VMF steel, there was used a solid carbide end mill MC089 (Ø16 mm).

Figure 3 shows the MC089 solid carbide end mill.



a) *b)*

Figure 3 – Solid carbide end mill MC089:
a – side view; b – front view

Figure 4 shows the process of machining 15H12VMF steel using high-speed milling.

a) *b)*

a – the process of machining with a solid carbide end mill MC089; *b* – a photograph of a machined sample made of 15H12VMF steel; 1 – a vice for clamping; 2 – the sample being machined; 3 – solid carbide end mill MC089

Figure 4 – The process of machining 15H12VMF steel by high-speed milling

Numerical simulation of high-speed milling process

Developing a 3D model of a "tool-workpiece"

Currently, creating a three-dimensional model does not present any particular difficulty. Since almost all CAD systems are integrated with all the software systems based on finite element analysis (FEA) The end mill model is created in the Kompas-3D program and then imported into Ansys WB, where a model of a rectangular prism workpiece is developed (Figure 6).

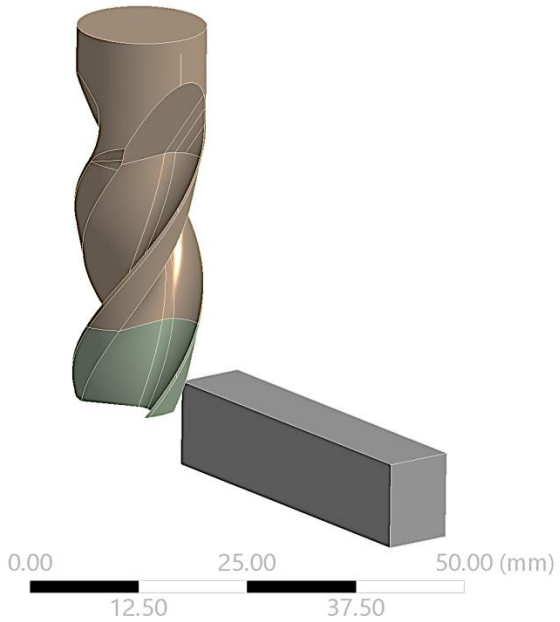


Figure 5 – 3D model of an end mill with a workpiece

Research team

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List of publicationsСписок публикаций

1. Sherov K.T., Sikhimbayev M.R., Sherov A.K., Donenbayev B.S., Musayev, M.M. Matematical modeling of thermofrictional milling process using ANSYS WB software / Journal of Theoretical and Applied Mechanics, Sofia, Vol. 47, No. 2 (2017) pp. 24-33. https://doi.org/10.1515/jtam-2017-0008 **(percentile 42%).**

2. B.S. Donenbayev, K.T. Sherov, M.R. Sikhimbayev, B.N. Absadykov. Using ansys wb for optimizing parameters of a tool for rotary friction boring / News of the natonal academy of sciences of the Republic of Kazakhstan series of geology and technical sciences ISSN 2224-5227 Volume 3, Number 447 (2021), 20-27. https://doi.org/10.32014/2021.2518-170X.57 Percentile **47%.**

3. Donenbayev B., Sherov K., Mazdubay A., Sherov A. and etc. Investigation of the method of processing holes with a rotary cup cutter with surfacing. Journal of Applied Engineering Science, (2021) 19(4), 862–867. https://doi.org/10.5937/jaes0-27504 **percentile52%.**

4. Donenbayev, B.; Sherov, K.; Mazdubay, A.; Sherov, A.; Mussayev, M.; Gabdyssalyk, R.; Ainabekova, S.; Taskarina, A.; Tussupova, S. Investigation of the method of processing holes with a rotary cup cutter with surfacing / Journal of Applied Engineering Science, 2021, 19(4), pp. 862–867. DOI: 10.5937/jaes0-27504

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Information for potential consumers

In this project, the analytical calculation of cutting modes of difficult-to-process materials for various mechanical operations will be considered, taking into account the results of experimental and numerical finite-element modeling of the machining process. Optimum modes of cutting for various methods of mechanical processing will be determined.

The stability of the cutting tool will be studied, which leads to the occurrence of oscillations during mechanical treatment, which negatively affect the accuracy of processing and the high consumption of the cutting tool.

The practical significance of the results of this study will be directly applied to the solution of the current problems of socio-economic and scientific-technical development of domestic machine-building enterprises of the Republic of Kazakhstan.

The developed methods have scientific and practical value for the mechanical engineering industry, as well as for specialists engaged in the development of software complexes.

Scope

Machine building enterprises of the Republic of Kazakhstan.

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