SELECTED ABSTRACTS OF D.SC. AND PH.D. THESES SUBMITTED AT RUSSIAN UNIVERSITIES

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Akulich, V. Yu. Stress-strain state and equilibrium stability of cylindrical shells under elastic and elastic-plastic deformations, including those interacting with the surrounding base, considering the change in the calculation model in time. Abstract of Ph.D. (Eng) thesis [*Napryazhenno-deformirovannoe sostoyanie i ustoichivost ravnovesiya tsilindrichekikh obolochek pri uprugikh i uprugo-plasticheskikh deformatsiyakh, v tom chisel vzaimodeistvuyushchikh s okruzhayushchim osnovaniem, s uchetom izmeneniya raschetnoi modeli vo vremeni. Avtoref. dis… kand. tekh. nauk*]. Moscow, RUT publ., 2021, 24 p.

Thin-walled elements – shells are widely used in modern building structures. They are used in transport, industrial and civil construction in construction of towers, supports, tanks, vaults, tunnels, etc.

Shells have several advantages: they are able to effectively absorb the applied load due to their geometric shape, they are aesthetic and preferable from an architectural point of view.

Shell elements play a special role in underground structures, where cylindrical and other vaulted surfaces are often used. With a fairly broad study of the features of operation of cylindrical shells, questions remain regarding taking into account the influence of the contact interaction between the shell and the base, nonlinearity of ongoing processes, and the change in the stress-strain state (SSS) of the shell during its installation, which does not allow us to give a real assessment of SSS and stability of such structures from the start of construction work to its completion. This predetermines the relevance of the research topic on the development of methods for calculating the strength, stability and rigidity of shells interacting with the surrounding base.

The objective of the thesis work is to develop and develop methods for calculating and analysing the stress-strain state of cylindrical shells interacting with the surrounding base, in planar and spatial formulations of problems.

The scientific novelty of the study lies in assessment of SSS and stability of cylindrical shells, considering the interaction with the surrounding base and the stages of construction, namely:

1. Finite element models of the «cylindrical shell–surrounding base» system are built, which change in time, taking into account the gap between the shell and the base at the construction stage using one-way contact interaction and the physical nonlinearity of materials.

2. The dimensions of the spatial fragment of the system «cylindrical shell–surrounding base» are determined, which are necessary to obtain reliable results of calculating the settlement of the upper surface of the base.

3. An algorithm for estimating SSS and stability of the «cylindrical shell–surrounding base» system has been developed and implemented.

4. PCL program in the PATRAN software package for automating the process of creating a solid-state design model of the «cylindrical shell–surrounding base» system with the ability to take into account the construction gap between the shell and the base with one-sided contact interaction.

To solve the problems posed in the thesis work, the finite element method in displacements was applied, including construction of computational models of the systems under consideration, their numerical linear and geometrically, physically and constructively nonlinear analysis. To take into account development of plastic deformations of materials, the theory of plastic flow with the Mohr–Coulomb and Drucker–Prager plasticity criteria is used.

The generalized results of the conducted studies are as follows.

A numerical method has been developed for taking into account the construction gap between

the cylindrical shell and the surrounding base, based on spatial calculation models using two methods for creating a gap that allow taking into account the «lost volume» of soil from operation of a mechanized tunnel boring complex. The calculation models are compared with each other and with the known semi-empirical method. The best results were shown by the model with contact elements approximating the gap in calculations to determine the settlement of the surface of the array both in the transverse and longitudinal directions to the shell axis.

The dimensions of the spatial fragment of the array are determined, which are necessary to obtain reliable results of calculating the settlement of the upper surface in the transverse and longitudinal directions to the axis of the shell according to the developed calculation models that take into account the gap. Taking into account the results of calculations of the SSS of the system, it can be recommended in practical calculations to determine the settlement of the surface of the array in the transverse direction to the shell axis to take the distance L from the edge of the shell to the side ends of the array (in the transverse direction), satisfying the condition $L \geq 5D$, where D is the diameter of the shell. When determining the settlement of the surface of the array in the longitudinal direction to the axis of the shell, it can be recommended to take the distance L from the edge of the shell to the ends of the array (in the longitudinal direction), which also satisfies the condition $L \geq 5D$.

A program has been developed to automate the process of creating a solid-state computational model of a cylindrical shell, the surrounding array and contact elements of the gap in the PCL command language, which is part of the MSC PATRAN system.

A practical problem has been solved to determine the subsidence trough of a section of the earth's surface with operated railway tracks of Moscow Railway, located within the zone of influence of the construction of the planned distillation tunnels of Kalininsko-Solntsevskaya line of Moscow Metro from Ramenki metro station to Rasskazovka metro station. The results obtained are compared with geodetic monitoring data.

A technique has been developed and implemented based on spatial computational models that change over time, allowing to consider a different number of stages in construction of cylindrical shells interacting with the surrounding base. The models consider one-way contact interaction, building gap and physical non-linearity of materials. The influence of considering the phased erection of a structure on the stress-strain state of a cylindrical shell of finite dimensions interacting with the surrounding base is studied using numerical methods. It has been established that the values of internal forces in the body of a cylindrical shell strongly depend on the number of stages in the design case. Based on the results obtained, it is recommended to take 8 or more design stages of shell construction in practical calculations.

It has been established that considering the friction coefficient in staged design cases significantly reduces the maximum stresses in the cylindrical shell. It is shown that introduction of the elastic-plastic model of the material for the shell into the calculation also significantly reduces the magnitude of maximum stresses.

The features of the SSS of a system consisting of two parallel cylindrical shells and the surrounding base are determined, namely: the influence exerted on the first shell by the gradual construction of the second nearby shell is determined. The results obtained showed that this effect is generally insignificant and the stress increase for all considered rings of the first shell did not exceed 7,8 %, except for the last ring, where the stress increase was 116,8 %.

A technique and algorithm for obtaining critical loads and forms of buckling of a cylindrical shell for various models of materials and conditions of contact interaction with the surrounding base have been developed and implemented. Rod, flat and spatial models of the «shell–base» system were compiled. Spatial calculation schemes are built with and without considering the coefficient of friction between the shell and the base, as well as within the framework of linear elastic and elastic-plastic models of materials. A numerical analysis of the system was carried out to determine the critical load at which the shell structure interacting with the surrounding base loses its equilibrium

stability, and the forms of buckling in linear and nonlinear design cases, followed by a comparative analysis of the results.

It has been established that in calculations for stability at large displacements of the system, a nonlinear calculation by step-by-step application of a load and an iterative procedure makes it possible to find zones of absence of element contact (the area of shell detachment from the base) and to determine the position of the shell that changes in time, which excludes overestimated values of the critical load obtained at linear calculation when the displacements are small. It is also determined that considering the coefficient of friction provides better joint operation of the shell and the surrounding base and allows obtaining slightly higher values of the critical load, both with a linear elastic model of the material and with an elastic-plastic one.

Numerical analysis of the spatial system «shell–base» in the case of inhomogeneous physical and mechanical properties of the base along the longitudinal axis of the cylindrical shell found that the loss of stability of the shell occurs in the area of the weaker base.

2.1.9. – Structural mechanics.

The work was performed and defended at Russian University of Transport.

Bunkova, T. G. Increasing the resource of the wheel-rail pair through the rational selection of material properties. Abstract of Ph.D. (Eng) thesis [*Povyshenie resursa pary «koleso-rels»* za *schet ratsionalnogo podbora svoistv materialov. Avtoref. dis… kand. tekh. nauk*]. St. Petersburg, PGUPS publ., 2022, 18 p.

To date, the problem of increasing productivity and reducing the cost of the transportation process in railway transport is being solved by increasing the axle load and speed of the rolling stock. The practice of operating the car fleet has shown an increase in the wear rate of both wheels and rails, which undoubtedly affects safety of train traffic on the railway track. It has been experimentally established that wear resistance of triboelements of the «wheel–rail» system is largely characterized by the hardness of their materials. Numerous experiments on the effect of hardness on wear were often carried out for a wheel and a rail separately from each other. It is possible to reduce wheel and rail wear by searching for the optimum ratio between the hardness of wheel and rail steels.

Objective of the study. Increasing the resource of the «wheel–rail» pair due to the rational selection of the properties of their materials.

In theoretical studies, the main provisions of tribology, the theory of experiment planning and mathematical modelling are used. The experimental part of the work is based on a method for determining the wear of a wheel and a rail using specially designed equipment, a method for determining hardness, and metallographic analysis. The analysis of the obtained data was carried out in the software packages ANSYS, Statistica, MathCAD.

Scientific novelty of the thesis work:

- Mathematical models of the dependence of wear on the hardness parameters of the «wheel–rail» tribosystem, the effective axial load and the speed of the car are constructed.
- A rational range of hardness values for railway wheel and rail steels is proposed, which reduce their wear and increase the wheel overhaul life.
- The dependence of wheel wear on the run to formation of rolled products of rejection value is established for various values of the hardness of steels of the wheel and rail.
- The equivalent stresses and contact pressures of wheels with nominal and minimum rim thicknesses in the presence and absence of a chip are determined.

The main scientific and practical results of the thesis work are as follows:

1. The analysis of defects excluded from operation of wheel sets of «standard» and «solid» wheels was carried out, which made it possible to reveal an ambiguous dependence of the wear resistance and resource of the «wheel–rail» tribosystem on the hardness of steels. With an increase in the hardness of the wheel steel, the percentage of defects decreases – a thin ridge and a pointed ridge roll, but the percentage of cuts along sliders and dents increases.

2. An experimental method is proposed for determining the rational ratio of hardness of rail

and wheel steels, considering variable axial loads and rolling stock speeds, which allows predicting the overhaul period (mileage) of a freight car wheel, and can be used in the design of new rolling stock and as recommendations in production of a railway track.

3. Experimental studies have been carried out to evaluate the dependence of the wear resistance and resource of a «wheel–rail» pair on the ratio of hardness of their steels using the designed installation and acting axial loads. The optimal ratio of wheel and rail steel hardness (360/360 HB) under any operating conditions was revealed, which will reduce the wear rate of these elements and increase the resource and overhaul life of a freight car wheel up to 1,5 times.

4. The expected annual economic effect when using the proposed ratio of wheel and rail steel hardness will be 1,37 thousand rubles per unit of production (car wheel).

05.22.07 – Railway rolling stock, train traction and electrification.

The work was performed and defended at Emperor Alexander I St. Petersburg State Transport University.

Dunaev, A. M. Automated subsystem for diagnosing electrical equipment of frequency converters. Abstract of Ph.D. (Eng) thesis [*Avtomatizirovannaya podsistema diagnostirovaniya elektrooborudovaniya preobrazovatelei chastoty. Avtoref. dis… kand. tekh. nauk*]. Irkutsk, IRNITU, IrGUPS publ., 2022, 16 p.

An important task in the field of automation and control of technological processes and industries is to ensure reliability of operation of complex electrical equipment (EE), which includes power semiconductor frequency converters (FC), which are part of frequency-controlled electric drives of general industrial electrical equipment. The aforementioned equipment, in particular, includes asynchronous electric drives for cranes, conveyors, pumps, fans, metal-cutting machines and industrial robots. In addition, a significant amount of technological equipment for production and repair includes modern frequency-controlled electric drives.

Frequency converters are the most complex electrical equipment of a modern frequency-controlled electric drive, since they include power semiconductor diodes and transistors, as well as a microprocessor control system of the inverter, including the control system of the entire electric drive.

The solution to the problem of reducing time and improving quality of diagnosing the aforementioned complex equipment can be the use of technical diagnostic methods. The logical algorithms of methods of this class are algorithms that use the apparatus of mathematical logic. The mathematical model of the diagnosing object (OD) considers the OD as a system of interconnected functional elements that can be in one of two states: 0 – not normal, 1 – normal.

Currently, the most time-consuming components of the diagnosing process are situation assessment and decision-making, which is explained by the ever-increasing amount of information that must be considered to increase the objectivity of the situation assessment, as well as the heuristic nature of knowledge that allows the expert to obtain high-quality and effective solutions to the tasks. In connection with these circumstances, there is a need for complex automation of the process of collecting information and decision-making, for implementation of which it seems promising to use intelligent systems developed on the basis of application of logical methods of technical diagnostics and methodology of expert systems (ES).

The objective of the work is to create an automated subsystem for diagnosing electrical equipment of frequency converters, which increases the efficiency of the troubleshooting process.

The scientific novelty of the work lies in the fact that for the first time:

1. Logical algorithms for diagnosing electrical equipment are proposed, taking into account its technical conditions, which differ from the known algorithms for half division by the rules for choosing the first check in the object of diagnosis.

2. A procedure has been developed for constructing a tree of the optimal logical algorithm for diagnosing electrical equipment.

3. A tree of the optimal logical algorithm for diagnosing frequency converters has been built, which differs from the known diagnosing algorithms by a minimum indicator of average diagnostic costs.

4. A structure of the knowledge base of the expert complex for diagnosing the electrical equipment of frequency converters has been developed, based on the proposed optimal logical algorithm for diagnosing.

The conclusions and results of the work were obtained using the mathematical apparatus of Boolean algebra, optimization methods, programming technology in high-level languages, and expert system development technology.

During the thesis, the following main results were obtained:

1. The current state of methods and systems for diagnosing electrical equipment, including equipment for AC electric drives, is analysed.

2. Based on the performed analysis, the structure and algorithms for functioning of the automated subsystem for diagnosing electrical equipment of frequency converters are proposed.

3. New logical algorithms for diagnosing electrical equipment have been developed, which differ from the known algorithms by the rules for choosing the first test and are more efficient when applied to frequency converters.

4. A procedure for constructing an optimal logical algorithm for diagnosing electrical equipment of frequency converters is proposed. An optimal logical algorithm for diagnosing frequency converters has been developed, which is characterized by minimal time consumption.

5. Based on the optimal algorithm, the structure of the knowledge base of the expert complex for diagnosing the electrical equipment of frequency converters has been developed.

6. In accordance with the proposed structure and operation algorithms, an automated subsystem for diagnosing electrical equipment of frequency converters used in industry has been implemented. The subsystem allows diagnosing in real time and in the mode of consulting assistance.

7. Approbation of the implemented subsystem showed that its application to real electrical equipment of frequency converters allows for an average threefold reduction in the time of diagnosis and adjustment.

2.3.3 – Automation and control of technological processes and industries (technical sciences).

The work was performed at Federal State Budgetary Educational Institution of Higher Education Irkutsk National Research Technical University (IRNITU), defended at Irkutsk State Transport University (IrGUPS).

Pershin, N. V. Automation of management of transportation of liquefied natural gas by sea. Abstract of Ph.D. (Eng) thesis [*Avtomatizatsiya upravleniya perevozkami szhizhennogo prirodnogo gaza morskim transportom. Avtoref. dis… kand. tekh. nauk*]. Moscow, RUT publ., 2021, 23 p.

The Arctic zone, rich in natural gas, needs to create effective transport and logistics systems for safe, uninterrupted, and economically rational export of hydrocarbon raw materials. The development of the Northern Sea Route as a historically established national unified transport communication of the Russian Federation in the Arctic, as well as growing production, processing, and transportation of natural gas in this region, require creation of an automated control system that ensures cost-effective and safe transportation of liquefied natural gas (hereinafter referred to as LNG), which determines the relevance of this study.

Objective of the study. Development of principles for building an automated system for managing LNG transportation by sea, which ensures safe and cost-effective delivery of natural gas.

Methods of system analysis, control theory, probability theory, operations research and mathematical statistics, optimization theory are used.

Scientific novelty of the thesis:

• Based on the analysis of existing methods for planning and managing LNG transportation

by sea, economic feasibility of creating an automated control system was shown.

• For the first time shown and substantiated based on processing of statistical data, the dependence of productivity of the LNG plant on the meteorological factor.

• The need for development of automated systems for managing LNG transportation by sea was for the first time substantiated by the results of processing statistical data on LNG consumption volumes.

• For the first time, a mathematical model has been developed that makes it possible to analyse time losses in the interaction of manufacturing plants and loading operations of gas tankers.

• To analyse the dynamics of functioning of LNG transportation management system by sea in the presence of disturbances, the probabilities of finding gas tankers near LNG plant in the conditions of the possibility of their full load and the absence of time losses are determined, allowing to develop appropriate controls in an automated system.

• Based on the analysis of movement of gas tankers in confined waters, the productivity of LNG production plants, the cost of LNG, the daily freight rate of gas tankers, an optimization problem was set and solved for choosing the time for the approach of a gas tanker to enter confined waters, which ensures minimization of economic costs.

• Developed and substantiated the principles of building an automated system for managing LNG transportation by sea, including planning algorithms and ways to implement the implementation of the schedule of gas tankers for LNG export in real time due to the receipt of operational information from the objects of the transportation process.

The main results are as follows.

1. The analysis of methods for planning and managing LNG transportation by sea showed that there are currently methods for developing logistics schemes for transporting LNG, scheduling LNG transportation, an economically viable method for transporting LNG from areas with harsh climatic conditions, and methods for transporting LNG. At the same time, in world practice there are no automated systems for planning and managing LNG transportation by sea, in which the above developments can be used. The analysis carried out made it possible to formulate requirements for an automated control system.

2. The study of productivity of manufacturing plants has been conducted.

LNG (on the example of the production complex of the Sakhalin-2 project, located in the village of Prigorodnoye on Sakhalin Island), during which the dependence of the productivity of the LNG plant on the meteorological factor was established, which has a significant impact on the LNG transportation process and should, unlike known methods, be taken into account when planning LNG transportation and scheduling movement of gas tankers.

3. A statistical study of the dynamics of LNG consumption in the world showed:

• Increase in the amount of energy consumed from the considered LNG terminals from 2014 to 2018 by 22 % and a jump in 2019 by 45 % compared to 2018.

• The prevailing impact on the pricing (import and export) of LNG of the cost of oil, compared with the competition of gas sources.

• The growth in LNG consumption confirmed the relevance and necessity of creating an automated system for managing LNG transportation by sea.

4. A mathematical model «Tanker-gas carrier – Plant for production of liquefied natural gas» has been developed, based on the theory of Markov processes, which makes it possible to determine the probability of a gas tanker being at the point of loading with raw materials under various weather conditions and the probability of LNG in the reservoirs of the manufacturer.

5. The study of the dynamics of functioning of the LNG transportation management system by sea showed that:

• The probability of presence of LNG at the LNG plant during operation of three technological lines and the presence of a gas tanker near the LNG plant in summer is 29 % higher than the corresponding probability, in relation to winter conditions.

• The increase in the number of production lines of the LNG plant from one to two leads

to a decrease in the probability of downtime for a gas tanker by 29 % in summer and 35 % in winter.

• The increase in the number of production lines of the LNG plant from one to three leads to a decrease in probability of downtime of a gas tanker by 43 % in summer and 48 % in winter, in relation to one production line.

6. The analysis of movement of gas tankers in constrained waters under various hydrometeorological conditions was carried out, on the basis of which the problem of choosing the time for the approach of a gas tanker to enter constrained waters according to the criterion of minimum economic costs by the optimum-nominal method was set and solved.

7. The principles of construction, structure, and algorithms for operation of an automated system for managing transportation of liquefied natural gas by sea have been developed, which make it possible to reduce losses during transportation of LNG from the freezing seas of the Arctic zone by eliminating downtime of gas tankers during loading and long-term storage of LNG in tanks due to its daily evaporation.

8. The effectiveness of the results of the work is confirmed by their use in the companies of the Gazprom Group and the inclusion in the educational process of the universities of the Russian Federation (FSBEI HE Saint-Petersburg Mining University, Federal State Autonomous Educational Institution of Higher Education Russian State University of Oil and Gas (NRU) named after I. M. Gubkin, Russian State Hydrometeorological University).

As recommendations and prospects for further development of the topic of the thesis, the solution of an optimization problem for the full cycle of movement of a gas tanker from an LNG plant to an LNG terminal with development of an appropriate automated control system is proposed.

2.3.3 – Automation and control of technological processes and productions.

The work was performed and defended at Russian University of Transport.

Vetchanin, E. V. Qualitative analysis of the characteristic features of the behaviour of hydrodynamic and nonholonomic systems with periodic controls based on finite-dimensional models. Abstract of D.Sc. (Physics and Mathematics) thesis [*Kachestvenniy analiz kharakternykh osobennostei povedeniya gidrodinamicheskikh i negolonomnykh sistem s periodicheskimi upravleniyami na osnove konechnomernykh modelei. Avtoref. dis… doc. f.-m. nauk*]. Moscow, MAI publ., 2021, 38 p.

At present, due to development of electronics and circuitry, much attention is paid to development of various autonomous and controlled mobile robots moving in an aquatic (air) environment or on solid surfaces.

Propellers are the traditional means of generating propulsive force when moving in liquids, in the application of which significant success has been achieved, mainly due to the needs of the military-industrial complex. Autonomous uninhabited underwater vehicles designed for ocean exploration are usually equipped with propellers.

In the last two decades, the idea of self-propelling of solids in a liquid due to movement of internal masses or rotation of internal rotors has been studied. With this method of movement, it is assumed that the system may not have external moving elements at all. Note that this method of movement dates back to the work of the Soviet engineer V. N. Tolchin. Modern theoretical studies of this method of movement are presented, in particular, in the work of Academician of the Russian Academy of Sciences V. V. Kozlov, the work of Academician of the Russian Academy of Sciences F. L. Chernousko and some foreign works.

To implement movement of mechanical systems on solid surfaces, wheel and caterpillar drives are traditionally used. However, it is an interesting idea to develop spherical robots, which can also be controlled by internal rotors and moving internal masses.

From a mathematical point of view, the problem of controlling motion of a mechanical system with the help of internal masses and rotors is reduced to the choice of laws for changing the

position of the centre of mass, moments of inertia and gyrostatic moment of the system. In this case, the control laws that ensure motion in the vicinity of trajectories of even a simple form (straight line, circular arc) turn out to be nontrivial. From an engineering point of view, the simplest for implementation are periodic control laws. We note that the motion of internal mechanisms, in particular, periodic motion, can lead to the appearance of parametric resonance, various asymptotically stable or chaotic modes of motion. Thus, along with the problem of constructing explicit controls (program or based on feedback), the problems of studying the stability of motion and stabilizing particular motions also arise.

The objective of the work is to analyse the behaviour of dynamical systems with periodic controls based on finite-dimensional models of ordinary differential equations; identification of features that characterize the plane-parallel motion in a liquid of a solid body with an internal rotor and periodically changing circulation, a solid body with a movable internal mass that performs periodic movement relative to the body, a solid body, which is subject to periodic external forces and a moment of force, rotation of a solid body with a fixed point and periodically changing moments of inertia, rolling along the plane of balanced and unbalanced spherical bodies with periodically changing moments of inertia and gyrostatic moment.

On the basis of analytical and numerical methods of qualitative analysis, the behaviour of finite-dimensional dynamical systems with periodic coefficients, describing:

- Plane-parallel motion in a liquid of a solid body with an internal rotor in the presence of periodically changing circulation.
- Plane-parallel motion in a liquid of a solid with a periodically moving internal mass in the presence of constant circulation.
- Plane-parallel motion of a solid body in a liquid under the action of external periodic force and moment of forces in the presence of constant circulation.
- Rotation of a rigid body with a fixed point and periodically changing moments of inertia at a constant gyrostatic moment.
- Rolling of a balanced and unbalanced spherical body on a plane without slipping and spinning in the case of periodically changing moments of inertia and gyrostatic moment.

The following results were achieved in the previous works, which formed the basis of the thesis research. A qualitative analysis of motion of an elliptical profile in an ideal fluid under the action of periodic oscillations of the rotor in the presence of constant circulation is performed. An approximate solution of the equations describing the motion of a circular profile in a viscous fluid under the action of a periodic control and a periodically changing circulation is constructed. A computer analysis of the motion of an elliptical profile in a viscous fluid under the influence of a periodic change in the gyrostatic moment and a periodically changing circulation is performed.

A computer analysis of motion of an elliptical profile in a viscous fluid under constant circulation and under the influence of oscillations of an internal material point is performed.

A qualitative analysis of motion of a balanced circular profile in an ideal fluid under the action of external periodic force and moment of forces has been carried out. In work the author carried out an analytical and numerical study of motion of an elliptical profile in an ideal and viscous fluid under the action of external periodic forces and moment of forces, analysed integrable cases and their periodic perturbations.

Exact solutions of the equations of motion of a balanced circular profile in a fluid under the action of external periodic force and moment of forces in the form of single and double rows are constructed. In work the author studied the phenomenon of asymptotic stability with respect to some variables in a mathematical model describing motion of a balanced circular profile in an ideal fluid under the action of a periodic external moment of forces with a nonzero average value.

The dynamics of a body with a fixed point and periodically changing moments of inertia and gyrostatic moment has been studied, resonant frequencies have been found, and stability diagrams have been constructed.

The influence of friction and a constant external moment of forces on the dynamics of a body with a fixed point and periodically changing moments of inertia is studied.

Based on the harmonic balance method, the boundaries of instability regions for a body with a fixed point and periodically changing moments of inertia are analytically constructed.

A numerical assessment of stability of plane-parallel motions of a balanced spherical body with periodically changing moments of inertia and gyrostatic moment, rolling on a plane without slipping and spinning, is performed. Together with the co-author, a computer analysis of motion of a balanced spherical body with periodically changing moments of inertia and gyrostatic moment was performed, and the dynamics were shown to be non-conservative.

The author performed an analysis of stability of the upper equilibrium position of an unbalanced spherical body moving along a plane without slipping and spinning due to a periodically changing gyrostatic moment, and together with co-authors, an analysis was made of stability of the lower equilibrium position of an unbalanced spherical body moving along a plane without slipping.

01.02.01 – Theoretical mechanics.

The work was performed at the Department of Theoretical Physics of Udmurt State University and defended at Moscow Aviation Institute (National Research University) (MAI). ●

NEW BOOKS ON TRANSPORT AND TRANSPORTATION

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Ashikhmin, S. A., Ashikhmina, E. A. Car maintenance: Textbook [*Tekhnicheskoe obsluzhivanie avtomobilei: Uchebnik*]. Moscow, Academiya publ., 2022, 252 p. ISBN 978-5-0054-0267-7.

Eremeeva, L. E. Intermodal and multimodal transportation: Study guide [*Intermodalnie i multimodalnie perevozki: Ucheb. posobie*]. 2nd ed., rev. and enl. Moscow, Infra-M publ., 2022, 221 p. ISBN 978-5-16-014609-6 (print).

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