**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 processing remains the main type of shaping of parts. High requirements for accuracy, roughness and surface quality require the need to improve processing technology and pre-production, especially when processing parts made of hard-to-process materials in the conditions of machine-building enterprises of the Republic of Kazakhstan. Hard-to-process materials include large-sized parts and modern wear-resistant materials.

In the domestic enterprise, mainly factories specialize in the manufacture and performance of restoration work of large-sized parts: JSC "Almaty Heavy Machinery Plant" (AZTM) and JSC "Petropavlovsk Heavy Machinery Plant" (PZTM).

In order to study the problems associated with the manufacture of large-sized parts, a study was conducted in the conditions of JSC "AZTM".

As a result of the conducted research, the state of issues related to the processing technology and ensuring the quality indicators of large-sized parts in the conditions of JSC "AZTM", a number of problems were identified: time spent on installation, alignment, fastening and removal of large-sized parts; the need to manufacture additional accessories; the occurrence of fluctuations negatively affecting the accuracy of processing and the durability of the cutting tool resulting in to a large consumption of cutting tools.

Also, when processing modern materials, the choice of processing mode parameters is further complicated due to their absence.

The efficiency of processing hard-to-process materials can be improved by numerical modeling of processing processes in software packages for engineering calculations. And this requires the development of a new methodology for modeling processing processes. The creation of such a technique makes it possible to obtain data on deformations, stresses, temperature, and the distribution of cutting forces 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 durability and the quality of the treated surface.

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

***Project goal***

The purpose of the project is to increase the durability of the tool and the quality of the processed surface of hard-to-process materials.

***Achieved and Expected results***

Results achieved in the first half of 2025:

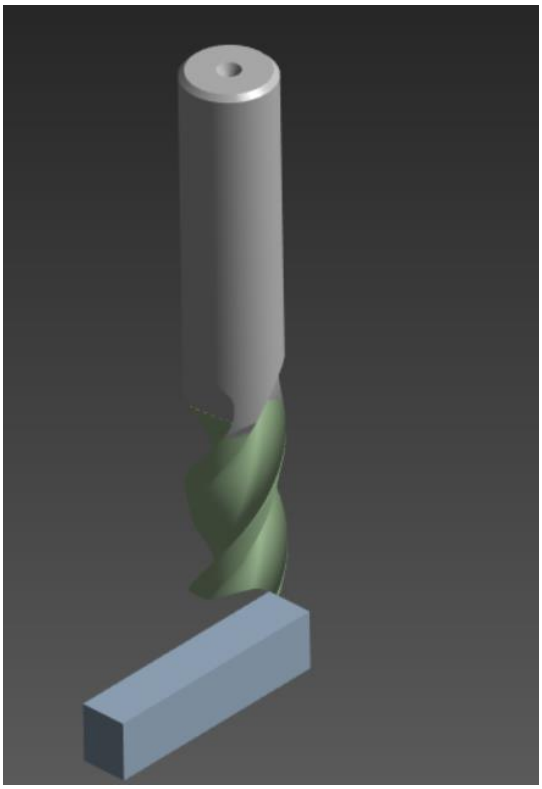
A certificate of state registration of copyright rights was obtained for the numerical modeling of the processing of difficult-to-process materials in order to determine the cutting conditions suitable for various processing methods. May 27, 2025, No. 58780. Bakytzhan Serikovich Donenbayev, Karibek Tagayevich Sherov, Sabit Shamilevich Magavin. Scientific work: "quantitative modeling methodology for determining optimal cutting modes of hard-to-process materials."

Expected results for the second half of 2025

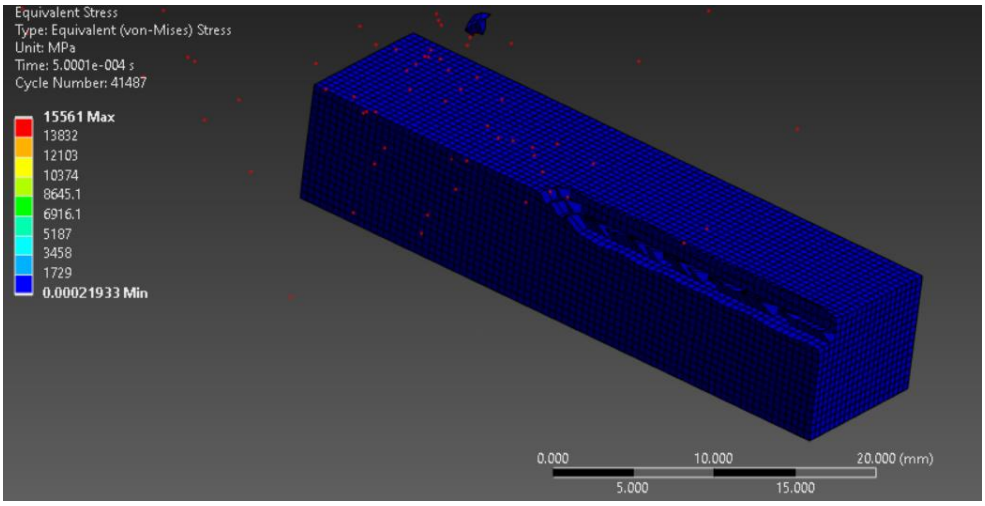
- various machining methods (milling, turning, drilling, etc.) and optimal cutting modes will be determined.;

- recommendations on the choice of cutting mode and the act of commissioning will be given for various processing methods, as well as approval protocols will be formed.

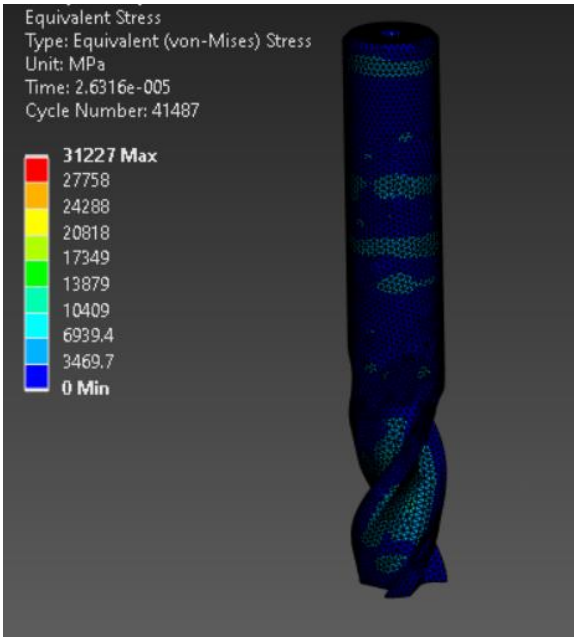
- 1 (one) article will be published in journals from the first three quartiles of the impact factor in the Web of Science database or having a CiteScore percentile in the Scopus database of at least 50.



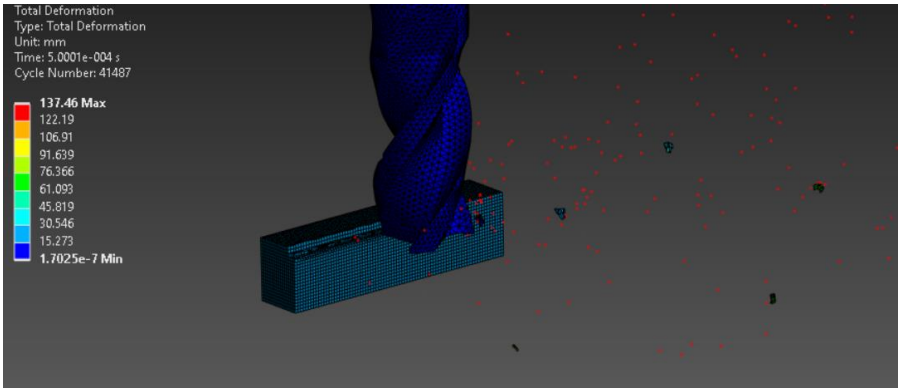
**Picture 1** – 3D model of end mill and workpiece




**Picture 2** – Equivalent stress in the workpiece




**Picture 3** – Equivalent stress in end mill




**Picture 4** – Chip formation during end milling

***The research group***

| No. in sequence | Full name (if available), education, degree, academic title | Main place of work, position | Hirsch index, ResearcherID, ORCID, Scopus Author ID (if available) | Brief justification of participation |
|---|---|---|---|---|
| | Donenbayev Bakytzhan Serikovich, PhD | Non-Profit Joint Stock Company "Abylkas Saginov Karaganda Technical University", Senior Lecturer | The Hirsch Index - 2, ResearcherID: Y-2178-2018, https://orcid.org/0000-0001-6923-3476, Scopus Author ID: 57193404717 | Determination of mechanical and plastic characteristics of materials based on testing on the MI-40 bursting machine of samples from hard-to-process materials. Comparison of the |

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| | | | | results of sample destruction with test numerical modeling. Creation of an algorithm for calculating numerical simulation of processing |
| | Magavin, Sabit. candidate of technical sciences | Non-Profit Joint Stock Saken Seifullin Kazakh Agrotechnical University, assistant professor | The Hirsch Index – 2, ResearcherID: FMW-5410-2022, https://orcid.org/0000-0003-0920-1442 , Scopus Author ID: 57193404717 | Organization, control and execution of work, processing and analysis of the results obtained in the process of experimental research, development and selection of optimal parameters of a prototype rotary tool. |

***List of publications***

свидетельство о государственной регистрации прав на объект авторского права для методики численного моделирования процесса обработки труднообрабатываемых материалов с целью определения условий резания, подходящих для различных методов обработки. "27" мая 2025 года № 58780. Доненбаев Бакытжан Серикович, Шеров Карибек Тагаевич, Магавин Сабит Шамильевич.

Б.С. Доненбаев, К.Т. Шеров, С.Ш. Магавин, А.К. Ракишев, Л.Н. Махмудов «Техникалық ғылымдар және технологиялар» сериясының 2024 жылдың №4 «Л.Н.Гумилев атындағы Еуразия ұлттық университетінің хабаршысы журналы

B. Donenbaev, K. Sherov, B. Mardonov, L. Makhmudov, S. Magavin, A. Rakishea, A. Sherov/ Research and modelling of the high-speed milling process of heat-resistant high-alloy steel 15Kh12VMF.

Б.С. Доненбаев, С.Ш. Магавин, К.Т. Шеров, А.К. Ракишев, М.М. Мусаев. Төмен көміртекті болаттың қырауының даму кезеңін тәжірибелік зерттеу және сандық үлгілеу // Л.Н. Гумилев атындағы ЕҰУ хабаршысы. Техникалық ғылымдар және технология сериясы. №3/2023. – 134-142б.

***Information for potential users***

This project will examine the analytical calculation of cutting modes of difficult-to-machine materials for various mechanical operations, taking into account the obtained results of experimental and numerical finite element modeling of the processing process. Optimal cutting modes for various methods of mechanical processing will be determined.Будет исследована стойкость режущего инструмента приводящим возникновению колебании при механической обработке отрицательно влияющих на точность обработки и к большому расходу режущего инструмента.

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.

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

***The field of application***

Machine-building enterprises of the Republic of Kazakhstan.

*Date of information update: 01.07.2025*