

Application of Prefabricated Building Construction Technology in the Construction Management of Construction Engineering

Hui Chen^{1, a}, Dandan Wang^{2, b, *}, Ming Lei^{1, c}, Chuzhe Xu^{3, d}

¹ School of Urban Construction, Yangtze University, Jingzhou 434000, Hubei, China

² Programme and Finance Division, Yangtze University, Jingzhou 434000, Hubei, China

³ Yunnan Yuanda Engineering Consulting Limited Liability Company, Kunming, Yunnan 650000, China

^a2445008575@qq.com, ^b*723737529@qq.com, ^c88456455@qq.com, ^d1580961625@qq.com

Abstract

In the context of accelerated urbanisation in China, assembly building has become the leading trend in the development of the construction industry due to high construction efficiency and low material consumption. This paper starts from the concept and development of assembly building, and analyses the content and characteristics of its construction technology. In view of the continuous improvement of construction standards in building projects, the rational application of this technology is an important issue for construction enterprises. Through the case study, it can be seen that it has the advantages of improving efficiency, ensuring quality, energy saving and environmental protection, and significant economic benefits in construction management. This study can provide reference for related industries.

Keywords

Features of Prefabricated Buildings; Installation and Construction Technology; BIM Technology.

1. Introductory

In the field of modern construction, assembled buildings are widely used and show great potential for development. Under the guidance of national policy, assembly building has become the focus of current promotion by virtue of its significant energy saving and environmental protection characteristics. Assembled buildings have been developed to the industrialization 3.0 level, and have achieved remarkable results in terms of construction efficiency, project quality and environmental protection and energy saving. For example, the standardized prefabricated component production significantly reduces the on-site wet work time, shortening the overall construction period by about 30%; the refined processing of components in the factory also effectively reduces the quality defect rate[1]. However, there is still room for improvement in the current assembly building in terms of component connection precision and construction process standardization. In order to improve the construction quality of assembled buildings, managers should continue to optimize and innovate the use of assembly building construction technology, optimize the construction process through the introduction of BIM technology, and research and development of new connecting materials to improve the stability of the structure, in order to ensure the sustainable and stable development of the construction industry.

2. Overview of Assembly Building Works

2.1 Assembly Building Concept and Development

Assembled building is a new type of building system, which adopts advanced technologies such as standardized design, factory production and assembly construction, and prefabricates the main components of the building in the factory and then transports them to the construction site for assembly. This construction method changes the traditional on-site pouring mode, significantly improves the construction efficiency and quality, and also has the advantages of energy saving and environmental protection.

Conceptually, the core of assembly building lies in “prefabrication” and “assembly”. Prefabrication means that the main components of a building are made in a factory, including walls, columns, beams, slabs and stairs, etc., while assembly means that these prefabricated components are assembled at the construction site to form a complete building structure. This approach not only reduces on-site wet work and construction noise and dust pollution, but also significantly improves construction speed and shortens the construction period.

At the end of the 20th century, the relatively slow pace of technological development of assembled buildings, coupled with its low seismicity and quality deficiencies such as waterproofing and soundproofing, prevented it from receiving sufficient attention. Nevertheless, in the last decade, with the continuous progress of science and technology and the rapid development of the construction industry, assembled buildings have received more and more attention and application. The state has vigorously promoted assembly building and formulated a series of policies and standards to promote its healthy development. Local governments have also actively introduced relevant policies to encourage and support the development of assembled buildings. Driven by both market demand and technological progress, assembly building is gradually becoming a mainstream trend in the construction industry[2].

In the future, assembled buildings will continue to develop in the directions of greening, intelligentization and modularization. New green building materials and technologies will be widely used in assembled buildings to realize energy saving and emission reduction and sustainable development. Meanwhile, with the application of artificial intelligence, Internet of Things and other technologies, assembly buildings will realize more intelligent production and management. Modularized design will also become an important feature of future assembled buildings, further improving their flexibility and variability.

2.2 Assembly Building Characteristics

Assembly buildings are characterized by fast construction speed, short construction cycle, high productivity, good project quality, environmental protection and energy saving and significant economic benefits[3]. Although the application of prefabricated and semi-finished components reduces the need for construction management techniques in assembly building construction, it also reduces the workload of traditional building construction sites and improves the overall synergistic efficiency of assembly building construction.

(1) High construction efficiency and short construction period: prefabricated components are directly transported to the site for assembly, which reduces a large amount of on-site wet work time, such as masonry, supporting molds and concrete pouring. The standardized component installation process, together with professional lifting equipment and construction technology, can shorten the overall construction period by 30%-50% compared with traditional construction, which can quickly respond to market demand and accelerate the project construction progress.

(2) High production efficiency and precision: the components are standardized in the factory, and through the intelligent production line, high-precision molds and automated equipment, accurate control of steel processing, concrete pouring and other processes is realized, compared with traditional on-site construction, the components have smaller dimensional errors, and the surface flatness and finish are more likely to meet the design standards, effectively reducing quality defects.

(3) Remarkable effect of energy saving and environmental protection: the factory production mode reduces the dust, noise and sewage discharge from the construction site and improves the construction environment. At the same time, the use of green materials as well as efficient thermal insulation, energy-saving doors and windows and other technologies to reduce the energy consumption of the building in the process of use. Precise production of components can also reduce material waste and improve resource utilization efficiency, in line with the concept of green building development.

(4) Beneficial to the development of industrial modernization: the development of assembly building drives the upstream and downstream industry chain to make progress in a coordinated manner, and promotes the development of equipment manufacturing, new materials research and development, and other related industries. At the same time, the application of information management means improves the management level of construction enterprises, cultivates a group of professionals who master assembly building technology, and promotes the transformation and upgrading of the construction industry in the direction of modernization and intelligence.

3. The Main Content of Assembly Building Construction Technology

3.1 Construction Technology of Assembled Concrete Elements

The construction technique of assembled concrete components is now considered as a landmark technology in the field. First of all, suitable molds are made using various materials according to the specific needs of the project. On the one hand, the type and size of the molds can be accurately grasped through the use of computer programs to assess their functionality, which not only helps to shorten the prep time, but also effectively responds to the actual problem of lack of space in the construction area. On the other hand, assembly line production methods can be used to standardize the production of key components to ensure the manufacturing quality of each component. In addition, through the unified pouring process, not only the standardized production quality of each component is guaranteed, but also the construction efficiency of the project is enhanced[4]. For the volume measurement of the rectangular part of the assembled concrete, the formula can be used:

$$V=L \times N \times H \quad (1)$$

In equation (1): V is the volume of the component, m^3 ; L is the length of the component, N is the width of the component, and H is the height of the component, m .

When calculating the volume of the shaped component, the whole component is firstly split, and then refer to the method of calculating the volume of the rectangular component. By calculating the size and quantity of each component, it is possible to accurately measure the area of all concrete pours, and finally evaluate and analyze the total amount of pours for the entire construction.

3.2 The Use of BIM Technology in Assembled Buildings

BIM technology plays a crucial role in assembled buildings, which is mainly reflected in the following three aspects: ① collision detection and simulation of installation, designers and constructors can use BIM technology to carry out collision detection and simulation of prefabricated components installation visualization check in advance to ensure that the deviation in the construction process is minimized, so as to improve the efficiency of the work on the construction site[5]. ② Collaborative design and information sharing: although in practice, each participant may use different BIM software or versions, BIM technology still provides effective support for collaborative design and information sharing. Although facing the problem of incompatible data formats, BIM technology continues to promote cooperation and communication among parties. ③ Model construction and data acquisition: Although the number of components in an assembled building is large and diverse, BIM technology combined with modern measurement technologies such as laser scanners can realize

automated data acquisition and model construction, improving the efficiency and accuracy of model construction.

3.3 Assembly Steel Structure Construction Technology

The core objective of adopting assembly steel structure construction technology is to provide a diversified combination method for steel structure projects and to meet the construction standards of steel structure buildings based on mechanical principles. Before the official start of construction, the quantity and specifications of the relevant steel components must be counted. Through its integrated preparation and process treatment, the seismic and flood resistance of the building is improved, and the quality of the construction project is essentially improved[6]. At present, the application of this technology can meet the requirements for the construction of emergency function buildings, quickly realize post-disaster reconstruction, and meet the needs of a large number of residents' lives, which has very important practical value.

3.4 Construction Technology of Assembled External Wall Floor Slabs

The construction process of prefabricated facade panels includes key aspects such as waterproofing of facade joints and overall facade installation. First of all, the nodes of the external wall need to be waterproofed, and the core task is to solve the waterproofing problems in the corners of the wall and other parts. The waterproofness of the building can be significantly improved by reasonably setting up the blocking device. Secondly, in the production of waterproofing elements, the standardized construction operation of the assembly line can be used to ensure the stability and reliability of the construction quality. Compared with traditional waterproofing elements, this new construction technology and construction quality have been significantly improved. In addition, in the construction of exterior wall slabs, it is usually necessary to carry out accurate measurement and estimation of the construction area and make corresponding adjustments according to the actual situation[7]. Therefore, the use of assembly type exterior wall construction technology can ensure the standardized manufacturing of all components, and in the construction process of reinforced concrete structure and frame building, it is only necessary to fill the gaps at the joints with cement, which can effectively reduce the difficulty of construction, thus significantly improving the construction efficiency of the overall construction project.

4. Practical Application of Assembly Building Construction Technology

4.1 Project Overview

This paper takes an assembly building residential project as an example, the main part of the project includes 3 high-rise buildings and 2 small high-rise buildings, and the building design service life is 50 years. 3 high-rise buildings adopt prefabricated staircase and stacked plate assembly form, while 2 small high-rise buildings adopt whole assembly shear wall structure, and the bottom of the stacked plate adopts formwork rapid demolition and support construction technology. The project covers a total area of 27,833 m². The construction unit carried out the secondary design of the structural drawings of the project according to the requirements of the relevant documents and the actual situation of the project in order to meet the needs of the professional manufacturers.

4.2 Prefabricated Component Production Technology for Assembly Buildings

4.2.1 Prefabricated Component Design

The design of components involves the collaborative work of design, construction and production, which directly affects the quality and efficiency of on-site assembly and construction. The design process of prefabricated components is further improved by systematically collecting design data and reference opinions and strictly complying with component design specifications. At the same time, BIM technology is used to optimize the design of prefabricated components, and the existing component design information is directly applied to the design of standard components, or new component types are developed on the basis of the original component design, to ensure the accuracy

of the piping arrangement, to reduce the design difficulty, and to enhance the feasibility of the design scheme[8].

4.2.2 Fabrication of Prefabricated Components

Molds are key tools in the precast component production process. Most of the operations can be done automatically by the machines and equipment after setting the corresponding equipment operation parameters. To ensure that the quality inspection of the components meets the requirements of the Code of Practice for the Quality Acceptance of Concrete Structural Engineering Construction, a good relationship should be established with a manufacturer with advanced equipment, high technical level and rich experience. Employees responsible for prefabricated components in the factory need to maintain effective communication with designers to ensure consistency in design planning and data, and to produce according to drawings. At the same time, the entire production process should be strictly monitored and the quality of the molds should be strictly managed. The molds used in the production of prefabricated components must have sufficient strength, stiffness and overall stability, and their geometric deviations should be within the allowable range[9]. During the manufacturing process of prefabricated beams, columns and other building components, the positions of holes and embedded parts required for other walls and decoration must be accurately reserved and the position of the molds must be ensured to be firm. In addition, the smoothness and perpendicularity of the components should be inspected to ensure that their quality meets the standards.

The dimensional deviation of precast elements should be in accordance with the provisions in the Code for Quality Acceptance of Concrete Structural Engineering[10].

4.2.3 Transportation and Storage of Prefabricated Components

(1) There is a certain distance between the manufacturing plant of building components and the construction site. When the components are completed and enter the installation stage, the transportation scheme should be reasonably planned according to the variety of components and their transportation distance, and the means of transportation matching the size and load capacity of the components should be selected in order to scientifically set the transportation route[11]. In addition, all components need to be marked and organized in order, and strengthen the soft packaging and covering and other safeguards to ensure that the components can arrive at the destination at the fastest speed.

(2) Arrange professional personnel and equipment to dismantle prefabricated components and set up specialized storage areas according to the types of components. The storage area should be maintained flat and stable, and for the components that need to be waterproof and moisture-proof, a suitable storage environment should be constructed, with reasonable planning of the drainage system to ensure that the air is circulating and dry, and special personnel are assigned to be in charge of cleaning and other maintenance work[12].

4.3 Installation and Construction Techniques for Assembled Buildings

4.3.1 Prefabricated Components Lifting

The importance of lifting operations is particularly significant in the process of integrating and installing various prefabricated components to achieve a tight and strong connection to the cast-in-place structure to build a complete building system. Therefore, the quality of the components must be verified prior to lifting. For example, it is necessary to check whether the materials used and their dimensions after processing are in accordance with the requirements of the building, and at the same time to confirm that the marking numbers on the components and the information on the intended installation locations are correct. In addition, it is also necessary to organize relevant professionals to discuss and determine a reasonable lifting scheme, select appropriate lifting equipment, and provide detailed operational guidance by professionals[13].

4.3.2 Prefabricated Panel Installation

In the process of installing prefabricated panels, appropriate prefabricated hanging panel installation techniques should be selected, the installation path of the panels should be reasonably adjusted, and

the installation, fixing and splicing of each hanging panel should be completed in an orderly manner according to the numbering consistent with the design blueprint. At the same time, it is also necessary to protect the prefabricated panels and the overall structure during the installation stage, and to place a temporary support frame at the bottom of the panels (see Fig. 1) to ensure that an effective spacing is maintained between them and the working level[14]. Therefore, in the process of building design, it is necessary to pay attention to the synergistic effect of each link to ensure that all operators strictly comply with the corresponding technical specifications and efficiently complete the construction task.



Fig. 1 Support frames underneath assembled engineered laminated panels [15]

4.3.3 Prefabricated Wall Panel Construction

In order to ensure the smooth implementation of the lifting plan, professional personnel and corresponding equipment should be assigned to the site to carry out the work. In particular, large equipment such as cranes must be checked and adjusted in advance to ensure stability at the intended workplace, so as to avoid offsetting or tilting during the lifting process. The lifting point should be set precisely on the member and ensure that the hook is secure, and then start the lifting procedure at a slow and even speed. When the components are 50 cm above the ground, it is necessary to carefully check whether there is any damage to the components and whether the lifting rings are firm, and after checking, the wall panels will be lifted to a position more than 50 cm above the working surface. In addition, it is also necessary to verify whether the ground arrangement is perfect, and with the help of professionals to accurately position the wall panels so that they can be gradually lowered. Finally, after adjusting the position of the wall panels, they are fixed (see Fig. 2).



Fig. 2 Support frames underneath assembled engineered laminated panels [15]

5. Conclusion

In summary, the application of assembly building construction technology in construction project management has important practical significance and broad development prospects. With the

continuous progress of technology and the continuous expansion of application fields, it is expected to play a more important role in the construction industry in the future, and make a greater contribution to the construction of a green, efficient and sustainable building environment. In order to further improve the construction management level of assembly buildings, construction units should clarify the specific content of assembly building construction technology, based on the actual situation of the project, through the design and production of prefabricated components, transportation and storage, installation of prefabricated panels and construction of prefabricated wall panels and other aspects of the standardization of operation to achieve. For example, the introduction of BIM technology for collision detection in the design phase of prefabricated components can reduce more than 70% of the design changes in the construction phase; and the use of intelligent monitoring system to monitor the status of components in real time in the transportation link reduces the damage rate of components by 30%. At the same time, through the establishment of the whole process of quality traceability system, the use of Internet of Things technology for component production, transportation, installation of the whole process of data collection and analysis, can realize the rapid positioning and rectification of quality problems, thus significantly improving the economic and social benefits, and promoting the construction industry to industrialization, intelligent direction to accelerate the transformation.

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