Scientific and technical maintenance of transport infrastructure facilities

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Abstract. The work aimed to determine the concepts of scientific training, the relationship of this concept with the scientific and technical maintenance of design, the definition of goals, consideration of the current state of the issue, the identification of problems of this type of activity, the definition of the scope of work in the preparation and maintenance of design and the suggestion of a further development path. The methods of the study were the analysis of the current regulatory documentation and the identification of provisions that normalize scientific preparation and scientific and technical maintenance of design, the collection and analysis of publications on topics related to the topic of this article, the analysis of the experience of this type of activity by various organizations, the subsequent generalization of the analysis results and the formation conclusions. As a result of the study, the concepts of scientific preparation and scientific and technical maintenance of design were established, the relationship between these concepts was established, the composition of work for this type of activity was determined - the minimum standardized, typical and advanced. A circle of problems and questions was also identified that accompanies the implementation of scientific and technical maintenance of design, including requirements for the results of work and their executors, criteria for the need for STMP (scientific and technical maintenance of design). In conclusion, the urgency of the problem is indicated, a way to solve it and a possible positive effect are proposed. This study substantiates the need for the development of regulatory documentation containing various requirements, norms and criteria concerning activities for scientific and technical maintenance of design.

1. Introduction

The aim of this work was to define the concept of scientific training and support of the design, to indicate its relationship with the concept of scientific and technical support, to set its purpose, to establish a list of existing documents governing this type of work, to determine the list of works performed in the framework of the scientific-technical support to the design, and outline directions for the development of normative-technical documents governing the activity.

Recently, there has been an increased interest on the part of developers in the construction of buildings and structures with a high level of responsibility, in particular high-rise residential buildings with a height of more than 120m and large-span sports facilities, as well as complex structures of transport infrastructure. In relation to such buildings and structures, according to the technical regulations, it is necessary to conduct scientific and technical support in the design. However, the requirements for this type of activity are not regulated.
To achieve the goals of the study, the current technical regulations, normative and technical documents and methodological materials, as well as publications by various authors, were analyzed. In particular, the work used the publications of A. A. Lapidus on the topic of scientific and technical support at the stages of design and construction surveys, publications of P. G. Eremeev and I. I. Vedyakov on the topic of design features of large-span unique buildings, an article by Vedyakova I. I., Konina D. V., reflecting the experience of designing high-rise buildings and other publications related to the design of objects of increased responsibility.

The purpose of this study is to establish the requirements for scientific and technical support of design and determine possible directions for the development of normative and technical documentation in terms of requirements for this type of work.

2. Research materials and methods

In the course of the study, the existing normative and technical documents and methodological materials were analyzed for the content of provisions regulating these types of activities. There was also an analysis of publications on the issues of scientific training and scientific and technical support of design, reflecting the views of various authors on this issue and the experience of these works. The study also took into account the experience of personal participation in the work on the STMP.

According to the recommendations on the construction of residential and public high-rise buildings [1], scientific preparation and scientific and technical support are considered as components of a single type of activity. However, the concept of scientific preparation is not disclosed, and moreover, it is not separated from the concept of scientific and technical support, including regarding the composition of the work performed. Thus, the concept of scientific preparation and scientific and technical support of design can be considered the same.

Scientific preparation of design and its support, i.e. scientific and technical support of design is the process of solving design problems using scientific methods and scientific and technical means on issues that are not reflected in the design standards [2], methodological, standard and other technical documentation, and can not be solved by standard means.

In accordance with the current regulatory documents in the field of designing the foundations of buildings and structures, Scientific and technical support is a set of scientific, analytical, methodological, informational, expert control and organizational work carried out in the process of research, design and construction in order to ensure the reliability of structures taking into account the use of non-standard calculation methods, design and technological solutions.

Scientific and technical support of the design is provided for by the current technical regulation on the safety of buildings and structures, as well as the current regulatory documents for buildings and structures with an increased level of responsibility for the reliability, a list of which is presented in this regulatory documentation and technical regulations [3]. For these buildings and structures, scientific and technical support for design in accordance with the requirements of regulatory documents on the reliability of buildings and their foundations should be carried out by an outside organization as an independent control.

The main purpose of scientific and technical support of the design is to ensure the requirements of reliability and safety of the designed object, which is provided by identifying deviations and errors in the project during scientific and technical support of the design, including those that can not be identified during the examination of the project documentation in the State examination bodies [4].

Taking into account the indicated goal, scientific and technical support of design can be perceived, including as an additional and deeper examination of design decisions. However, in contrast to the usual expertise, the result of scientific and technical design support is not only a list of comments but also detailed recommendations for their elimination and adjustment of design decisions. In addition to the expertise of design decisions during the scientific and technical support of design, scientific organizations support designers in organizing design work, in optimizing decisions made, in developing special technical conditions and in solving design problems using tools and methods not established by applicable regulatory and technical documents.
Work on the scientific and technical support of design work can be organized according to two options for interaction with customers of these works:

1. carrying out scientific and technical design support in relation to a fully completed project documentation with the issuance of the results of the STMP, which include a list of identified errors and deviations, as well as not optimal solutions, with detailed recommendations for updating the project documentation. These, in the image and likeness of the examination of project documentation, with the additional formation of recommendations for its adjustment.

2. conducting scientific and technical support of design in parallel with the development of project documentation in close collaboration with the design organization. In this option, scientific and technical support of the design is carried out in relation to individual design decisions, structures and units based on the results of an alternative calculation with the formation of design recommendations.

As with any activity in construction and design, the scientific and technical support of the design and its results, as well as the organizations and their personnel that will be engaged in the scientific and technical support of the design, must be subject to certain requirements.

From the name itself, it follows that scientific and technical support should be carried out by organizations or persons conducting scientific activities in the corresponding profile, i.e. on the subject of scientific and technical design support.

Thus, in order to conduct scientific and technical support, according to regulatory documents and design recommendations, it is necessary to involve research organizations, or groups of organizations, and their personnel, the field of scientific activity of which is the subject in which scientific and technical support will be provided. More specific requirements for organizations and their personnel that can carry out work on the scientific and technical support of design are not indicated in the current regulatory and methodological documents [5].

As previously indicated, the implementation of scientific and technical design support is provided for buildings and structures with an increased level of responsibility for reliability. But do all buildings and structures of an increased level of responsibility require scientific and technical support in their design? According to Boris Ilychev, the head of the Construction Solutions Directorate for Glavgosekspertizy and his deputy Yevgeny Leontiev, the developers of normative documents, when compiling and including requirements for the need for scientific and technical support for facilities with a high level of responsibility for reliability, were most likely focused on technically complex and unique objects, however, the practice of applying standards has shown that the need for scientific and technical support and independent monitoring design is sometimes excessive demand and requires specification of criteria under which it must perform. [6] In other words, there is no need to carry out scientific and technical support in relation to objects for the design of which atypical design solutions were not applied or design conditions were not adopted outside the normalized range, even if the designed objects are objects of an increased level of responsibility, because, for the design of these objects, the current standards are enough.

The other side of the coin is technically complex and unique buildings and structures, the design of which is impossible within the framework of current standards. Unique sports facilities erected for the 2018 FIFA World Cup can be cited as examples of such buildings and structures. When designing these objects, not only innovative constructive solutions were used, but also new calculation methods developed specifically for these objects, and the predicted climatic effects were taken into account, taking into account the durability of these objects and the peculiarities of climatic effects, taking into account the complex spatial shape of the designed objects [7].

Another side of the issue of scientific and technical support for design is a list of works that must be carried out as part of the maintenance [4]. To date, scientific and technical support for design work is not regulated by any regulatory and technical documents, there are only references in a number of regulatory documents with an approximate minimum list of necessary checks, which does not fully reflect the range of problems encountered in the design of unique and technically complex buildings and structures.
On the basis of the aforementioned list and practices of scientific and technical support for project work, including experience in conducting technical and scientific support projections, based on the experience of working with project organizations and bodies of the State examination to date has formed a list of the main areas of STMP, including 7 points:

1. Analysis of design and survey documentation;
2. The expertise of engineering survey results;
3. Numerical modelling of the system “Foundation bed - foundation - underground part”;
4. Development of geotechnical and technical monitoring programs;
5. Aerodynamic tests or building modelling in a specialized software package;
6. Performing an alternative calculation of the carrier system in a different software package than that used in the main calculation;
7. Technical support during the examination of project documentation.

In addition to the specified list of the main directions within the scientific and technical support of the organization’s design, its implementers can take part in the preliminary study of the designed object, in the development of special technical conditions for design work, develop recommendations for the use of innovative materials and technical solutions, etc. [2, 8, 9]. The list of works on STMP can be expanded by the customer to optimize the parameters of the designed facility, for example, to reduce the cost of construction and increase consumer attractiveness.

3. Results

However, in spite of the experience of various organizations in conducting scientific and technical support for design, questions still arise about the composition of the necessary STMP work and the requirements for their results that must be met to ensure reliability and safety requirements and to successfully pass design expertise documentation.

Thus, today in relation to the work on scientific and technical support of design, there are three big issues:

1. Requirements for organizations and personnel that can carry out work on the scientific and technical support of design work;
2. Criteria for assessing the need for scientific and technical support for design in relation to buildings and structures;
3. The list of necessary works on scientific and technical support of design and requirements for their results.

In addition to the above issues, the issue of determining the estimated cost of scientific and technical support of design and its accounting in the total cost of design work in particular and in the cost of the construction project as a whole is also important, because the current standards for determining the estimated cost of design and construction do not provide for STMP.

Given the increasing prevalence of buildings and structures with a high level of reliability responsibility, for which the current technical regulations and regulatory documents provide for scientific and technical support for design work, there is an increasing need to develop regulatory documents that would give answers to these questions in relation to STMP, which is confirmed by other studies [10]. Those normative documents are required, which would contain requirements for organizations and personnel that can carry out work on STMP, criteria for the need for STMP, a list of necessary work and requirements for their results, as well as the development of standards for determining the estimated cost of STMP and its accounting in the cost of construction products.
4. **Discussion**

The availability of normative documentation that answers the questions posed regarding the STMP will reduce the time and material costs of its implementation by eliminating the redundancy of the STMP caused by fears due to uncertainty through the use of clear criteria for assessing the need for its implementation, rationing the requirements for the composition and results of work, standardization of requirements for performers. In addition, the availability of norms for determining and accounting for the estimated cost will help to resolve issues regarding the financing of these works.

Further research on the topic of scientific and technical support for design can be continued by specifying the requirements for the set and results of work, organizations and specialists performing them, developing criteria for evaluating the need for this type of work, as well as methods for determining the cost of work on STMP.

5. **Conclusions**

As a result of the research, a list of issues was identified that reflect the directions for further development and improvement of the regulatory and technical framework for scientific and technical support of design. These results will help in the formation of proposals for the development of normative and technical documents and methodological materials in the framework of state programs to improve the system of technical regulation in construction.

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