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

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Kudryavtsev, A. N. Accounting for structural destruction of unreinforced stone material of foundations in design of road pavements. Abstract of Ph.D. (Eng) thesis [*Uchet strukturnykh razrushenii neukreplennogo kamennogo materiala osnovanii pri proektirovanii dorozhnykh odezhd. Avtoref. dis... kand. tekh. nauk*]. Moscow, MADI publ., 2021, 22 p.

The objective of the thesis was to develop a computational model for accounting for structural destruction and a methodology for selection of unreinforced stone material for foundations during designing road pavements.

The scientific novelty lies in the fact that the developed methodology, in contrast to the existing methods of designing pavements, allows to directly consider such important characteristics of the stone material of the foundations as: grade for crushing, grade of abrasion, and frost resistance. The development of such a technique became possible since the improved computational model considered the processes of destruction and repackaging of unreinforced stone material in the foundations of pavements during their service life.

Based on the results of the analysis, the causes and factors of destruction of unreinforced stone material in the foundations of road pavements were identified. It was determined that the majority of models for predicting residual sagging in base layers, as a rule, were not intended for problems of design and calculation of road pavements.

The influence of the grade of stone material in terms of crushability, grade of abrasion, grade of frost resistance, average particle diameter of stone material and technology of arrangement of the base layer out of unreinforced stone material on the amount of residual settlement has been theoretically proved.

The performed studies allowed developing a computational model considering structural destruction of stone materials, which makes it possible to determine the required characteristics of unreinforced stone material when designing road pavements. The boundary conditions for application of this computational model are determined.

The relationship between grades of stone material in terms of crushing and abrasion has been established, which made it possible, while designing road pavements, to integrate these indicators within an integral characteristic of quality of stone material. A method has been developed for determining the calculated modulus of elasticity of the base layer, depending on its residual porosity and the grade of crushing of stone material. The values of the elastic moduli have been determined for the base layers, arranged according to the wedge method, considering the inhomogeneous and non-uniform structure over the layer thickness. The values of the moduli of elasticity of layers made of rationally selected mixtures for various grades of stone material in terms of crushing have been clarified. It has been established that rationally selected mixtures have a uniform density in thickness and greater stability over a long period of time in comparison with foundations arranged according to the wedge method. It is proposed to assign the physical and mechanical characteristics of the unreinforced stone material of foundations while designing road pavements, depending on the total number of applications of the design load.

The process of loading a stone material during operation of highways was modelled using a designed and patented installation for dynamic testing of pavement bases. Experimental studies made it possible to evaluate the mechanisms of changing the granulometric

composition of stone material in foundations of road pavements with formation of fine fractions and accumulation of irreversible sagging due to cyclic loading.

Practical recommendations have been developed for the choice of unreinforced stone material and the optimal area of its application in foundations for design of road pavements. When comparing various designs of road pavements and considering discounted costs, it was found that the options designed in accordance with the methodology for selection of unreinforced stone material proposed in this work are more efficient, while savings by the end of the service life of road pavements are up to 18 %, depending on the type and composition of the repair measures being performed.

05.23.11 – Design and construction of roads, metro, airfields, bridges, and transport tunnels.

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

Makovetsky, O. A. Calculation and design of an artificial foundation: «structural geotechnical massif». Abstract of D.Sc. (Eng) thesis [*Raschet i konstruirovanie iskusstvennogo osnovaniya «strukturniy geotekhnicheskiy massiv*». *Avtoref. dis... doc. tekh. nauk*]. Moscow, RUT publ., 2021, 38 p.

The objective of the work is to create a theory of calculation and design of an artificially improved foundation with given physical and mechanical characteristics, that is of «structural geotechnical massif», optimally considering the geotechnical and urban planning conditions of the construction site.

The scientific novelty of the work consists in development of the theory of calculating the stress-strain state of a soil mass vertically reinforced with rigid elements made using the technology of jet cementation of the soil.

Based on the performed complex of experimental and theoretical studies, the use of the technology of jet cementation of soil in weak water-saturated soils for construction of structural geotechnical arrays with formation of rigid reinforcing elements with specified geometric dimensions and physical and mechanical characteristics of a soil-cement composite («soil concrete») is substantiated:

• The dependence of the radius of the reinforcing element and the physical and mechanical features of soil concrete on the assigned technological parameters of jet grouting of the soil was experimentally and theoretically, determined.

• Statistical processing of data of more than 800 tests of soil concrete samples drilled from experimental reinforcing elements allowed to obtain the main physical and mechanical characteristics of the material: compressive strength, deformation modulus and correlation dependences between them.

• Based on the experimental data obtained for the first time ever, a rheological model of soil concrete is proposed, which, using the theory of hereditary aging, describes development of creep processes at different «ages» of loading.

The theoretical foundations of transformation of mechanical properties of weak water-saturated soils when performing vertical reinforcement with rigid soil-concrete elements and with an intermediate flexible grillage have been developed:

• The construction of the foundation that is «structural geotechnical massif» was proposed, physical and calculation models of force resistance were built for the design of its optimal structure.

• Based on representation of the geotechnical massif as of a solid body with a structure, the dependences of the influence of thickness and mechanical characteristics of a flexible grillage on distribution of pressures between reinforcing elements and the surrounding soil were obtained.

• The problem of determining effective deformation characteristics of the geotechnical massif as of a composite transverse isotropic medium has been solved, the dependence of the integral modulus of deformation on the percentage of reinforcement has been experimentally confirmed.

• The problem of determining the rate of development and relative deformation of the creep of the geotechnical massif depending on the change in viscosity of the soil concrete in

the process of gaining strength was posed and solved.

• Based on numerical modelling, the dependences are obtained that determine the effective speed of propagation of the transverse seismic wave and the decrease in acceleration of seismic vibrations in the centre of the site in relation to the initial state, depending on the design characteristics of the geotechnical massif.

The obtained theoretical solutions were calibrated according to the data of stamp tests of the geotechnical massif with static loads and the conditions for using the model (Hardening-Soil) for predicting the integral mechanical characteristics of the «structural geotechnical massif» were substantiated. Comparison of the stress-strain state of the structural geotechnical massif obtained in the course of computer modelling according to the proposed theoretical relationships and experimental data of geodetic observations of development of the sagging of buildings under construction showed their good qualitative and quantitative agreement (the excess of the calculated settlement over the experimental is 15...25 %).

In general, the results of experimental and theoretical studies allow obtaining a solution to a scientific problem of great economic importance of creation of a theory of calculation and construction of an artificial foundation with given physical and mechanical characteristics which is «structural geotechnical massif».

05.23.02 − Bases and foundations, underground structures.

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

Prisukhina, I. V. Machine identification of operating modes of rail circuits and ALSC code signals. Abstract of Ph.D. (Eng) thesis [*Mashinnaya identifikatsiya rezhimov raboty relsovykh tsepei i kodovykh signalov ALSN. Avtoref. dis... kand. tekh. nauk*]. St. Petersburg, PSTU publ., 2021, 18 p.

The objective of the study is to improve the methods for determining the operating modes of the rail circuit and decoding code signals of the automatic locomotive signalling of continuous operation (ALSC).

As a result of the research carried out within the framework of the thesis, a method for synthesis of the training sample required for machine identification of operating modes of the rail circuit has been developed. The technique allows calculating the complex values of voltages and currents at the input and output of the rail circuit under various combinations of external influences (changing insulation resistance of the rail line, the coordinate of the train shunt, the coordinate of the break of the rail line) in normal, shunt and control modes of operation.

Algorithms for machine identification of operating modes of a rail circuit using logistic regression, Hermite polynomial transform and support vector method have been developed. Algorithms make it possible to identify each of the operating modes of the track circuit (including the control sample one).

A method for synthesis of a training sample required for machine identification of ALSC code signals has been developed. The technique allows synthesising oscillograms of code signals («Z» [green], «Zh» [yellow], «KZh» [red/yellow]) with various types of distortions typical for real operating conditions of rail circuits (impulse noise, shape distortions, the influence of the locomotive receiving equipment and unstable properties of the rail line).

Systems for machine identification of ALSC code signals with synchronisation of oscillograms, with Fourier transform and asynchronous processing of oscillograms have been developed. The developed systems allow correct identification of code signals under the influence of destabilising impacts.

05.22.08 − Management of transportation processes.

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

Pronevich, O. B. Automated fire risk management system for ensuring traffic safety on railways. Abstract of Ph.D. (Eng) thesis [*Avtomatizirovannaya sistema upravleniya pozharnymi riskami pri obespechenii bezopasnosti dvizheniya na*

***zheleznodorozhnom transporte. Avtoref. dis... kand. tekh. nauk*]. Moscow, RUT publ., 2021, 23 p.**

The objective of the thesis is to reduce the number of dangerous states leading to fires and to increase traffic safety by automating the processes of fire risk management for infrastructure facilities and railway rolling stock.

The expediency of development and use of algorithms for intellectualisation of diagnostics of malfunctions of railway facilities, leading to an increase in fire risk, has been substantiated. Analysis of the state of the problem of assessing and managing fire risks at railway facilities, types of automated fire risk management systems in Russia and European countries revealed the need to develop methods and algorithms that provide the ability to predict the probability of fire based on the technical characteristics of railway infrastructure facilities and rolling stock.

Classifiers of railway facilities malfunctions destabilising fire safety, as well as control and evaluation cards have been developed for intellectualisation of their diagnostics within the framework of an automated audit of fire risks at electrical interlocking posts, traction rolling stock, information and computing centres of JSC Russian Railways, traction substations of JSC Russian Railways, railway stations.

A method for mathematical modelling of the fire risk at a railway facility at the operation stage has been developed. The method is based on the results of statistical analysis of fires and failures at railway facilities. It consists in formalisation of the description of the process of changes in the states of the railway object using an oriented graph of states, modelling of development of events leading to a fire.

A method for determining the probability of an object's transition to dangerous states from an identified non-hazardous state is proposed, which makes it possible to determine the a priori probability of a fire based on information about initial and subsequent possible states of the railway object, identified by the results of the audit.

A method and algorithms have been developed for automated diagnostics of fire risks for potential ignition source at infrastructure facilities and on rolling stock, which for the first time allow collecting initial data for assessing fire risks without involving supervisory officials.

Methods for assessing fire risks at infrastructure facilities and on railway rolling stock have been developed. These techniques are implemented at JSC Russian Railways in the fire risk management system.

A mobile hardware and software complex has been created that allows for an audit of fire safety and an assessment of fire risk at the stage of operation of infrastructure facilities and railway rolling stock, providing the possibility of simultaneous mass calculations of fire risks.

Calculations of the fire risk were carried out for 407 stationary facilities of JSC Russian Railways. Based on the results of diagnosing fire hazardous conditions, an undesirable level of fire risk was revealed for 25 (out of 365) railway stations, 19 (out of 32) electric centralisation posts, 4 (out of 10) traction substations.

The audit and assessment of fire risk was carried out on 806 locomotives, according to the results of which 23 051 fire hazardous conditions were eliminated. In the Far Eastern Traction Directorate, an unacceptable level of fire risk was identified for 207 TE10 diesel locomotives, and an undesirable level of fire risk was established for 14 diesel locomotives. An unacceptable level of fire risk was set for 585 electric locomotives of Krasnoyarsk Traction Directorate.

As recommendations and prospects for further development of the topic of the thesis, it is proposed to increase accuracy and reliability of predicting fire risks of railway facilities by processing big data on fire hazardous states of transport facilities using methods and algorithms of artificial intelligence (Data Mining and Data Science).

05.13.06 –Automation and control of technological processes and production (transport).

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

Skorobogatov, M. E. Means of increasing the efficiency of automated control of train traffic on sections electrified with alternating current. Abstract of Ph.D. (Eng) thesis [*Sredstva povysheniya effektivnosti avtomatizirovannogo upravleniya dvizheniem poezdov na uchastkakh, elektrifitsirovanykh peremennym tokom. Avtoref. dis... kand. tekh. nauk*]. Irkutsk, ISTU publ., 2021, 18 p.

The aim of the thesis is to increase the efficiency of automated control of train traffic by modernising continuous automatic locomotive signalling devices (ALSC) at sections electrified with alternating current.

The operational consequences of malfunctions of ALSC locomotive devices have been analysed and it has been established that, within the framework of the technological process of controlling movement of trains on sections electrified with alternating current, the main negative consequence is a decrease in the section speed by 3,6 km/h.

Based on the results of processing the above set of experimental data, the mechanism of the effect of stationary and random interference was refined and the characteristics of the interference acting on the mountain section electrified with alternating current were estimated. Thus, the threshold signal-to-noise ratio under the action of stationary harmonic interference on the useful signal of a numerical code with a frequency of 25 Hz is 0,681, for a useful signal frequency of 75 Hz this value is 0,592. The threshold signal-to-noise ratio under the action of a random impulse noise on a useful numerical code signal with a frequency of 25 Hz is 0,805; for a useful signal frequency of 75 Hz, this value is 0,478.

A method has been developed for determining the operability of ALSC locomotive devices under the conditions of stationary harmonic and random impulse noise, which is based on the criterion for evaluating the duration of the first interval between pulses of a numerical code signal.

A method of single-band digital filtering for digital code signals of automatic locomotive signalling is proposed and requirements for a narrow-band locomotive digital filter are formulated. It is shown that for implementation of narrow-band digital filtering of a numerical code signal with permissible distortions of the shape-temporal parameters of the signal, it is necessary to provide: a sampling frequency of at least 500 Hz, a suppression level in the stopband of at least 30 dB, an elliptical approximating function, and an infinite impulse response.

Scientific and technical recommendations are proposed to reduce the degree of negative influence of the main causes of failures on ALS devices. To reduce the influence of asymmetry of reverse traction current on operation of ALS locomotive devices, it is necessary to prevent the train from entering the section of unconditional failure in the case when a heavy train is located on the corresponding mountain-pass section of the probable failure. Moreover, this recommendation applies both to trains moving along one track, and on neighbouring ones. It is necessary to revise the algorithms for checking the ALS equipment in the conditions of locomotive depots and create fundamentally new technical means on a modern element base that allow controlling the parameters of the ALS equipment when exposed to artificial interference. They should provide an opportunity to assess the individual noise immunity of the ALS equipment of a particular locomotive in accordance with the selected criteria. A digital narrow-band filter is proposed for extracting ALSC signals, which should be installed between the ALSC receiving locomotive coils and the locomotive amplifier. The use of this filter will allow upgrading the existing ALSC relay system to the required level of noise immunity, which will give a greater economic effect compared to the full-scale implementation of CLUB or BLOCK microprocessor devices.

05.13.06 – Automation and control of technological processes and production (transport).

The work was performed and defended at Irkutsk State Transport University.