

Development software for the non-destructive control of monolithic structures in housing construction

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Abstract. We describe in this article the developed software package. This software package improves the efficiency of the non-destructive quality control system for monolithic structures. The need to create a comprehensive tool was justified. This tool is capable of solving complex problems, both at the stage of technological design and during construction production. In construction, atypical heterogeneous tasks often arise that must be solved in conditions of financial, labor and time constraints. This is due to the specifics of the construction industry. A new direction - "the potential for the effectiveness of organizational and technological solutions" can solve this problem. Earlier studies of the potential for using non-destructive testing methods made it possible to form a scientific base for the formation of a comprehensive program program. The methodology for calculating the potential for using non-destructive testing methods in organizing the construction of residential buildings has been described. An algorithm for determining the qualitative characteristics of the potential during the implementation of the construction project was also developed. This algorithm includes 4 stages: comparative analysis of the existing situation at the facility; selection and establishment of levels of values of the parameters of ATM calculation of organizational and technical potential; calculation of a psychophysical assessment corresponding to the value of the potential.

1. Introduction

Monolithic construction is one of the most promising technologies for the construction of residential buildings and structures today. The scale of the buildings being erected states that the implementation of a construction project, taking into account the influence of all factors as much as possible, helps to reduce risks and reduce material costs. The development and improvement of the organization of production processes is one of the main tasks to improve the quality level of capital construction objects in monolithic housing construction. The problem of organizing construction, in particular the organization of production processes associated with the use of non-destructive control methods, is one of

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the most important in the construction of residential buildings and structures from monolithic reinforced concrete at the present time. Organizational and technological documentation regulating the procedure for conducting tests by non-destructive methods requires special attention when organizing the construction of residential buildings from monolithic structures. The formation of a non-destructive quality control system takes place within the framework of organizational and technological design. Modern domestic science pays insufficient attention to theoretical developments to optimize organizational and technical solutions when planning and conducting tests by non-destructive testing methods. Poorly developed organizational and technological documentation in terms of quality control of monolithic reinforced concrete structures leads to large losses on the part of the work manufacturer. Improving the efficiency of the quality control system by non-destructive methods is one of the key roles in organizing the construction of residential buildings. This is due to the fact that untimely testing of monolithic structures by non-destructive methods complicates the organization of construction production. The lack of organizational and technical tools to improve the efficiency of the non-destructive quality control system makes this topic relevant in the construction of monolithic reinforced concrete structures. The development of correct organizational, technical and managerial measures for the application of methods of non-destructive quality control of monolithic structures is one of the key components in the process of high-quality implementation of a construction project. The development of an organizational and technical model to improve the effectiveness of the organization of the construction of residential monolithic buildings is an urgent topic for research at the present time. [1-19, 25-28]The dependence of increasing the efficiency of the erection of monolithic structures on the organization of testing by non-destructive testing methods was proved in the work carried out. [20-24] The list of parameters affecting the quality of the final indicators during the implementation of the construction project was identified. The pace of construction and technical and economic indicators are meant by the final indicators. The identified factors were grouped into production and technological modules (PTM) for the purpose of further experiment. The result of this experiment was the creation of a mathematical tool. This tool is represented by a function with independent parameters, which were previously evaluated by expert groups, as a result of which their weights were determined. Developing an easy-to-use tool for calculating the quality values of an object is the next step. The development of digital technologies and computerization make it possible to solve this problem by developing software.

2. Material and Methods

This software package (PC) is an Internet application. It will be possible to calculate the potential when conducting tests by non-destructive methods of non-testing, giving out quantitative values with translation into qualitative ones with its help. We were guided by the following approaches when developing the software package:

1. Technological conditions.
 - conservative design, including warm, eye-pleasing tones;
 - ease of use;
 - modern, stylish interface.
2. Font, design
 - The font size should provide a comfortable perception of the information.
3. Programming languages:
 - Java Script, CSS, PHP, HTML, AJAX.
4. The possibility of using this complex on different devices:
 - stationary PC, laptop, smartphone, tablet, etc.

Using the program starts from the main page. «Figure 1»

Calculation of the potential for using non-destructive testing methods

An object

Multi-storey residential buildings

PTM1 - Readiness of the construction site for testing
Select option

PTM2 - Availability and timeliness of providing information on concrete
Select option

PTM3 - Personnel qualification level
Select option

PTM4 - Quality of project documentation (elaboration of organizational and technological documentation)
Select option

PTM5 - Application of non-destructive testing methods (direct, indirect)
Select option

PTM6 - Seasonal test conditions
Select option

PTM7 - The presence of the laboratory at the construction site
Select option

PTM8 - Terms of testing after the formation of the structure
Select option

Calculate

Fig. 1. Main page

On the main page, we need to select the type of object from the pop-up window. This window contains the following assignments: underground structures (foundations, piles), retaining walls, low-rise construction, multi-storey residential buildings, high-rise construction, structures (masts, basins, gravels). The next step will be the required parameter values. «figure 2»

PTM1 - Readiness of the construction site for testing

Select option

Site not ready for testing

Security service, responsible manufacturers were not notified of the arrival of laboratory specialists, the site is not ready for testing. The presence of defects in the measurement area (delamination, microcracks of the cavity, etc.), damage to the surface layer, the place for testing has not been cleared

Responsible personnel are aware of the arrival of specialists, there are no defects in the measurement area, the test site is not illuminated, there are hard-to-reach places for control

The construction site is completely ready for testing, all places are cleaned and prepared for testing, there are no hard-to-reach places to check the strength of structures

PTM2 - Availability and timeliness of providing information on concrete

Select option

No information available on concrete

There is no information about the tested structures at the time of testing. Concrete work log is not being maintained correctly.

Information about the tested structures is not given in full. Concrete work log is not being maintained correctly. The transfer of passports and certificates is delayed.

Information about the tested structures is given in full, there is a correctly and timely filled out log of concrete works with attached concreting schemes (including the numbering of concreting structures agreed by the General Contractor with the laboratory).

PTM3 - Personnel qualification level

Select option

Engineering and technical staff have no work experience in this specialty, do not have higher specialized education or have higher education in another specialty.

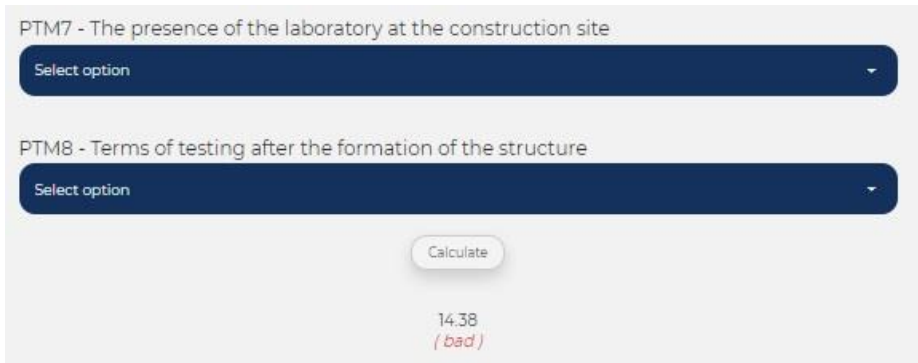
The laboratory representative does not have a complete higher education. Work experience less than 1 year

The representative of the laboratory has a higher education. Work experience up to 2 years

The representative of the laboratory has a higher education. Work experience from 2 years, has a master's degree

Fig. 2. Parameter selection

The calculation is the next step after the selection of parameter values. We get the result in the form of quantitative and qualitative assessment «figure 3»



PTM7 - The presence of the laboratory at the construction site

Select option

PTM8 - Terms of testing after the formation of the structure

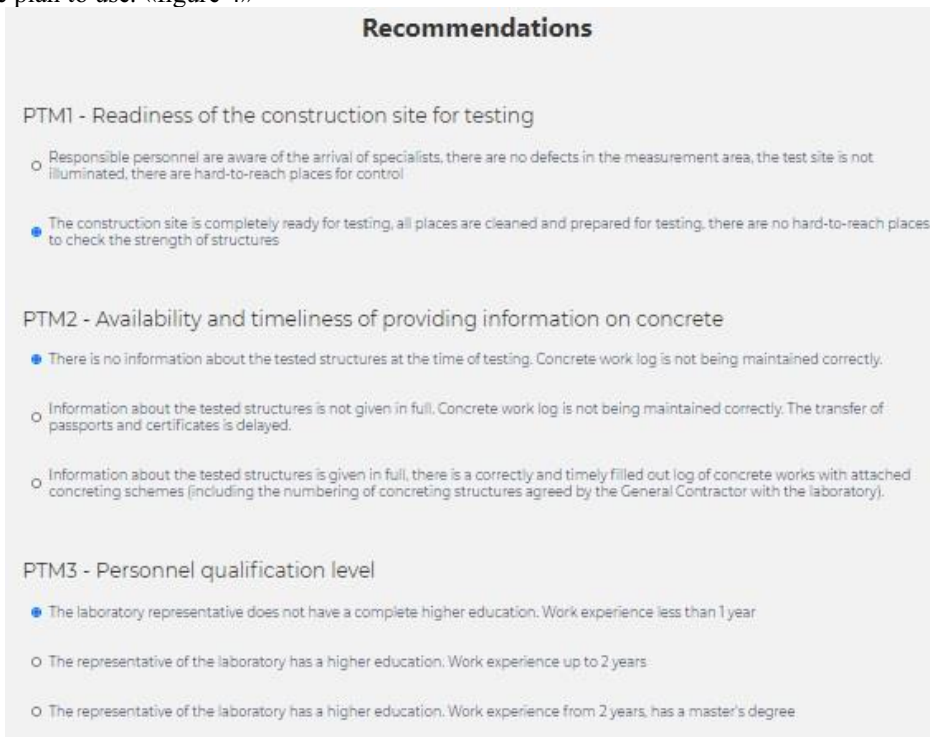
Select option

Calculate

14.38
(bad)

Fig. 3. Getting results

Using the recommendations for capacity building will be the next step if we are not satisfied with the result. In the window that appears, we are given a choice of recommendations for increasing the value, which we can use. It should be noted those that we plan to use. «figure 4»



Recommendations

PTM1 - Readiness of the construction site for testing

- Responsible personnel are aware of the arrival of specialists, there are no defects in the measurement area, the test site is not illuminated, there are hard-to-reach places for control
- The construction site is completely ready for testing, all places are cleaned and prepared for testing, there are no hard-to-reach places to check the strength of structures

PTM2 - Availability and timeliness of providing information on concrete

- There is no information about the tested structures at the time of testing. Concrete work log is not being maintained correctly.
- Information about the tested structures is not given in full. Concrete work log is not being maintained correctly. The transfer of passports and certificates is delayed.
- Information about the tested structures is given in full, there is a correctly and timely filled out log of concrete works with attached concreting schemes (including the numbering of concreting structures agreed by the General Contractor with the laboratory).

PTM3 - Personnel qualification level

- The laboratory representative does not have a complete higher education. Work experience less than 1 year
- The representative of the laboratory has a higher education. Work experience up to 2 years
- The representative of the laboratory has a higher education. Work experience from 2 years, has a master's degree

Fig. 4. Recommendations for capacity building

The final step is to obtain a recalculated potential value. If it does not suit us again, then we can again use the algorithm to increase the value of the potential. «figure 5»

PTM7 - The presence of the laboratory at the construction site

- Departure of the laboratory to the construction site for non-destructive strength tests is carried out upon the call of the customer's representatives
- Departure to the construction site by representatives of the laboratory for testing by non-destructive methods is carried out according to the work schedule agreed in advance with the customer's representatives
- Permanent presence of laboratory representatives at the facility under construction

PTM8 - Terms of testing after the formation of the structure

- The tests were carried out when assessing: stripping strength and strength parameters of structures before they set design values - average value
- The tests were carried out at the early stages of concrete hardening, when assessing the stripping strength and during the curing process, when assessing the strength parameters of structures up to their set design values - the best value
- Tests were carried out at all stages of concrete strength gain

Recalculate

77.18
(good)

Fig. 5. Retrieving Potential Values after allocation

The algorithm for calculating organizational and technical potential includes the following four stages:

1. Comparative analysis of the existing situation at the facility, where it is planned to conduct non-destructive testing using the developed organizational and technical model.
2. Selection and establishment of levels of values of the parameters of PTM. The establishment takes place in accordance with the created model of organizational and technical potential.
3. Calculation of the organizational and technical potential of the use of methods of non-destructive testing of the strength of monolithic structures in the implementation of a construction project for the construction of residential buildings.
4. Calculation of the psychophysical assessment corresponding to the value of the potential.

3. Results and Conclusion

The need to use an algorithm for increasing the potential arises if the result is unsatisfactory. This algorithm includes:

- repeated comparative analysis is carried out using the created organizational and technical model;
- selection of ATM parameters that have the worst level of values (-1);
- the level of the selected parameters of the ATM is increased;

The next step is to re-calculate the potential. In the event that the result according to the psychophysical scale is again unsatisfactory, then it is necessary to return to measures to increase the value of the potential and repeat all the stages again.

The software package was developed according to this layout. This software package allows online calculation of the value of the potential for using non-destructive testing methods. This tool will allow, if necessary, to increase the efficiency of the application of non-destructive testing methods in the construction of residential buildings from monolithic reinforced concrete

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