

## Discussion on the Application of BIM Technology in the Assembly Building

Yuanyuan Duan <sup>a</sup>, Hongyong Liu

School of Southwest Petroleum University, Chengdu 610500, China

<sup>a</sup>1127900583@163.com

### Abstract

With the unceasing progress and development of society, housing industry has become a major trend of the current construction industry. Prefabricated construction began to rise, how to introduce BIM Technology into the assembly building has become the focus of contemporary human attention. In this paper, based on the characteristics of BIM technology and prefabricated construction, from the architectural design, manufacturing, operation and maintenance phase, discussed the application of BIM technology in the prefabricated construction project. The study found that using BIM Technology can increase the design efficiency of prefabricated type construction, optimization and integration of the precast production process. 5D construction is used to simulation and optimization of construction, cost planning etc. BIM Technology promotes the further development of prefabricated construction.

### Keywords

BIM Technology; assembly building; RFID Technology; simulation.

### 1. Introduction

China's statistics on the completion total area of the urban and rural construction is about 20 square meters, and China becomes the world's largest construction market. However, there have been many problems in the China's construction industry, such as high energy consumption, high cost, long cycle, poor quality, environmental protection and a series of problems. It is necessary to take the modernization means to promote the construction industry reform and upgrading. In 2016, China's "government work report" special reported, China should actively promote green building, and vigorously develop the prefabricated construction, improve the standards and quality of construction projects. The State Council recently issued "a number of opinions on the further strengthening of urban planning and construction management work". It also suggested that develop new construction, increase policy support, and strive to use about 10 years time to make the prefabricated construction accounted for the proportion of new buildings to reach 30%. Providing new prefabricated construction to meet the market requirements, environmental protection and energy saving, labor-saving and time-saving has become necessary to promote the sustainable development of the architectural industry.

In recent years, China's construction field vigorously promote BIM related technologies and methods. In terms of prefabricated construction, BIM Technology platforms and tools can greatly improve the efficiency of the assembly type structure in design, production and construction, thereby promoting the further rapid development of prefabricated construction form.

### 2. BIM Technology and Assembly Building

#### 2.1 BIM Overview

BIM full name is Building Information Modeling, based on all relevant information and data of construction project, building information model is established. The real information of buildings is simulated by digital information simulation<sup>[1]</sup>. BIM not only is the integration of digital information, but also the application of digital information, and it is digital methods that can be applied to the

design, construction, management. This digital method can support the integrated management environment of the construction project, which can greatly improve the efficiency of the construction project in the whole process, and reduce a lot of unnecessary risks.

The real BIM has five major features, such as visualization, coordination, simulation, optimization and drawing.<sup>[2]</sup> BIM model is a project integrated management information model based on BIM application as the carrier, in order to enhance the production efficiency of the project, to improve the quality of construction, to shorten the project duration, and to reduce construction costs and so on. Specific implementation is reflected in: 1) 3D rendering and promotional display; 2) fast calculation and improved accuracy; 3) precise plan and reduce waste; 4) compared and effective management and control; 5) virtual construction and effective coordination; 6) collision checking and reduce rework; 7) call conflict and decision support.

## 2.2 Assembly Building Overview

Assembly building is like "building blocks" to build a house, as "producing" a house on a production line. Namely, the main components of the building are processed and manufactured in the factory assembly line, such as wall, beam, slab, column, etc. Each component is transported to the site, and then assembled together in accordance with the order, to form a new building, in order to achieve a variety of design, functional modernization, manufacturing factory, assembly of the construction. The "three criteria" (Standardization, industrialization, informatization) method is used to build, use and manage building<sup>[3]</sup>, and to prompt the construction industry from the traditional way to intensive, conservation, environmental protection, green, technology and other modern ways to change. From the Statistics results of the pilot program in Shanghai residential, compared to the prefabricated construction and traditional cast-in-place construction, land and materials can be saved 20%, water can be saved 60%, energy can be saved 50%, while the reduction with the amount of construction waste reached 80%, the efficiency of construction improved 4 times to 5 times etc..<sup>[4]</sup>.

## 3. BIM and Prefabricated Assembly Building Fit

BIM used three-dimensional digital simulation technology, and integrated into the life cycle of the building, to link up each process of the construction industry chain and to integrate the data model of the project related information. BIM provides a new mode of production and management for the construction industry. It successfully solved the problem of multi-organization, multi-stage, and information sharing in the whole life cycle of building construction. Established BIM model can make the construction project information in the planning, design, construction and operation and maintenance of the whole process fully shared, and lossless transmission.<sup>[5]</sup> It also provides a reliable basis for the decision of the building from conceptual design to demolition in the whole life cycle.

In order to improve the efficiency of prefabricated assembly building in the various stages of the design, production and construction of construction, this paper will focus on the application of the BIM technology in the industrial architectural design stage, the component manufacturing stage, the site construction stage, the operation and maintenance stage.

## 4. Application of BIM Technology in the Assembly Building

Compared to the architectural precast and cast-in-place construction, it is more a precast production stage, the application framework of BIM Technology in prefabricated construction is shown in Fig. 1.

### 4.1 Application of BIM Technology in Architectural Design Stage

#### 1. PC collaborative design

There are three main points on the characteristics of BIM collaborative design, one is "the relationship of form and spirit to have both". The "form" refers to the appearance of a building, namely 3D model structure itself; The "spirit" refers to the information and parameters contained in the building. Two is visualization and simulation. Three is "a modification, everywhere modification"<sup>[6]</sup>.

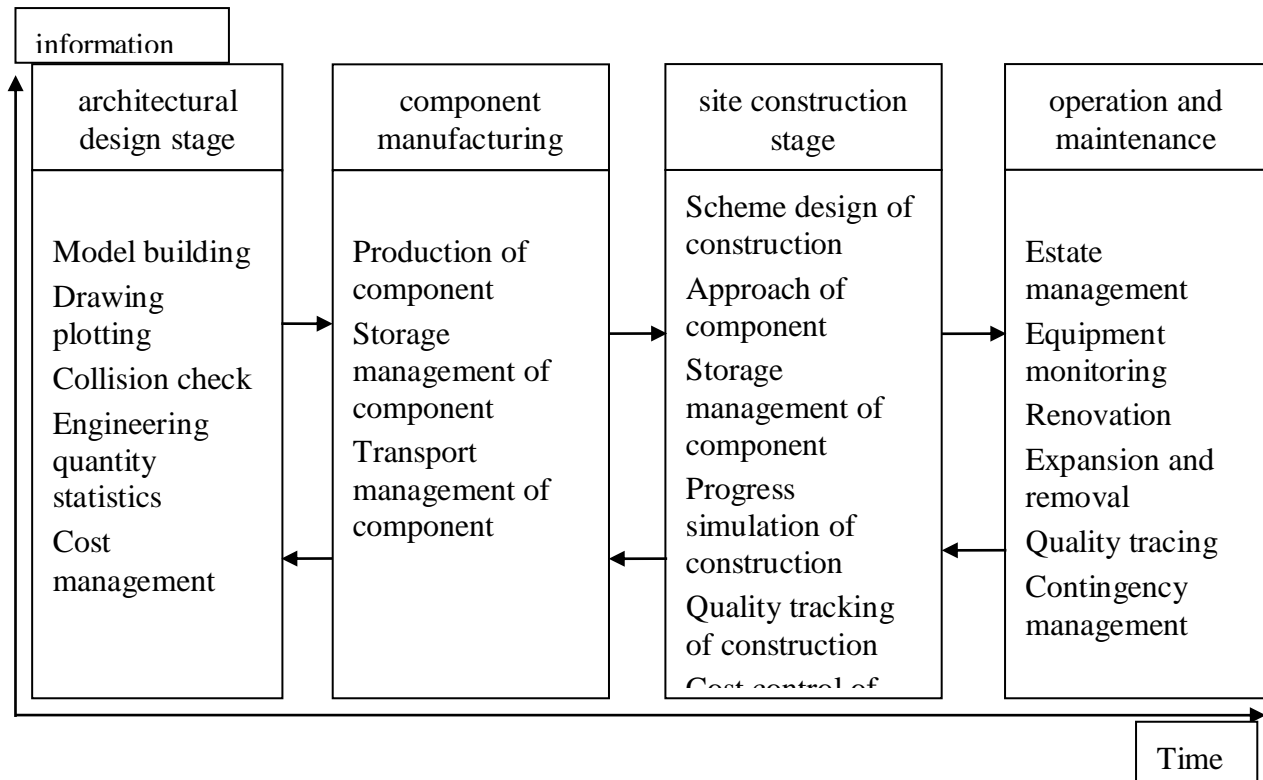


Fig. 1 the application framework of BIM technology in assembly building

## 2. Building performance analysis

Based on BIM model and combined with related building performance analysis software, it is convenient to realize the sunlight analysis, lighting analysis, heating and ventilation load, ventilation simulation, energy saving design, energy efficiency evaluation and noise analysis of construction.

## 3. Split component

At present, many projects split component in the two-dimensional drawings, but in the process of resolution, we should refer to the three-dimensional BIM model, to deepen the understanding of the structure, so as to avoid the design of the blind spot and tedious work on the map which is not easy to find on the 2D drawings, and to reduce the occurrence of errors and improve the efficiency.

## 4. Key points of collision detection on component and reinforcement

To deepen the design of prefabricated components, the purpose is to ensure that each component shipped to the construction site can be installed in accordance with the design of the program, to avoid the occurrence of "wrong, leakage, touch, lack". Using BIM technology can quickly and accurately put the potential conflict and collision in the field prior to elimination in the BIM model.<sup>[7]</sup> It is very necessary to make a collision check of steel bars, to avoid idleness and rework due to the collision of prefabricated reinforced in construction stage, to ensure project successfully completed.

## 5. Generation of drawings and engineering quantity statistics

There are a number of prefabricated component in assembling building, and the deepening of the design also have a large map. In the past, the workload of manual drawing method is very large, and it is difficult to avoid all kinds of mistakes. BIM software may meet intelligent drawing and automatically update function, to determine the corresponding work for the template of the drawings. It can automatically generate the component level, vertical profile, and component drawings.

## 4.2 Application of BIM Technology in the Component Manufacturing Stage

### 1. Component production management process

The central database of the BIM model in the PC project is to store the BIM model data of the specific engineering construction life cycle<sup>[8]</sup>. In the deepening of the design stage, all related data of the

deepening design of the component is conveyed to the BIM center database, then to complete the coding of the component; In the production of prefabricated components stage, the management subsystem of the production information may read and determine the related data of the component design from the BIM central database, as well as the basic information for the production of components. At the same time, the information and quality inspection information in the production process of prefabricated are returned and recorded in the center database; In the field construction stage, the construction scheme is simulated and optimized by BIM model. By reading the data from the central database, you can understand the specific information of prefabricated components (weight, location etc.), and it is convenient to the construction. At the same time, after the completion of the component installation, the situation of the component installation are returned and recorded in the center database.

## 2. Component transportation management

Taking into account the needs of the actual construction project management and in order to facilitate the acquisition and tracking of component information management, it needs to install the RFID chip in each component. The coding of the chip is consistent with the component coding. At the same time, the information of the chip is recorded into the BIM model. The acquisition and transmission of the PC building data in the component manufacturing, site construction phase is completed through the electronic equipment.

### 4.3 Application of BIM Technology in the Site Construction Stage

#### 1. Site construction simulation planning

PC construction has the high mechanization level, the complex construction technology, and the high security requirements, so we must coordinate with each. Therefore, before construction, the construction side can use the BIM technology to build the model to carry on the scene construction simulation, to further optimize the construction process and construction scheme, to ensure accurate positioning of components, so as to achieve high quality of the installation. The 3D model which was originally established is associated with the construction plan, and the time plan of the construction plan is recorded in the attribute of each component. Therefore, the time factor can be incorporated into the 3D model, making the fundamental 3D model can be transformed the 4D model which can simulate the field construction and hoisting management.

#### 2. The site management of prefabricated component

In the site management, combining BIM technology with RFID Technology, it can track the components in real time. When the component is in the entrance, you can set the RFID reader in the access control system.<sup>[9]</sup> When the transport vehicle's information is received, it should be immediately organized personnel to enter the field test. Confirmed the qualified and accurate information, according to the previously planned route guidance to the designated location, the component will be placed in storage requirements. Meanwhile the relevant information has been entered into the RFID chip. In the component hoisting stage, the staff members hold the reader and the display, according to the information on the display in order to carry on the lifting and assembly, so that it may complete the standard and one step in place, to improve the working efficiency.

### 4.4 Application of BIM Technology in Building Operation and Maintenance Stage

With the rapid development of the internet, the application of BIM technology in the operation and maintenance stage of assembly building also ushered in a new opportunity. In the emergency management, such as fire, through the BIM information model interface, it can automatically trigger the fire alarm, and accurately locate the location of fire, to provide important information for the timely evacuation of the crowd and the processing of the disaster.<sup>[10]</sup> The prefabricated construction and equipment maintenance, maintenance management can directly transfer relevant information of prefabricated components and equipment from a BIM model, to improve the efficiency and level of maintenance. Operation and maintenance personnel can access to stored the component quality information from the RFID label of prefabricated presupposition, and also to obtain the production

workers, transport, installation workers and construction personnel and other related information, to meet the traceability for quality of prefabricated construction and a clear attribution of responsibility.<sup>[11]</sup> By the default RFID label in prefabricated components, you can monitor, detect and analyze the energy consumption of the whole process in assembly building. Therefore, it can accurately locate the high energy consumption parts in the BIM model, and take appropriate measures to deal with it, So as to realize the green operation and maintenance management of the prefabricated construction.

## 5. Application Value of BIM Technology in the Assembly Building Design

### 1. Improve the efficiency of assembly building design

Using BIM Technology to build a shared design platform, the various professional design personnel in the assembly building design can share their good professional design information, to achieve the objective of design scheme to “synchronous” to modify. Professional designers, component split design personnel and related technology and management personnel in the assembly building project are distinguished and given different management and modification. So it can make more related technology and management professionals involved in the process of the prefabricated construction design. more professional opinions and suggestions are put forward according to the own good professional, to reduce the change of precast production process and assembling construction process, so as to reduce or avoid costs and waste of resources due to the design of the project. At the same time, it also improves the design efficiency of the assembly building, and then improves the satisfaction of the owner to the assembly building design unit.

### 2. The optimization and integration of prefabricated component production process

In order to ensure the accuracy of the information needed in the production process of prefabricated components, the prefabricated components manufacturer can directly transfer the geometric size of the precast, kinds of materials, installation location and other information from the BIM model. In the production stage, the all kinds information of prefabricated components are implanted RFID chips, using RFID technology takes control of state formation of prefabricated components, so as to improve the storage and transport efficiency of prefabricated components. Meanwhile the component production schedule information should be promptly communicated to the construction unit.

### 3. 5D construction simulation optimization construction and cost planning

In the assembly building project, BIM technology is used to add time and resources into the BIM model, to make the "3D-BIM" model translate into the "5D-BIM" model. The construction unit can use the "5D-BIM" model to simulate the use of various materials in the whole construction process, to establish "Dynamic construction planning" for assembly building<sup>[12]</sup>, so we can intuitively grasp the construction process, schedule planning and phased funding, resources, investment, etc.; We can also found the existing problems in the simulation process of the construction program, then for the problems to be fully optimized, so as to avoid the construction cost increases and schedule delays due to the consideration.

## 6. Conclusion

Application of BIM technology avoid assembly building "wrong, leakage, touch, lack" and other construction problems, to achieve the integration of assembly construction from design to operation and maintenance management, and effectively enhance the overall construction and management level of assembly. BIM technology as an important change in the development of the construction industry in twenty-first Century, will be a strong impetus to the development of assembly building, and promote the construction industry to upgrade, so as to realize the industrialization of the construction industry and information technology. However, to make the BIM technology more closely applied to the assembly building need to continue to run in practice and improve, meanwhile all the construction industry need to participate in the joint efforts of the staff.



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