Technological Installation Drawings of Roof Construction and Suspended Ceilings Using Combined Method

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Abstract. The article describes various installation schemes for roofing structures and suspended ceilings using combined method for industrial buildings. The article inspects three installation options for assembling building elements: transversal motion of the crane across spans, working motion of the crane across the spans with idle returns, and installation spanwise. The advantages and disadvantages of each mounting option are also discussed. The article describes in detail methods of installing structural elements of a building, which allows the work to be completed with minimal labor costs. Schemes for installing coating structures and suspended ceilings using combined method are also considered.

1 Introduction

The construction of industrial buildings is one of the most important elements of industrial development in any country. For the successful design and construction of buildings, in addition to architectural and structural design, it is necessary to take into account the installation features of roofing structures and suspended ceilings. These processes require the use of modern technologies and equipment, as well as certain knowledge and experience. This article discusses installation schemes for roofing structures and suspended ceilings using combined method. The features and advantages of each installation scheme are described, as well as the necessary technologies and equipment for their implementation. The purpose of this article is to provide useful information for industrial building construction professionals, architects, civil engineers and other interested parties.

2 Materials and Methods

In this study, we observed various methods of installing roofing structures and suspended ceilings using a combination of cranes and other equipment. Information was collected from published sources, technical reports and examples of completed projects.

We analysed the advantages and disadvantages of different installation methods, taking into account such factors as the size and complexity of the building, the type of materials used and site conditions. We also examined the economical effectiveness and efficiency of

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each method, including the duration of the installation process and the number of workers required.

To provide a comprehensive overview, we have divided installation methods into three categories: cross crane movement, longitudinal crane movement, and combined methods [1]. We have described the procedures and requirements for each method, including the use of specialised equipment such as cranes, winches and scaffolding, as well as the necessary safety precautions.

The technological diagram shows the installation of roofing structures and suspended ceilings using combined method. Installation of structural elements of the covering and suspended ceiling in each section of the building using the combined method is accomplished in one pass of the crane [2].

Installation is considered for an industrial building with a grid of columns 12x18 metres and a height to the bottom of the roof trusses - 6 metres. At the same level there is a suspended ceiling made of prefabricated reinforced concrete structures of the 4-959-65 series “Designs of a typical section of a lanternless building with a grid of columns 12x18 metres for enterprises of textile industrial field". These buildings have a flat roof.

The developed scheme considers two installation options: with the movement of the assembly crane when performing installation work across the spans of the building and along the spans. When moving an assembly crane along the spans of a building, crawler cranes SKG-63A with a lifting ability of 63 tons are required. When moving across spans, crawler cranes with a smaller lifting capacity can be used - RDK-25 (25 tons) [3].

The combined method of installing roof structures and suspended ceilings predetermines the installation of the following four structural elements in each building cell with plan dimensions of 12x18 metres: roof trusses, suspended ceiling beams, suspended ceiling panels and coating slabs [4].

In order not to change the mounting devices on the crane, Central Research and Design and Experimental Institute Organization, Mechanization and Technical Assistance for Construction has designed a universal strongback for a complex installation. This strongback is designed for the installation of all four structural elements of a suspended ceiling and has a load capacity of 20 tons for roof trusses, 8 tons for coating slabs, 6.3 tons for a suspended ceiling beam and 2.5 tons for suspended ceiling panel. The height of the slinging of the structural elements of the suspended ceiling and coating is chosen in such a way that all of them can be mounted by the RDK-25 crawler crane with a boom length of 22.5 metres.

The diagram (fig. 1) shows three options for the sequence of installation of coating structures and suspended ceilings using combined method when the installation crane moves across the spans [5].

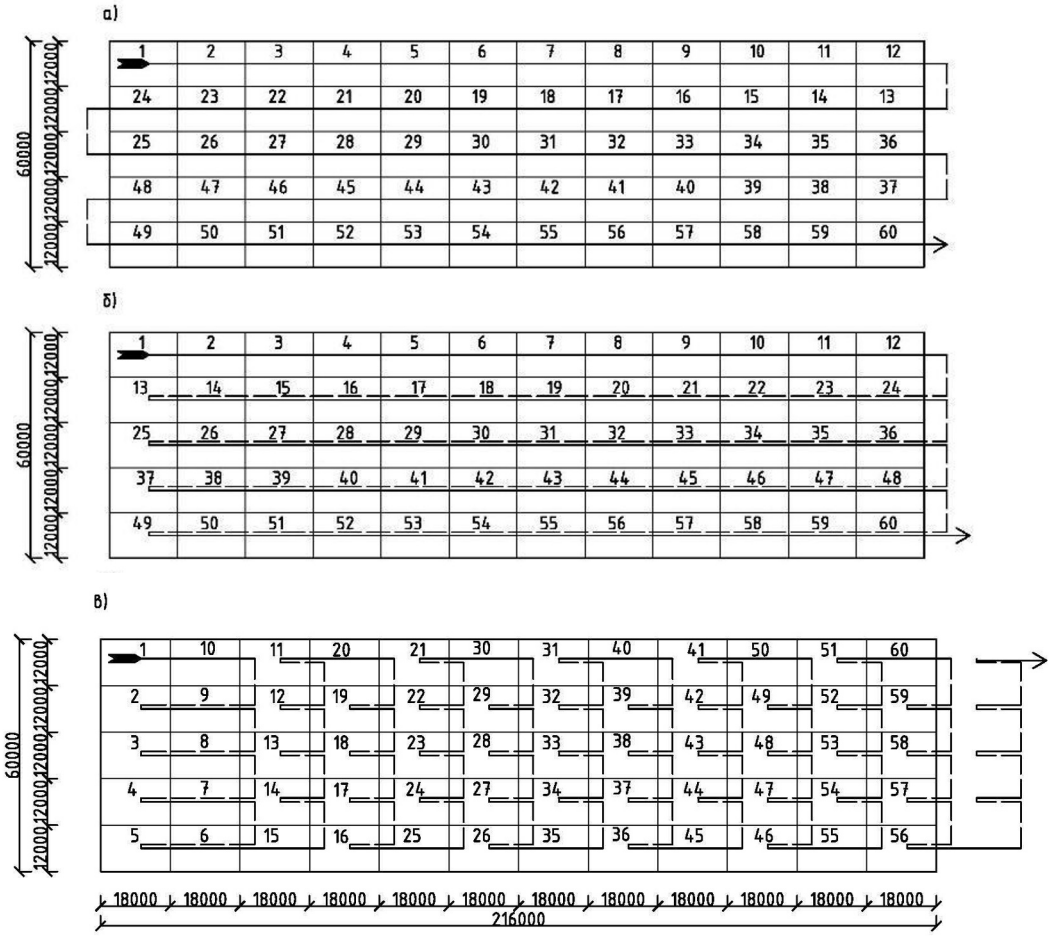

Fig. 1. Installation sequence design. а, б, в - respectively, the first, the second and the third options.

The first installation option - with the shuttle movement of the crane across the spans - allows you to assemble building elements along its entire width by one step, i.e., 12 metres, in one crane pass. In this case, 12 building grips with plan dimensions of 12x18 metres are installed in one crane pass. According to this option, the crane's idle passage for one step of columns, i.e., 12 metres, is carried out along the span upon completion of the installation of every 12 sections of the building.

The second installation option, when the crane moves across the spans with idle returns also across the spans, allows you to assemble building elements in one pass of the crane in the same way as in the first option [6].

When idling, the crane moves across the spans of the building. Having completed the installation of every 12 grips of the building, the crane also performs idling along the span by the distance of the column spacing, i.e. 12 metres.

The third installation option makes it possible to obtain five finished building cells located along one span in one working pass of the crane. Thus, this installation option allows it to be carried out spanwise; it differs from the previous ones in a significantly larger value of idle passages of the valve. As a result, for the installation of one building cell there is one working passage, approximately equal to the span (18 metres), and two idle passages: one along the span of 12 metres and across it - 18 metres [7].

To sum up, according to the first two options, the building is mounted along its entire width, and with the third option, along the spans.

Installation of roof structures and suspended ceilings using combined method can be carried out with the transverse movement of the RDK-25 crane and with the longitudinal movement of the SKG-63A (Fig. 2 and 3) [8].

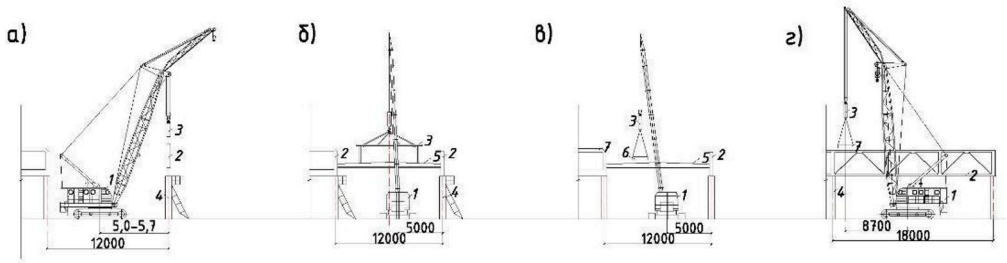

Fig. 2. Installation schemes of covering structures and suspended ceilings by the transverse method. а - rafter truss; б - attic floor beam; в - attic floor slab; г - covering plate; 1 - mounting crane RDK-25 (boom length 22.5 m); 2 – rafter truss; 3 - universal traverse; 4 - column; 5 - attic floor beam; 6 - attic floor plate; 7 - covering plate.

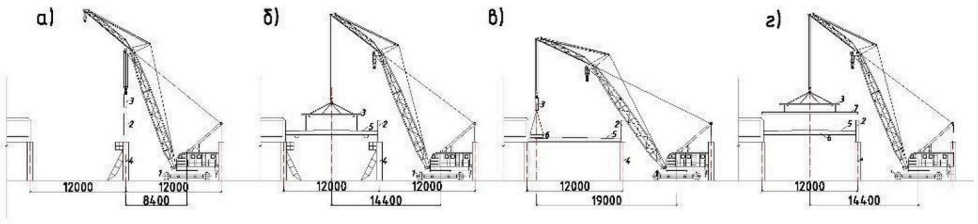

Fig. 3. Installation schemes of covering structures and suspended ceilings by the longitudinal method. а - rafter truss; б - attic floor beam; в - attic floor slab; г - covering plate; 1 - mounting crane SKG-63A (tower length 20 m, boom length- 10 m), 2 – rafter truss; 3 - universal traverse; 4 - column; 5 - attic floor beam; 6 - attic floor plate; 7 - covering plate.

The use of modern methods of installation of each structural element of the building allows the work to be completed with minimal labor costs.

3 Results and Discussion

This study examined various methods for installing roofing structures and suspended ceilings using a combination of cranes and other equipment. The advantages and disadvantages of different installation methods, taking into account such factors as the size and complexity of the building, the materials used and site conditions, were analysed [9]. The effectiveness of each method and the cost of its application were also studied, including the duration of the installation process and the number of workers required.

The study identified three main categories of mounting method: transverse crane movement, longitudinal crane movement and combined methods. Procedures and requirements were described for each method, including the use of specialised equipment such as cranes, winches, and scaffolding, as well as required safety precautions.

The installation of suspended ceilings and various types of support systems such as hangers, steel cables and metal gratings were also covered. The advantages and

disadvantages of each system were reviewed and recommendations were given for choosing the most suitable one for a particular project [10].

Finally, several examples of completed projects were presented, illustrating the successful application of various installation methods and support systems. These examples highlight the importance of proper planning, coordination and communication between all parties involved in the construction process, from the design phase to final installation.

4 Conclusion

This article examined various methods for installing roofing structures and suspended ceilings using cranes and other equipment. We analysed the advantages and disadvantages of each method, taking into account such factors as the size and complexity of the building, the type of materials used and conditions at the construction site. Installation methods have been classified into three categories: transverse crane movement, longitudinal crane movement and combined methods.

We also looked into the installation of suspended ceilings and the different types of support systems used in the process. The advantages and disadvantages of each system were reviewed and recommendations were given for choosing the most suitable one for a particular project.

A study of examples of completed projects showed that proper planning, coordination and communication between all participants in the construction process, from the design phase to the installation of structures, play an important role in the successful implementation of the project.

Based on the conducted research, it can be concluded that the choice of installation method of covering structures and suspended ceilings should be based on a thorough analysis of the specific project conditions and customer requirements. Choosing the right installation method and support system will help increase efficiency and reduce installation time, as well as improve safety.

References

1. Telichenko V.I., Terentyev O.M., Lapidus A.A. *Technology of construction processes./ Textbook for construction specialties of universities / Volume Part 1*. Moscow, 2002.
2. Telichenko V.I., Terentyev O.M., Lapidus A.A. *Technology of construction processes/ Textbook for bachelors* / Moscow, 2007.
3. Topchy D.V., Lapidus A.A., Yurgaitis A.Yu. *Method of installation of large-span coatings by pushing force*/ Patent for invention 2789028 C1, 27.01.2023. Application No. 2021130004 dated 14.10.2021.
4. Vorobyeva A.D., Shulga E.S. *Actual problems with non-system installation of suspended ceiling structures* // In the collection: The eleventh International scientific and practical conference "KNAUF in the world construction complex". Collection of reports. Dedicated to the 75th anniversary of South Ural State University and the 25th anniversary of KNAUF in Russia. South‑Ural State University (National Research University), Institute of Architecture and Civil Engineering, Knauf Consulting Center, KNAUF GYPSUM CHELYABINSK LLC Ural Sales Directorate – f‑l KNAUF GYPSUM LLC (Chelyabinsk). 2018. pp. 51-56.
5. Ryazanova G.N., Fedotov A.S. *Features of the technology of fastening drywall to various surfaces* //In the collection: Traditions and innovations in construction and architecture. Construction. collection of articles. Samara, 2018. pp. 304-311.

6. Zhuravlev S.V., Roslikov A.N. *Suspended ceilings* // Vologda readings. 2004. No. 38-2. pp. 196-197.
7. Dmitrieva A.O. *Metal suspended ceilings in the premises of industrial enterprises* / In the book: SCIENCE, EDUCATION AND EXPERIMENTAL DESIGN. Abstracts of reports of the international scientific and practical conference, teaching staff, young scientists and students. Moscow Architectural Institute (State Academy). 2014. pp. 417-418. 0
8. Kostolomova Yu.V. *Suspended ceilings of public buildings* // In the collection: XVI International Youth Scientific Conference "Severgeoecotech-2015". conference materials: In 6 parts. Ukhta State Technical University. 2015. pp. 120-123.
9. Ryazanov M.A., Shishov I.I., Murkin V.V. *Covering of an industrial building on sub-rafter frames* // Bulletin of the South Ural State University. Series: Construction and Architecture. 2020. Vol. 20. No. 2. pp. 20-27.
10. Lapidus A.A., Abas M.H. *Improvement of construction control in the construction of industrial buildings* // Prospects of science. 2022. No. 5 (152). pp. 101-107.