The effectiveness of flow charts in improving the quality control of repair and construction work

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Abstract: Currently, improving the quality of repair-construction works is an important complex problem, insufficient attention to which inevitably leads to an increase in the cost of repair-construction works, an increase in operating costs, an increase in the number of current and overhaul repairs, as well as a decrease in the time between repairs, worsening the quality of life of consumers. In the worst cases, a low level of quality of repair and construction work can lead to accidents, become a source of threat to life and health, leading to accidents.

Keywords: quality control, technological map, repair and construction works, organizational and technological documentation, technological process, standardization

1 Introduction

Quality control is the process of ensuring that repair and construction work is performed to the highest standard and meets the necessary specifications and requirements. Quality control involves a number of steps, including planning, execution and monitoring. Effective quality control is necessary to ensure that the repair and construction work is completed on time, within budget, and to the highest standard.

On the quality of repair-construction works affects perfection and planning of technological processes; observance of correct technological sequence of works; rhythm of production; qualification level of personnel; coordinated actions of all subdivisions of construction organization and its subcontracting organizations; quality of construction materials, raw materials and equipment used; organization of effective quality control. All these factors function in close interrelation, so they should be considered within the framework of the general system. It is obvious that in order to solve the stated problem it is necessary to substantiate and make organizational and technological solutions taking this aspect into account [1,2,3].

When executing overhaul works of MFBs there take place deviations from the required parameters of materials and technological tolerances in the process of works performance,
which entails deterioration of quality and safety of repaired facilities; defects of repair works results should be quantitatively assessed in the process of technological (operational) control and by the results of these defects assessment by organizational and technological solutions to minimize their adverse effects on the operational properties of facilities [4-7].

To minimize errors and deviations, the work must be carried out only by qualified specialists. However, even the most experienced and educated builder should regularly resort to normative documents, recommendations, instructions. One of such documents are flow charts. On the basis of analysis of existing standard flow charts you can identify deficiencies and errors, the elimination of which will subsequently help builders to quickly control the quality of the finished product, to eliminate the defect aspect [8].

Technological charts refer to graphic representations of technological processes and systems involved in construction and repair work. They can be considered as a visual representation of the stages of design, planning and execution of these projects. Task sheets are usually created using computer software and can be adapted to reflect the unique requirements of each individual project.

Technological map, as well as the construction organization project and the project of works production, is one of the organizational and technological documents in construction [9].

The availability of organizational and technological documents, including flow charts, and their use in construction production largely predetermine the competitiveness of a construction organization [10,11].

2 Methodology

The methods of research were the study, analysis and synthesis of existing standard flow charts for various construction works, carried out in the process of overhaul. The main purpose of the study was to assess the effectiveness of flow charts in improving the quality control of repair and construction works.

The flow chart is the most important document for the organization of construction processes, as it specifies guidelines for workers, the order of placement of tools and equipment, storing materials, supplies, quality requirements, safety measures and much more. All this contributes to the timely completion of each stage of work, rapid delivery of the project, reducing the number of errors and irregularities. Technological charts are designed to standardize the activities of workers at the construction site, providing the most efficient methods of performing various types of work and ensuring that the workers comply with the production process to complete the work without missing any cycles.

The effectiveness of flow charts lies in their ability to provide a chain of actions that a worker must perform in a specific sequence. This ensures that the worker does not miss any cycle of the production process, as any errors or omissions can have significant consequences on the overall quality of the project and the completion time. Overall, flow charts play an important role in the construction process by promoting standardization, ensuring quality and safety standards are met, and reducing errors and defects.

A flow chart can be a useful tool for improving the quality of repair and construction work by providing a clear visual representation of project phases and the resources required to complete the project. By breaking a project down into its individual components, a flow chart can help identify potential problems and inefficiencies and provide a roadmap for streamlining the workflow.

Several typical flow charts were selected for the research for the following construction work performed during major renovations: repairs of waterproofing, masonry, roofs and...
ceilings, stairs, windows, painting, reinforced concrete panels, floors, ceilings, thermal insulation, foundations, and plastering. The analysis is supposed to establish the completeness and informativeness of the sections "Quality Control". It was decided to check how completely the following information is reflected in the flow charts: the name of the work to be controlled; the work to be controlled; the subject, composition, scope of the control performed, including information about the acceptable deviations from the norm; the scope of the control performed, as well as the indication of the person responsible for the work performed. Attention was also paid to the information about the regulatory documents that builders need to refer to in the process of work. The study of flow charts will emphasize the importance of ensuring that the standard flow charts used in construction work are complete and informative, especially in terms of quality control.

3 Results

During the analysis of selected flow charts in accordance with MDS 12-29.2006 "Guidelines for the development and design of flow charts" (paragraph 5.4) the following conclusions were made.

The section that outlines the standards for the quality of work is incomplete as it doesn't cover all the parameters that need to be controlled during the technological process and related operations. The cards also lack important details such as the location of control stations, who is responsible for performing the checks, the extent and nature of the inspections, the methods and tools used for measurements, and the procedures for documenting results and deciding whether to exclude defective products from the process.

To ensure the accuracy of the results obtained through applied methods and measuring tools, it's important to adhere to the rules and standards of the State measuring system.

Quality control is the most important aspect of construction processes because it helps to ensure that the final product meets the necessary standards, specifications and requirements [12]. Poor quality control can lead to design defects, increased costs, and safety hazards that can adversely affect the longevity and functionality of the finished project.

The technological chart includes quality control measures such as examining the design and technological documentation during the incoming inspection stage, inspecting the materials, products, and structures used during construction, monitoring the technological process during operation, checking the quality of the completed works, installed structures and equipment, and constructed buildings and structures during acceptance quality control, and keeping a record of the quality control results and approving the completed works.

One of the key ways in which flow charts can help improve the quality control of repair and construction work is by providing a clear and comprehensive overview of all the processes involved in these projects. This can help ensure that all necessary steps are taken to produce the desired results, and that the quality of work is consistently maintained throughout the project [13,14].

In addition, flow charts can also help minimize the risk of errors and deficiencies by providing a visual representation of all the interrelated systems and processes involved in construction and renovation projects. This can help ensure that everyone involved in the project is aware of the requirements and responsibilities of each stage, which can help minimize the risk of errors and deficiencies.

According to the guidelines, the key data and parameters necessary for control purposes are presented in tables. For instance, Table 1 demonstrates how to create a table for operational process control, while Table 2 illustrates how to prepare a tabular list of work
processes and operations that require monitoring, along with the methods and tools for conducting the checks.

Table 1

<table>
<thead>
<tr>
<th>Name of the technological process and its operations</th>
<th>Controlled parameter (according to which normative document)</th>
<th>Permissible parameter values, quality requirements</th>
<th>Method (method) of control, means (devices) of control</th>
</tr>
</thead>
</table>

Table 2

<table>
<thead>
<tr>
<th>Name of processes, products to be controlled</th>
<th>Subject of control</th>
<th>Tool and method of control</th>
<th>Monitoring time</th>
<th>Supervisor in charge</th>
<th>Technical criterion for quality assessment</th>
</tr>
</thead>
</table>

Input control

|                  |                  |                           |                 |                     |                                             |

Operational control

|                  |                  |                           |                 |                     |                                             |

Acceptance control

|                  |                  |                           |                 |                     |                                             |

In the flow chart should include methods of control, tools, schemes, rules of measurement and testing, the rules of processing the results of measurements and tests and their evaluation, established by the standards, technical specifications [15]. In the section of the operational control of the technological process schemes should be given. The main purpose of such schemes is to show the foreman and workers places of quality control. An example of an operational quality control scheme is shown in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Operational control scheme</th>
<th>Painting facades</th>
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Composition of operations and controls

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<tr>
<th>Stages of work</th>
<th>Controlled operations</th>
<th>Control (method, volume)</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory work</td>
<td>Check:</td>
<td>Visual</td>
<td>Certificate, passport, general work log</td>
</tr>
<tr>
<td></td>
<td>- availability of a quality document for paint compositions and fillers;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- certificates of acceptance of work previously performed works;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- air temperature;</td>
<td>Visual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- surface preparation (no damage, efflorescence, damp, rusty and resinous stains);</td>
<td>Measuring Visual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- the quality of the priming, puttying.</td>
<td>Measuring Visual</td>
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<tr>
<td>- availability of a quality document for paint compositions and fillers;</td>
<td></td>
<td>- correspondence of weather conditions (air temperature, wind speed);</td>
<td></td>
<td></td>
<td>Visual, Measuring</td>
<td>Certificate, passport, general work log</td>
</tr>
<tr>
<td>- certificates of acceptance of work previously performed;</td>
<td></td>
<td>- observance of technological regimes and the sequence of application of layers of paints;</td>
<td></td>
<td></td>
<td>Visual</td>
<td>Certificate, passport, general work log</td>
</tr>
<tr>
<td>- air temperature;</td>
<td></td>
<td>- consistency of the texture;</td>
<td></td>
<td></td>
<td>Visual</td>
<td>Certificate, passport, general work log</td>
</tr>
<tr>
<td>- surface preparation (no damage, efflorescence, damp, rusty and resinous stains);</td>
<td></td>
<td>- evenness of paint lines at the joints of surfaces painted in different colors;</td>
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<thead>
<tr>
<th>Acceptance work performed</th>
<th>Painting facades</th>
<th>Control:</th>
<th></th>
<th>Visual, Measuring</th>
<th>Visual</th>
<th>Certificate of acceptance of work performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>- the quality of the painted surfaces, including no streaks, stains, drips, wrinkles, underlying layers of paint showing through bleed-through of underlying paint layers, evenness of paint lines at joints of surfaces painted in different colors;</td>
<td></td>
<td>- correspondence of weather conditions (air temperature, wind speed);</td>
<td></td>
<td></td>
<td></td>
<td>Certificate of acceptance of work performed</td>
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<tr>
<td>- consistency of the color of the facade samples colors.</td>
<td></td>
<td></td>
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</table>

Measuring tools: metal tape measure, ruler, moisture meter, thermometer.

Operational control is carried out by: master. Acceptance control is carried out by: employees of the quality service, master, representatives of the technical supervision of the customer.

**Technical requirements**

**Permissible deviations**

- of the surface from the plane when checking with a 2-meter rod - 3 mm;

The following are the required standards for the surface and dihedral corners from the vertical: 2 mm for 1 m and 5 mm for the floor. Additionally, there should be a maximum gap of 10 mm between the surface and window or door trim, as well as the belts of architectural members. The acceptable humidity level varies depending on the surface type: concrete, plastered or puttied surfaces should be monitored until liquid droplets appear, while wooden surfaces should not exceed 12%.

The paint coating must have a thickness of at least 25 microns, and the curvature of lines in places where different colors meet should be 5 mm for simple painting and 2 mm for improved painting. The curvature of panel lines and painted surfaces in different colors should be 1 mm per 1 m of length.

Acceptance of the painting works can only be done after the water paints have completely dried. After drying, the surfaces should be monochrome, and any local fixes should not be noticeable from a distance of 3 m from the surface, except for simple backgrounds.

**It is not allowed to paint facades:**

- In dry and hot weather with air temperature in the shade of +27°C and above
- In dry, hot weather with air temperature in the shade of +27°C and above and in direct exposure to sunlight;
- During rain or on a wet façade after rain;
- In windy conditions with wind speeds exceeding 10 m per second;
- without surface preparation.

**Quality requirements for the materials used**
Paints shall be supplied in batches. The quantity of one brand and color of paints, received during one technological and accompanied by the quality document in which the following data are to be stated indicated:
- name of the manufacturer and its trade mark;
- name, brand and color of the material
- net weight
- batch number;
- date of manufacture;
- designation of the normative and technical documentation;
- results of tests and confirmation of compliance with materials to the requirements of regulatory documents;
- type of packaging and number of packages in the batch;
- information on special properties of the material (fire and explosion, toxicity).

Paints are packed in wooden drums, flasks, steel barrels, cans metal barrels, polyethylene cans of different capacity.

Paints are stored and transported at temperature above 0°C.

The warranty storage period for paints - 6 months from the date of production.

Operating instructions

Before you start painting facades, you should check the condition of roofing, metal coverings, drains, gutters, funnels and other elements.

The walls must be cleaned of loose and lagging plaster.

Surfaces with strong plaster must be cleaned of old lime and silicate plaster, etc. lime, silicate and weak oil paints. Repaired areas of plaster must be carefully lapped at the joints with old plaster without applying new mortar. The texture of the new plaster must match the old plaster. All cracks are widened to a width and depth of at least 2 cm, washed with water and grouted with plaster mortar.

Priming, filling and painting of facades can be performed at temperature at least +5°C.

Painting should be carried out in continuous strips vertically and the painting should be done in continuous strips vertically and horizontally to any partitioning of the facade. The edge of the next band overlap the previous one by 30-50 mm. Interruptions in the painting are allowed only on the borders of architectural members of the facade.

The painted surface must be a single tone and thoroughly blended over the entire surface of the facade, without stains, streaks, washes, wrinkles, flaking and underpainting.

Despite the many advantages of using flow charts in construction projects, there are also a number of problems and limitations that must be considered. Some of the most common problems include a lack of standardization in the use of flow charts, difficulties in integrating flow charts into existing systems and processes, and a lack of understanding and experience in using these charts [16,17].

Process charts can play an important role in improving the quality control of repair and construction work by providing clear and organized information about the processes involved in a project. This information can include required materials and equipment, estimated timelines for the work, and other important information such as safety recommendations and protocols. By having this information in one place, flow charts help ensure that everyone involved in the project has a clear understanding of what is expected of them and that they work together to ensure that the project is completed to the highest standard [18-20].

4 Conclusion

In the course of the research, it was concluded that the existing standard flow charts are very outdated. There is no unified database where the standard flow charts would be collected. There are also no mandatory requirements for their preparation, and
methodological recommendations are often simply not used in the preparation of construction documents. In the course of work several dozens of standard flow charts for various types of construction work have been analyzed and none of them fully complies with the recommendations. Such maps do not contain complete information and instructions for work, in all maps there were no visual technical schemes. In many maps there were no permissible deviations, elementary lack of a list of necessary tools. Thus, we can conclude that the construction worker would be difficult to understand the process card in case of any questions. I would like to draw attention to the fact that at the construction site may be not only foremen with extensive experience, but also young professionals who would need technological charts to successfully perform the work. Separately, I would like to note that in many of the analyzed technological charts there are not even references to regulatory documents. Summarizing the study, we can conclude that the use of flow charts can help improve the quality of repair and construction work through clear guidance and a structured approach to the implementation of the construction process. This can lead to a decrease in the number of errors, increase the efficiency and effectiveness of the construction process.

References


