Research on the Application of BIM Technology in the Whole Life Cycle of Prefabricated Buildings

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Abstract. This article explores dynamic control in the entire life cycle construction of modern prefabricated buildings from the perspective of "design production construction" general contracting. Based on BIM technology, an application model for the full life cycle management of prefabricated buildings in "design transportation installation construction operation and maintenance" is constructed. The implementation process of prefabricated buildings is systematically and finely managed through information technology application, systematized into a building information platform, Provide certain suggestions to promote the development of information technology in prefabricated buildings, and assist in the intelligent construction of prefabricated buildings during the current upgrade period of "China Construction".

Keywords: prefabricated buildings; BIM technology; full life cycle.

1 Introduction

In the current historical new era of transformation and high-quality development in China's construction industry, with the development of information technology and the goal of fully realizing construction industrialization by 2035, the Ministry of Housing and Urban Rural Development has proposed to accelerate the development of "China Construction" during the 14th Five Year Plan period, promote the transformation and upgrading of the construction industry. As a new construction method, prefabricated buildings, due to their advantages in green and environmental protection, It is gradually being implemented under the guidance of national and local governments.

Building Information Modeling is a multi-dimensional model information integration technology that gradually develops using computer technology on the basis of its auxiliary design[1]. It mainly digitizes and visualizes the physical characteristics and related functional information of building engineering in three dimensions. With the modernization of the construction industry, informatization has become one of its main characteristics. The application of BIM technology, as an important component of building informatization, is promoting the transformation of traditional production methods in the construction industry. Its application in the process of national green construction is becoming increasingly widespread, helping intelligent construction[2].

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2 Development status of prefabricated buildings in China

With the continuous expansion of the construction industry, issues such as environmental friendliness and low production efficiency under traditional on-site construction methods have gradually become prominent. Green buildings and green construction are inevitable outcomes advocated by national sustainable development policies in the construction industry. During this period, prefabricated buildings, as one of the ways to transform production methods, gained the favor of the government and industry due to their low energy consumption and high efficiency. Against the backdrop of the national proposal of "building industrialization", local governments have also introduced corresponding policies to vigorously promote the development of prefabricated buildings. However, as the proportion of prefabricated buildings in the construction market gradually increases, although China has introduced some mature foreign technologies, there are still some shortcomings in the specific implementation process of prefabricated buildings, mainly reflected in the following points.

2.1 Standards and specifications need to be further improved

Prefabricated buildings have gradually emerged from developed countries, and currently, various policies, standards, and specifications related to prefabricated buildings in foreign countries such as the United States have become relatively mature [3]. However, China is still in the initial stage of development. Although some mature foreign technologies have been introduced, the standards and regulations related to prefabricated buildings based on China's national conditions still need to be continuously improved and unified by the government.

2.2 Insufficient systematic managementd

Compared to the traditional cast-in-place construction method, prefabricated buildings involve many implementation units throughout the entire construction process, including design, pre ordering and production of prefabricated components, transportation of components, and on-site installation, resulting in more dispersed building information. Each unit mainly focuses on the content of the building they are responsible for, which can easily cause information silos and increase unnecessary costs for the owner during the construction process.

2.3 Low level of informatization

Building informatization is one of the development directions of China's construction industry. Under the guidance of national policies, the application level of building informatization is gradually improving. Compared with the full life cycle informatization application under traditional cast-in-place construction methods, prefabricated buildings are currently in the early stage of localization development, and their informatization application is more limited.

3 A Life Cycle Management Model Based on BIM Technology

During the decision-making stage of the entire lifecycle of a building, an information platform based on BIM technology stores information related to the feasibility research content of the construction project, enabling the platform to store project information in its entirety[4]. This article is mainly based on the "design stage production stage transportation stage construction

stage operation and maintenance stage", comparing traditional construction methods, and constructing a management model for the entire life cycle of prefabricated building construction based on system management principles using BIM technology. The application of BIM technology in prefabricated buildings systematizes into a unified building information platform, improves the informatization level of the entire building and various prefabricated components, optimizes the current project management of prefabricated buildings, and improves the achievement of the comprehensive management goals of "progress quality cost green" in prefabricated buildings. The systematic application model of prefabricated buildings is shown in Figure 1.

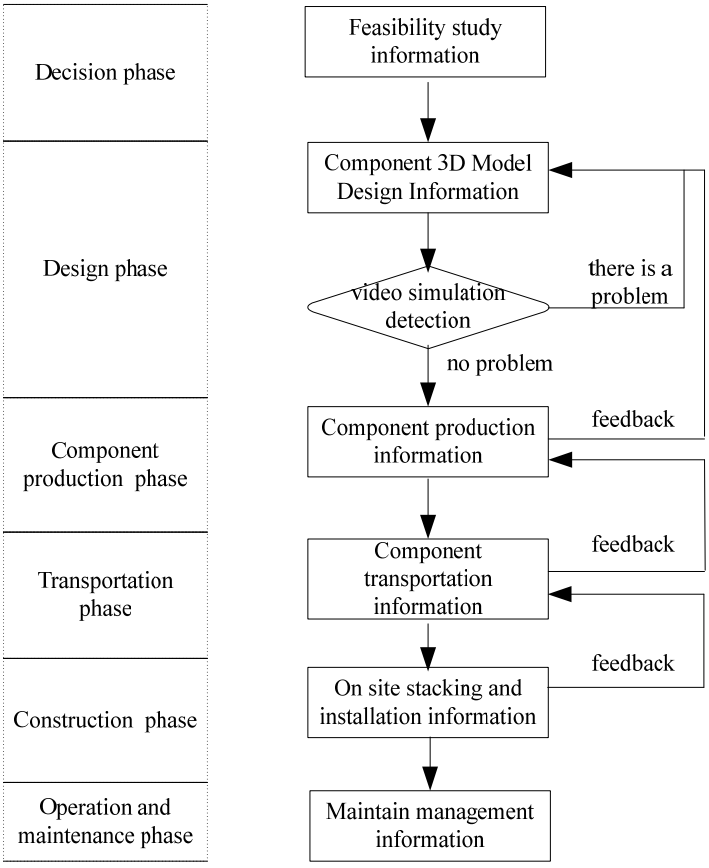

Fig. 1. Application model of BIM technology for the whole life cycle of prefabricated buildings.

3.1 Design phase

In the traditional design stage, the design party mainly delivers two-dimensional design drawings to the owner according to requirements for the next implementation stage. With the development of building informatization, on the basis of traditional 2D drawing design, designers can use modeling software such as Autodesk to design physical 3D models of buildings and directly present 3D building effects[5]. In the design phase of prefabricated buildings, it is necessary to decompose and refine the prefabricated components based on

drawings and 3D models, and the three-dimensional physical properties of each prefabricated component are stored on the information platform. In the design process, using the information of prefabricated components from existing resource libraries for standardized design can help improve the overall efficiency of design, transportation, and installation. During each design phase, the design team decomposes the prefabricated components into three dimensions according to the actual engineering needs. If there are new component designs, the component resource library should be supplemented and updated in a timely manner. Afterwards, preliminary 3D dynamic installation simulation of prefabricated components was conducted using animation video related software. In the design inspection at this time, if there are errors such as component collisions and conflicting dimensions, timely platform feedback should be provided to efficiently carry out design modifications and improvements.

3.2 Production phase

The work in the production phase is for the production party to pre produce and manufacture in the factory based on the physical property information of the three-dimensional component model decomposed during the design phase. Compared to traditional construction methods, the production of components in most prefabricated buildings is transferred from on-site pouring operations to factories. In this process, the proficiency of workers in the factory, the process flow, and the temperature, humidity, and other environmental conditions required for the production and maintenance of prefabricated concrete components are easier to control, while also ensuring the quality of the finished components.

In the design phase of prefabricated buildings, more consideration needs to be given to the completion of subsequent work and the tools required for component production. At this stage, new processes and designs used in the production process of components can also be applied for invention patents, such as template design used in the production of engineering specific shaped concrete components and tool design that can improve production efficiency, while also enhancing the soft power of the enterprise.

Timely input production conditions, production dynamics, management control measures, and other information during the production stage into the information management platform for production information storage and dynamic control of various management objectives. Problems that arise during the production phase can also be continuously fed back to the design phase through the platform, enabling managers to make timely adjustments. There are many types and quantities of prefabricated components in the factory. In the production stage of large-scale engineering projects, modern information technology such as QR codes can be combined to mark the name, size, raw materials, process, and installation position of each component, and preliminary storage can be carried out in the comprehensive management platform. Finally, it can be implemented in conjunction with mobile terminals to improve overall construction efficiency.

3.3 Transportation phase

Based on the detailed decomposition of prefabricated component model dimensions and other related information, combined with the location of the project, predict various risk factors during transportation, develop component transportation plans, and complete transportation

goals while ensuring component quality and construction progress. The transportation plan includes the transportation tools used, transportation time, road information, and stacking methods during the transportation process. Timely input the various information in the transportation plan into the system platform, and timely summarize the transportation information for any problems that occur during the transportation process before providing feedback to the previous stage, so that the adjustable and controllable links can be dynamically adjusted to ensure construction quality and progress.

3.4 Construction phase

Compared to the traditional construction method of on-site pouring, the work of prefabricated buildings during the on-site construction stage mainly includes the stacking of prefabricated components and the installation of component connections.

3.4.1 On site stacking

Unlike traditional cast-in-place operations, prefabricated prefabricated components are transported to the site and placed on site before installation according to the construction schedule. After the prefabricated components are transported to the site, the on-site stacking location and method are determined based on the component installation method and construction machinery in the construction plan to ensure the quality of the building products. During this process, the physical characteristics of the site, lifting equipment, lifting tools, and component size information are integrated into the platform information database, and then animated simulations of on-site stacking are carried out to eliminate uncertain factors that may affect the quality of components during the stacking stage as much as possible.

3.4.2 On site installation

During the on-site installation phase, a reliable connection method between prefabricated components is also a key link in ensuring the overall quality of prefabricated buildings throughout the entire construction process. In actual construction, the construction unit prepares corresponding manpower, materials, machinery and equipment according to the different connection methods between components in the construction plan. In the construction preparation process, in addition to traditional technical preparation, it is necessary to set up the lifting machinery, rigging, pouring materials and other information used in the component installation process on the information platform. Combined with the information of the stacking site in the previous stage, software should be used to simulate the installation process of the components and adjust some problems or contradictions that may arise during the installation process. At the same time, construction simulation can also enable management personnel to pre control some unfavorable factors on site. Before installing the components, on-site workers can use animated simulation videos from mobile terminals to provide more intuitive guidance for on-site lifting, pouring, and other operations.

During this process, all construction information is promptly entered into the information platform for feedback and storage. At the same time, if any abnormal situations occur in the components, timely feedback is provided to the previous stage for controllable adjustment to ensure the quality of prefabricated buildings.

3.5 Operation and maintenance phase

After the completion acceptance of the project, a completed building entity model is established on the comprehensive information platform, which includes detailed assembly component attribute information during the design construction phase, which can be extracted by the operation and maintenance phase if necessary. The operation and maintenance stage is also a summary and inspection stage of the entire pre construction process of prefabricated building projects. This stage summarizes the experience and lessons learned from the implementation stage of each engineering project, providing reference and reference for the construction and implementation of prefabricated buildings in the future, thereby improving the strength of enterprises and ultimately promoting the high-quality development of prefabricated buildings.

During the entire life cycle of prefabricated buildings, the information stored for the design, production, transportation, storage, connection and installation, and operation and maintenance of the components of prefabricated buildings together constitute the physical information of completed prefabricated buildings in the comprehensive information management platform.

4 Implementation suggestion

Based on the characteristics of the work content in each stage of the entire life cycle of prefabricated buildings, with the comprehensive benefits of "green progress quality cost" as the management goal, the implementation suggestions for the development of prefabricated buildings are as follows.

4.1Construction through general contracting method

Based on the characteristics of BIM technology information integration and utilizing the advantages of BIM technology comprehensive information platform, if the "design construction" general contracting mode is adopted for engineering construction tasks during project contracting, the project general contractor will serve as the information integration platform application and system management responsible party for the entire life cycle management. With the support of the owner, the information from the previous and subsequent stages will be continuously stored on the platform, It will better leverage the management efficiency of the BIM platform system, which will help achieve the comprehensive management goals of "progress quality cost green" for the development of prefabricated buildings.

4.2Construction of standardized resource library

In prefabricated buildings, standardized components are both convenient for design and can improve the construction efficiency of transportation, installation, and other links, which is an effective means to improve the overall work efficiency of prefabricated building projects in the design transportation construction stage. In the early stage of implementing prefabricated construction, the industry, local authorities, and the country can gradually unify component standards, thereby improving the management efficiency of the "pre construction, during construction, and post construction" trinity. The construction of prefabricated building

component resource library is based on enterprises, which can be established and expanded step by step and continuously supplemented throughout the entire construction process of prefabricated buildings. After review, it gradually forms a standard component resource library at the industry and even government level, promoting the informationization and industrialization development of the construction industry.

5 Conclusion

Building application models based on BIM technology throughout the entire life cycle of prefabricated buildings, improving the level of informatization of prefabricated buildings, enabling managers to comprehensively and systematically grasp the information of prefabricated buildings, optimize management objectives, dynamically control the construction process, promote the high-quality development of prefabricated buildings in China, and assist in the systematic and industrial development of prefabricated buildings. With the progress of the information age, the development of prefabricated buildings will also be combined with the systematic application of information technology to achieve comprehensive and high-quality development.

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