Research on Key Technologies and Methods of Construction Safety Supervision of Large Public Building Projects

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Abstract: Because of its large scale, complex structure and changeable construction environment, large-scale public building projects are facing many challenges in construction safety supervision. In this paper, the characteristics and difficulties of construction safety supervision of large public building projects are deeply analyzed, and the related key technologies and methods are discussed. It is found that risk identification and evaluation technology, safety monitoring and early warning technology and information management technology are the key technologies to ensure construction safety. Among them, risk identification and assessment technology can effectively reduce the probability of accidents by establishing a risk database, identifying potential risk points and formulating special control measures; Safety monitoring and early warning technology realizes real-time monitoring of the construction site by means of sensors, video monitoring systems and unmanned aerial vehicles, and timely discovers and warns potential safety hazards; Information management technology realizes information sharing, data analysis and safety performance evaluation by building a BIM collaborative management system and developing a special APP, which improves the efficiency of safety supervision. In addition, this paper also puts forward some strategies such as constructing safety supervision system, implementing whole-process safety supervision and strengthening personnel training and education, which provides theoretical guidance and practical reference for construction safety supervision of large public buildings.

1. Introduction

Large public buildings, such as airport terminals, stadiums, exhibition centers and cultural facilities, not only carry important social functions, but also are an important part of the city image. However, the construction process of these projects is often accompanied by high-risk operations, complex construction environment and collaborative work of multiple participants, which makes the construction safety issue particularly important [1]. In recent years, although governments and relevant industry organizations in various countries have continuously strengthened the supervision over the construction safety of large-scale public building projects and issued a series of laws, regulations and standards, safety accidents still occur from time to time. These accidents not only caused huge economic losses, but also seriously threatened the life safety and social stability of construction workers [2]. Therefore, how to effectively carry out construction safety supervision and ensure the safe and smooth progress of large-scale public building projects has become one of the key problems to be solved urgently in the field of current project management. This study discusses the key technologies and methods of construction safety supervision of large public building projects. By systematically analyzing the characteristics of large-scale public building projects and the difficulties of safety supervision, and combining the advanced safety supervision theories and technical means at home and abroad, a set of construction safety supervision system and methods suitable for such projects are put forward.

2. Characteristics and difficulties of construction safety supervision of large public building projects

Construction safety supervision of large public building projects is a highly professional work, involving a wide range. Supervision work not only needs solid theoretical knowledge, but also

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needs rich practical experience to ensure that various safety problems in the construction process can be effectively identified and handled. Safety supervision usually realizes the control of engineering objectives by monitoring the supervision system of the construction unit. This means that the supervision unit needs to rely on the internal supervision system of the construction unit to ensure the effective implementation of safety measures [3]. In large-scale public building projects, supervision units need to communicate and coordinate with owners, design units, contractors and other stakeholders. A good communication mechanism helps to ensure the timely transmission of information and the rapid solution of problems. The supervision of the supervision unit on the construction process directly affects the quality and safety of the project. Effective supervision can prevent non-compliance and ensure that construction standards are observed. The role of supervision units in contract management can not be ignored. The clarity and execution of contract terms are very important to prevent disputes in the process of project implementation. The management of the construction site is the key factor to ensure the smooth progress of the project. Supervision units need to ensure the rational use of construction materials and equipment and the cultivation of workers' safety awareness.

In the process of building project implementation, there are often obstacles in communication between supervision units, contractors, design units and owners. The information transmission is not timely and the communication mode is single, which leads to the slow progress of the project and even misunderstanding and controversy, which affects the normal progress of the project. The professional technical level of supervisors is uneven, and some supervisors lack relevant practical experience and professional knowledge, so they can't effectively identify and deal with technical problems in construction [4]. In some projects, the supervision unit has insufficient supervision over the construction process, resulting in some non-compliance phenomena being ignored. Some contractors may lower the construction standards due to the lack of effective supervision, which will affect the final project quality. Unclear or ineffective implementation of contract terms leads to disputes in the process of project implementation. Some supervision units lack experience in contract management and effective control over contract execution and change, which easily leads to the increase of project cost and the delay of construction period. The management of the construction site is the key factor to ensure the smooth progress of the project, but in actual operation, the site management is often not in place, which leads to improper use of construction materials and equipment, weak safety awareness of workers, and affects the progress and safety of the project.

3. Key technology of construction safety supervision of large public building projects

3.1 Risk identification and assessment technology

From the construction preparation stage to the whole process, a professional team is introduced to identify potential risk points, establish a risk database and update information in real time by combining construction drawings and schemes. For example, special control measures are formulated to ensure that the risk control rate reaches the standard for dangerous sources such as deep foundation pits and aerial work [5]; At the same time, pay attention to the new risks brought by new technologies and materials, familiarize yourself with technical standards and usage norms through interviews and investigations, and formulate corresponding supervision countermeasures. Focus on the evaluation of dangerous partial projects. It is necessary to review the special construction plan submitted by the construction unit, organize experts to demonstrate its safety and technical feasibility, and revise and improve it according to the argumentation opinions before approval and implementation [6]. Based on the risk assessment results, plan the emergency plan and resource allocation in advance. High-risk operations are prohibited under bad weather conditions, or temporary support structures are reinforced to reduce the probability of accidents from the source.

3.2 Safety monitoring and early warning technology

Deploy sensors and video monitoring systems in high-risk areas to collect environmental

parameters and equipment operation status data in real time. Automatic monitoring of tower cranes, lifts and other heavy machinery is realized by using the Internet of Things technology, and an alarm will be triggered immediately if the inclination exceeds the standard or is overloaded [7]; Quickly cover a large area of construction site through drone inspection, and improve inspection efficiency and coverage. Integrate the data analysis model and set thresholds for key indicators such as wind speed, vibration frequency and temperature change. When the monitoring value is close to the dangerous range, the system automatically pushes the early warning information to the mobile terminal of the management personnel, and links the on-site acousto-optic alarm device to shorten the response time to within minutes. Use electronic fence to delimit the restricted area, and combine face recognition or RFID badge to track the activity track of workers. Give real-time reminders to individuals who enter dangerous areas without wearing safety protection equipment, and strengthen individual protection awareness and compliance operation.

3.3 Information management technology

Build a BIM collaborative management system covering the whole cycle of design, construction and acceptance, and integrate functional modules such as schedule planning, quality inspection and safety log. Multi-party data sharing is realized through cloud storage, which ensures that the supervision instructions are immediately conveyed to the team level and reduces the execution deviation caused by communication lag. The algorithm is used to deeply learn historical accident cases and predict the high-risk time and location under similar working conditions. Regularly generate safety performance reports to provide quantitative basis for management to adjust resource input and form a closed-loop improvement mechanism [8]. Develop a special APP to support offline filling of safety hazard records, taking photos and uploading comparison charts before and after rectification. Supervisors can issue the rectification notice online and track the implementation, so as to realize the trace management from problem discovery to closed-loop disposal.

4. Methods and strategies of construction safety supervision of large public building projects

4.1 Construction of safety supervision system

The effective implementation of safety supervision depends on the scientific and standardized system support, and the core is to form a management framework with "clear responsibilities, clear processes and strong implementation" through the coordination of system norms, organizational structure and technical tools (Figure 1).

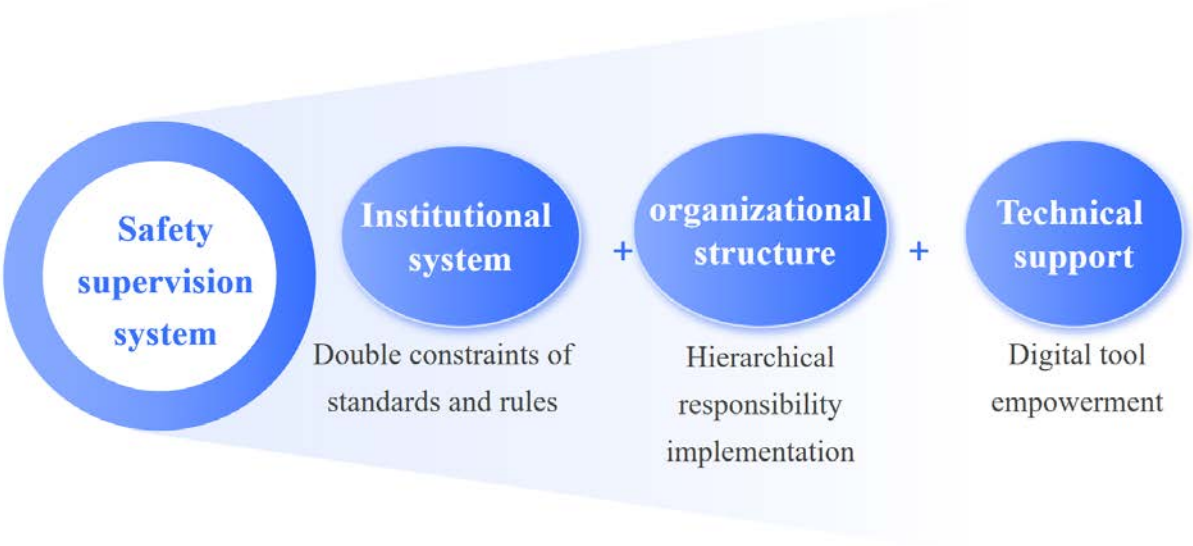

Figure 1 Collaborative support of system-organization-technology

4.1.1 Double constraints of standards and rules

Based on the national Regulations on the Administration of Work Safety in Construction Projects, the Provisions on the Administration of Safety in Sectional Projects with Greater Danger and other laws and regulations, and combined with the characteristics of the project, the special safety supervision plan and implementation details are compiled. Planning needs to specify the supervision objectives, supervision scope (covering all construction stages and operation links) and supervision basis (laws and regulations, design documents, special programs, etc.); The detailed rules formulate specific control points for high-risk processes and complement the safety management system of the construction unit.

4.1.2 Hierarchical responsibility implementation

Establish a three-level responsibility system of "chief supervision engineer-professional supervision engineer-supervisor". As the first responsible person, the chief supervision engineer comprehensively coordinates the safety supervision work and connects the construction unit with the supervision department; Professional supervision engineers are responsible for the safety supervision of specific processes according to the professional division of labor; The supervisor is responsible for the daily inspection on site, forming a closed loop of "top decision-making-middle implementation-bottom implementation". At the same time, make clear the list of safety responsibilities of each post, and strengthen the responsibility constraint through supervision contract and internal assessment mechanism.

4.1.3 Digital tool empowerment

Introduce technical tools such as BIM and smart site platform to assist supervision. Use BIM to simulate complex nodes in three dimensions, identify collision risks in advance and optimize the construction scheme; By collecting data in real time through the sensors of the smart site platform, the supervisor can remotely monitor key indicators and realize the dynamic control of "online early warning+offline verification" in combination with on-site inspection.

4.2 Whole process safety supervision method

Large-scale public buildings have a long construction period and significant differences in stages, so safety supervision should take targeted measures according to the risk characteristics of each stage to form a full-cycle management chain of "pre-control-process strict control-post-summary" (Figure 2).

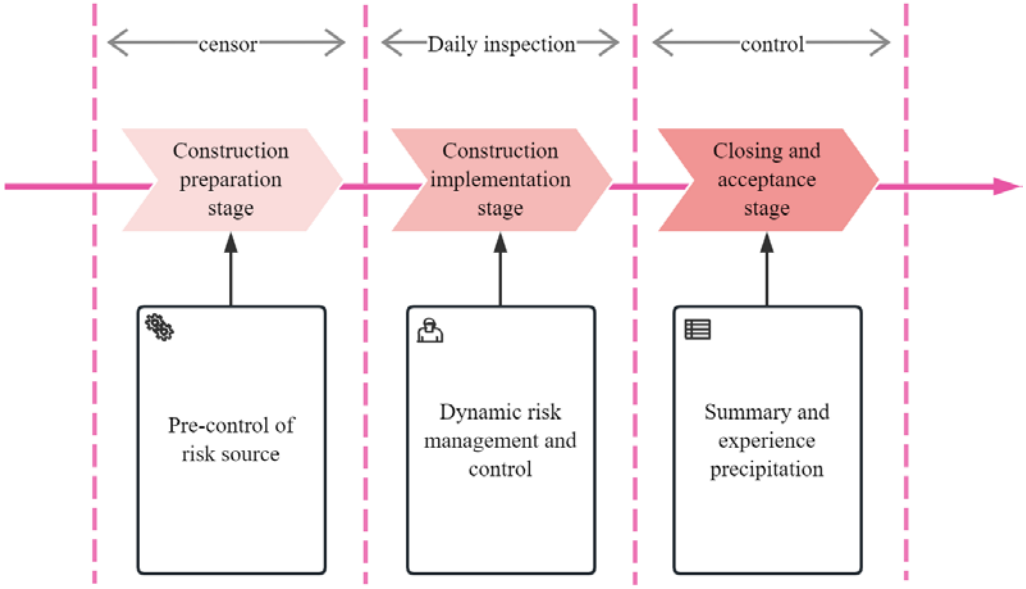

Figure 2 Precise policy in stages

4.2.1 Construction preparation stage

The key point is to review the construction scheme and the ability of the participants. First,

strictly review the special construction plan prepared by the construction unit, focusing on the pertinence (whether it is combined with geological conditions and surrounding environment), technical feasibility and integrity of safety measures; The second is to check the qualifications of the construction unit and personnel, as well as the operation of the safety management system; The third is to participate in the joint review of drawings and design disclosure, focus on safety design defects, and put forward optimization suggestions in advance.

4.2.2 Construction implementation stage

Taking "daily inspection+key marking and prevention+linkage disposal" as the core. Daily inspection covers the whole site, focusing on checking workers' behavior, equipment status and environmental conditions; Implement "on-site supervision" for high-risk processes and supervise the operation process throughout the process; Establish a hierarchical disposal mechanism for hidden dangers-general hidden dangers require immediate rectification and re-examination, while major hidden dangers are issued with a Notice of Rectification for Shutdown, and the construction unit and the construction unit jointly formulate a rectification plan and track the closed loop [9].

4.2.3 Closing and acceptance stage

The key point is to control the remaining project risks and the whole process data. On the one hand, strengthen the supervision of the easily overlooked links in the closing stage; On the other hand, the records in the process of safety supervision are sorted out, and the high-frequency risk points are analyzed to form the Summary Report of Project Safety Supervision, which provides reference for similar projects.

4.3 Personnel training and education

4.3.1 Professional ability training of supervision team

In view of the technical complexity of large public buildings, supervisors are regularly organized to participate in special training, including: interpretation of the latest safety regulations, key points of high-risk process supervision, application of new technologies, and emergency handling skills. The training form can be combined with case discussion, on-site observation, assessment and encouragement (linking training results with post promotion) to ensure that supervisors can not only understand technical specifications, but also accurately identify risks.

4.3.2 Cooperation of safety education for construction unit personnel

The supervisor should supervise and participate in the three-level safety education (company level, project level and team level) of the construction unit, focusing on the pertinence and effectiveness of the education content (verifying whether the workers have mastered the safety operation skills through practical assessment). At the same time, the construction unit is urged to establish a normalized education mechanism such as "safety score system" and "standardization of pre-shift meetings". The supervisor will check the education records and the workers should know the situation through inspections, forcing the construction unit to implement the main responsibility.

4.3.3 Construction of safety culture atmosphere

Strengthen safety awareness through visual means: set up safety warning slogans, risk publicity columns and accident case display boards at the construction site; Organize "Safety Month" activities regularly, encourage supervisors and constructors to participate together, and promote the cultural change from passive compliance to active prevention.

5. Conclusion

The construction safety supervision of large public building projects faces many challenges, such as communication barriers, uneven professional level of personnel, insufficient supervision, poor contract management and inadequate on-site management. In order to solve these problems, the risk identification and evaluation technology is introduced. Through the professional team to identify

potential risk points in the whole construction process, the risk database is established and the information is updated in real time, and the partial projects with greater risk are evaluated emphatically, and the emergency plan and resource allocation are planned in advance. Using safety monitoring and early warning technology, deploying sensors and video monitoring systems in high-risk areas, using Internet of Things technology to realize automatic monitoring of heavy machinery, integrating data analysis models to set thresholds, automatically pushing early warning information and linking field alarm devices; Using information management technology, a BIM collaborative management system is built, and various functional modules are integrated. A special APP is developed to support off-line filling of safety hazard records, so as to realize the whole trace management. In terms of methods and strategies, a safety supervision system with "clear responsibility, clear process and strong implementation" is constructed, and the effective implementation of safety supervision is ensured through the double constraints of standards and rules, hierarchical responsibility implementation and empowerment of digital tools. At the same time, according to the risk characteristics of each stage of construction, targeted measures are taken to form a full-cycle management chain, and personnel training and education are emphasized to create a safety culture atmosphere. The construction safety supervision system and method proposed in this study provide a scientific and effective solution for the safety management of large-scale public building projects, which is helpful to reduce the incidence of safety accidents and ensure the safety of construction workers and social stability.

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