

# *Application of BIM Technology in the Design of Prefabricated Building Integrated System*

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**Abstract:** This paper expounds the design mechanism and technical characteristics of BIM Technology in prefabricated building integrated system, analyzes the comparative advantages of BIM Technology and traditional two-dimensional building design, and discusses the application ways and methods of improving BIM Technology in prefabricated building design, so as to promote this technical advantage to be brought into play in a wider range.

## 1. Introduction

BIM Technology is a new technology which adapts to the national green ecological construction. As soon as BIM Technology is applied in the design of prefabricated building integrated system, it has gradually become the mainstream of prefabricated building integrated construction design because of its advanced design concept, simple construction process, modular integration degree and great advantages in reducing energy waste, reducing environmental pollution, accelerating construction progress, improving construction efficiency and protecting ecological environment. Based on the understanding of BIM technology's advanced nature, applicability, safety and environmental protection, this paper will study and discuss this technology in a wider range and wider scope, with a view to providing references for promoting the green environmental protection technology in the construction industry to further develop in depth.

## 2. Overview of BIM Technology

BIM Technology is based on three-dimensional digital technology, based on simulating the data of each component project in the whole life cycle of engineering construction project, with the main goal of visualization, coordination and simulation, through the design process of digital integrated

three-dimensional model. BIM Technology is applied in the design of prefabricated parts assembled and formed on the project site. Most of the prefabricated parts are manufactured by the manufacturer in advance, which can reduce the construction cost, improve the degree of mechanization, shorten the construction period, and reduce the consumption of energy and materials, which is conducive to maximize the economic benefits of the enterprise. The visual use of BIM Technology can realize the arbitrary disassembly and combination of building structure "toy model", which is convenient for construction operators to understand and grasp more intuitively and clearly. The deep optimization of this technology can be realized through high-level data model integration, which can deeply optimize the difficulties of physical information data such as geometric dimensions of building structures and infrastructure structure in the process of design, construction, production and installation through simulation design, so as to reduce the phenomenon of engineering construction affected by engineering design or other process errors [1].

### 3. The Design Method of BIM Technology in Prefabricated Building System

#### 3.1 Principles of Design System

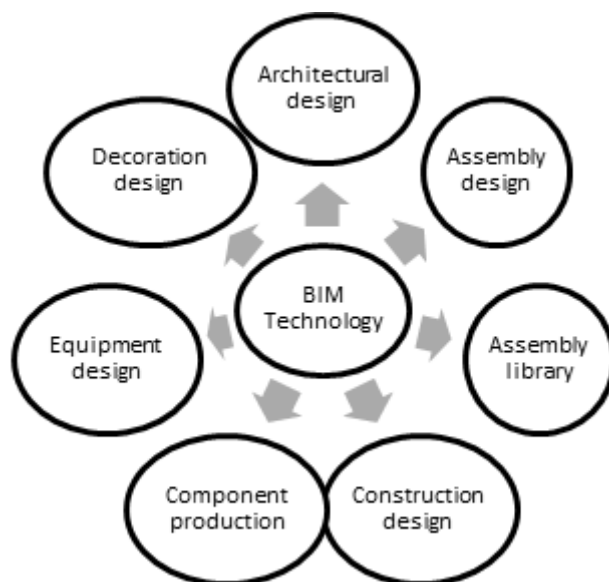


Figure 1. Application of BIM Technology in prefabricated building integration system

Abandon the traditional architectural design concept that the construction process and each link are separated from each other and designed independently, and eliminate the malpractice that the construction process overemphasizes the main building construction, material delivery, construction acceptance and other engineering construction stages are disjointed. According to figure 1, the application of BIM Technology is very extensive, involving all aspects of prefabricated building construction. Through the application of BIM Technology in the design of prefabricated building system, it can ensure the coordination and linkage of the whole process of building, complete and unified implementation of specifications and standards, realize the close integration of all aspects, and improve the construction efficiency and quality through design optimization. BIM Technology can not only realize the design idea of building structure design integration, but also ensure the integration of water, electricity, heating, ventilation and other infrastructure construction and equipment installation design with the main construction of the project, and ensure the smooth operation of the design scheme and construction process operation and maintenance with the support of BIM technology [2]. With the advantages of information technology and network digital

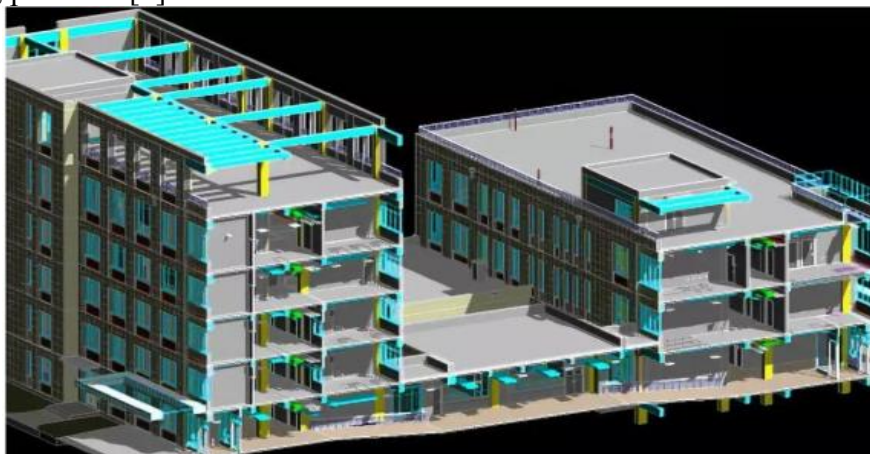
application and the support of powerful information data module, the geometric size and type of building components can be more matched. Through software simulation, the whole process of engineering construction can be simulated and the sand table drill of management process can be carried out, and the problems and quality defects can be found as soon as possible, and measures can be taken to solve them.

### 3.2 Standardized Design System

Standardized design system is realized by establishing the benchmark platform of prefabricated building system, with the help of advanced design concept and information technology advantages of BIM Technology. According to the building standards and building module performance requirements, the practicability, applicability and safety of construction process management are fully integrated into the design concept, and the standardized operation mode is established. From the reality of realizing the overall layout of architectural planning and design and the functions of each construction process, the building performance system and the requirements for the whole prefabricated building are decomposed into the selection of each component, each construction link and each material, and the standardization of each component in the building system is used to ensure the use of the overall function, demand and demand of the building Completion acceptance and standardization of operation and maintenance after use. In line with the requirements of the construction industry in the new era during the transition period from extensive, energy consumption type to fine management type and environmental protection and conservation type, the standardized design is carried out around the construction product standards with low resource utilization, small environmental damage and high production efficiency[3].

### 3.3 Modular Design System

BIM Technology is used in modular design of prefabricated building system, which is essentially the scientific application of "disassembly" and "combination"(Figure 2). First of all, based on the full study of the overall structure of the building, the whole building construction process is divided into several construction links and the building structure into several modules by the idea of assembly design. On this basis, according to the independence and cooperation of each component, it is subdivided into sub unit modules with more detailed functions. Then, through BIM Technology integration simulation, it forms the assembly building module function which is relatively independent and unified, so as to simplify the design, improve the process service and provide high-quality building products [4].



*Figure 2. Effect picture of BIM Technology in application*

Secondly, according to the general standard of modular design system, we should grasp the three key stages of modular design system. The first stage is the design preparation stage. According to the general requirements of the planning and design of the construction project, the designer plans the scheme and specific content of the design module on the basis of the overall analysis and research of the construction project, and according to the use function and safety requirements of different components of the building, Through the application of BIM Technology, the module design meets the requirements of industrial construction standards and engineering project construction. The second stage: three-dimensional modular design stage. According to the space planning of architectural design, according to the logical relationship between architectural structure, architectural function, whole and part function, the theoretical and practical module grading design is carried out, so as to achieve the further division of BIM Technology in the design of prefabricated building integrated system from space function, standard layer, overhead layer, operation module and electromechanical module. The third stage: refinement stage[5]. BIM Technology in this stage of design to adapt to different buildings and users in the form of diversified, multi standardized, multi-functional use of the market demand as the standard, while the space layout, visual impact effect, beautification and lighting of environmental protection needs, as well as buildings and other adjacent buildings The comprehensive needs of human environment in residential community should be realized through fine design.

#### 4. Application of BIM Technology in Prefabricated Building System

##### 4.1 Determine the Key and Difficult Points of BIM Technology Application According to the Actual Situation of the Project

According to table 1, the scale of prefabricated buildings has been expanding in recent years. In the actual construction, we need to guarantee the quality from the design and construction and other aspects, which requires the full play of BIM Technology. Taking a large residential community in Shanghai as an example, the project covers an area of 2450 square meters. When BIM Technology is used in this project, it is necessary to grasp the design principle of prefabricated building system, combine with the form and characteristics of reinforced concrete frame structure and fully prefabricated prefabricated construction of the construction project, and make clear the relationship between the ground and underground structure of the foundation layer, the building area and the adjacent structures Based on the detailed information of building floor height, the application design of prefabricated building is carried out. Secondly, grasp the key and difficult points in the process of engineering design and implementation, summarize and deepen the design procedures through overall research, so as to ensure that the structure of prefabricated components is reasonable and meet the physical protection requirements of no collision between each other [6]. Thirdly, organize technical personnel to conduct on-site technical disclosure, understand the contents of design drawings according to the construction procedures, ensure the accurate and rapid construction of component devices, and create conditions for high-quality assembly tasks.

*Table 1. Scale of prefabricated buildings*

Particular year	Scale / 100 million square meters
2017	1.6
2018	2.89
2019	4.18

## 4.2 BIM Technology in the Stage of Assembly Building Design

A BIM Technology should do a good job in the design of assembly building, how to use BIM Technology in the process of planning and site selection. Eliminate the idea of ignoring the analysis site, treat the analysis site as the key component of the project height, and ensure the correctness and rationality of the positioning of the assembly building project by scientific and reasonable site analysis. The advanced technology of BIM 3D model is effectively used to collect accurate and reliable data through field investigation, establish the site conditions and spatial information of the building, and complete the high-quality construction model which is consistent with the data to pave the way for the subsequent construction. Thirdly, the advantages of clear, intuitive and visible drawing of BIM Technology are exerted [7]. All elements and meanings of engineering construction are the greatest advantages of BIM Technology are expressed through BIM Technology construction model, and the design method is constantly improved and improved to optimize it. In the construction of building 3 of this project, after the BIM Technology is used to establish the model, the problems in the installation of the assembly structure are simulated and installed. It is found that there is a collision between the wall panel reserve and the vertical reinforcement of the structural column. The technology is used to deal with it, and the construction scheme is optimized to reduce the occurrence of the later modification of drawings and rework problems.

## 4.3 BIM Technology in the Production and Processing of Prefabricated Components

During construction, the production and processing design of prefabricated components is placed on the same platform of BIM to ensure that the whole process of pre-made components production and processing from professional technology, production process to product implementation is achieved in the unified technical design standard and meet the final unified confirmation standard requirements [8]. Meanwhile, the advantages of drawing automatic completion and deepening in BIM software are exerted, and the accuracy of data transmission in the whole system from the selection of production materials, transportation in the way to the whole system of workshop production and processing is maintained, and the errors caused by human operation are reduced and the production efficiency is improved. Strengthen the management of the prefabricated parts in the later stage of delivery, implement the pre-fabricated component code registration system, and integrate all the production personnel, inspection personnel, binding steel bars, hole reservation and production date of each prefabricated component into the information network system, and implement the "quality lifelong system" of the production and processing management of prefabricated components to ensure that the shape of all components is complete The internal quality is complete without defects(Figure 3). For example, when calculating the quantities of assembled building steel, it is necessary to make clear the rules of calculation. Two different ways can be used for calculation according to the theoretical weight, as follows:

(1) Weight of steel = volume of steel × Density of steel;

(2) Weight of steel = length of steel × Weight of steel per unit length, of which the density of commonly used steel is  $7.85 \times 10^3 \text{ kg/m}^3$ .

Among them, the formula for H-beam calculation is as follows: b is width, h is height, t1 is the thickness of web of steel plate beam, t2 is the thickness of flange of steel beam, and L is the length of steel beam:

$$M=(2bt^2+ht^1-2t^1t^2)L \times 7.85 \times 10^{-9}$$

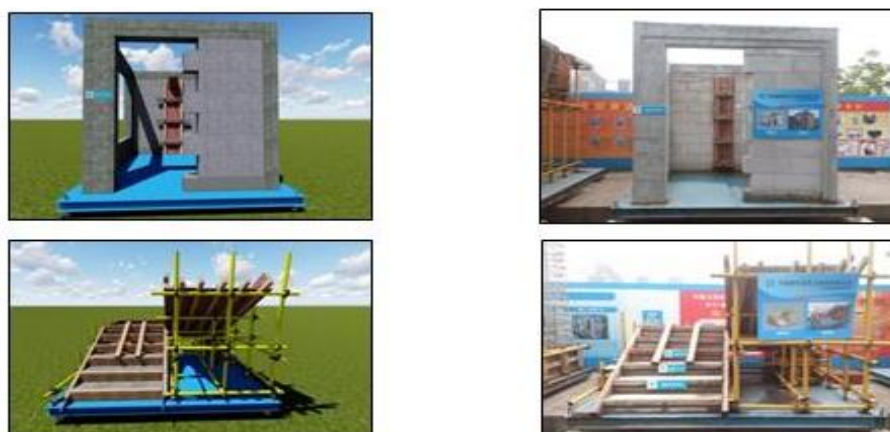


Figure 3. Application of BIM Technology

#### 4.4 BIM Technology Application in Construction Stage

First, the system of the person in charge of reservation, collection and use of prefabricated structural parts is established. In the whole construction stage of assembly building, the relevant responsible person shall prevent the loss, misuse and damage of components in the process of assembly construction according to the characteristics of different parts, components, different use time and different assembly complexity [9]. Secondly, the project manager of construction site shall simulate the site function combined with BIM Technology, simulate the construction process by accurately calculating construction data, so as to achieve reasonable process, orderly organization and smooth connection, and prevent secondary handling and inter process stop from affecting construction efficiency. In addition, strengthen the management of the transportation process of prefabricated structural parts, establish inspection system and set up access control system at the construction site. Quality inspectors shall implement the materials before entering the site at the first time to ensure the safety of the prefabricated components in the assembly construction. At the same time, before the formal construction, according to the actual characteristics of the project, BIM Technology was used to simulate, and combined with the structure model, site model and construction plan, the construction simulation animation was generated, the construction process, requirements and planning were mastered in advance, and the problems in the whole scheme were found, so as to meet the requirements of scientific construction.

#### 4.5 Application of BIM Technology in Operation and Maintenance

Firstly, during the process of assembly building integration, we should monitor the technical parameters of the building dynamically through BIM software to ensure that all construction elements of the project, including equipment and management personnel, operate under the condition of state safety. Secondly, strict measures such as collision prevention, deformation caused by uneven force must be set up to avoid structural damage caused by prefabricated components when building expansion and special case demolition and assembly operation are carried out through BIM Technology. Thirdly, BIM Technology should establish the concept of green environmental protection, select renewable resources to be recycled, carry out the research on the application of green environmental protection construction technology and materials, reduce the emission of building pollution, reduce the consumption of building materials and energy, and promote the sustainable development of green environmental protection of construction enterprises [10].

## 5. Conclusion

BIM Technology has obvious advantages in the design of assembly building integration system compared with traditional design methods. In the future, construction enterprises should grasp the key and difficult points of BIM Technology Application accurately, and strengthen the application of this technology in the design stage, prefabrication production and processing stage, construction and operation maintenance stage, The BIM Technology can play a better role in the integration of assembly building in improving the building grade, reducing energy consumption and reducing environmental pollution, and promoting the sustainable development of green and environmental protection for construction enterprises.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

## References

- [1] Li Wei. *Based on BIM, the application practice of green construction of prefabricated and assembled building is discussed. Green environmental protection building materials*, 2021 (05): 21-22.
- [2] Liu Zhan, xingzezhong, Huang Chun, Du Xiuli. *Digital twin modeling method for assembly construction process. Journal of architectural structure*, 2021,42 (07): 213-222.
- [3] Cao Jing. *Application of self supporting system in the construction of cast-in-place floor of assembled steel structure building. Anhui architecture*, 2021,28 (05): 55-56.
- [4] Wang Mingqi. *Design optimization of assembly building structure. China Science and technology information*, 2021 (11): 52-53.
- [5] Cheng Xiaoke. *On assembly building. China construction informatization*, 2021 (10): 28-33.
- [6] Wang Wei. *On the quality supervision of assembly building. Guangxi urban construction*, 2021 (05): 50-52.
- [7] Yu Li. *Research on prefabricated building integration system based on BIM Technology. Architectural engineering technology and design*, 2018(23): 4900.
- [8] Sun Weikun. *Analysis on the application of BIM Technology in prefabricated architectural design. Commodity and quality*, 2018(20): 90.
- [9] Meng Lin. *application of BIM based prefabricated building integrated construction system. Microcomputer application*, 2018, 305(09): 122-126.
- [10] Zhang Junjie. *Research on prefabricated building integration system based on BIM Technology. Architectural engineering technology and design*, 2018(09): 271.