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Risk Analysis of Prefabricated Building Development and Construction

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Abstract: As an important form of building industrialization, prefabricated building has the characteristics of industrialization of component production, modularization of architectural design, and high efficiency of on-site assembly, but it faces multiple risks in the process of development and construction, such as economy, market, technology and management. According to the characteristics of the development and construction of prefabricated buildings, this paper analyzes the risks in the development and construction of prefabricated buildings, finds out various possible risk factors in the development and construction process, and puts forward the corresponding risk control strategies.

Keywords: Prefabricated buildings; development and construction risks; risk management.

1. Introduction

The 14th five year plan for national economic and social development of the people's Republic of China and the outline of long-term goals for 2035 clearly put forward the need to actively promote the development of prefabricated buildings. With the acceleration of the process of building industrialization, prefabricated building has become an important direction to promote the transformation and upgrading of the construction industry with its advantages of standardization, modularization and efficiency. Compared with the traditional cast-in-place building, the prefabricated building significantly shortens the construction period, reduces resource consumption, and improves the building quality through the mode of factory prefabricated components and on-site assembly construction. However, this new construction method also exposes many risks and challenges in the development and construction process. From the economic point of view, a large amount of money needs to be invested in the early stage of prefabricated construction for production line construction, mold development and special equipment procurement, resulting in increased capital pressure on enterprises; At the market level, consumers' awareness of prefabricated buildings is insufficient, and its initial cost is high, which limits the market acceptance; At the technical level, the difficulties of multi-disciplinary collaborative design, the complexity of component production quality control, and the immature node connection technology increase the technical risk of the project; At the management level, the cooperation efficiency of design, production, construction, supervision and other multi subjects is low, and the definition of quality responsibility is unclear, which is easy to cause poor information transmission and potential safety hazards.

According to the actual content and characteristics of the development of prefabricated buildings, this paper analyzes the risks in the development and construction of prefabricated buildings, finds out the various risk factors that may exist in the development and construction process, and puts forward the corresponding risk control strategies, in order to provide theoretical guidance and practical reference for the smooth implementation of prefabricated buildings.

2. Characteristics of Development and Construction of Prefabricated Buildings

Prefabricated buildings are also called prefabricated buildings, that is, some components such as floors, walls, stairs, balconies, etc. are fabricated in the factory first, and then transported to the construction site to be assembled through connection, pouring and other measures. The development and construction of prefabricated buildings have the following main characteristics:

(1) Industrialization of component production

The main components of prefabricated buildings (such as walls, floors, stairs, beams and columns, etc.) are produced in a high degree of mechanization in the factory. The production process is standardized. The unified production standards and technical specifications are adopted, which effectively reduce the error of manual operation, greatly improve the accuracy of components, and the quality is easy to control.In addition, the unit cost is effectively reduced through mass production, which is especially suitable for residential and public buildings with high repeatability.

(2) Modularization of architectural design

In the design of prefabricated buildings, the characteristics of mass production and industrialization of components are generally considered. They are usually divided into standard modules (such as apartment unit and toilet module) according to their functions, emphasizing less specifications and more combinations, reducing the types of components, and implementing flexible modular combinations to meet diversified needs and improve versatility and reuse rate.

(3) High efficiency of field assembly

Compared with traditional buildings, the on-site construction of prefabricated buildings mainly focuses on dry operations such as hoisting, which reduces the wet operation of traditional cast-in-place concrete, and the on-site assembly is less affected by bad weather such as rain and snow, which can effectively improve the efficiency of on-site assembly and greatly shorten the construction period.

3. Development and Construction Risks of Prefabricated Construction Projects

Although the development and construction of prefabricated building has the advantages of standardization, modularization and efficiency, there are certain risks in the development of prefabricated building projects in terms of economy, market, technology and management.

3.1. Economic risk

In the early stage of prefabricated buildings, a large amount of R&D costs need to be invested in advance for the construction of prefabricated building production lines, mold development, etc. the initial equipment investment and site construction costs are high, which may lead to the difficulty of capital turnover of development enterprises and fall into economic risks. At the same time, the transportation and hoisting of prefabricated components require special equipment, which also increases the transportation and installation costs.

3.2. Market risk

Compared with traditional buildings, prefabricated buildings have certain market promotion resistance, which is mainly reflected in two aspects: cost competitiveness and consumers' value cognition of prefabricated buildings. The initial cost of prefabricated buildings is high, the investment willingness of developers is not high, and the cost competitiveness is weak. On the other hand, some consumers have low awareness of prefabricated buildings, have some concerns about the quality and safety of prefabricated buildings, and have deviations about the technical characteristics and quality assurance system of prefabricated buildings, especially the doubts about structural safety and durability have not been effectively eliminated, resulting in a certain impact on the market acceptance of prefabricated buildings [1].

3.3. Technical risks

The design of prefabricated buildings includes architecture, structure, mechanical and electrical and other disciplines, which requires collaboration among multiple disciplines. If the collaboration mechanism is not perfect, it will lead to on-site installation conflict. In addition, in the production process of prefabricated components, improper control of mold accuracy and concrete pouring process can easily lead to component quality defects, improper application of node connection technology or new materials, which may lead to structural safety hazards[2]. Prefabricated buildings have high requirements for managers and skilled workers, and lack of professional training may lead to safety accidents. The construction site involves a large number of high-altitude operations and heavy machinery operations. If the safety protection measures are not in place or workers operate in violation of regulations, it is easy to cause safety accidents.

3.4. Managing risk

In the actual process of development and construction of prefabricated buildings, it involves multiple subjects such as design, production, construction and supervision, which need to be coordinated and coordinated by multiple parties. The communication channels and information resources exchange platform between various parties of prefabricated buildings are not efficient enough, which easily leads to poor information transmission and management difficulty higher than traditional projects [3]. In addition, the production and construction of prefabricated components are separated, and the definition of quality responsibility is not clear. The splicing quality of components at the construction site is greatly affected by the construction level. If the acceptance is not strict, potential safety hazards may be buried.

4. Risk Response Measures for the Development and Construction of Prefabricated Buildings

4.1. Coping strategies for economic risks

Due to the high R&D cost in the early stage, the assembly building can establish a cooperative R&D center with relevant universities and research institutes, share BIM database and component library, and jointly develop and reduce the repeated R&D cost [4]. At the same time, in order to reduce the cost of mold development, the standardized design of components can be implemented, the principle of less specifications and more combinations can be implemented, and the types of components can be compressed in a certain range as much as possible. At the stage of transportation and hoisting, we can consider establishing a regional shared factory mode, shortening the transportation radius, cooperating with logistics enterprises to establish a component transportation alliance, selecting the most appropriate one from the nearest component manufacturing enterprises, controlling the transportation distance of prefabricated components within 100 kilometers, checking the conditions along the way in advance, determining the best transportation route, reducing the transportation distance and difficulty, and reducing the transportation cost. In addition, the BIM can simulate the hoisting path, reduce the on-site adjustment time, improve the utilization rate of the tower crane, and greatly reduce the hoisting cost.

4.2. Coping strategies for market risks

Market risk is the second key risk factor affecting the development and construction of prefabricated construction projects in China. The market level should be adjusted as soon as possible to attract and encourage more construction enterprises to develop in the field of prefabricated construction. In addition, in view of the cost competitiveness and consumer awareness of prefabricated buildings in the market promotion, we should reduce the risk from the following aspects: (1) improve the popularity and awareness of prefabricated buildings. Compared with traditional buildings, the popularity and cognition rate of prefabricated buildings in the whole market is still not high, which also leads to consumers' less choice of prefabricated buildings. The publicity and recommendation of prefabricated buildings should be strengthened. BIM models and component production process videos can be set in the model houses to visually present the technical reliability of prefabricated buildings and improve the value cognition of prefabricated buildings in the market. (2) Improve the industrial chain and realize the dual control of cost and quality. We will improve the industrial chain related to prefabricated buildings and seamlessly connect the four links of production, transportation, assembly and sales. Promote the coordination of the whole industrial chain of design, production, construction, operation and maintenance, and realize the dual

control of cost and quality through EPC mode (EPC). Improve the production efficiency of components through standardized design, implement large-scale production, reduce the amortization cost of molds, and reduce the transportation and installation costs of components through the research and development of lightweight and high-strength materials [5].

4.3. Coping strategies for technical risks

Technical risk is also the main risk factor affecting the development of prefabricated building projects. The design of prefabricated buildings includes architecture, structure, electromechanical and other specialties, which need collaboration among multiple specialties. BIM (building information model) technology can be considered to realize the three-dimensional collaborative design of architecture, structure, electromechanical and other specialties, and to discover and solve pipeline conflicts in advance through collision detection. According to the technical needs and safety assurance of professionals, on the one hand, we can consider establishing the skill certification standard for prefabricated construction workers, implementing pre job training for key types of work such as component installers and grouting workers, and requiring them to obtain corresponding certificates before taking up their posts, so as to avoid the workers' influence on the process level due to operation problems, and control the production quality from the source of production. On the other hand, VR simulation, live rehearsal and other methods can be used to carry out special training for high-risk links such as aerial operation and hoisting operation, so as to strengthen the safety awareness of management personnel and ensure that the safety technical disclosure covers all important construction links.

4.4. Coping strategies for managing risks

In view of the problem that the prefabricated building involves multiple subjects such as design, production, construction and supervision, and needs to coordinate and cooperate with each other, we can effectively integrate BIM Technology to realize the real-time data sharing and dynamic update of design, production, construction and supervision, clarify the responsibilities and docking specifications of each party, implement the "design production construction" integrated management mode, and reduce the error caused by multiple transmission of information. In addition, the risk of management has an important relationship with the comprehensive quality and management level of managers. Enterprises should carry out regular professional training for managers, strengthen their management knowledge, improve their management level, carry out irregular functional assessment for managers, and standardize their management methods at work. In order to improve the management and control of the construction process, the training of construction personnel should also be strengthened, and special skill training and practical assessment should be carried out for key processes such as prefabricated component hoisting and node connection, so as to ensure that construction personnel master the standardized operation process.

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