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Application Analysis of Prefabricated High-rise Building Construction

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Abstract:

This paper analyzes the application of prefabricated high-rise building construction. Based on the quality of prefabricated buildings, this paper studies the theory and practice of quality management in manufacturing and construction industry at home and abroad. Based on the background of "integration of two modernizations", this paper combs the relevant research results of intelligent information transmission and collaborative management, and makes an in-depth study on the quality problem and improvement mechanism of prefabricated buildings as the core problem. This paper analyzes the performance and causes of quality problems in the construction process of prefabricated buildings by using arrangement diagram method and 4M1E method. This paper puts forward the quality problem improvement mechanism from four aspects: organization, culture, process control, technical guarantee and information collaborative management.

Keywords: *Wooden Structure, Fabricated High-rise Building, Construction Analysis, Quality Improvement Mechanism.*

I. INTRODUCTION

Under the background of the gradual disappearance of China's demographic dividend, the number of school-age labor force is seriously insufficient [1-2]. The construction industry is facing the dilemma of rising labor cost and shortage of skilled workers. Affected by social values, workers' needs for working environment and working status are not effectively met, the attraction of the construction industry to employees is rapidly weakened, and the production efficiency of traditional construction methods has not been improved [3]. Assembled monolithic buildings have potential advantages in improving working conditions and labor intensity, improving project quality, improving labor production efficiency, reducing safety accidents and promoting sustainable development [4]. They are consistent with the current concept of green development and building century old buildings in China, and quickly enter the "opportunity

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period" of development.

The seismic performance of prefabricated buildings is equal to or even higher than that of cast-in-situ concrete structures, but at this stage, China's prefabricated buildings are in the pilot period, the technical development is not mature enough, and the technical level and management level of enterprises are uneven. There is a gap between the laboratory conditions and the actual conditions of large-scale production [5]. The standardized construction can not be fully guaranteed on site, and some quality problems have been exposed in the pilot project. If the quality problem of prefabricated buildings can not be effectively controlled, it will have an adverse impact on the construction stage and operation and maintenance stage. First of all, it will increase the rework in the construction stage, delay the construction period and increase the construction cost [6]. Secondly, the operation and maintenance stage will increase the cost of building maintenance, aggravate the contradiction between owners and developers, and even affect the structural safety of buildings. In the promotion pilot stage, once a structural safety accident occurs, it will not only affect the brand image of relevant enterprises, but also hinder the promotion of the industry in China. Therefore, it is necessary to study the quality of assembled integral buildings.

II. STUDY ON QUALITY PROBLEMS IN CONSTRUCTION PROCESS

1.Data sorting and analysis

The quality problems reflected in 30 on-site meeting documents are divided into three links according to design, production and transportation and on-site hoisting construction. The frequency and frequency distribution of quality problems in each link are shown in table 1. The frequency of quality problems in the three links are 11%, 31.37% and 57.52% respectively [7]. The construction link has the highest frequency, followed by the production and transportation link, and the design link is the least. Next, make detailed statistics on the frequency, frequency, occurrence time, problem manifestation and rectification of quality problems in the three links.

TABLE I. Frequency and frequency distribution of quality problems

Category	Frequency	Frequency
DESIGN LINK	17	11%
PRODUCTION AND TRANSPORTATION LINKS	48	31.37%
CONSTRUCTION LINK	88	57.52%

Due to the particularity of the design work, most of the quality problems related to the design are intensively exposed within one month after the commencement. Because the time

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span is short, the frequency of design problems is very few. However, the analysis of quality problems in design can not be limited only by frequency and time, because the impact of quality problems caused by insufficient design on cost and construction period is much greater than that in construction stage. Moreover, it is easy to produce "Butterfly Effect" on subsequent construction links. Therefore, doing a good job in component deepening design and strengthening cooperation with component production units and on-site construction units play a decisive role in reducing quality problems in the design stage.

The mechanical bending and displacement of exposed reinforcement also occur in the whole process. The spacing and position fixation of exposed reinforcement of finished components are not considered during production, which makes it difficult to bind the reinforcement at the nodes of adjacent components on site and increases the dimensional deviation of component installation [8]. It is suggested that the component manufacturer can design and use special reinforcement positioning fixture to reduce the difficulty of on-site construction and improve the component installation accuracy. The quality problems on the production line were not improved until two months after the commencement of construction. The on-site supervision and the rectification of component production enterprises have played an obvious role in the improvement of component production quality. The problems of incomplete component accessories, rough surface of vertical joint surface, keyway treatment and side cleaning are concentrated within one month after commencement. The components are returned to the factory and the rough surface is manually chiseled, resulting in the delay of construction period. Inadequate treatment of the joint surface is extremely unfavorable to the integrity of the prefabricated building. The reason for this quality problem is that the factory workflow design and worker training are not in place. Firstly, the rough surface treatment process is not included in the standardized operation process, and the arrangement of workers' post responsibilities is not clear. Secondly, the workers are not proficient in the operation process and the component disassembly drawings.

2.Analysis on key points of quality improvement

(1) Improve the prefabricated building management system. The system refers to that the government construction administrative department entrusts a third-party organization recognized by the government to carry out mandatory supervision on the quality of the project in accordance with relevant laws and regulations, mandatory standards and systems, so as to reduce the occurrence of project quality problems from a macro perspective. (2) Quality culture cultivation and talent cultivation. Accelerate the cultivation of professional and technical talents of prefabricated buildings, strive to improve the quality of industry supervisors, and comprehensively enhance the soft power of the development of prefabricated buildings in Shandong Province. Through the construction of national demonstration base, evaluation of demonstration projects, selection of excellent project managers and other ways, excavate and introduce a number of excellent assembly project managers. Make an overall plan to carry out

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the training of prefabricated building theory and practical skills, link it with registration examination, post promotion and continuing education, and improve the quality and ability of supervision and management personnel. (3) Information Collaborative Management Based on BIM. Under the background of "integration of two modernizations" in the construction industry, it is an inevitable trend to introduce BIM Technology, RFID technology, cloud computing, mobile Internet, VR and AR technology into the life cycle management of construction projects. These technologies can assist quality supervision in the process of project information integration and management integration. With the help of collaborative management technology, it helps to integrate the activities of all parties involved in the construction into an organic whole according to a certain logic from the perspective of the overall system, give full play to the integration benefits, carry out automatic collection and processing of project information, and realize automatic, digital and intelligent project management.

III. ORGANIZATIONAL MEASURES FOR QUALITY IMPROVEMENT

1.Quality supervision system

(1) Strengthen the supervision of construction units. Clarify the primary quality responsibility of the construction unit. The construction unit is the most important quality responsibility subject affecting the project quality and should bear the primary quality responsibility. At present, there are few regulations on the quality responsibility of construction units in laws and regulations. It is suggested that the market behavior and quality responsibility of the construction unit should be clearly standardized in the legislation, and the primary responsibility of the construction unit for the project construction quality should be emphasized and implemented. (2) Construction unit. Ensure the integrity of the project management organization of the construction unit, strengthen the supervision of the staffing of the project management organization of the construction unit, and ensure the integrity of the organization of the project management organization. The project manager and staff at important posts who are absent or fail to perform their duties shall be dealt with in time, and the construction unit who changes the members of the project department without authorization in violation of the provisions of the contract shall be punished. Further, we should establish a dynamic assessment system for practitioners' professional qualification. (3) Social quality supervision and management system. The social engineering quality supervision system includes the supervision and management of engineering design and construction process quality by supervision units, engineering quality inspection and project management units. As an auxiliary supervision mode, social supervision mode plays a very important role in the supervision of engineering construction. Timely and effective supervision and management can improve the project quality and promote the sound and rapid progress of construction engineering.

2.Production site management

The production status of the construction site can reflect the production management level

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and quality of the whole enterprise to a certain extent. If the materials and tools on the worktable are placed together irregularly, the operation time will be wasted when the operator works, and the beat of each work station cannot be unified; The identification of the material box is not clear, and it is easy to cause confusion during use. The disordered production site is very unfavorable to the project quality. Therefore, it is necessary to standardize and rectify the cleanliness of the project construction site. Through the research on the advanced production management methods of construction site at home and abroad, it is found that the most effective production management methods of construction site are 8s management method, benchmarking method and Kanban management method.

Large integrated and mechanized construction platform shall be adopted to reduce the amount of on-site labor and reduce the impact of construction on the environment.

3.Cultivation of enterprise quality culture

This paper proposes to build an enterprise quality culture system from three aspects: mission, vision, values, enterprise system and employee behavior. Only when the enterprise quality culture changes, the on-site quality and management conditions of the enterprise may change fundamentally. Mission, vision and values are the core of the enterprise quality culture system. They regulate the behavior of enterprises and employees from the perspective of ethics and strategy, and serve as the basis for the formulation of enterprise system to standardize the quality behavior of employees through two levels of guidance.

The business decision-making of the whole process of the enterprise will increasingly become the decisive factor for the survival of the enterprise. Therefore, the real meaningful improvement is the improvement of the whole process of the operation. To ensure that the whole process of the operation is the best, we can really ensure that the improvement of product quality is the most successful. To form the coordination and cooperation of all personnel in the whole process, that is, to form the quality culture of the enterprise, we can solve the current quality problems and find potential quality problems, focusing on updating the quality concept and improving the quality of employees. Closely combine professional ethics education, code of conduct training and standard procedures learning.

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Fig 1: Enterprise quality culture system

IV. DESIGN OF CONSTRUCTION PROCESS QUALITY CONTROL PLATFORM BASED ON INTERNET OF THINGS AND BIM

Quality control system is a control system established on the idea of integrated management. It is mainly used for the collection and delivery of quality information, and all-round control in the process of construction product production. Firstly, it defines the quality standard and evaluation index system of components and parts production, collects and stores various information of components and parts in a quantitative form, and can analyze and report the quality of components and parts according to relevant information, so as to realize the quality monitoring of components and parts. In the collected information system, it can realize the rapid query of component information and realize the integrated management of information.

The basic framework of the quality management platform consists of one main line and three systems. Taking the field information collection and BIM model data export as the main line, it expands three highly related subsystems - information collection system, detection system and management statistics system. The three systems are the fundamental way to solve the problem. The system carries out the transportation of prefabricated buildings, information collection at the construction site, problem discovery and management from three links. It is mainly based on standards and specifications and based on operation management and information security. It is divided into three levels: induction, network and application. Starting from all levels and links, it realizes the sharing and communication of information, data and resources among all participants.

The promotion of new technology of project quality management until it is adopted by

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enterprises generally follows the following rules. (1) In the early stage of new technology promotion, about 5% of enterprises will realize the benefits brought by new technology and adopt new technology to improve management efficiency. Such enterprises generally have strong capital strength, strong management ability and the foundation of information management. (2) In the mid-term of new technology promotion, about 15% of enterprises are willing to adopt new technologies, because they see the benefits brought by large enterprises adopting new technologies, and some relatively powerful enterprises will introduce new technologies according to their own conditions. At this time, the cost of introducing new technologies is gradually decreasing. (3) At the climax of new technology promotion, about 60% of enterprises will use new technology. In addition to the gradual improvement of new technology, it is also because the cost of introducing new technology is reduced and can bring good economic benefits to enterprises. (4) In the stage of new technology popularization, most enterprises have used new technologies, new technologies have been gradually improved, and the risks brought by new technologies have been gradually reduced.

TABLE II. Benefits of quality management system adoption

INCOME TYPE	REVENUE ITEM
SHORT TERM INCOME	Improve the management efficiency in the production process of components and parts
	Reduce inventory and facilitate material turnover
	Reduce the time wasted due to finding matching components
	Increase supply flexibility
	Improve the efficiency of information storage and secure transmission
	Improve the management level of information
LONG TERM BENEFITS	Improve the installation level of components and fittings to ensure the project quality
	Improve the competitiveness of construction units in the construction market
	Enhance the coordination and cooperation among enterprises on the supply network to achieve smooth communication
	Enhance the application of new technology in enterprise technological innovation

III. CONCLUSION

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Assembled monolithic buildings have potential advantages in improving working conditions and labor intensity, improving project quality, improving labor production efficiency and promoting sustainable development. In the context of the country's transformation of the mode of economic growth and the promotion of the transformation and upgrading of various industries, it has quickly entered a "period of opportunity" for development. At present, the technical level and management level of prefabricated construction related enterprises are uneven, and the construction of industrial chemical personnel team is not perfect, which has exposed some quality problems in the pilot project. Through theoretical research, field investigation and relevant document research, and with the help of relevant quality management methods, this paper analyzes the problems and causes of prefabricated building design, production transportation and construction quality.

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