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Information support of monitoring of technical condition of buildings in construction risk area

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Abstract. The paper presents the results of the research devoted to the development of a model of information support of monitoring buildings technical condition; these buildings are located in the construction risk area. As a result of the visual and instrumental survey, as well as the analysis of existing approaches and techniques, attributive and cartographic databases have been created. These databases allow monitoring defects and damages of buildings located in a 30-meter risk area from the object under construction. The classification of structures and defects of these buildings under survey is presented. The functional capabilities of the developed model and the field of it practical applications are determined.

1. Introduction
Large-scale construction in megapolises, especially due to the reconstruction of already developed territories, is associated with a dangerous technogenic impact, causing various deformations of building structures [1, 2]. These technogenic impacts negatively affect both the objects under construction, and buildings and structures located in the risk area of new construction [3, 4].

Due to the emerging danger of deformation and collapse of buildings that are located in the area of influence of the negative impact from neighboring construction (30-meter risk area of the surrounding building), they need continuous monitoring and evaluation of their technical condition.

For visual detection and fixing defects and determining the category of technical condition of the building and its structures, it is necessary to perform a visual and instrumental survey. There is not ratified methodology for implementation of this type of work either in the technical literature or in normative legal documents [5]. As well as, there is no unified software and information support that allows monitoring and evaluating technical condition of buildings based on the results of performed visual and instrumental surveys. These facts justify the urgency of developing modern information support for monitoring of the technical condition of buildings that fall into the construction risk area.

The purpose of the research is to improve the system of monitoring and evaluating of the technical condition of buildings, which are located in the construction risk area, based on its visual and instrumental surveys using modern DBMS and CAD.

2. Objects of research and methods
The objects of the research were capital construction objects of two categories: an erected (under construction) building and a building which is processed by visual and instrumental survey.

The survey object is a residential 4-storey building located in the Frunzensky district of St. Petersburg (Rasstannaya St., 13 A). The reason of this building survey was the construction of a new
residential block "New Ligovsky", which is located at: St. Petersburg, Rasstannaya St., 11, and its cadastral number is 78:13:0007316:2776. Figure 1 shows a scheme of the location of the object under construction and the surveyed object on a public cadastral map.

**Figure 1.** A scheme of the location of the building under construction (a) and the surveyed object (b) on a public cadastral map.

The main research methods were: instrumental method, analytical method, database design methods, modeling methods with the use of DBMS and CAD.

### 3. Results and Discussion

The issues of information support of monitoring buildings and structures are reflected in the articles of many Russian and foreign authors, in particular, from the standpoint of preserving historical buildings and objects of cultural heritage [6, 7, 8], monitoring and controlling of the technical condition of buildings and structures [9, 10, 11, 12], comprehensive assessment of the technical condition of residential building construction [13], etc.

An analysis of existing methods of visual and instrumental survey and modern trends of the monitoring of the building technical condition was performed. A model of information support of monitoring the technical condition of buildings, which are located in the 30-meter construction risk area, includes two components:

1. **Attributive database** for system storage, systematization and analysis of the characteristics of the constructed and surveyed objects, as well as the realization of requests and reports generation;
2. **Cartographic database** for layer-by-layer mapping of all building structures and various types of defects and damages for the purposes of spatial analysis and evaluation.

In the process of system analysis of the subject area, the following documents have been analyzed: floor plans of buildings; technical passports of buildings; town-planning plans of land plots; cadastral passports of land plots; cadastral coping of land plots; topographic plans of survey territories; technical reports of engineering and geological surveys and other documentation.

As a result, a conceptual model of the attributive database of visual and instrumental survey of the building technical condition was created.

The result of information-logical design was the logical data model (Figure 2).

The physical model was created in the DBMS Microsoft Access.

The cartographic database created in the AutoCAD software allows displaying plans of the defects and damages of the surveyed building (floor plans), as well as the facade profile. The model provides the layered visualization depending on the type of defect and the type of construction (Table 1).
4. Conclusion
The created model of information support of monitoring the technical condition of buildings which are located in the construction risk area allowed one to systematize information in a single formalized form about erected buildings, about buildings which are located in the area of new construction influence, about the presence of defects and damages on these buildings, and their technical condition.

Table 1. Classification of structures and defects.

| Type of construction (defect location) | Defect type                           |
|--------------------------------------|---------------------------------------|
| Roof                                 | Network of hairline cracks            |
| Stairs                               | Soaking and soiling of the furnish     |
| Window and door openings and fillings, linear openings | Zone of destruction of the furnishing layer |
| Basement                             | Cracks                                |
| Foundation of a building             | Lack of window sills                  |
| Attic                                | Destruction of the plaster layer      |

During the completed visual and instrumental surveys, as well as automated processing of their results, it has been revealed that the greatest number of different types of defects and damages were observed on the facades of buildings. Some of them are presented in Figures 3, 4.
Figure 3. The layer "Network of hairline cracks".

Figure 4. Combining different layers of the map database.

The proposed model helps to solve many problems, in particular:
- processing of survey results in a single and structured form;
- improvement of control over the performance of visual and instrumental survey of buildings technical condition;
- visualization of existing and emerging defects and damages during new construction;
- maintenance of a unified database of erected objects, buildings under surveying, defects and damages;
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- reduction of the number of lawsuits between developers, executors and owners of residential buildings;
- creation of a common information space for interaction with state structures and other organizations;
- ensuring timely repair or reconstruction of the surveyed buildings, which will ensure the safety of existing buildings;
- reduction of time and money costs during data processing and analysis.

Such advantages enable the broad practical application of the model by the following subjects:
- heads of municipalities, executive bodies;
- architecture and town planning bodies;
- State Construction Supervision and Expertise Service;
- specialized organizations in the field of cadastre, monitoring and land management;
- legal entities and individuals - developers;
- other interested legal entities and individuals.

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