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 machine 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.

At the domestic industry, the following plants mainly specialize in manufacturing and restoring large-sized parts: the Almaty Heavy Machinery Plant (AZTM) JSC and the Petropavlovsk Heavy Machinery Plant (PZTM) JSC.

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 studies carried out on the state of issues related to the technology of machining and ensuring quality indicators of large-sized parts in the conditions of the AZTM JSC, a number of problems were identified: time costs for mounting, aligning, fastening, and removing a large-sized part; the need to manufacture additional tooling; the occurrence of vibrations that negatively affect the accuracy of machining and the durability of the cutting tool leading to high consumption of the cutting tool.

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

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

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

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 project purpose:

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

Expected and achieved results:

A methodology of numerical modeling of machining difficult-to-machine materials will be developed to determine favorable cutting conditions for various methods (milling, turning, drilling, etc.) of mechanical treatment, as well as a methodology of developing a model of the destruction of difficult-to-machine materials for software packages.

Domestic machine-building enterprises are considered as potential consumers of the proposed scientific products.

Based on the results of the project, there will be published the following:

- 2 (two) articles in journals from the first three quartiles by impact factor in the Web of Science database or having a percentile by CiteScore in the Scopus database of at least 50;
- 2 (two) articles and (or) reviews in peer-reviewed foreign and (or) domestic publications recommended by the CQASHE;
- 1 certificate of state registration of rights to a copyright object.

Based on the results of the study, recommendations will be developed for machining difficult-to-machine materials using various methods (milling, turning, drilling, etc.) of mechanical treatment, as well as for the selecting of cutting modes.

The Design Bureau "STEP" LLP is directly involved as a private partner that contributes funding in monetary terms in the amount of 1% of the project amount.

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

Scientific developments have a high degree of commercialization in the future.

End mills are a type of cutters used on milling machines and are necessary for machining narrow planes, grooves, ledges and contour treatment. End milling is one of the most common procedures in industrial machining. This process differs from the other operations in the presence of cutting teeth on the sides and at the end of the cutter, and this is the main difference from the other cutters.

For a numerical study of the distribution of deformations and stresses in the machining zone, a 3D model of the tool and workpiece was developed.

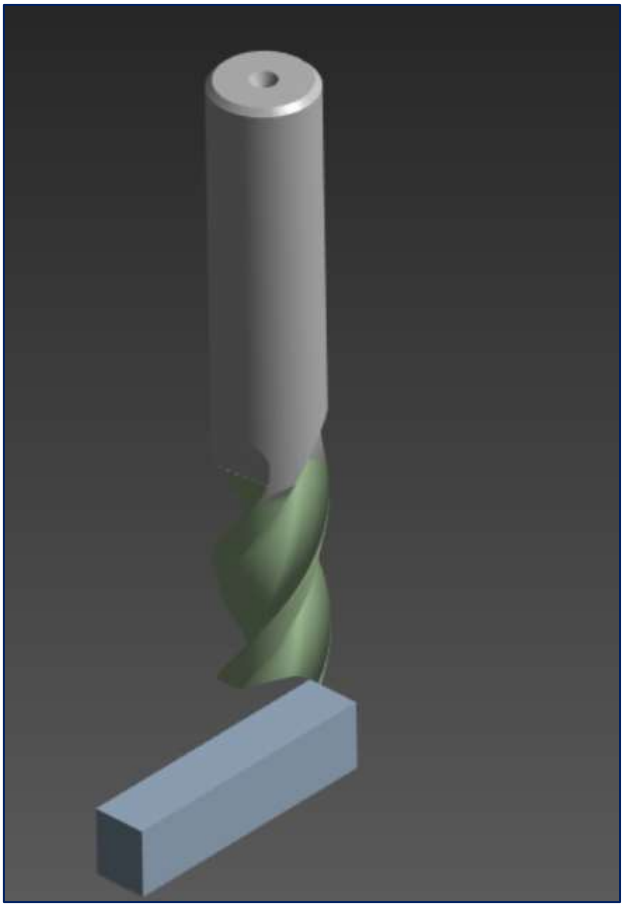

Figure 1 – 3D model of the end cutter and workpiece

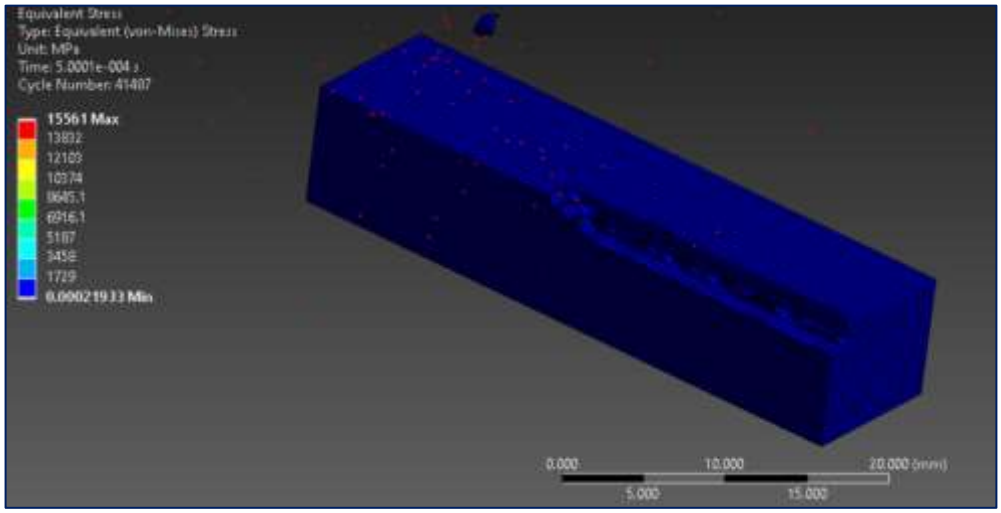

Figure 2 – Equivalent stress in the workpiece

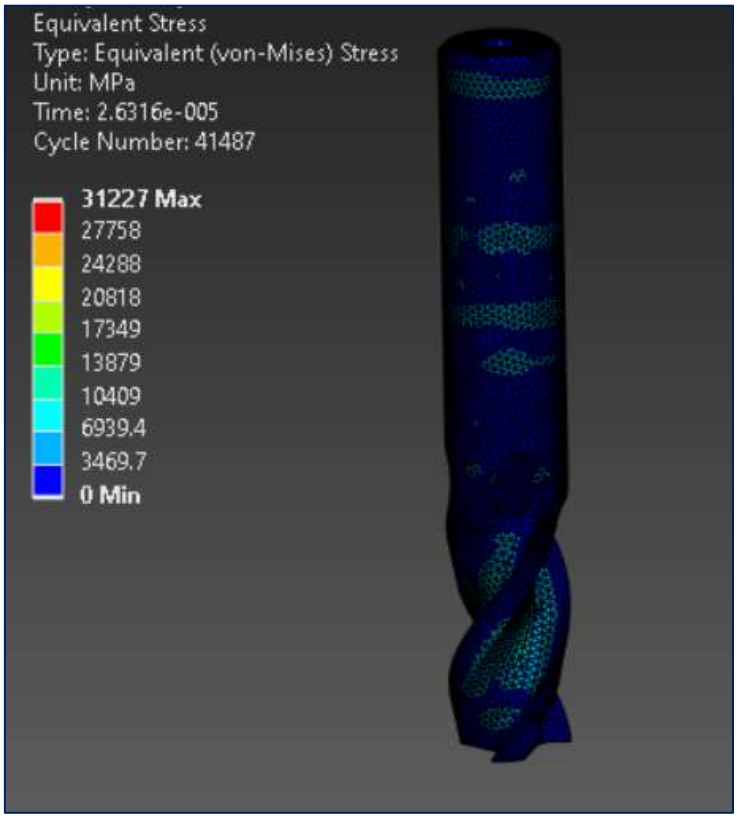

Figure 3 – Equivalent stress in the end cutter

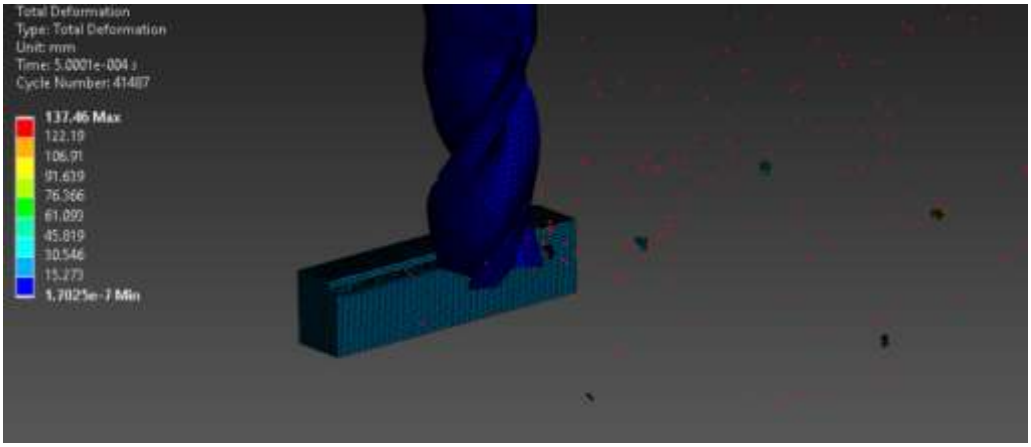

Figure 4 – Chip formation when machining with the end milling

Research group:

No	Full name, education, academic degree, title	Main place of work, position	Hirsch index, ResearcherID, ORCID, Scopus Author ID identifiers (if any)	Role in the project, character of the work performed
1	Donenbayev Bakytzhan Serikovich, PhD	Abylkas Saginov Karaganda Technical University NJSC, senior teacher	Hirsch index - 2, ResearcherID: Y-2178-2018, ORCID: https://orcid.org/0000-0001-6923-3476, Scopus Author ID: 57193404717	Project manager
2	Magavin Sabit Shamilyevich, Cand. Tech. Sci.	S. Seifullin Kazakh Agrotechnical University NJSC, Associate Professor	Hirsch index – 2 Scopus Author ID - 57203157613 ORCID: https://orcid.org/0000-0003-0920-1442 , Scopus Author ID: 57193404717	Scientific consultant

List of publications:

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 **Percentile 52%.**

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

5. Rakishev A., Sagitov A., Donenbaev B. and etc. Calculation of the multi-blade rotary-friction tool's cutting cupped cutter to strength in the ansyswb surrounding. Journal of Applied Engineering Science, 18(2020)4, 643 - 648. https://doi.org/10.5937/jaes0-24328 **Percentile 52%.**

6. Sabit Magavin, Karibek Sherov, Medgat Mussayev. Investigation of the method of thermal friction turn-milling of high strength materials / Journal of Applied Engineering Science, 2022, 20(1), pp. 13–18. doi:10.5937/jaes0-29546 **Percentile 52%.**

7. Magavin, S.Sh., Aimurzinov Zh.K. Research of the design and study of the parameters of the drilling working body. Science Bulletin of the Kazakh Agrotechnical University named after S.Seifullin (interdisciplinary). 2018. No. 1 (96). Astana, KATU publishing house. P.140-149.

8. Aikenova R.A., Magavin S.Sh., Tanibergenova A.Sh. Methodological principles of formation of integral-creative thinking of university students. Bulletin of the Academy of Pedagogical Sciences of Kazakhstan, No. 2. Almaty, APNK publishing house, 2018. P.38-48.

9. Aikenova R.A., Magavin S.Sh., Yusbekova N.N. Criteria and indicators of the evaluation of the computer linguistic competence of students. Bulletin of the Academy of Pedagogical Sciences of Kazakhstan. 2019. No. 3 (89). Almaty, Publishing House of the Academy of Pedagogical Sciences of Kazakhstan. P. 27-36.

10. Donenbayev B.S., Sherov K.T., Tusupova S.O., Rakishev A.K., Musayev M.M., Sherov A.K., Kurmangaliyev T.B., Sarymbay A.K. Quality control and testing of thermofriction tools deposited with wear-resistant surfacing materials. Science News of Kazakhstan, 2020. No. 3 (145). P. 82-91.

11. Donenbayev B.S., Rakishev A.K., Sherov K.T., Sovet N.R. Study of the rigidity of the bearing parts of the rotary-friction tool in NX CAE. Science and Technology of Kazakhstan. 2019. No. 3. P. 96-103.

12. Donenbayev B.S., Sherov A.K., Finite element study and optimization of geometric parameters of parts of rotary-friction tool // Mechanics and technology. Taraz: Publishing house "Taraz University" of TarSU named after M.Kh. Dulati, 2018. No. 1 (59). P. 7-16.

13. B.S. Donenbayev, S.Sh. Magavin, K.T. Sherov, A.K. Rakishev, M.M. Musayev Experimental studying and numerical modeling of the development stage of low-carbon steel destruction // L.N. Herald of Gumilev National University. Technical Sciences and Technology Series.No. 3/2023. 134-142b.

Information for potential consumers:

This project will consider 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 machining process. Optimal cutting modes for various methods of mechanical processing will be determined.

The durability of the cutting tool leading to the occurrence of oscillations during mechanical treatment that negatively affect the accuracy of machining and provide high consumption of the cutting tool, will be investigated.

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 treatment industry of mechanical engineering, as well as for specialists involved in the development of software packages.

Scope:

Machine-building enterprise of the Republic of Kazakhstan.

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