

BUILDING CONSTRUCTION, BUILDINGS AND STRUCTURES**DESIGN OF VENTILATION AND COMMUNICATION CHANNELS
FOR UNDERGROUND STRUCTURES IN HORIZONTALLY
SHIFTING SOILS****N. A. Ozerney, A. P. Lapshin, A. V. Baranenko**

Annotation. The article is dedicated to the justification of engineering solutions in the design of ventilation and communication shafts in underground structures within soils experiencing horizontal displacement and pressure on vertical structures with shifting but without destruction. It examines structures that are classified as deep (up to 300 m) and extremely deep (more than 300 m) in complex geological conditions. To protect vertical ventilation and communication shafts from destruction, we propose a design that allows for the maintenance of their functional parameters during deformation without structural failure. A description and drawings of the proposed design are provided. We as well propose a technical solution that allows for the integration of an emergency lift into the proposed shaft design.

Keywords: transverse soil shear; ventilation and communication shafts; horizontal soil shift; emergency lift.

**ANALYSIS OF THE LEGISLATIVE AND REGULATORY FRAMEWORK
FOR CONDUCTING TECHNICAL SURVEYS OF ENGINEERING
STRUCTURES****G. D. Shmelev, A. N. Ishkov, I. S. Alirzaev, I. S. Burenkov**

Annotation. The article analyzes regulatory documents related to conducting technical inspections of engineering structures and buildings. The authors have performed a deep system analysis of current legislative and regulatory documents, including Federal Law No. 384-FZ, Government Decree No. 47, GOST 31937-2024, SP 454.1325800.2019, SP 547.1325800.2025, and others. Significant contradictions between these documents have been identified, including: the arithmetic threshold for emergency (more than 5% or 50% of structures) contradicts the principle of single-point failure, which is outlined in the Technical Regulations on the Safety of Buildings and Structures; the exclusion of wooden roof structures and stairs from the overall assessment of the building's emergency does not take into account the hidden threat to the overall stability of the building; the simplified survey data according to SP 454.1325800.2019 is considered insufficient for the development of design solutions during major repairs and renovations of buildings. Based on the analysis conducted, the authors have proven that GOST 31937-2024 is the methodological core that defines the general rules for surveys, while the sets of rules (SP 454.1325800.2019, SP 547.1325800.2025, and SP 368.1325800.2017)

act as applied add-ons for solving highly specialized tasks. We propose a clear four-level hierarchical survey system, which includes the stages of initiation, preparatory and visual work, detailed instrumental control, and result processing (engineering survey). The developed approach ensures a transition from simplified survey methods (visual and measurement control) to detailed methods (detailed instrumental survey) when signs of problems are detected, which increases the reliability of technical condition assessment and the safety of building operation.

Keywords: survey; technical condition; engineering structures; buildings and structures; hierarchical system.

ENGINEERING SYSTEMS AND SERVICES

COMPARISON OF SOLAR COLLECTORS' CALCULATION USING VARIOUS DATA SOURCES ON SOLAR RADIATION FLOWS IN THE VORONEZH REGION

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Annotation. The paper presents the results of calculating the heat output, coolant flow rate, and heating surface area of flat solar collectors for private residential hot water supply systems in the climatic conditions of the Voronezh region. The calculations were performed using solar radiation data from various reference sources, as well as based on experimental data. A significant discrepancy was found between the experimental data and the reference values. We show that taking into account local experimental data can reduce the error in calculating the collector area and reduce capital costs. The results can be used in the design of energy-efficient heating systems for individual housing construction.

Keywords: solar collector; heat supply; coolant consumption; energy efficiency.

COMPREHENSIVE ASSESSMENT OF THE TECHNICAL CONDITION AND DESIGNATION OF THE RESIDUAL RESOURCE OF INDOOR GAS PIPELINES IN RESIDENTIAL BUILDINGS

A. V. Rukoleev

Annotation. The article presents a methodology for a comprehensive assessment of the technical condition and safety of operation of indoor gas pipelines of residential buildings, which is focused on practical application by maintenance organizations and municipal housing management bodies. The methodology combines the analysis of design and executive documentation, visual inspection of accessible areas, localization of defects and instrumental diagnostics using gas ana-

lyzers (leak detectors), ultrasonic thicknessometry, as well as the control of the tightness of joints after repair actions. The regulatory basis is the requirements of SP 62.13330.2011 "Gas Distribution Systems", the provisions of RD 09-102-95 regarding the residual resource after the standard service life of steel gas pipelines (30 years), and the requirements of Government Decree No. 410 dated May 14, 2013. Based on the results of surveys of residential buildings in Biysk-city, I found that the key factors contributing to reduced reliability are corrosion-induced thinning of pipe walls and leakage in threaded and welded joints, high humidity and insufficient ventilation accelerate degradation processes. The paper presents calculated reliability indicators (failure rate, availability factor, and probability of failure), an approach to classifying the technical condition of sections, and the assignment of residual resource. I as well formulated recommendations for determining the priority of repair actions, the frequency of diagnostics, and the prevention of failures, including measures to maintain protective coatings and improve the quality of maintenance.

Keywords: gas supply; operation; residential buildings; diagnostics; service life; residual resource.

IMPROVEMENT OF THE METHOD FOR CALCULATING THE DEW POINT TEMPERATURE OF NATURAL GAS FROM WATER USING A SIMPLIFIED METHOD

D. N. Kitaev

Annotation. The use of adequate mathematical models that improve the accuracy of natural gas calculations, as well as the efficiency and safety of its use in urban housing and utilities, is consistent with the tasks of digital transformation of the Russian economy. One of the most important characteristics of natural gas, significantly affecting the dew point temperature, is the mass concentration of water vapor, which is constantly monitored in municipal gas supply systems. Increased moisture concentration increases the risk of accidents and reduces the efficiency and reliability of gas supply systems. Dew point temperature values obtained from actual measurements with a condensation hygrometer are always lower than the true thermodynamic temperature and depend on the metrological characteristics of the measuring system and the algorithm of the measuring instrument. Since January 1, 2023, GOST 34807-2021 has been in effect in the Russian Federation. It regulates the methods for calculating the water dew point temperature and the mass concentration of water vapor for natural gas, including for municipal and domestic use. This article presents the results of a study examining the adequacy of the equation recommended by GOST as a first approximation for calculating the dew point temperature using a simplified method within the pressure range of urban gas distribution systems. The resulting equations show greater accuracy when used as a first approximation in the implementation of the computational algo-

rithm, significantly reducing the number of calculations without the use of specialized software.

Keywords: gas supply; gas pipelines; dew point temperature; calculation method.

PROSPECTS FOR THE APPLICATION OF GRAPHENE POLYMER MEMBRANES AND GRAPHENE OXIDE MEMBRANES IN VENTILATION SYSTEMS

A. R. Gataullina, V. A. Vakhrushev, Y. M. Khabirov

Annotation. Modern requirements for building energy efficiency stimulate the search for new materials for ventilation systems capable of ensuring deep heat and moisture recovery. The aim of this work is to analyze the potential and identify promising directions for the application of graphene polymer composites and graphene oxide (GO) membranes in enthalpy recuperators. The article systematizes the synergistic effects resulting from the use of intercalated structures and photocatalytic coatings, and presents an estimated calculation of the efficiency of a recuperator with a GO-based membrane for climatic conditions typical of the cold season. We show that the application of these materials makes it possible to increase the efficiency of recuperators up to 90...95 %, expand the operating temperature range (down to -40°C and below), and ensure the stability of transport properties through intercalation and photocatalytic self-cleaning. We as well substantiated technological limitations requiring further research in the sphere.

Keywords: graphene oxide; graphene polymer membrane; enthalpy recuperator; nanochannels; heat and mass transfer; TiO_2 photocatalysis; intercalation.

ENSURING THE TIGHTNESS AND CORROSION RESISTANCE OF THREADED CONNECTIONS OF GAS EQUIPMENT IN RESIDENTIAL BUILDINGS USING NANO-MODIFIED SEALANTS

E. S. Aralov, N. Ja. Marchukov, A. S. Salieva, M. R. Streljaeva

Annotation. This article discusses the problem of ensuring the reliability of threaded connections of indoor gas equipment, which account for up to 65...70 % of all gas leaks in residential buildings. We have identified the main destabilizing factors: mechanical stress, temperature fluctuations, corrosion processes, and the chemical effect of odorants. We as well substantiated the ineffectiveness of traditional sealing materials under the combined influence of these factors. As a promising solution, we propose the use of nanomodified acrylate sealants with the addition of functionalized multi-walled carbon nanotubes (MWCNTs). Based on theoretical analysis and mathematical modeling, we determined the optimal range of

MUNT concentrations (0,03...0,1 % mass.), with the most likely value of 0,05 % mass., which provides the maximum improvement in performance. We established the mechanisms of increasing the barrier properties of nanocomposites: the labyrinth effect, the reduction of the segmental mobility of polymer chains, the formation of interfacial layers and percolation structures. It is predicted that the rate of pressure loss will decrease by 2...4 times, the corrosion resistance will increase by 3...5 times, and the service life of the joints will increase from 10...15 to 20...25 years. Also, we substantiated the economic feasibility of using nanomodified sealants.

Keywords: gas supply in residential buildings; threaded connections; sealants; nanomaterials; carbon nanotubes; corrosion resistance; indoor gas equipment.

MODELING OF AIR DISTRIBUTION IN A PUBLIC BUILDING DURING RECONSTRUCTION TAKING INTO ACCOUNT ARCHITECTURAL CONSTRAINTS

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Annotation. In the article we analyze the problem of modernizing ventilation systems in rooms with high architectural and aesthetic requirements, where the priority is to preserve the historical appearance of the interior. The object is a meeting room that requires the renovation of engineering equipment without replacing existing decorative air distributors. The purpose of the work is to ensure the regulatory parameters of the microclimate by optimizing the internal design of air distribution devices. We present here the results of numerical modeling of aerodynamics in the SolidWorks software environment. We as well consider the options without changing the design of the air distributors and with the introduction of perforated plates. By iterative selection, the optimal number of plates and the diameter of the holes (10 mm) were determined, ensuring the uniformity of the air flow. Also, we analyzed the velocity fields and carbon dioxide concentrations in the serviced area. The results confirmed the compliance of the adopted design decision with the standards of air quality.

Keywords: air distribution; reconstruction of ventilation systems; architectural constraints; perforated plates; numerical modeling; air quality.

EVALUATION OF THE EFFICIENCY OF DRINKING WATER TREATMENT METHODS IN BURUNDI

Dieudonne Niyonkuru, V. I. Shcherbakov

This article analyzes drinking water purification methods used in the Republic of Burundi. It describes the technological processes for purifying water from

various natural sources. It presents the results of an analysis of the performance of a Lake Tanganyika water treatment plant using the slow sand filtration method. It is demonstrated that water purified by this method complies with the WHO standards adhered to by Burundi. The results of an analysis of river water purification using the rapid filtration method are presented. It was found that the quality of treatment does not meet drinking water standards due to high turbidity and a high concentration of residual chlorine remaining after treatment. The main problem is identified: filter clogging caused by high concentrations of organic matter and suspended particles, which occurs during the rainy season. A description of the rural water supply structure and the problems within this structure is provided. Since most drinking water in rural areas comes from natural sources, public standpipes, and groundwater from wells, chlorination is the only method used at upstream water intakes, and regular water quality monitoring is not conducted.

Keywords: purification methods; drinking water; slow sand filtration; physicochemical analysis; water quality.

URBAN PLANNING. RECONSTRUCTION, RESTORATION AND LANDSCAPING

INDEX OF INFORMATION POTENTIAL AS A BASIS FOR ASSESSING THE DEVELOPMENT OF TERRITORIES ADJACENT TO RAILWAY TERMINALS AND STATIONS OF THE CITY OF VORONEZH

M. V. Maximova, A. S. Tankeev

Annotation. Within this study, we propose a methodological approach to analyzing the information potential of an urban territory, using the city of Voronezh as an example. A special attention is paid to the territories adjacent to railway terminals and stations. The paper examines the influence of transport interchange hubs on the formation of the urban environment. We used information flow mapping, dividing the study area into individual cells. We as well present the results of the distribution of urban infrastructure facilities around the main transport hubs of Voronezh-city. We show a classification of territories based on the identified criteria. We detected three categories of development density (low, medium, and high). The presented data facilitates an understanding of the relation between the quality of the urban environment and transport services, offering specific tools for substantiating urban planning decisions.

Keywords: information potential; planning grid; transport hubs; urban environment; development density, infrastructure assessment; transport accessibility.

ECOLOGY AND SAFETY OF THE URBAN ENVIRONMENT

USING THE TOXODOSE VALUE TO ASSESS THE EFFECTS OF EMERGENCY CHEMICAL RELEASES

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Ovchinnikova**

Annotation. The article discusses the theoretical and practical aspects of using the toxico-dose as an integral criterion for assessing the damaging effects of accidental releases of chemical substances. The main types of toxico-doses (lethal, disabling, and threshold) are analyzed, and their relationship to the physical and chemical properties of substances and the parameters of the emergency situation is examined. Mathematical models are developed for calculating the toxico-dose under various scenarios of an emergency release, including the primary cloud of a gaseous substance, the secondary cloud formed by the evaporation of a liquid phase, and the combined effect. The results of calculations for chlorine, ammonia, toluene, and chlorobenzene are presented. It is shown that the use of the toxodose approach allows for the quantitative assessment of environmental and social risk, the determination of the boundaries of the sanitary protection zone, and the justification of the need for cleaning of emergency emissions.

Keywords: toxodosis; emergency release; harmful substances; damaging effect; environmental risk; social risk; sanitary protection zone; mathematical modeling; chemically hazardous facilities.

ROAD TRANSPORT, AGRICULTURE AND CONSTRUCTION MACHINES

INTEGRATION OF UNDERGROUND SPACE INTO THE TRANSPORT FRAME OF LARGE CITIES (ON THE EXAMPLE OF THE CITY OF VOLGOGRAD)

N. V. Korosteleva, I. A. Krasnova, A. A. Dmitrukha

Annotation. The article is devoted to the problem of integrating underground space into the transport frame of large cities using the example of the historical center of Volgograd. The relevance of the study is due to a critical imbalance between the rapid growth of motorization and the limited capacity of the road network formed in the conditions of historical development. The work revealed the key nodes of the critical overload of the central area of the city. We analyzed the restraining factors for the development of underground space: urban planning (cultural heritage sites, light rail line), geotechnical (landslide processes, high groundwater levels) and regulatory (protected zones, urban planning regulations). Based

on the generalization of domestic and foreign experience, we formulated the principles of integration of underground structures: system connectivity, functional polycentricity, complementarity of ground and underground infrastructure, adaptability, consideration of restrictions, comfort and safety. We propose a classification of functional scenarios for the use of the underground level: transport tunnels – relief roads for the withdrawal of transit flows, multi-level interchange nodes integrated with public transport, and underground parking hubs, including intercepting parking at the entrances to the center. We have developed conceptual proposals for the placement of underground multifunctional complexes in the region. The implementation of the proposed scheme will relieve the above ground road network, eliminate the shortage of parking space, preserve the historical and cultural heritage and improve the quality of the urban environment.

Keywords: underground space; underground construction facilities; transport infrastructure; historical center; transport frame.

ECONOMICS AND ORGANIZATION OF CONSTRUCTION

ECONOMIC EFFICIENCY OF MAJOR REPAIRS OF APARTMENT BUILDINGS IN THE TRANSITION FROM INTEGRAL TO ELEMENT-BY-ELEMENT ASSESSMENT OF PHYSICAL DEGRADATION

G. D. Shmelev, I. S. Burenkov, T. G. Shmeleva

Annotation. The relevance of the study is due to the cancellation of the methodology of general physical deterioration (VSN 53-86(r)) and the introduction of SP 547.1325800.2025, which provides for an element-by-element assessment of the technical condition of structures. The paper proposes an economic model for assessing the effectiveness of major repairs, based on the differentiated accounting of the wear and tear of non-replaceable and replaceable building elements. It is shown that the boundaries of the feasibility of major repairs are determined not by a single percentage of the building's wear and tear, but by the ratio of repair costs and the remaining service life of the load-bearing structures. We developed an efficiency index, and performed calculations for a typical residential building constructed in 1961, with different levels of wear and tear on the main structural elements. We established three zones of economic efficiency: expedient (wear and tear of walls and foundations up to 30...40 %), borderline (40...50 %), and inexpedient (more than 50...60 %). We show that the element-by-element approach allows for more precise allocation of resources and avoids unnecessary costs for repairing structures that are almost impossible to repair. The results can be used in the development of regional major repair programs.

Keywords: physical deterioration; major repairs; economic efficiency; non-replaceable elements; replaceable elements; replacement cost; efficiency index; housing stock.
