
BUILDING CONSTRUCTION, BUILDINGS AND STRUCTURES

THE METHOD OF ACCOUNTING FOR SHRINKAGE DEFORMATIONS AND TRANSVERSE FORCE EFFECTS IN ASSESSING THE CRACK RESISTANCE OF MASONRY

G. D. Shmelev, D. A. Drapalyuk, M. P. Sukhorukov

Annotation. We developed an engineering methodology for assessing the crack resistance of masonry, which for the first time combines in a closed computational model the time factor of carbonation shrinkage, temperature deformations and horizontal tensile stresses arising in brick during vertical compression. In our research we took into account the anisotropy of the tensile strength of the masonry, the level of adhesive strength of the "brick–mortar" contact and the creep phenomenon affecting stress relaxation. The kinetics of carbonation is described by an exponential function, temperature effects are expressed through the closing temperature of the structure. Transverse deformations are based on the condition of compatibility of vertical deformations of bricks and mortar joints. We introduced as well the coefficient of constraint, reflecting the design features of the wall sections. The crack formation condition is formulated as an inequality comparing the total tensile stress and the effective temporary resistance of the masonry to stretching. We provided calculation examples for various operating periods, number of floors, and climatic conditions, demonstrating both the formation and absence of cracks. We also showed that neglect of carbonation shrinkage and transverse force effects leads to underestimation of the risk of cracking, especially in the lower floors of buildings. The technique can be used in the examination, certification and design of major repairs of stone buildings

Keywords: masonry; shrinkage deformations; carbonation; temperature deformations; transverse expansion; crack resistance; strength anisotropy.

ENGINEERING SYSTEMS AND COMMUNICATIONS

EXPERIMENTAL STUDY OF A WALL BLOCK WITH CAPILLARY TUBES FOR A WATER HEATING SYSTEM

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Annotation. This study examines an experimental study of a wall unit with a capillary tube system, which can be used as a heating element in a hot-water heating system. We conducted the study using second-order orthogonal design. Processing the experimental data yielded regression relationships between the coolant temperature at the experimental unit outlet, between its average surface temperature and the supplied coolant temperature, as well as between mass flow rate and

capillary tube diameter. The significance of the regression equation coefficients was verified using the Student's *t*-test. The adequacy of the resulting regression equations was confirmed using the Fisher exact test with a confidence level of 0,95. The study identified the temperature and flow rate ranges that ensure uniform heating of the surface of the wall block under investigation.

Keywords: wall block; regression dependence; temperature of the coolant; surface temperature; uniform heating.

JUSTIFICATION OF THE CONFIGURATION OF HEATING NETWORKS IN A RESIDENTIAL AREA

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Annotation. When constructing heat sources on vacant sites, several placement options are possible, all of which meet safety requirements. The challenge arises of choosing a rational boiler house location, a decision influenced by various technical and economic factors, including those dependent on the heat network configuration. This paper examines the design of a heating network for a residential area of the city, taking into account various heat source locations. Based on determining the minimum values for the network's material characteristics, pressure losses during coolant transportation, and the cost of the heating network, it is possible to make a decision on the most appropriate boiler house location for the area.

Ключевые слова: heat supply; boiler room; heating network; justification of the project; performance criteria.

INVESTIGATION OF THE SPATIAL NON-UNIFORMITY OF RADIANT HEATING IN THE WORKING ZONE USING A GAS RADIANT HEATER

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Annotation. The paper considers the spatial distribution of radiant thermal effects in the working zone when using a linear gas radiant heater. The study is based on a mathematical description of a finite radiating element that makes it possible to determine the radiant heat flux density taking into account the position of the calculation point relative to the source. The surrounding air space is assumed to be transparent, with radiation attenuation neglected, which makes it possible to isolate the influence of geometric factors on the formation of the thermal field. For further analysis, the initial relationship is expressed in terms of the spatial coordinates of the calculation point. The radiant heat flux density function is differentiated with respect to the horizontal and vertical coordinates. Based on the obtained derivatives, we determined the gradient magnitude to characterize the intensity of spatial variation of the thermal effect. We propose a dimensionless indicator to compare

the degree of non-uniformity at different positions within the working zone while accounting for the average heat flux level. We also perform numerical modeling to investigate the variation of this indicator with changes in the horizontal position, distance from the center of the radiator, and height of the calculation point. Correlation and regression methods are applied to analyze the calculated relationships, determine the nature of the observed variations, and obtain corresponding analytical dependences. The proposed approach extends the possibilities of mathematical analysis of radiant heating and makes it possible to assess the spatial non-uniformity of the thermal effect without the need for experimental determination at each individual point.

Keywords: gas radiant heater; radiant heating; linear source; working zone; mathematical model; numerical modeling; regression analysis.

DETERMINING LOCATIONS FOR AIR INTAKE AND EXHAUST FOR VENTILATION SYSTEMS IN PUBLIC BUILDINGS

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Annotation. Here we present analysis of common errors in the relative positioning of air intake and exhaust devices in buildings of various types. We substantiate the necessity of considering additional ventilation system parameters when managing airflow patterns. We provide a list of parameters which are based on regulatory requirements and must be taken into account when determining the minimum distances between outdoor air intakes and exhaust outlets. We present results from solving several ventilation system design tasks. These results were obtained using a proprietary online program that implements an enhanced calculation methodology. We also demonstrate some graphs to visually illustrate the recommended distances between exhaust and intake units. The proposed approach enables designers to make informed choices regarding safe distances while ensuring compliance with sanitary and hygienic standards.

Keywords: ventilation; air intake; air exhaust; horizontal distance; exhaust air class; recirculation; public buildings.

SIMULATION OF HEAT LOSS THROUGH CRACKS IN BUILDING ENCLOSING STRUCTURES

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Annotation. The article is devoted to the development and verification of a comprehensive mathematical model for calculating heat loss through cracks in enclosing building structures. Based on an analysis of the current regulatory framework and scientific articles, we identified the absence of a unified engineering

methodology that would take into account two fundamentally different physical mechanisms of heat transfer, namely thermal conductivity through the wall material and the air gap for non-through (blind) cracks, and convective infiltration of external air for through-cracks. During the study we performed numerical modeling for thirteen combinations of geometric parameters of cracks (depth from 5 to 510 mm, opening width from 0,1 to 5,0 mm) for an external wall made of silicate brick. It was established that the depth of the defect rather than its width has a critical impact on thermal protection for blind cracks, while the heat transfer resistance decreases according to a hyperbolic law. We identified a cubic dependence of heat loss on the opening width for through cracks. Comparing the obtained results with studies of the causes of crack formation made it possible to describe the stages of thermal insulation degradation and the moment of catastrophic transition from one mechanism of heat loss to another. The proposed model allows for quantitative assessment of heat losses without the use of resource-intensive finite element modeling and can be used in energy surveys of buildings.

Keywords: crack; infiltration; thermal resistance; thermal-technical heterogeneity; enclosing structure; temperature-shrinkage deformations.

DETERMINATION OF HYDRAULIC REGULARITIES IN INSTALLATION OF WATER PRESSURE REGULATORS WHEN DESIGNING MULTI-STOREY RESIDENTIAL BUILDINGS

V. V. Pomogaeva

Annotation. In the article I touch upon the principles for installing pressure regulators on cold water supply networks in the design of residential buildings with enhanced comfort. I also determined the hydraulic regularities of the installation of water pressure regulators in the design of multi-storey residential buildings. Firstly, I carried out a quantitative assessment of the pressure distribution on floors of 17 and 25-storey buildings. The main method we used there is modeling the operating mode of the water supply network. The object of the study is the pressure water supply network of a residential building. Next, I performed hydraulic calculations of typical water supply schemes for houses with the construction of water head diagrams. I considered single-zone and dual-zone water supply schemes. As a result, we determined distribution of water heads by floor, pressure drops on floor-by-floor lines, throughput coefficients, and conditions cavitation emerging. I finally justified places of installation of pressure regulators for multi-storey buildings. In conclusion I give some recommendations on bringing pressure parameters in floor-by-floor inlets to normative ones.

Keywords: water supply; water pressure regulator; reduction; water head diagram.

URBAN PLANNING. RECONSTRUCTION, RESTORATION AND LANDSCAPING

INTEGRATION OF HISTORICAL AND ARCHITECTURAL HERITAGE OBJECTS INTO THE STRUCTURE OF A MODERN MEGACITY: URBAN PLANNING ASPECTS

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

Annotation. In conditions of intensive urbanization and globalization, modern megacities face an acute contradiction between the need for dynamic development and the preservation of historical and cultural identity. The article examines the urban planning aspects of integrating objects of historical and architectural heritage into the structure of a large city. Based on the analysis of domestic and foreign experience, the main methods of reconstruction of historical buildings are systematized: contextualism, which presupposes a harmonious fit of a new object into the current environment; a contrasting approach that creates dialogue between eras through the juxtaposition of forms and materials; hidden reconstruction, transforming peripheral and courtyard spaces without disturbing the ceremonial appearance; as well as revitalization and adaptation, allowing historical buildings to be endowed with new features while maintaining their appearance. Urban planning factors that determine the choice of strategy have been identified: regulatory restrictions (protection zones according to 73-FZ), the physical condition of the facility, the urban planning context (location, density, scale), economic and landscape conditions. The authors' typology of cultural heritage objects is proposed on two key grounds - the degree of permissible transformation (conservation, restoration, reconstruction, adaptation) and the nature of interaction with new buildings (isolated objects, a regulatory zone integrated with symbiosis or contrast, objects as part of multifunctional complexes). A practical matrix for choosing the best integration strategy has been developed for use by architects and urban planners in design. We formulated six criteria for the harmonious inclusion of historical elements in the modern urban environment, among which the key ones are the preservation of authenticity, the dialogue of the old and the new. The proposed approaches make it possible to preserve the historical identity of cities, avoid destructive changes and form aesthetically integral, comfortable public spaces.

Keywords: object of cultural heritage; urban environment; reconstruction of historical buildings; restoration; historical environment.

METHODOLOGY FOR ASSESSING THE LOCATION OF EDUCATIONAL INSTITUTIONS, TAKING INTO ACCOUNT THE FORMATION OF URBAN HEAT ISLANDS (USING THE EXAMPLE OF THE CITY OF ROSTOV-ON-DON)

E. A. Pasko, A. A. Fedorovskaya

Annotation. In the context of the growing influence of urban heat islands on the microclimate of large cities, social infrastructure facilities, particularly schools, are particularly vulnerable. This paper proposes a comprehensive methodology for assessing the location of schools relative to zones of thermal discomfort. The article as well justifies adaptation measures using the example of the city of Rostov-on-Don. The methodology consists of five sequential steps: mapping urban heat islands using remote sensing data; creating a database of school buildings; analyzing their spatial distribution; differentiating adaptation measures for different types of buildings; and grouping schools based on their exposure. Based on current data (106 schools), we established that about 40% of institutions are located in unfavorable areas with surface temperatures exceeding 50 °C, which requires priority in modernization. The developed recommendations can be used by local governments and project organizations to improve thermal resistance of school infrastructure in the face of a changing climate.

Keywords: comprehensive assessment of the territory; urban heat islands; educational institutions; temperature balance.

THE CONCEPT OF CREATING A SINGLE URBAN «SMART PARK» THROUGH THE ORGANIZATION OF CYCLE AND PEDESTRIAN WAYS

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Annotation. The development of «smart» technologies is currently a priority area worldwide. The article examines the concept of creating a unified urban recreational system in Voronezh-city, which would unite parks, embankments, and green spaces through cycle and pedestrian routes and digital technologies. The aim of the study is to develop the principles for creating a «smart park» that would ensure spatial connectivity, environmental sustainability, safety, and uninterrupted operation, as well as the comfort of residents and tourists. We analyzed the domestic experience of creating such zones. We proposed a concept for creating cycle and pedestrian routes that unite park areas located along the Voronezh Reservoir into a single system. Implementing the concept will increase the accessibility of recreational areas, improve the transport situation, optimize operating costs, and unlock the city of Voronezh's tourism potential.

Keywords: a city park; a smart city; cycle and pedestrian connections; a digital twin.

ECOLOGY AND SAFETY OF THE URBAN ENVIRONMENT

PROBLEMS OF INTRODUCING NOISE MAPS INTO THE TERRITORIAL PLANNING SYSTEM OF RUSSIAN CITIES: A SYSTEMATIC ANALYSIS OF LEGAL GAPS IN URBAN PLANNING

N. V. Korosteleva, M. V. Korosteleva

Annotation. The article is devoted to the identification and comprehensive analysis of legal gaps that hinder the introduction of noise maps into the urban planning documentation of Russian cities. In conditions of increasing noise load, which is one of the most aggressive anthropogenic factors affecting public health, legislative consolidation of effective territorial planning tools is becoming an urgent task. Using an analysis of the regulatory framework (Urban Planning Code of the Russian Federation, federal laws ‘On the Protection of Atmospheric Air’, ‘On Environmental Protection’, ‘On the Sanitary and Epidemiological Well-Being of the Population’ codes of practice), we found a systemic discrepancy: the by-law (SP 51.13330.2011 ‘Protection against noise’) prescribes the inclusion of noise maps in territorial planning documents, while the Urban Planning Code of the Russian Federation does not contain direct imperatives in this regard. We as well assessed the legal force of noise maps existing in individual Russian cities. As a result, we established that they do not have a mandatory effect, are not submitted to public hearings and do not affect urban planning decisions. We summarized the experience of Germany, where noise cards serve as a full-fledged legal mechanism: they ensure control over compliance with standards, inform citizens and serve as the basis for lawsuits. Based on the analysis, we proposed amendments to Articles 23, 30 and 42 of the Urban Planning Code of the Russian Federation, as well as a legal mechanism for using noise maps to establish zones with special conditions for the use of territories, namely zones of acoustic discomfort. It was concluded that without legislative recognition of noise maps, urban protection against noise in Russia remains only a declaration, and the proposed changes are a prerequisite for the transition from stating a problem to its practical solution.

Keywords: noise maps; Town Planning Code of the Russian Federation; territorial planning; acoustic discomfort zones; noise protection.

RELATIONSHIP OF NOISE IMPACT ASPECTS AND PARAMETERIZATION OF RAILWAY TRACK TURNING RADII

S. V. Artyshchenko, E. I. Golovina, P. Yu. Gusev, D. A. Sokolov

Annotation. In this paper we examine various aspects of noise impact, considering both the classifications found in cited studies and an original classification proposed by the authors. In addition to physical, psychological, physiological, and social impacts, we separately identify the effects of noise on sleep, as well as its occupational and economic implications. The interrelationships and mutual influences among these aspects are established and illustrated in a corresponding flowchart. We identified and classified primary and secondary aspects of noise impact, and determined the unidirectional or bidirectional dependencies between them. The study compares noise reduction methods across various countries and regions and examines the corresponding regulatory frameworks. We analyzed an urban acoustic index, serving as the basis for a classification of environmental acoustic quality. Building upon concepts established in the authors' previous work, the study addresses key factors influencing the selection of railway curve radii in the Russian Federation. We also present here considerations regarding the assessment, selection, and optimization of these radii during the design and reconstruction of railway lines. Within this same conceptual framework, we stress the need to determine the minimum and maximum radii of the circular arcs corresponding to the railway tracks. The potential for the concentration and intensification of adverse effects at the point corresponding to the center of the circle is also highlighted. It has been proposed that, when designing and constructing railway sections in areas containing facilities sensitive to residential zones, care should be taken to avoid placing them within so-called "foci" – points along the track's curvature where vibroacoustic and seismic impacts are concentrated and significantly amplified. The same considerations should guide the design and new construction of such sensitive facilities within the context of existing railway landscapes and infrastructure.

Keywords: noise impact; railway transport; urban acoustic index; turning radius of railway tracks.