

ANNOTATION

for a dissertational work for the degree of Philosophy Doctor (PhD)
6D071200 - Mechanical Engineering

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Investigation of the effect of residual stresses arising after machining strength transitional planting.

Evaluation of contemporary states of solvable scientific and technical problems (tasks)

The problems of strength and wear resistance are central to providing resource management in mechanical engineering. Therefore, a thorough knowledge of area of modern methods of calculation for strength, durability, wear stamina and reliability. Terms strength and reliability products are laid on the stages designing. Design, technology manufacturing, conducting TI and used materials must to be interconnected and conditioned. it is basis creation all chains process manufacturing new details and machines. At modernization machines unacceptable arbitrary change only material, designs or technology. Failure these conditions automatically makes all other requirements and criteria for the quality of machines meaningless. Decisive influence on the operational properties details products render characteristics superficial layer materials details.

Main aspect work is residual stresses. Residual stresses (RS) - elastic deformation and the corresponding stresses balanced inside the body in the absence of external forces. RS persists in time. The main reason for the occurrence of RS is the inhomogeneity of the deformation induced state due to different changes in length (volume) in different body zones. The following effects of residual stresses are possible: warping, change sizes and even destruction. Residual stresses must be mutually balanced, and caused deformations admissible.

Relevance of research topic. The problems of formation, control and monitoring of surface residual stresses in parts are one of the most important tasks, the successful solution of which will significantly increase the stability of the strength characteristics of engine parts during their manufacture, which will help ensure the required reliability of engines. In the manufacture of machine parts and mechanisms, various technologies of pressure treatment, casting, welding, heat treatment, grinding, cutting and others are used, which is accompanied by the appearance of internal and surface stresses in the product. In most cases, stresses are completely or partially retained in the metal after the end of the technological process and are therefore called residual stresses.

Residual stresses arise due to unequal plastic deformation or different changes in specific volume at different points of the body. Reducing the level of unfavorable residual stresses is provided by various technological methods, for example, heat treatment. In the overwhelming majority of cases, the magnitude, sign, and

distribution of residual stresses over the volume of the product are unknown. To determine these characteristics, it is required to violate the integrity of the product or use non-destructive testing methods that allow estimating the level of surface residual stresses (SRS). The most significant scientific and methodological problems are the lack of non-destructive testing methods for the most critical and complex areas of gearbox parts; lack of non-destructive methods for determining stress diagrams by the depth of the surface layer of the part; lack of methods for modeling residual stresses during machining and hardening operations by various methods.

Goals and tasks of the work. The aim of this work is to study the residual stress after machining and its influence on the strength elements of structures with considering constructive-technological factors.

For achievements given goals were formulated the following main tasks:

- analyze the reasons and general patterns of formation of residual stresses in structural elements.
- develop a scheme for calculating residual stresses in typical elements of structures with stress concentrators under elastic and elastic-plastic deformation with taking into account constructive and technological factors;
- investigate the effect of SSS and residual stresses in elements of structures on their strength. With taking into account technological heredity.

Scientific positions, taken out on the defence:

- reduction of residual stresses due to the selection of optimal cutting conditions for processing workpieces of machine parts and mechanisms;
- scheme for calculating the stress-strain state in standard elements of engineering structures with stresses with taking into account constructive and technological factors in preparation and plan loading;
- results of calculation of the stress-strain state of joints with transitional landings.
- factors, influencing on the origin and value of residual stresses after machining workpieces.
- methods of modeling residual stresses and their results in the form of calculations of stress-strain state for coatings and details.
- computer 3D model of blanks and connections with transitional landings.
- grade influence of tensile residual stresses on bending strength of parts of a cylindrical gearbox of complex configurations.

Scientific novelty of research results:

- SSS calculation scheme was developed and residual stresses in elements of structures, which differs in taking into account structural and technological factors and stresses loading;
- general patterns of formation of residual stresses with taking into account technological heredity in details with stress concentrators;
- influence of constructive factors and various technological operations on the manufacture of parts, taking into account operational characteristics;

- defined critical loads in connection with transitional landings;
- proposed methods for determining residual stresses in thin-walled products.

Practical significance of work:

- developed models, taking into account influence residual stress, provide clarification of strength characteristics at the design stage and development technological the process of manufacturing parts of complex mechanisms;
- research results implemented on the enterprise JSC "Zhaken-Kalsha", LLP "Almaty Plant Electrosheet", Almaty for the analysis and adjustment of serial technological processes for the manufacture of various production parts;
- results scientific research given work may to be used at designing elements structures with taking into account technological heredity.

Methodology and research methods

The methodology of theoretical, mathematical analysis, methods research, methods of reliability theory and processing of statistical and experimental research data in laboratory conditions, research methods in technology engineering, mathematical modeling, research methods in the theory of mechanisms and machines, fundamentals of parts design and theory of elastic-plastic deformation. Numerical calculation implemented on the basis of the finite element method using ANSYS software and computing systems, DEFORM-3D.

Processing of research results

Experimental studies were carried out:

- 1) With the use of laboratory stands of the department "Mechanical Engineering"

KazNRTU named after K.I. Satbayev were experimental studies;

- 2) Using laboratory instruments, measuring instruments and stands

Department of "Mechanical Engineering Technology" of the Tashkent Polytechnic University named after Beruni (Tashkent, Uzbekistan) were experimental studies;

- 3) Processing of experimental data was carried out in accordance with the algorithm for processing deterministic and stochastic data, taking into account the limiting absolute error.

Approbation of work. The main provisions and scientific results were discussed at international scientific and technical conferences and published in journals:

- 1) At the technical seminars of the Department "Mechanical Engineering" KazNRTU named after K.I. Satbayev, Department of Mechanical Engineering Technology, Tashkent Polytechnic University named after Beruni (Tashkent, Uzbekistan), Department of "Transport equipment, mechanical engineering and standardization" of the Kazakh University of Railways.

- 2) Industrial transport of Kazakhstan No. 2 (63) - Almaty KUPS , 2019 , pp. 32 - 36 ISSN 1814 - 5787.

3) Theoretical foundations of the reliability of mechanical systems of transport vehicles. Industrial transport of Kazakhstan No. 3 (64) - Almaty KUPS , 2019 , _ pp. 190 - 194 ISSN 1814 - 5787.

4) Proceedings of the international scientific and practical conference "Modern materials science: experience, problems and development prospects" - Almaty: KazNTU Publishing House 2015. - P. 164-166. ISBN 962-603-324-294-1.

5) Proceedings of the international scientific and practical conference "SATPAEV READINGS - 2022. TRENDS IN MODERN SCIENTIFIC RESEARCH". Volume-1. Satbayev University, Kazakhstan, Almaty 2022, p . 1000-1003. ISBN 978-601-323-291-1.

6) Journal of Applied and Computational Mechanics. Volume 8, Issue 4, 2022, Pages 2383-4536. Shahid Chamran University of Ahvaz. ISSN: 2383-4536 percentile 92.322 %

7) Engineering for Rural Development Volume 16, 2017, Pages 36-41 ISSN: 16913043 percentile 84.767 %.

Publications. Main results dissertations reflected in 7 printed works, including 2 articles in journals recommended by the CQASE, 2 articles in journals, indexed by Scopus, 3 in the collections of International scientific conferences.

Contribution of the dissertation student to the preparation of publications

1. **"Theoretical foundations of the reliability of mechanical systems of transport vehicles."** Search for publications for the review and its writing, writing sections: research methodology, research results, design of graphs, responses to comments.

2. **"Calculation of the adhesion strength of the transitional fit and interference fit of the shaft-ring connection."** Selection of materials for the review, writing a review and introduction, processing and description of the results of experiments, writing a conclusion.

3. **"Computational and Experimental Study of the Composite Material for the Centrifugal Pump Impellers Manufacturing."** Section writing: introduction, research methodology, mathematical processing and discussion of experimental results, article design.

4. **"NEW TYPE CAM-SCREW MECHANICAL PRESS"**. Drawing up an article plan, writing sections, discussing research results and conclusions, article design.

5. **"Influence of processing by surface plastic deformation on residual stress of the surface casting disc."** Development of a report plan, selection and systematization of materials, writing two sections, presentation at a conference.

6. **"Sandyk bagdarlamalyk baskaruy bar machine tool bilikterdin mechanicallyk  ndeuininin tiimdiligin zertteu zhane taldau"**. Development of a report plan, selection and systematization of materials, writing two sections, presentation at a conference.

7. **"Influence of turning modes on the surface roughness of the casting disk "**. Development of a report plan, selection and systematization of materials,

writing two sections, presentation at a conference.

The structure and scope of the dissertation. The dissertation consists of an introduction, four chapters, major conclusions, literature list and applications. Work contains 116 pages typewritten text, including 52 figure, bibliography from 107 items, 3 applications.