Evaluation criteria for scientific and technical support of a pilot project

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Abstract. Scientific and technical support for engineering, design and construction of buildings and structures increased level of responsibility (grade KS-3) provides for the Technical regulations on safety of buildings and constructions, town-planning code of the Russian Federation and other interstate standard. Experimental construction - construction carried out on the basis of the results of research and design work in order to verify the adopted technical and technological solutions, the use of new materials in the reconstruction and construction of buildings and structures for various purposes. By decree of the Government of the Russian Federation of 20.05. 1998 No. 1 "on priority directions of scientific and technical progress and introduction of new effective technologies, materials and structures in the construction complex and housing and communal services of the Russian Federation” highlights the main directions of scientific and technical development of construction and housing and communal complexes. The research describes the existing approaches to setting up and conducting an experiment at various stages of the life cycle of a construction object, which allow us to determine whether an investment and construction project belongs to an experimental project in various aspects. Criteria for evaluating the quality of scientific and technical support results have been developed that allow formalizing the terms of reference for performing scientific and technical support and ensuring proper quality of work, as well as formalizing and making an objective assessment of the results of scientific and technical support of an investment and construction project at various stages of its life cycle.

1. Introduction

In the process of experimental construction and subsequent operation, new space-planning, structural and technological solutions, planning techniques and urban development are comprehensively tested. Experimental construction can also be carried out in order to pre-test new methods of construction and installation works, forms of organization and management of construction production [1-7]. The objects of experimental construction can serve as individual industrial, residential, public buildings or special structures (dams, bridges, road sections, utility networks, etc.), as well as groups of buildings.

The main directions of scientific and technological development of construction and housing and communal complexes. Cases related to the pilot project were expanded in accordance with Presidential Decree No. 899 of July 7, 2011 (in order to ensure the development of critical technologies and priority areas for the development of science, technology and technology in the Russian Federation), and Presidential Decree No. 204 of 7 May 2018 (in order to accelerate the introduction of digital technologies in the economy and social sphere), by Order of the President of the Russian Federation to the Government of the Russian Federation No. PR-1235 (in order to transfer to the life cycle
management system of capital construction facilities by introducing those nology Information Modeling), the national project "Housing and Urban Environment", National Program "Digital Economy of the Russian Federation" and the "Regulations on the experimental design and construction of capital facilities in the city of Moscow" approved by 19.05.2015.

2. Methods
This study considered the following methods for evaluating the effectiveness of management systems [20-22]:
  - multi-dimensional statistical analysis method;
  - methods of multi-criteria evaluation.
  
  The method of multivariate statistical analysis, as part of the quality control method, is a method that allows you to identify violations and problems in the organization of construction production and technological processes at each stage of the life cycle of the ACS to assess the effectiveness of management systems.

  Quality is usually characterized by several indicators and these indicators can be correlated with each other. In the latter case, independent monitoring of individual indicators can lead to significant errors. The result of the control is often inadequate to the actual situation, since it is possible to skip the actual process breakdown, and unjustified stops when the used statistics go beyond the control limits [17-19].

3. Results
Three main directions are highlighted and detailed:
  - new technological solutions;
  - new technical solutions (including structural ones);
  - new materials.
    New technological solutions include:
    - organization and management technologies;
    - automated technologies for construction production;
    - green building technologies;
    - robotization technologies in the construction industry;
    - 3D technology in construction;
    - VR / AR technology;
    - technologies of the “smart city”;
    - information modeling technologies.

    New technical solutions include:
    - new design solutions;
    - solutions for thermal insulation of rooms.

    New materials include:
    - membrane technology;
    - new types of fittings;
    - self-compacting and self-healing concrete;
    - 3D panels;
    - the use of nanotechnology in building materials and structures.

4. Discussion
In order to standardize approaches to performing work in experimental design and construction, providing scientific and technical support was analyzed in relation to new practices on the application and implementation of new developments in capital construction, the principle novelty, and the effectiveness of which contribute to significant improvement of qualitative properties and/or operational performance as well as security, reliability, cost and energy efficiency of the facility [8-12].
1. Implementation of research and development results that affect the safety and reliability of buildings and structures and require pilot implementation:
- new technological, technical, and design solutions,
- new organizational and economic measures and methods,
- innovative materials, structures and equipment,
- new urban planning solutions, methods of planning and development of the city territory,
- methods of organization of construction and production of works that ensure improvement of safety, energy, economic and environmental efficiency, quality and reliability of operation of capital construction facilities, as well as improvement of regulatory documents.

2. New technological, technical and design solutions.

The introduction of new technological, technical and structural solutions provides scientific and technical support for engineering surveys, design and construction of buildings and structures. The process includes a description of solutions, technical description, specifications, drawings, regulatory and technical documentation, and certification documents. Pilot implementation of new technologies must meet the requirements of the Technical regulations on the safety of buildings and structures, the Interstate standard GOST 27751-2014 "Reliability of building structures and foundations. Basic provisions", SP 20.13330.2016 "Loads and impacts", SP 22.13330.2016 "Foundations of buildings and structures" and other requirements of the legislation of the Russian Federation regulating the construction of capital construction projects.

Technological solutions are a set of measures to coordinate architectural, space-planning, structural and engineering design solutions with the functional purpose of the capital construction object and the features of technological processes implemented in the planned capital construction object. Technological solutions must ensure the effective functioning of the capital construction facility [13]. You can select several directions:
- automated construction production technologies;
- green building technologies;
- technology of robotics in the construction industry;
- VR / AR technologies;
- 3D technologies in construction;
- smart home technologies.

Design solutions provide a detailed study of load-bearing structures and those elements of the architectural concept that affect their load-bearing capacity, and determine the purpose and specifics of structures that are necessary to ensure the reliability, stability and durability of the capital construction object. These include the creation of new types of structures and their components, including for unique buildings and structures that increase reliability and reduce the material and labor intensity of work. If the design used previously unproven design solutions or for which there are no reliable calculation methods, it is necessary to use data from experimental studies on models or full-scale structures. Research is performed according to a specially developed program drawn up by the General designer or the organization that implements the NTS, and approved by the customer [14].

Technical solutions in the design process are developed to obtain objective technical information about the capital construction object and its engineering infrastructure. These include the use of non-traditional and renewable energy sources, new technical solutions in wastewater treatment, as well as the use of experimental technical solutions in the design and construction of engineering networks and infrastructure.

3. Application of innovative materials, structures and equipment.

Application of innovative materials to provide increased strength and efficiency of thermal insulation, waterproofing, and noise absorption in load-bearing and enclosing structures. These include:
- application of nanotechnology in building materials and structures,
- self-compacting and self-repairing concrete,
- 3D panels,
− new types of fittings;
− membrane technology.

4. New urban planning solutions, methods of planning and development of the city territory, including the use of technologies:
− "smart city»;
− VR / AR technologies;
− information modeling.

5. Technology of management organization in the implementation of investment and construction activities [15].
− application of "intelligent" and automated technologies for collecting, processing and analyzing information about the control object and its management systems;
− development of fundamentally new management decisions in the planning, organization and control of construction, including the use of information systems;
− ensuring the efficiency of capital investments based on the use of progressive and modern solutions.

Criteria for evaluating the scientific and technical support of an experimental project are necessary to formalize the influence of complicating factors and types of work performed during the pilot project.

It should be noted that scientific and technical support can be provided at the following stages of the pilot project implementation:
− pre-project work;
− design and survey works;
− construction (reconstruction);
− demolition and disposal.

The composition of scientific and technical support works performed at each stage is determined by the customer (developer) based on the requirements of normative and technical documents for the capital construction object and works, as well as their own needs. Specialized organizations can be engaged for the entire scope of scientific and technical support performed at the current stage of the pilot project, or for certain types of work [16].

Based on the analysis of existing practices of scientific and technical support of work on the creation of a capital construction object, including during experimental construction, the criteria for evaluating scientific and technical support of an experimental project were identified:
− the level of complexity of the object;
− class of structures;
− geotechnical category of the object;
− the list of performed works subject to scientific and technical support;
− the level of complexity of the work performed, subject to scientific and technical support.

The level of complexity of the object is evaluated according to the following factors:
− the possibility of dangerous natural processes and phenomena and man-made impacts on the territory where the construction, reconstruction and operation of a building or structure will be carried out (in accordance with FZ-384) - factor 1;
− belonging to hazardous production facilities (in accordance with FZ-384) - factor 2;
− fire and explosion-fire hazard (in accordance with FZ-384) - factor 3;
− level of responsibility (in accordance with FZ-384) - factor 4;

The class of structures is set in the design assignment by the General designer in agreement with the customer in accordance with the classification provided in GOST 27751-2014 Reliability of building structures and foundations. Fundamentals:
− class of structures KS-1:
  a) greenhouses, greenhouses, mobile buildings (collapsible and container type), temporary storage facilities that do not provide for permanent residence of people;
  b) structures with limited service life and the presence of people in them.
− class of structures KS-2:
− construction class KC-3.
  a) buildings and structures of particularly dangerous and technically complex objects.
  b) all structures that are designed and constructed using fundamentally new design solutions and
technologies that have not been tested in the practice of construction and operation;
  c) life-support facilities for cities and localities;
  e) tunnels, pipelines on roads of the highest category or having a length of more than 500 m;
  g) construction objects with a height of more than 100 meters;
  I) bridge spans with a span of more than 200 meters;
  j) large-span coatings of construction objects with a span of more than 100 meters;
  l) construction objects with cantilever structures more than 20 meters;
  m) construction sites with a depth of more than 15 meters underground.

Geotechnical category of the construction object, in particular of underground structures, represents
a category of its complexity, in terms of geotechnical design, which depends on the aggregate level of
responsibility and complexity of the object as a whole, as well as the complexity of engineering-
geological conditions of the construction site.

The complexity category of engineering and geological conditions of construction should be
determined in accordance with SP 47.13330.

Three geotechnical categories are established for assigning requirements to engineering surveys
and geotechnical sections of an underground construction project:
− 1st (simple),
− 2nd (medium difficulty),
− 3rd (difficult).

The scope of work to be performed, subject to NTS, is determined by the customer (developer) and
evaluated in accordance with the following factors:
− the contractor performs certain types of work subject to NTS at this stage of the project
  implementation-factor 1;
− the contractor performs the entire scope of work subject to NTS at this stage of the project
  implementation-factor 2.

The level of complexity of the work performed, subject to NTS, is assessed in accordance with the
following factors:
− qualification level of the work performed (in accordance with professional standards) - factor 1;
− level of mechanization and automation of the process-factor 2.

Criteria for assessing the quality of the STC pilot project needed to be reviewed for, whether
achieved or improved under the project, the performance of the object without increasing the
estimated cost of the relevant types of work pilot project. The following criteria are considered:
− the quality of design and survey work performed for compliance with technical and economic
  indicators and requirements of regulatory documents (SNiP, GOST, TU, etc.).
− successful examination of design and estimate documentation and results of engineering surveys
  (including repeated);
− results obtained from the results of technical audit;
− the quality of construction and installation works performed and used construction materials,
  structures and products and their compliance with technical indicators, requirements of regulatory
documents (SNiP, GOST, TU, etc.);
− assessment of the implementation of the operation mode of the object, in terms of ensuring planned
  operation, the absence of technical failures, defects, damage to structures, deformation of soil bases
  and emergencies;
− successful completion of the examination of the project of organization of works (POR) for the
demolition of the capital construction object;
− the quality of work performed during the demolition of a capital construction object, their
  compliance with the requirements of regulatory documents (SNiP, GOST, TU, etc.).
5. Conclusions
Testing and testing in full-scale conditions of the results of research and development work, new technological, technical, design solutions, new organizational and economic measures and techniques, innovative materials, structures and equipment, as well as new urban planning solutions, methods of planning and development of the city territory, methods of organizing construction and production of works that improve safety, energy, economic and environmental efficiency, quality and reliability of operation of capital construction projects, as well as improvement of regulatory documents.

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