

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

*The texts of the abstracts originally written  
in Russian are published in the first part of  
the issue.*

*Тексты авторефератов на русском языке  
публикуются в первой части данного  
выпуска.*

DOI: <https://doi.org/10.30932/1992-3252-2021-19-4-18>

World of Transport and Transportation,  
2021, Vol. 19, Iss. 4 (95), pp. 311–315

**Nguyen Xuan Hien. Methodology for developing location requirements for image and video registration complexes under the conditions of the Socialist Republic of Vietnam. Abstract of Ph.D. (Eng) thesis [Metodika opredeleniya trebovaniy k mestam razmeshcheniya kompleksov foto-videofiksatsii dlya uslovii sotsialisticheskoi respubliki Vietnam. Avtoref. dis... kand. tekhn. nauk]. Moscow, MADI publ., 2021, 23 p.**

The objective of the thesis is to improve road safety in the city of Hanoi (Vietnam) by developing a methodology for determining the requirements for location of photo and video registration complexes under the given financing conditions.

Were developed:

- A mathematical model of functioning of the photo-video recording system, which makes it possible to assess the degree of its influence on the characteristics of the transport flow and accident rates.
- A software for choosing the structure and justifying the parameters of the system of photo-video recording of traffic violations.
- A methodology for determining the requirements for location of photo and video registration complexes to increase the efficiency of the photo and video registration system.

The analysis of road accident rates in the world and in Vietnam was carried out that showed that road traffic accidents are currently a social problem that is faced all over the world. The role of intelligent transport systems in improving safety and organization of road traffic has been determined.

To improve road safety and quality of traffic, the world experience is considered, which shows that some countries, such as Sweden, Japan, Singapore, etc., have received good results from

implementation of state programs to improve efficiency and safety of the road transport system.

The analysis of the state of application of intelligent transport systems and the system of photo and video recording in Vietnam shows that the practices of implementing ITS in Vietnam meet a number of significant shortcomings and problems, such as lack of standards for installation and use of photo and video recording complexes; lack of principles of synchronisation of photo and video recording within the system; limited functionality of photo and video registration complexes, mainly for traffic monitoring.

The main elements of the target function are substantiated to optimise the parameters of the given type of a photo and video recording complex, based on the following aspects: increasing road safety (by reducing the focus points of accidents); improving the efficiency of traffic management (by increasing traffic capacity); introduction of control in areas of systemic violations of traffic rules (violation of the speed limit, road marking requirements, dangerous and aggressive driving).

Two variants of the objective function have been synthesised:

- Maximum efficiency of installation of the photo and video registration system was determined when funding is limited.
- Maximum relative efficiency of implementation of the photo and video recording system with the maximum profitability has been determined.

A mathematical model of influence of functioning of the photo and video recording system on safety and on organisation of road traffic has been developed. Such a model can identify additional baseline data using expert estimates and a hierarchy analysis method based on the official incomplete data on road accidents in Vietnam.

The analysis of problem points within the road network of the city of Hanoi was carried out. 10 points with existing cameras of photo and video recording and 10 points without cameras were identified. Based on identification of the total weighted value of effectiveness of the installation of the means of photo and video recording, the points were determined where new types of photo and video cameras should be installed.

Software has been developed to assess the efficiency of the photo and video recording system. The program evaluates the efficiency of the photo and video recording system based on the established criterion. With the help of the developed software, it is possible to select the best version of the photo and video recording



system that will better implement its goals and objectives.

A method for choosing an effective solution while creating a photo and video recording system has been developed, considering the established criterion for choosing its rational option. The method makes it possible to calculate feasibility of using various technical means of photo and video recording system at the points under consideration.

A method has been developed for determining the requirements for location of the photo and video registration complexes in Vietnam under the specified financing conditions.

It is advisable to further develop and improve the studied approach towards:

- Development of a system of national standards for ITS and for the system of photo and video recording, regarding also implementation of scientifically grounded methods for setting state priorities for implementation of a system of photo and video recording.

- Development of principles for coordinating the actions of ministries and other executive authorities to complete the system for collecting and storing data on road safety, to increase the accuracy of analysis and research in this subject area and the use of reliable methods of calculation and analysis.

- Development of software based on modern programming languages, for example, C++, Python, SQL, which is easy to update and to use to provide calculation results for users, including investors.

#### 05.22.10 – Operation of road transport.

*The work was performed and defended at the Moscow Automobile and Road Construction State Technical University (MADI).*

**Russkikh, S. V. Nonlinear mechanics of elastic transformable and controlled space systems. Abstract of D.Sc. (Physics and Mathematics) thesis [*Nelineinaya mekhanika uprugikh transformiruemykh i upravlyaemykh kosmicheskikh sistem. Avtoref. dis... doc. fiz.-mat. nauk*]. Moscow, MAI publ., 2021, 40 p.**

The work is a contribution to the solution of an urgent and important problem which is the creation of reliable mathematical models that allow solving a wide class of problems of nonlinear mechanics of elastic transformable and controlled space systems and structures containing rod and tether elements:

New equations for the dynamics of spatial and plane motion of a spacecraft with a tether in

the central gravitational field of the Earth have been obtained, which can be used for numerical simulation of motion of spacecraft with tether elements, in particular, a spacecraft with a tether ejected from it as a space tug for those satellites that have exhausted their resource, capture of large objects of space debris, etc.

For the first time, nonlinear equations with analytical expressions of all coefficients for plane motion in a moving coordinate system of a spacecraft with an attached system of rods interconnected by elastic-viscous hinges, allowing large angles of rotation, are obtained. These equations make it possible to solve a new class of problems of deploying a system of rods from a transport position folded into a package to an operating position in various ways, including due to inertial forces of rotation and movement of the spacecraft.

New equations of unsteady rotation and nonlinear oscillations in the roll plane of a spacecraft with two elastic multi-section solar panels are obtained. Based on these equations, it is possible to carry out numerical ground testing of deployment of panels under the action of prestressed springs at the nodes connecting the sections.

A functional diagram has been proposed and a mathematical model has been developed for a cyclically symmetric umbrella-type antenna consisting of flexible radial multi-link rods interconnected in nodes along parallels by tensile cables. A new method has been developed for solving the inverse nonlinear problem of quasi-static antenna shaping after deployment of radial rods due to their bending under the action of the force created by a damping hydraulic cylinder, considering the reactions of tensile cables. This will contribute to creation of large-size antennas deployable in space.

For the first time, refined equations of thermoelastic bending vibrations of a thin-walled extension rod with a circular cross-section, connected to a mobile spacecraft, and subjected to solar heating, are obtained considering changes in the angles of incidence of solar rays due to rotations of surface elements of an elastic rod and taking into account external and internal heat radiation. The equations are used to calculate non-stationary thermoelastic vibrations of a rod with a spacecraft when it leaves the shadow.

An approach is presented to obtain equations of motion for elastic composite nonlinear systems with geometric constraints based on the principle of possible displacements by using equations in coupled moving coordinates and in generalised coordinates for individual free subsystems, considering unknown interaction reactions and

attaching the conditions of connection to these equations. The solution of these differential-algebraic nonlinear equations can be obtained using the well-known standard integration algorithms for «rigid» systems.

A new approach to solving terminal problems of passive force and kinematic control of elastic, in the general case, non-stationary and nonlinear systems has been developed using Bubnov–Galerkin method in the time domain with their finite movements for a certain time from one state (rest or motion) to another state with elimination of fluctuations at the end of the operation. Problems for linear systems with constant parameters are solved by expansion in terms of natural vibration modes using exact solutions of equations in normal coordinates for several lower modes to be eliminated. In this case, the control action is sought in the form of a finite series of simple finite functions with unknown coefficients, which are determined from the initial and final conditions.

A new method is proposed for «tuning» several lower natural frequencies of oscillations of linear systems with constant parameters, which repeatedly perform the same type of operations, like high-speed manipulators, to eliminate oscillations at the end of each operation using a simple control function with one unknown factor.

*01.02.04 – Mechanics of a deformable solid.*

*The work was performed at the Institute of Applied Mechanics of the Russian Academy of Sciences (IPRIM RAS) and defended at Moscow Aviation Institute (National Research University).*

**Sakharov, R. A. Technical diagnostics of the profile of the rolling surface of railway wheels during operation. Abstract of Ph.D. (Eng) thesis [Tekhnicheskoe diagnostirovanie profilya poverkhnosti kataniya zheleznodorozhnykh koles v protsesse ekspluatatsii. Avtoref. dis... kand. tekhn. nauk]. St. Petersburg, PSTU publ., 2020, 18 p.**

The objective of the study is to improve safety of train traffic by technical diagnostics of critical states of structural heterogeneity of the metal of the rolling surface profile and adjacent layers of solid-rolled wheels of freight cars (SRWFC) directly during operation (when the train is moving).

As a result of the thesis, it was determined that the existing systems for technical diagnostics of SRWFC on the railway network, due to the specifics of their operation, cannot provide an assessment of structural heterogeneity of the

metal of RSP and the adjacent layers of SRWFC during operation, and, consequently, an adequate assessment of the residual technical resource.

A list of requirements for on-board equipment has been formed, with the help of which technical diagnostics of RSP is carried out during operation of the latter;

Methods have been developed for assessing structural heterogeneity of the metal of the rolling surface profile and adjacent layers of SRWFC with the possibility of determining their pre-defect state and predicting the residual technical resource based on:

- An improved magneto-variational control method as applied to the problems of technical diagnostics of anisotropic objects, for example, railway wheels.

- The results of experimental studies to assess the structural heterogeneity of RSP in the conditions of the car repair depot, laboratories of PSTU and DTSNTI, confirming the possibility of a qualitative and quantitative assessment of the structural state of the metal of RSP and adjacent layers.

- The data obtained on the induction of the self-magnetic field of RSP and adjacent layers of wheels, which can be considered criteria and parameters of the main defects related to both the sudden and gradual mechanism of their formation and which have the greatest impact on the technical state of RSP and adjacent layers of SRWFC.

A device has been developed for the technical diagnostics of RSP and adjacent layers of SRWFC, which makes it possible to increase the accuracy of registration of defects, which is associated with the revealed relationship between the magnetic and structural state of the metal, due to which the application of physical criteria was justified to assess the configuration of the magnetic field near possible stress concentration zones of RSP and adjacent layers of SRWFC.

Scientific and technical proposals and recommendations for application of the developed device and methods for assessing the structural heterogeneity of the metal of RSP and adjacent layers of SRWFC are proposed and substantiated.

The experimentally confirmed dependence between the values of the hardness of RSP and the adjacent layers of SRWFC and the values of the magnetic field  $B$  above RSP of the wheel shows that the stresses in the near-surface layers of the wheel rim and the response surface of the magnetic field signal  $B$  correlate in the planes corresponding to the slip planes of the crystal lattice of the metal structure.

The main economic effect is the effect of automating the process of technical diagnostics



in real time. It is shown that the technical maintenance and repair of RSP based on the actual state in comparison with the traditional method can significantly reduce operating costs.

*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.*

**Stepanova, K. K. Improvement of electrical devices for railway power supply with high voltage direct current systems. Abstract of Ph.D. (Eng) thesis [Sovershenstvovanie elektrotekhnicheskikh ustroystv zheleznodorozhnogo elektrosnabzheniya sistemy postoyannogo toka vysokogo napryazheniya. Avtoref. dis... kand. tekhn. nauk]. St. Petersburg, PSTU publ., 2021, 24 p.**

The objective of the study is to improve performance and energy efficiency of direct current electric traction based on increasing the voltage level, applying achievements of power electronics and digital technologies.

The thesis contains a solution to a scientific and technical problem that is important for improving electrical devices for railway power supply based on a high voltage direct current system. Scientifically grounded solutions are presented that allow increasing the technical and energy efficiency of the electric traction system, including subsystems of the traction electric drive, electric rolling stock and the subsystem of direct current traction power supply.

A high-voltage direct current electric traction system is proposed, which makes it possible to implement energy-efficient and safe power supply of high-performance train traffic systems. It has been established that the efficiency of using high voltage direct current in comparison with an alternating current system of 25 kV (2 x 25 kV, 50 Hz) is achieved by increasing the efficiency of the contact network by about 6–8 %, reducing the consumption of copper for construction of the contact network by about 20 %, simplification of the contact network due to the absence of neutral inserts; increasing the distance between traction substations and reducing their number on the electrified railway line; reducing the negative impact on the external power supply system; and by eliminating the need to install reactive power compensating devices.

The rate of high voltage in the direct current catenary is established, at which the direct current system in terms of energy efficiency approaches the indicators of a single-phase alternating current

system. The minimum value of this level is 18 kV. To improve efficiency, a DC system of 24 kV and higher up to 35 kV is recommended, depending on the application conditions of the system.

The structure of the high-voltage electrical complex of traction power supply and high-voltage direct current electric rolling stock is substantiated, including a rectifier unit with a voltage of 24...35 kV, an electric traction network of 24...35 kV direct current and an input converter of a 24–35 kV for electric rolling stock. The structure of a converter complex based on high voltage direct current electric rolling stock on a reversible converter AIN PWM is proposed. Based on this structure of electricity conversion for electric rolling stock, it is proposed to develop multi-system electric rolling stock (24–35 kV DC/25 kV 50 Hz/3 kV DC).

A method has been developed for determining the parameters of the devices of the electric power complex of the high voltage direct current electric traction system at the stage of designing the life cycle of the electric traction system.

A simulation model of a direct current system with a high-voltage electric power complex has been built and its performance has been confirmed by conducting experiments using the model. A proposal was formulated for reconstruction of passenger-intensive lines with the transfer of 3 kV system to a centralised system of traction power supply with high voltage direct current 24 kV with a universal electric rolling stock.

*05.09.03 – Electrical engineering complexes and systems.*

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

**Zhaisan, Isa. Ensuring traffic safety for freight wagons manufactured in the PRC on the railways of Central Asia. Abstract of Ph.D. (Eng) thesis [Obespechenie bezopasnosti dvizheniya gruzovykh vagonov postroiki KNR po zheleznym dorogam stran tsentralnoi Azii. Avtoref. dis... kand. tekhn. nauk]. Moscow, RUT publ., 2021, 24 p.**

The objective of this thesis work is to study the indicators of dynamics, traffic safety and wear of the wheel and rails in the presence of elastic side bearings of constant contact and diagonal rods on silent blocks, as well as to determine the range of rational values of parameters of elastic side bearings and silent blocks.

The scientific novelty of the work lies in development of a refined, parametrised mathematical model of movement of a freight



bogie equipped with elastic side frames of constant contact and diagonal rods of side frames along straight and curved track sections. The developed model makes it possible:

- To carry out a wide range of studies of dynamic characteristics of freight wagons of the main types, equipped with elastic side beams of constant contact and diagonal rods of side frames when moving along sections of the railway track with an arbitrary shape, considering the effect of irregularities in the rail lines.

- To evaluate the influence of deviations in the dimensions of wagon parts and wear of individual elements of the running gear on dynamic performance and safety of freight wagons.

- To evaluate the influence of deviations in the technical condition of the rail track in straight and curved track sections on the dynamic performance of a freight wagon.

- To carry out the selection of rational parameters of geometric, inertial, stiffness and damping characteristics of the elements of the freight wagon and bogie.

As a result of the research carried out, an assessment was made of the influence of side bearings of constant contact and diagonal rods of the 18-9996 bogie on driving performance of freight wagons, traffic safety, wear in the wheel-rail system, and the choice of rational values of parameters of side bearings and silent blocks of this type.

A mathematical model has been developed describing the movement of a freight bogie 18-9996, equipped with side supports of constant contact and diagonal rods, along straight and curved track sections. The graphic 3D model was developed in the 3D modelling software «KOMPAS3D» environment. The model was imported into the «Universal Mechanism» software package and there it was implemented as a system of rigid bodies connected by means of hinges and load-bearing elements.

A fully parametrised, generalised design scheme and a mathematical model of the lateral sidewall of constant contact, diagonal rods, adapter gaskets, adapted to changing parameters and allowing to simulate various versions of the design and technical condition of supports and silent blocks of this type, have been developed.

The developed mathematical model of wagon movement has a high degree of detail and considers the real geometry of bodies, which makes it possible to use it to study the influence of parameters of side supports of the body of continuous contact and diagonal rods on the dynamics and safety of movement of rolling stock, considering the wear and tear arising in operation.

To determine angular stiffness, theoretical and experimental studies have been carried out.

Calculations have been carried out to identify the parameters of the calculation model of bogies' diagonal ties. The results obtained were close to the experimental data, which shows the adequacy of the selected parameters.

Identification of the work of the side body supports and diagonal rods showed good convergence of the results obtained with the results of previous studies.

Comparison of the results of computer modelling and experimental data on the indicators of dynamics and traffic safety showed their satisfactory agreement. At the same time, the discrepancies do not exceed 15–17 %. This indicates reliability of the results obtained.

Based on the results of a numerical experiment and the subsequent analysis of all assessed indicators, rational values of the adapter gasket were determined, which are within the following limits: vertical stiffness – 17–20•103 kN/m, longitudinal stiffness 3,5–5•103 kN/m, transverse stiffness – 2•103 kN/m.

An assessment of the influence of elastic-dissipative characteristics of the silent block of diagonal rods on the indicators of dynamics and traffic safety has been made. Based on the results of computer modelling, it is recommended to take values in the range from 5•103 N/m to 7•103 N/m as rational values of stiffness of silent blocks.

The results of calculations performed for bogies equipped with sideways of constant contact with rollers and diagonal rods, with selected rational parameters, show an improvement in the main estimated indicators when moving along straight and curved track sections.

The reduction in wear in the contact area between the wheel and the rail in the presence of an elastic side bearing with a roller and diagonal rods of side frames is 82 % for a straight line in an unladen mode, 36 % – for a straight line in a loaded mode, 25 % – for a curve  $R = 650$  m in an unladen mode, 30 % – for a curve  $R = 650$  m in loaded mode, 20 % – for a curve  $R = 350$  m in unladen mode and 36 % – for a curve  $R = 350$  m in loaded mode.

Calculations to assess the impact of the roller mechanism on estimated indicators showed that the presence of a roller helps to reduce the moments of friction forces between the body and the bolster when driving along the curve  $R = 350$  m by an average of 22 %, and the decrease in the main indicators is 3–11 %.

*05.22.07 – Railway rolling stock, train traction and electrification.*

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

