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Engineering and Technical Survey of Cultural Heritage Object in the Project for Its Restoration and Adaptation for Modern Use

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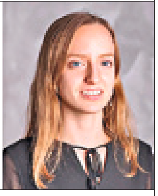

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The paper presents the results of an engineering and technical survey of building structures in a project to restore and adapt a cultural heritage site for modern use. The aim of this study is to develop and implement an integrated methodology for diagnosing the technical condition of building structures, taking into account the specific nature of cultural heritage sites, as well as to justify reinforcement and restoration measures aimed at extending the resource potential and adapting the site to its modern functional purpose. The initial permitting documentation for the surveyed site was studied and a survey programme was developed during the survey. The building space-planning solutions were established, the building's load-bearing elements design was determined. The building's structure measurements were taken, floor plans, facades, and characteristic sections were drawn up. A detailed inspection of the building's load-bearing structures was conducted, identifying their design features. Photographic recording was completed. The technical condition of the building's load-bearing and enclosing structures was determined. A technical report was prepared based on the survey results. Visual and visual-instrumental methods were used during the survey. Structural defects were visually identified, including cracks, deformations, load-bearing elements displacement relative to design positions, and others. Visual and instrumental methods were used to refine the geometric dimensions, and the actual physical and mechanical properties were examined. The building's technical condition was determined, and conclusions regarding its future operation were formulated based on the comprehensive engineering and technical survey results, in-place and laboratory tests, verification calculations, and an archival materials study. Verification calculations were performed for the building's metal roof truss, vertical displacements and *N* forces in the truss were determined, and designated cross-sections were checked for the first and second limit states, as well as for local truss stability. A seismoacoustic pile survey was also conducted to determine the pile depth. Furthermore, as the technical survey part of the cultural heritage site, a mycological test of the wooden dome roof structure was performed to detect infestation by biodegradable fungi (biological damage), and the possible causes of the infestation were determined. Specimens from the wooden supporting roof structures were examined using cultural and morphological methods.
Keywords: *comprehensive engineering and technical survey, cultural heritage object, reconstruction, seismoacoustic sounding, mycological research, verification calculations, strength assessment*

The cultural heritage preservation worldwide remains a pressing issue, as many countries possess vast numbers of historic monuments requiring protection and restoration. This article examines technical inspection methods applied to cultural heritage object in Russia. Mandatory comprehensive engineering and technical inspection is a key component of international heritage preservation programmes. This process involves detailed evaluation of structural characteristics, current condition, and related risks. The results form a scientific basis for effective restoration and adaptation strategies, incorporating advanced diagnostic technologies to improve accuracy and reduce damage risks during work [1–3].

The work objective presented in this article is to determine the building structural design, its technical condition, and the structures overall load-bearing capacity, identify hazardous damage, perform surveys with the architectural drawings and initial data for design, perform verification calculations, apply instrumental assessment methods, conduct laboratory tests taking into account the cultural heritage site objects and justify measures for strengthening and restoration aimed at extending the resource potential and adapting the site to its modern functional purpose. Engineering surveys types include engineering and technical inspection (building inspection, pit excavation, laboratory and office work). The survey was carried out in accordance with the requirements of Russian National Standard: GOST 31937–2024[1], Code of Practice: CP 13-102–2003[2], CP 70.13330.2012[3], CP 31-110–2003[4] [4–7].

The building discussed in this article is a regional cultural heritage site. The building was not in use prior to the survey and during the research. The building has a complex configuration, four stories high, with a basement, two mezzanines, superstructures, and a cinema on the second, third, and fourth floors. It was constructed between 1928 and 1931. Reconstruction was completed in 1972. The building is a special design object. Its structural design is mixed, with some parts being frameless and others being a partial frame. The column foundations are pile grillages connected by concrete slab with pile clusters. The wall foundations are composite strip foundations made of cut limestone rubble in a cement-sand mortar, concrete, and ceramic brick. The exterior walls are constructed of brickwork in a cement-sand mortar, plastered, and painted. The interior walls are

[1] GOST 31937–2024. Buildings and constructions. Rules of inspection and monitoring of the technical condition.

[2] CP 13-102–2003. Rules for inspection of load-bearing structural elements of buildings and structures.

[3] CP 70.13330.2012. Load-bearing and separating constructions.

[4] CP 31-110–2003. Design and erection of electrical equipment in residential and public buildings.

self-supporting, made of ceramic brick in a cement-sand mortar, and cinder concrete. The floor slabs are monolithic reinforced concrete, also made of precast reinforced concrete slabs on metal beams. The spandrel beams are reinforced concrete. The roof structures are complex in configuration, with flat and domed sections. The roof covering is galvanized steel sheet over wooden framings, with soft roofing made of rolled waterproofing membrane over reinforced concrete roof slabs. Water removal is controlled, while the external water removal is uncontrolled. The building's spatial rigidity is adequate, ensured by rigid joints connecting the beams to the columns and the floor slabs. The courtyard area is levelled. The adjacent asphalt pavement serves as a blind area in the courtyard, while paving slabs serve as a blind area on the main facades. Balconies are made of reinforced concrete slabs, cantilevered into the building's exterior wall. They are located on the main and courtyard facades at the second-story level. The building's facades are plastered and painted. Two- and three-flight staircases are made of monolithic reinforced concrete on a monolithic reinforced concrete slab, on steel stringers, with reinforced concrete landings and landings supported by reinforced concrete and steel beams and stairwell walls. Partitions are made of brick and cinder block. The building facade fragment is shown in Fig. 1.

The technical survey included a series of measures aimed at establishing the building materials strength characteristics in load-bearing structures using non-destructive testing methods. The concrete strength class was determined in compliance with the regulatory requirements set forth in Russian National Standard GOST 31937–2024[1]. The building's structural strength was assessed using the non-destructive, rapid impact pulse method using the Beton PRO Condtrol instrument in accordance with Russian National Standard GOST 22690–2015[5]. According to the test results, the average concrete strength of monolithic reinforced concrete columns was 31.8 MPa, the average concrete strength of monolithic reinforced concrete beams was 32.1 MPa, the average concrete strength of monolithic reinforced concrete floor slabs was 32.0 MPa, the average strength of ceramic bricks in the external walls of the 1st floor and basement was 9.3 MPa. Concrete strength was assessed using the ultrasonic device UK1401. Nondestructive testing results show that concrete strength in monolithic foundation slabs under blocks

[5] GOST 22690–2015. Concretes. Determination of strength by mechanical methods of nondestructive testing.

Fig. 1. The building facade fragment

1–5 matches class B25, as does strength in cast-in-place columns embedded in soil.

Verification calculations. Calculation relevance stems from ensuring reliability of metal roof trusses in a cultural heritage building under service loads. Work aims to verify vertical displacements and forces *N*, check assigned sections for ultimate limit states 1 and 2, and local stability per CP 16.13330.2017[6] and CP 20.13330.2016[7]. Tasks include load calculation, truss element strength and stability assessment, and local buckling analysis. Results confirm compliance of metal truss designs with standards and enhance operational reliability [8–15].

The designated sections were verified for the first and second limit states, as well as for local stability along the truss based on the verification calculations results (Fig. 2–4).

The maximum utilization coefficient of steel sections for the first limit state is 0.544 ($k_u = 0.544 < k_u^{max} = 1$). The maximum utilization coefficient of steel sections for the 2nd limit state is 0.550 ($k_u = 0.550 < k_u^{max} = 1$). The maximum utilization coefficient of steel sections for local stability is 0.702 ($k_u = 0.702 < k_u^{max} = 1$).

Calculation results confirm that the design cross-sections ensure required strength, stiffness, and stability of structures under

[6] CP 16.13330.2017. Steel structures.

[7] CP 20.13330.2016. Loads and actions.

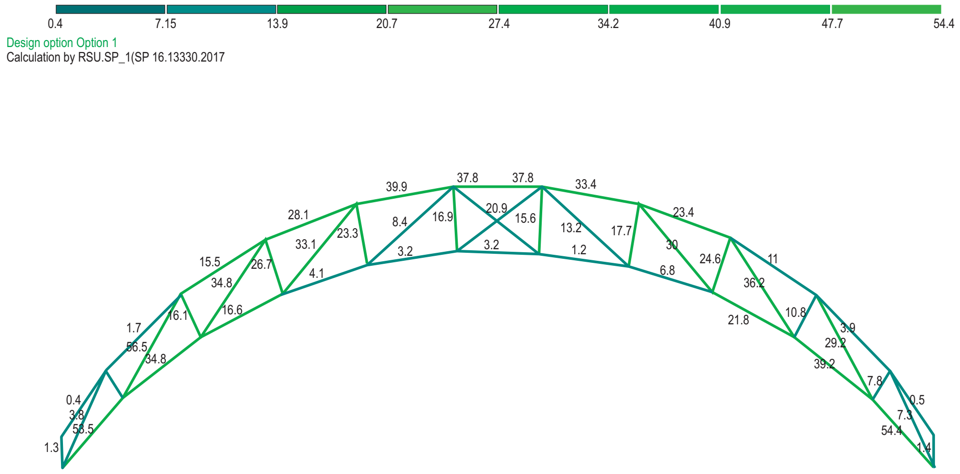

Fig. 2. Result of checking the assigned sections for the 1st limit state in the truss

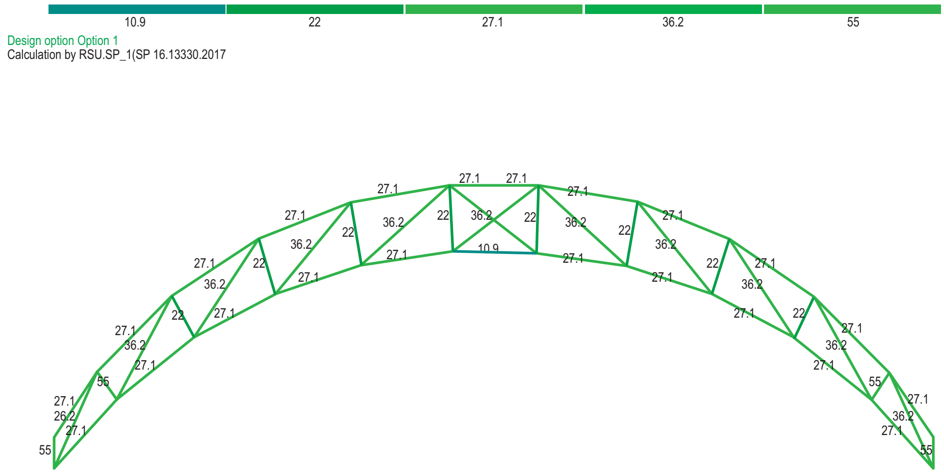

Fig. 3. Result of checking the assigned sections for the 2nd limit state in the truss

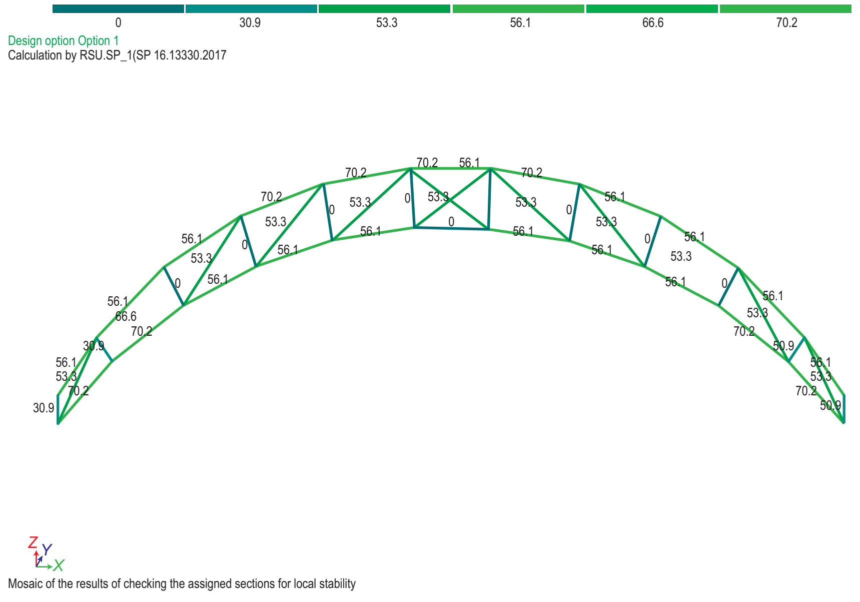

Fig. 4. Result of checking the assigned sections for local stability along the truss

design loads, thereby guaranteeing operational reliability of the building roof.

A seismoacoustic pile survey was also conducted to determine the pile emplacement depth. A pile extensiometer (IDS-1) was used to accomplish this task. 30 measurements were taken on the three piles under study at the survey site. The pile 1 length, according to data processing, was 5.7 m (±10 %, method error) based on the pile survey results. The pile 2 length, according to data processing, was 5.9 m (±10 %, method error). The pile 3 length, according to data processing, was 5.6 m (±10 %, method error).

Additionally, as part of the technical inspection in the cultural heritage object, the wooden dome roof structures mycological examination was performed to detect infestation by biodegradable fungi (biological damage) and to determine the damage possible causes. Specimens were collected nondestructively. Material fragments were taken from sites of natural failure or via surface mycological methods that preserve structural integrity. Specimens went into sterile containers. Specimens from the building's wooden supporting roof structures were examined using cultural and morphological methods. Localized areas of the wooden structures biodeterioration, in the form of small foci of rot at leak sites, were discovered on the inspected rafter system. Overall, the structures condition is acceptable: the wood is strong, the protective coating is functioning properly, and the structures exhibit only minor superficial biodeterioration. The building's wooden structures biodeterioration is assessed according to CP 28.13330.2017[8] as grade I, with localized areas of grade II–III damage requiring replacement or replacement. All preserved structures must undergo comprehensive antiseptic treatment.

The soil survey results. The soils assessment underlying the footing of the building's foundations was conducted based on the eighteen test pits results. The pits excavation was carried out from the basement level to a depth of approximately 0.5 m below the existing foundations footing. Soil specimens were collected beneath the foundation footings during the excavation and subjected to laboratory analysis in a stationary soil laboratory. Specimens were collected using sampling rings. It was determined that the immediate foundation soil for the building is a heavy, stiff loam containing plant residues based on the laboratory test results and

[8] CP 28.13330.2017. Protection against corrosion of construction.

an archival data analysis. The design bearing capacity of the foundation soils, R_0, for the existing foundation structure was calculated in accordance with formula 5.7 from CP 22.13330.2016[9].

This work presents results for strength and deformation characteristics of soil sampled during pit 3 excavation. Sampling interval is 1.35–1.55 m. Soil structure is not disturbed. Specimens are at natural moisture. Soil: heavy silty clay, stiff plastic with medium-deformed plant residue inclusions. Ring height is 25 mm (compression), 35 mm (shear). Ring diameter is 87.5 mm (compression), 72 mm (shear) per GOST 12248.1–2020[10]. The oedometric deformation modulus $E_{0.10\text{-}0.20}$ is 9.09 MPa. The compressive deformation modulus $E_{0.10\text{-}0.20}$ is 5.45 MPa. The deformation modulus taking into account $m_{oed}\,E_{0.10\text{-}0.20}$ is 13.2 MPa. The internal friction angle is 14.57°. The cohesion is 0.025 MPa.

The building foundation survey results. A lack of waterproofing material for the foundation structures was revealed during the foundations and base soils inspection.

Wall survey results. Basement walls, plinth, and exterior finishes, violations of masonry technology were identified, including missing bond, substandard joint sizes, mixed masonry (using ceramic and sand-lime bricks), and using bricks of varying strengths. Additionally, sections were identified where window and door openings have been narrowed or filled with masonry of various materials, use of irregular bricks and broken bricks, presence of decommissioned engineering communications embedded within wall thicknesses, areas with blocked niches and technological channels intended for pipe and utility passage, weathering of mortar joints in the masonry walls; localized damage to brickwork, patches of "chaotic" brickwork appearance, and numerous signs of water leakage on the wall surfaces were discovered. The finishing structures layers were dismantled.

The columns survey results. Chips in the protective layer of concrete, local exposure of longitudinal and transverse reinforcement, damage or absence of the concrete protective layer, transverse and longitudinal reinforcement corrosion, non-vibrated sections of monolithic structures, potholes and cavities on the concrete structures were found.

Floor slabs survey results. Water leakage traces on the slab surfaces, deterioration areas in the concrete slabs protective layer with reinforcing bars exposure, the slab reinforcement corrosion, localized damage to the protective concrete layer on the 1st, 2nd, and 3rd floors slabs, localized loss of the protective concrete cover with exposure and reinforcement bars surface corrosion in the basement slab, unplanned technological openings for utilities made during the building's operation, including openings created by breaking through structural elements, which compromised the concrete slabs reinforcement, non-vibrated areas in the monolithic slab structures, the protective concrete layer of monolithic reinforced concrete beams localized destruction, water leakage, and non-vibrated zones in the monolithic beam structures were identified as a floor slab and roof structures survey result. Taking into account that no significant defects or damage affecting the floors and roof load-bearing capacity were detected, the floors and roof load-bearing capacity is sufficient to withstand the actual loads.

Roof and roofing inspection results. The roof and covering structures survey revealed water leaks from the roof onto the covering, technological openings for utilities (ventilation) made during building operation — including openings created by perforating structures that compromised reinforcement in concrete slabs — damage to double joists between slabs due to natural wear, leaks including rot, lack of fire and bio protection for wood, compacted slag not meeting current thermal protection standards, mechanical damage to monolithic reinforced concrete beams, chips, exposed reinforcing bars, localized deterioration of the concrete protective layer on monolithic reinforced concrete beams, surface corrosion of reinforcement in monolithic beams, leakage traces, non-vibrated areas or formwork marks on monolithic structures, absence of fire and bio protection on wooden structures, damage to wooden elements from moisture and roof leaks (humidity, rot), missing components in wooden truss structures, peeling or missing paint on metal structures, localized surface corrosion at joints, localized missing bolts in connections, destruction of the upper layers of roll roofing (cracking, warping), clogged drainage funnels, areas of biological damage on the roofing, blisters and pimples in the roll roofing, localized roof leaks, deformation, mechanical damage, corrosion, and loosening of metal sheet fastenings on the dome roof. The drainage system's condition is unsatisfactory, with mechanical damage and surface corrosion on protective caps of drainage funnels. Water inlets are in poor condition due to deformation, surface corrosion, and clogging.

Fig. 5 shows the general view of the first-floor premises, the floor slabs and beams with repaired concrete protective layers, and column strengthening via injection grouting. Fig. 6 illustrates the dome on

Fig. 5. The general view of the first-floor premises

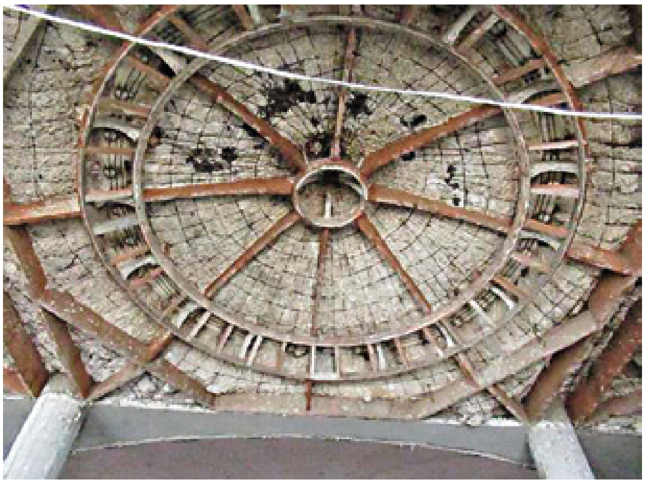

Fig. 6. The general view of the dome on a wooden frame located on the first floor

[9] CP 22.13330.2016. Soil bases of buildings and structures.

[10] GOST 12248.1–2020. Soils. Determination of strength parameters by shear strength testing.

Fig. 7. The masonry mortar weathering, local damage to the brickwork of the walls on the first floor

Fig. 8. Deformation, mechanical damages, corrosion, reduced tightness of metal sheet seam fasteners on the building's dome roofing

a wooden frame in the first-floor premises, including concrete deterioration with exposed and corroded reinforcement mesh. Fig. 7 documents mortar weathering, localized brick masonry damage in the walls of the first-floor premises, and wall strengthening through injection grouting. Fig. 8 reveals deformation, mechanical damage, corrosion, and loose fastening of metal roofing sheets on the dome roof.

Following a comprehensive survey, the structural elements technical condition in the building classified as a regional cultural heritage site was evaluated. It included the following types of work: detailed visual examination of all structural components with visible defects and damages identification, test pits excavation at key points to assess the foundations and soil condition, performing exploratory openings of finishing and structural layers to evaluate the actual state of concealed structural elements, instrumental measurements of geometric parameters and deformations in load-bearing structures, materials sampling for laboratory testing to determine their physical and mechanical properties, and the load-bearing capacity calculations considering identified defects, actual material properties, and applicable regulatory requirements — exhaustive data on the current technical condition were obtained.

The building's foundations, columns, walls, floor and roof structures, balconies and loggias, staircases, and timber and window assemblies are in working condition and capable of supporting existing loads. The identified defects and damage were the building's long service life result. There is no information on major repairs.

Thus, the survey conducted allowed to objectively assess the technical condition of the cultural heritage building, identify critical defects, and determine measures necessary for its preservation and further operation in accordance with regulatory requirements. Comprehensive technical survey using state-of-the-art technologies and standardized methods provide the basis for informed decision-making in preserving cultural heritage objects in international practice.

REFERENCES

1. Rimshin V., Roshchina S., Lukin M., Ketsko E. Scientific Basis of Studying the Pile Foundations Bearing Capacity During Building Reconstruction. Proceedings of MPCPE 2024. Lecture Notes in Civil Engineering. 2024; 576:282-294. DOI: 10.1007/978-3-031-81635-2_28
2. Telichenko V., Rimshin V., Ketsko E. Engineering structures stability against progressive collapse. E3S Web of Conferences. 2023; 410:02037. DOI: 10.1051/e3sconf/202341002037. EDN TYYYAK.
3. Rimshin V.I., Truntov P.S., Kuzina I.S., Roshchina S.I., Ketsko E.S. Engineering calculations of acidifier retaining walls during water treatment facilities designing. Lecture Notes in Civil Engineering. 2022; 182:55-73. DOI: 10.1007/978-3-030-85236-8_5. EDN YFEXGC.
4. Neverov A.N., Ketsko E.S., Truntov P.S., Rimshin V.I. Calculating the strengthening of construction structures before the reconstruction of the building. Lecture Notes in Civil Engineering. 2022; 182:173-179. DOI: 10.1007/978-3-030-85236-8_14. EDN GHCLDA.
5. Fadeev R., Lisyatnikov M., Rimshin V., Roshchina S. Investigation of the Strength Characteristics of Hydraulic Concrete Under Various Methods of Its Testing. Proceedings of MPCPE 2024. Lecture Notes in Civil Engineering. 2024; 576:113-125. DOI: 10.1007/978-3-031-81635-2_12
6. Kuzina E., Rimshin V., Neverov A. Residual resource of power resistance during building structures deformation. E3S Web of Conferences. 2019; 135:03009. DOI: 10.1051/e3sconf/201913503009. EDN UMYIGZ.
7. Krishan A.L., Rimshin V.I., Astafeva M.A. Deformability of a volume-compressed concrete. IOP conference series: materials science and engineering. 2018; 463(2):022063. DOI: 10.1088/1757-899X/463/2/022063. EDN WULQHB.
8. Telichenko V., Rimshin V., Ketsko E. Digital robotic systems for non-destructive reinforced concrete structures testing. E3S Web of Conferences. 2024; 533:02045. DOI: 10.1051/e3sconf/202453302045. EDN SRSXHS.
9. Rimshin V.I., Suleymanova L.A., Amelin P.A. Strength of Normal Sections of Flexural Reinforced Concrete Elements Damaged by Corrosion and Strengthened with External Composite Reinforcement. Structural Mechanics of Engineering Constructions and Buildings. 2024; 20(4):331-341. DOI: 10.22363/1815-5235-2024-20-4-331-341. EDN TZOMCJ.
10. Telichenko V., Rimshin V., Ketsko E. Promising directions for the artificial intelligence development in the housing and utilities sector. E3S Web of Conferences. 2024; 535:05001. DOI: 10.1051/e3sconf/202453505001. EDN OFARFI.
11. Krishan A.L., Astafeva M.A., Rimshin V.I., Shubin I.L., Stupak A.A. Compressed Reinforced Concrete Elements Bearing Capacity of Various Flexibility. Lecture Notes in Civil Engineering. 2022; 182:283-291. DOI: 10.1007/978-3-030-85236-8_26. EDN JPNURD.
12. Karpenko N.I., Rimshin V.I., Eryshev V.A., Shubin L.I. Deformation Models of Concrete Strength Calculation in the Edition of Russian and Foreign Norms. IOP Conference Series Materials Science and Engineering. 2020; 753(5):052043. DOI: 10.1088/1757-899X/753/5/052043. EDN TYMKCF.
13. Wang Sh., Jiang Y., Xu Y., Zhang L., Li X., Zhu L. Sustainability of Historical Heritage: The Conservation of the Xi'an City Wall. Sustainability. 2019; 11(3):740. DOI: 10.3390/su11030740

14. Penica M., Golovina S., Morgul V. Revitalization of Historic Buildings as an Approach to Preserve Cultural and Historical Heritage. International Scientific Conference Urban Civil Engineering and Municipal Facilities (SPBUCEMF-2015). Procedia Engineering. 2015; 117:883-890. DOI: 10.1016/j.proeng.2015.08.165. EDN UYZRDP.

15. Wang J., Zakaria S.A. Morphological Characteristics and Sustainable Adaptive Reuse Strategies of Regional Cultural Architecture: A Case Study of Fenghuang Ancient Town, Xiangxi, China. Buildings. 2025; 15(1):119. DOI: 10.3390/buildings15010119. EDN YPZSGO.

Инженерно-техническое обследование строительных конструкций в проекте реставрации и приспособления для современного использования объекта культурного наследия

В статье представлены результаты инженерно-технического обследования строительных конструкций в проекте реставрации и приспособления для современного использования объекта культурного наследия. Целью данного исследования является разработка и внедрение интегрированной методики диагностики технического состояния строительных конструкций с учетом специфики объекта культурного наследия, а также обоснование мероприятий по усилению и реставрации, направленных на продление ресурсного потенциала и адаптацию объекта к современному функциональному назначению. В ходе обследования изучена исходно-разрешительная документация по объекту обследования и составлена программа проведения обследования. Установлены объемно-планировочные решения здания, определено конструктивное исполнение несущих элементов здания. Выполнены обмеры строительных конструкций здания, оформлены планы этажей, фасады, характерные разрезы. Проведен детальный осмотр несущих конструкций здания с выявлением их конструктивных особенностей. Выполнена фотофиксация элементов конструкций здания. Определено техническое состояние несущих и ограждающих конструкций здания. Составлено техническое заключение по итогам обследования. При обследовании использовались визуальный и визуально-инструментальный методы. Визуально выявлялись видимые дефекты строительных конструкций: трещины, деформации, смещения несущих элементов относительно проектных положений и другое. Визуально-инструментальными методами уточнялись геометрические размеры строительных конструкций и отдельных элементов, исследовались фактические физико-механические характеристики материалов конструкций здания. По результатам комплексного инженерно-технического обследования, натурных и лабораторных исследований, поверочных расчетов и изучения архивных материалов определяется техническое состояние здания, сформулированы выводы о его дальнейшей эксплуатации. Выполнены поверочные расчеты металлической фермы покрытия здания, определены вертикальные перемещения и усилия N в ферме, выполнена проверка назначенных сечений по первому и второму предельным состояниям, местной устойчивости по ферме. Также было выполнено обследование методом сейсмоакустического зондирования свай с целью определения глубины их заложения. Кроме того, в рамках технического обследования объекта культурного наследия было выполнено микологическое исследование деревянных конструкций крыши здания купольного типа на предмет заражения грибами-биодеструкторами (поражения биологического характера), установление возможных причин поражения. Были исследованы пробы с деревянных несущих конструкций крыши здания культуральными и морфологическими методами.

Ключевые слова: *комплексное инженерно-техническое обследование, объект культурного наследия, реконструкция, сейсмоакустическое зондирование, микологическое исследование, поверочные расчеты, оценка прочности*

СПИСОК ИСТОЧНИКОВ

1. Rimshin V., Roshchina S., Lukin M., Ketsko E. Scientific Basis of Studying the Pile Foundations Bearing Capacity During Building Reconstruction // Proceedings of MPCPE 2024. Lecture Notes in Civil Engineering. 2024. No. 576. Pp. 282–294. DOI: 10.1007/978-3-031-81635-2_28
2. Telichenko V., Rimshin V., Ketsko E. Engineering structures stability against progressive collapse // E3S Web of Conferences. 2023. No. 410. P. 02037. DOI: 10.1051/e3sconf/202341002037. EDN TYYYAK.
3. Rimshin V.I., Truntov P.S., Kuzina I.S., Roshchina S.I., Ketsko E.S. Engineering calculations of acidifier retaining walls during water treatment facilities designing // Lecture Notes in Civil Engineering. 2022. No. 182. Pp. 55–73. DOI: 10.1007/978-3-030-85236-8_5. EDN YFEXGC.
4. Neverov A.N., Ketsko E.S., Truntov P.S., Rimshin V.I. Calculating the strengthening of construction structures before the reconstruction of the building // Lecture Notes in Civil Engineering. 2022. No. 182. Pp. 173–179. DOI: 10.1007/978-3-030-85236-8_14. EDN GHCLDA.
5. Fadeev R., Lisyatnikov M., Rimshin V., Roshchina S. Investigation of the Strength Characteristics of Hydraulic Concrete Under Various Methods of Its Testing // Proceedings of MPCPE 2024. Lecture Notes in Civil Engineering. 2024. No. 576. Pp. 113–125. DOI: 10.1007/978-3-031-81635-2_12
6. Kuzina E., Rimshin V., Neverov A. Residual resource of power resistance during building structures deformation // E3S Web of Conferences. 2019. No. 135. P. 03009. DOI: 10.1051/e3sconf/201913503009. EDN UMYIGZ.
7. Krishan A.L., Rimshin V.I., Astafeva M.A. Deformability of a volume–compressed concrete // IOP conference series: materials science and engineering. 2018. No. 463 (2). P. 022063. DOI: 10.1088/1757-899X/463/2/022063. EDN WULQHB.
8. Telichenko V., Rimshin V., Ketsko E. Digital robotic systems for non–destructive reinforced concrete structures testing // E3S Web of Conferences. 2024. No. 533. P. 02045. DOI: 10.1051/e3sconf/202453302045. EDN SRSXHS.
9. Rimshin V.I., Suleymanova L.A., Amelin P.A. Strength of Normal Sections of Flexural Reinforced Concrete Elements Damaged by Corrosion and Strengthened with External Composite Reinforcement // Structural Mechanics of Engineering Constructions and Buildings. 2024. No. 20 (4). Pp. 331–341. DOI: 10.22363/1815-5235-2024-20-4-331-341. EDN TZOMCJ.
10. Telichenko V., Rimshin V., Ketsko E. Promising directions for the artificial intelligence development in the housing and utilities sector // E3S Web of Conferences. 2024. No. 535. P. 05001. DOI: 10.1051/e3sconf/202453505001. EDN OFARFI.
11. Krishan A.L., Astafeva M.A., Rimshin V.I., Shubin I.L., Stupak A.A. Compressed Reinforced Concrete Elements Bearing Capacity of Various Flexibility // Lecture Notes in Civil Engineering. 2022. No. 182. Pp. 283–291. DOI: 10.1007/978-3-030-85236-8_26. EDN JPNURD.
12. Karpenko N.I., Rimshin V.I., Eryshev V.A., Shubin L.I. Deformation Models of Concrete Strength Calculation in the Edition of Russian and Foreign Norms // IOP Conference Series Materials Science and Engineering. 2020. No. 753 (5). P. 052043. DOI: 10.1088/1757-899X/753/5/052043. EDN TYMKCF.
13. Wang Sh., Jiang Y., Xu Y., Zhang L., Li X., Zhu L. Sustainability of Historical Heritage: The Conservation of the Xi'an City Wall // Sustainability. 2019. No. 11 (3). P. 740. DOI: 10.3390/su11030740
14. Penica M., Golovina S., Morgul V. Revitalization of Historic Buildings as an Approach to Preserve Cultural and Historical Heritage // International Scientific Conference Urban Civil Engineering and Municipal Facilities (SPBUCEMF-2015). Procedia

Engineering. 2015. No. 117. Pp. 883–890. DOI: 10.1016/j.proeng. 2015.08.165. EDN UYZRDP.

15. Wang J., Zakaria S.A. Morphological Characteristics and Sustainable Adaptive Reuse Strategies of Regional Cultural Architecture: A Case Study of Fenghuang Ancient Town, Xiangxi, China // Buildings. 2025. No. 15 (1). P. 119. DOI: 10.3390/ buildings15010119. EDN YPZSGO.

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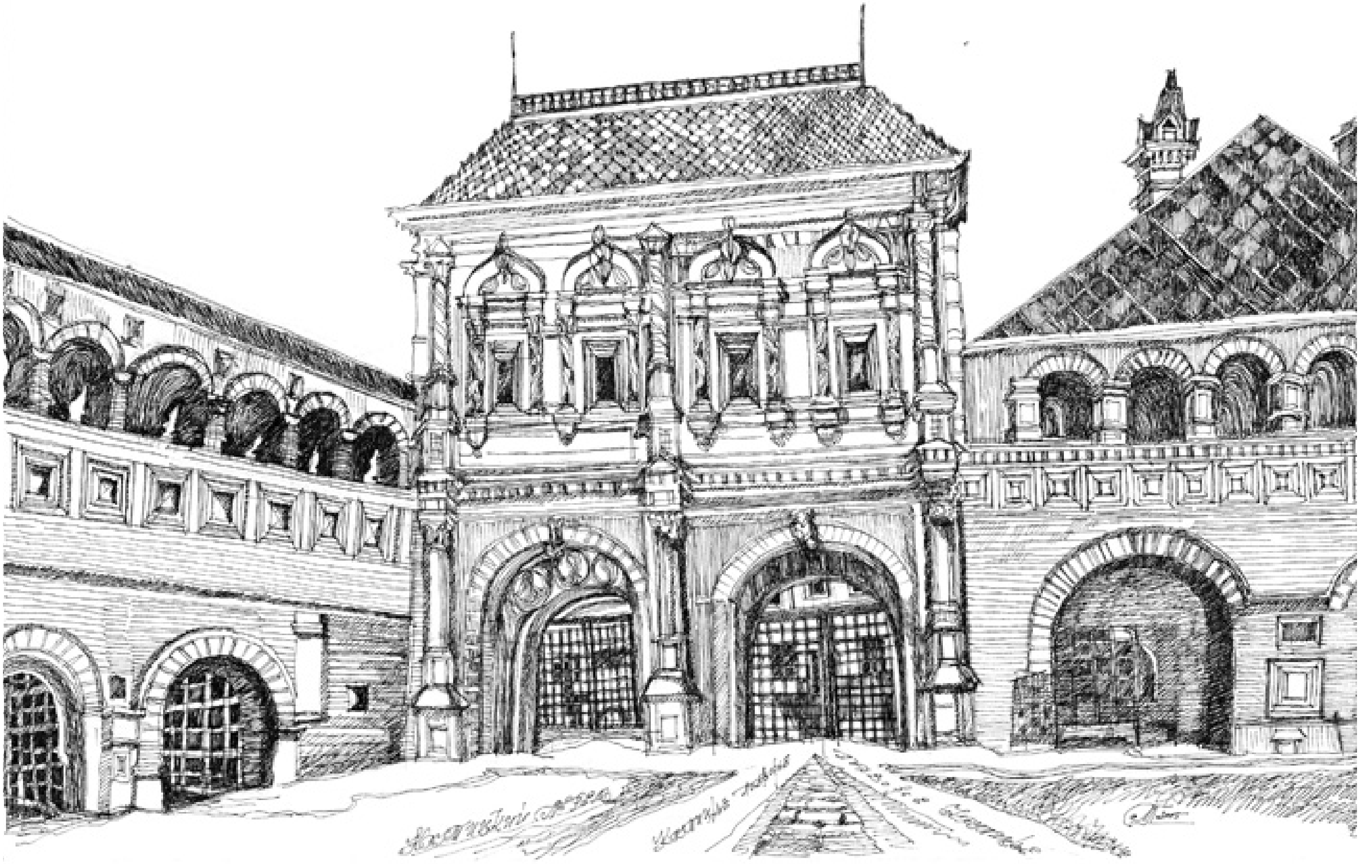

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