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Optimization of the Construction Organization Design of Office Building Projects

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Abstract: This paper focuses on the construction organization design of office building projects. It elucidates its concept, core elements, and characteristics, highlighting the shortcomings of traditional designs. The paper introduces the improvement effects of technologies such as prefabricated curtain walls, the collaborative optimization role of BIM technology, and various optimization methods, including the establishment of work breakdown structures and the creation of progress deviation warning systems. It also touches on aspects like green construction and risk management. Finally, it emphasizes the significance of optimizing construction organization design, addresses research deficiencies, and looks forward to future research directions.

Keywords: Office building project; Construction organization design; Optimization

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1. Introduction

With the acceleration of urbanization, the construction of office buildings is increasing day by day. The *Guiding Opinions on Improving the Quality Assurance System and Enhancing the Quality of Construction Projects*, released in 2019, emphasized the importance of improving the quality of construction projects. As a key document guiding construction, construction organization design is crucial for the construction quality and efficiency of office building projects. It covers various aspects such as project overview, project organizational structure and division of responsibilities, construction deployment, analysis of key and difficult construction points, and corresponding measures. However, traditional construction organization design has shortcomings in resource allocation and process connection, and technologies such as BIM and prefabricated curtain walls provide support for its optimization. At the same time, the reasonable construction of work breakdown structures and the establishment of a schedule deviation warning system play an important role in schedule management. In addition, the staggered allocation of labor and site layout also affects the implementation of the project. All of these need to be comprehensively considered in the construction organization design to meet the needs of office building

construction.

2. Overview of construction organization design for office building projects

2.1. Basic concepts and characteristics of construction organization design

Construction organization design is a comprehensive document that guides the technical, economic, and organizational aspects of various construction activities throughout the entire construction process. It is developed based on engineering projects, relevant regulations, standards, and engineering design documents, combined with specific conditions and requirements of engineering construction. The core elements include project overview, construction deployment, construction schedule, construction preparation and resource allocation plan, main construction methods, construction site layout, and main construction management plan. The construction organization design of office building projects has its own characteristics. Office buildings require efficient and rational planning in terms of space utilization to meet the needs of office functions. In terms of vertical transportation, efficient transportation of personnel and materials should be considered. Curtain wall construction should pay attention to aesthetics and safety. These particularities need to be fully reflected in the construction organization design [1].

2.2. The necessity of optimization and practical challenges

Traditional construction organization design has shortcomings in resource allocation and process connection. In terms of resource allocation, there may be issues such as material waste, idle or insufficient equipment, leading to increased costs and low construction efficiency [2]. Unreasonable arrangements in the process connection may cause construction delays, affecting the overall progress of the project. Taking the super high-rise office building project as an example, its complex structure and numerous construction processes require higher requirements for construction organization design. If resource allocation is improper, such as insufficient pumping equipment required for high-rise concrete pouring, it will seriously affect the construction progress. Unreasonable process connections, such as the overlapping and chaotic construction of the main structure and internal decoration processes, will increase the difficulty, quality, and safety risks of construction, highlighting the urgent need for optimization of construction organization design.

3. Optimization strategies from the perspective of technical management

3.1. Innovation in key technology applications

The core technologies of prefabricated curtain wall installation and deep foundation pit reverse construction have important improvement effects on the construction organization design of office building projects [3]. Prefabricated curtain wall installation technology can improve the efficiency and quality of curtain wall installation, reduce on-site workload, lower safety risks, and facilitate industrial production and quality control. The reverse construction method for deep foundation pits can effectively solve problems such as narrow construction sites and complex surrounding environments. By arranging the construction sequence reasonably, it is possible to achieve simultaneous construction above and below ground, shorten the construction period, improve land utilization efficiency, and have minimal impact on the surrounding environment. The innovative application of these key technologies provides strong support for the optimization of construction organization design in office building projects.

3.2. Collaborative optimization of BIM technology

BIM technology plays an important collaborative optimization role in the construction organization design of office building projects [4]. In terms of construction simulation, BIM can be used to virtually model and analyze the construction process, identify potential problems in advance, optimize the construction sequence and process, and improve construction efficiency and quality. In the comprehensive application of pipelines, BIM can integrate various pipeline information, perform collision detection, effectively solve pipeline conflicts, and plan spatial layout reasonably. For progress visualization, BIM can associate construction progress with models, visually display the progress of the project, facilitate construction management personnel to adjust the construction plan in a timely manner, and ensure that the project is completed on time. These applications greatly enhance the scientificity and rationality of construction organization design and promote the smooth implementation of office building projects.

4. Optimization path of progress management system

4.1. Dynamic optimization of a schedule plan

4.1.1. Work breakdown structure decomposition and critical path

Building a reasonable work breakdown structure is crucial in office building projects. By breaking down the project work in detail, clarifying the various work packages and their interrelationships, a foundation is laid for schedule management [5]. Optimize the cross-operation process between mechanical and electrical installation and the main structure using the critical chain method. The critical chain method considers resource constraints and project uncertainty. By identifying critical chains and setting buffer times, it can effectively avoid schedule delays caused by resource conflicts and uncertainty factors. On the basis of work breakdown structure decomposition, combined with the critical chain method, it is possible to better dynamically optimize the project schedule, ensure that all work is carried out in an orderly manner according to the plan, improve the construction efficiency and quality of office building projects, and achieve the optimization of the schedule management system.

4.1.2. Construction of progress warning mechanism

The key to optimizing the schedule warning mechanism is to establish a dynamic adjustment model based on a BIM+5D design schedule deviation warning system. By utilizing the visualization and information integration advantages of BIM, combined with the time dimension information of 5D, real-time monitoring of project progress can be achieved [6]. By setting a reasonable progress deviation threshold, the system can issue timely warnings when there is a deviation between the actual progress and the planned progress. At the same time, establish a dynamic adjustment model to quickly adjust the schedule based on warning information. This model can comprehensively consider various factors such as resource allocation and process logic relationships to generate optimized schedule plans, ensuring that the project can proceed smoothly according to predetermined goals and effectively improving the efficiency and accuracy of schedule management.

4.2. Resource-balanced allocation method

4.2.1. Tower crane scheduling optimization model

Establishing a multi-tower crane collaborative operation model based on a genetic algorithm is the key to solving the bottleneck of vertical transportation of materials in super high-rise buildings. This model encodes the operational parameters of tower cranes, transforming the scheduling problem of tower cranes into a chromosome

encoding problem in genetic algorithms. By utilizing the selection, crossover, and mutation operations of genetic algorithms, the scheduling scheme of tower cranes is continuously optimized to achieve high efficiency and balance in vertical material transportation. At the same time, consider the safety distance and operating range between tower cranes to avoid collisions and interference between them. Through simulation experiments and practical application verification, this model can effectively improve the utilization rate of tower cranes, reduce material transportation time, improve construction efficiency, and provide strong support for the progress management and resource balance allocation of office building projects [7].

4.2.2. Dynamic allocation of labor force

The staggered allocation of labor for curtain wall engineering and interior decoration is crucial for the construction of office buildings [8]. By analyzing the process characteristics and time nodes of curtain wall engineering and interior decoration, reasonable labor input can be arranged to avoid labor conflicts during peak construction periods between the two. Using the PDCA cycle for continuous improvement, develop a detailed plan for staggered labor allocation during the Plan phase; During the Do phase, strictly allocate labor according to the plan; Check phase, comparing the actual and planned differences; In the Act phase, adjust the configuration plan based on the inspection results, continuously optimize the dynamic allocation of labor, improve construction efficiency, and ensure project progress.

5. Comprehensive optimization plan for engineering planning

5.1. Key control points in early planning

5.1.1. Site dynamic planning strategy

Developing a phased site layout plan is crucial for solving the problem of narrow construction sites in urban office buildings [9]. It is necessary to comprehensively consider the characteristics and needs of each stage of construction and plan the site use reasonably. During the foundation construction phase, emphasis is placed on arranging material stacking and mechanical equipment parking areas to ensure the smooth progress of the foundation project. As the main construction progresses, adjust the site layout to provide sufficient space for materials such as formwork and steel bars, while setting up safety passages and protective facilities. During the decoration phase, it is necessary to reserve areas for material processing and finished product stacking to avoid interference with other construction areas. By dynamically planning the site, the utilization rate of the site can be improved to ensure construction progress and safety.

5.1.2. Optimization of a material supply system

Build a material entry plan under the JIT procurement model to meet the immediate needs of office building construction, improve the accuracy and timeliness of material supply, and reduce inventory costs and waste [10]. At the same time, establish an emergency reserve mechanism to reserve a certain amount of key materials for potential material supply interruption risks, such as natural disasters, supplier issues, etc. This not only ensures the continuity of the project, but also reduces the impact on project progress and quality in case of emergencies. Reasonably determining the types and quantities of emergency reserve materials requires comprehensive consideration of factors such as the characteristics of the project, the importance of the materials, and the stability of the supply market.

5.2. Collaborative management of the construction process

5.2.1. Multi-disciplinary coordination mechanism

In office building engineering, BIM-based multi-disciplinary collaborative management of mechanical and electrical, decoration, and curtain wall is crucial. By establishing a unified BIM model, each profession can integrate its own design information into it. Mechanical and electrical majors can accurately plan pipeline layouts in models to avoid conflicts with decoration and curtain wall structures. The decoration profession can determine space utilization and decoration details based on models, while considering the installation and maintenance space of mechanical and electrical equipment. The curtain wall profession designs the exterior facade based on the model to ensure a reasonable connection with the internal structure, mechanical and electrical components, and decoration. During the construction process, BIM models are used for real-time monitoring and adjustment, allowing professionals to communicate and coordinate in a timely manner, solve problems that arise, improve construction efficiency and quality, and ensure the smooth progress of office building projects.

5.2.2. Overall planning for green construction

In terms of overall planning for green construction, measures such as dust control and noise control need to be integrated. For dust control, fences can be set up at the construction site to cover exposed ground and materials, and the construction site should be regularly watered to reduce dust. At the same time, car wash basins should be set up at vehicle entrances and exits to prevent vehicles from carrying mud on the road. Regarding noise control, arrange construction time reasonably and avoid high noise operations during residents' rest time. Select low-noise construction equipment and conduct regular maintenance. Take shock-absorbing and noise-reducing measures for construction equipment, such as installing shock-absorbing pads, mufflers, etc. Through the comprehensive application of these measures, green construction can be achieved, reducing the impact on the surrounding environment and ensuring the continuity of office building construction.

5.3. Construction of a risk control system

5.3.1. Risk identification and assessment

During the construction process of office building projects, it is necessary to establish a risk matrix for high-altitude operations and equipment installation. For high-altitude operations, there may be risks such as personnel falling and object strikes. When identifying, factors such as work height, protective measures, and weather conditions should be considered. Assess its risk level, such as high altitude and insufficient protection, resulting in a higher risk level in adverse weather conditions. For equipment installation, risks include equipment damage, installation errors, etc. Consider the weight of the equipment, the complexity of the installation process, and the skills of the operators. When the installation process of large equipment is complex and the skills of operators are insufficient, the risk is greater. By detailed identification and assessment of these risks, a unique risk matrix for office building projects is constructed to provide a basis for subsequent risk control.

5.3.2. Design of emergency response plan

It is crucial to establish emergency response plans for office building construction projects. For extreme weather, pay attention to the weather forecast in advance. Before rainstorms, gales, and blizzards, reinforce, protect, or remove tower cranes, scaffolds, and other equipment on the construction site, and conduct safety inspections on temporary buildings to ensure that workers are transferred to safe areas. In addition, a sound health and safety response team should be established, equipped with professional first aid personnel and necessary first aid

equipment, in order to respond quickly in emergency situations, prevent and respond to risks such as heatstroke, frostbite, and other environmental health hazards, and ensure the safety and physical health of construction personnel. Through the above measures, the ability of office building construction to cope with extreme weather and other sudden risks will be comprehensively improved, providing a solid guarantee for the safety, stability, and smooth progress of the construction process.

6. Conclusion

Optimizing construction organization design is of great significance for office building projects. By planning the construction process and resource allocation reasonably, the construction efficiency has been significantly improved and the construction period has been shortened. At the same time, the effect is significant in cost control, reducing unnecessary expenses in materials, labor, and other aspects. However, there are certain shortcomings in current related research, such as insufficient depth of application of intelligent algorithms, which have not fully tapped into their potential in optimizing construction organization design. Looking ahead to the future, digital twin technology shows promising application prospects. Integrating it with construction organization can simulate the construction process more accurately, identify and solve problems in advance, further improve the scientificity and rationality of construction organization design, and promote the improvement of construction quality and efficiency of office building projects.

Disclosure statement

The author declares no conflict of interest.

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