Research on the Construction Efficiency Management of Prefabricated Buildings Based on BIM Virtual Modeling

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Abstract. Across the country, the government actively promotes the construction of such houses and widely uses BIM technology in prefabricated construction. The goal of this project is to use BIM technology to build virtual building models through case study, and to solve the problems of plane layout, quality, safety and schedule in the construction process. By simulating the working process of tower crane, transportation path, collision detection, construction progress and other links, it provides theoretical basis and technical support for the construction design and construction design of construction enterprises.

Keywords: BIM; virtual modeling; building information model; prefabricated building.

1 Introduction

At present, China's construction industry is still dominated by the traditional construction mode, which leads to a large number of building materials, labor force and environmental pollution problems, and has become an important factor restricting China's sustainable development [1]. In order to promote the sustainable development of China, BIM technology is introduced into every link of the whole process of engineering construction, in order to improve the speed and efficiency of construction [2]. However, due to the emergence of various problems, the overall construction quality has a certain impact on [3]. In order to solve these problems, China is gradually using the BIM virtual modeling method, to establish its three-dimensional structure based on BIM, and then to disassemble and optimize it. How to use BIM to cooperate efficiently and improve its construction speed is the current research hotspot in the construction field [4].

2 Application of BIM in building construction

2.1 Application of BIM in construction layout

In the construction site layout, the BIM simulation technology should be used to establish a scientific and reasonable mode. Through the efficient use of various available space in the site, avoid unnecessary repeated handling, to meet the needs of the site

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construction [5]. Establish a three-dimensional space plan through BIM technology to reflect the actual situation of the construction site, realize reasonable layout, and prevent the occurrence of accidents such as lifting collision. When designing the construction scheme, attention should be paid to the following aspects: reasonable layout of equipment on the site, allocating personnel, equipment and building materials according to specific requirements; optimizing the layout of living area and construction area; scientific design of the site line to adapt to the construction characteristics of prestressed concrete structure; and reasonable layout of tower cranes. Combining BIM technology and building planning, establish models of terrain, equipment, building, material placement area, temporary electricity consumption, temporary road, residential office area, etc., and make the equipment layout is comprehensively planned to prevent the collision of tower cranes and other equipment. The detailed architectural layout process is shown in Figure 1.

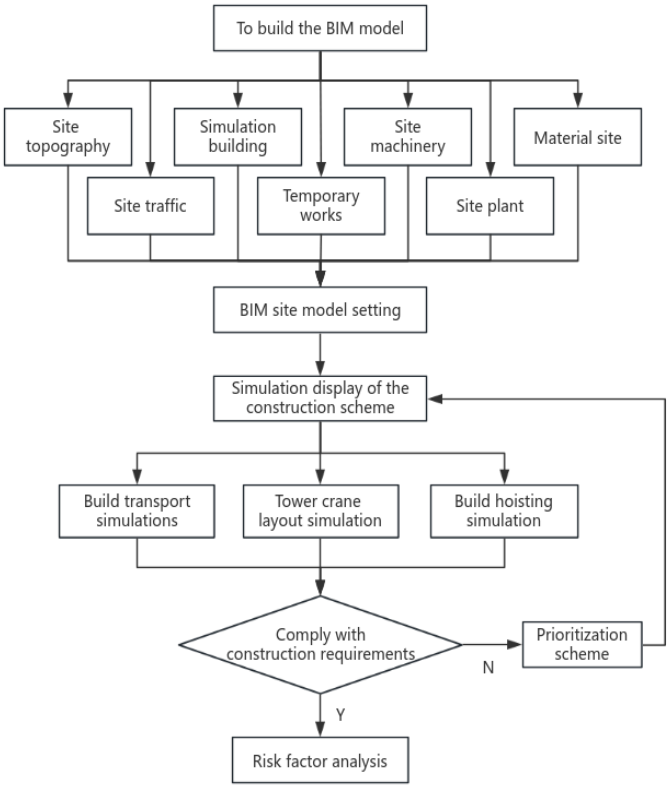

Fig. 1. Flow chart of BIM technology applied to the construction layout.

Traditional computer-aided design methods often fail to achieve the complete simulation effect, and it is difficult to find some non-standard phenomena in the building [6]. In contrast, the BIM virtual model can directly show the interconnection between

different regions, and can also clearly show the handling path and storage sites of building materials in different time periods. This helps to avoid conflicts between tower cranes and other machinery, thus improving the efficiency of site construction.

2.2 BIM technology is applied to the management of construction-related quality progress

2.2.1.Construction quality management. The BIM technology has a significant advantage in construction quality management. By comparing the requirements of construction process, process conversion, quality defects and acceptance, BIM technology can find out the quality and safety problems in the construction process, and formulate corresponding quality control countermeasures to improve the efficiency of construction quality management. The traditional review method only analyzes the problems on the drawings, while the BIM technology can help us to find the problems more accurately, so as to improve the accuracy of the audit [7]. By establishing corresponding BIM models by different professionals according to the drawings, and finally integrating these models, the differences can be found and corresponding suggestions for improvement, so as to improve work efficiency. The virtual modeling function of BIM enables the staff to directly understand the needs of the construction nodes through the model, and to avoid the unclear disclosure caused by communication problems, so as to improve the efficiency of the disclosure work [8]. Before component manufacturing, BIM technology is used to identify and prevent the possible problems in the project, improve the assembly process, and independently build the BIM model manufactured by the enterprise, to ensure that the specification, size and quality of the components meet the construction requirements. In the component manufacturing stage, the RFID tags are embedded in the BIM module using the BIM technology, so that the site workers can grasp the quality of the prefabricated parts. This topic is based on building BIM, through 3 d visualization and 3D information modeling, simulate the assembly process and detect and correct the existing problems in real time, and finally form the optimal design scheme [9] in line with the actual needs of the project. At the same time, the research is conducted from the optimization of component handling, optimization of component lifting sequence, reservation of component nodes and openings, and optimization of prefabricated parts. See Table 1.

Table 1. Member optimization design scheme

Order number	Member control	Scheme
1	Member transport	According to the location of the tower crane, the storage location of the components is designed, and the design needs to meet the transportation and installation of the components at one time.
2	Lifting order	It mainly depends on the force ability of the component.
3	Panel point	Improve the installation of design component nodes to avoid collision with steel bars during installation, and optimize the laying of water and electricity pipelines.
4	The hole reserved	Improve the location of flue and pipe Wells.
5	Embedded part	Position the position of connections and lifting points.

2.2.2.Safety and quality management. Applied BIM technology to the safety and quality control of engineering construction is an important study. Through BIM technology, risk control points, dangerous construction sites and important nodes in the construction process can be led to prevent accidents. Through 3D modeling, the safety risks existing in each construction stage can be displayed in advance, and the potential dangers can be analyzed in real time according to the project progress, and the [10] can be adjusted accordingly. In view of the safety problems generally faced by China's construction industry, this project is based on BIM technology, through BIM visual simulation technology, to identify various safety risks such as foundation pit collapse, falling from high altitude, lifting and collision, and take corresponding safety measures. This can improve the safety and quality level of the project construction. The safety facilities are shown in Figure 2.

Fig. 2. Safety facility model diagram.

2.2.3.Construction project time management. In the BIM environment, the project is a convenient and direct way. The Timeliner algorithm in Naviswork can simulate the engineering process and help us to better understand and control the project progress. The BIM technology can model, control, and optimize the for engineering projects [11]. This project adopts BIM technology, based on BIM, and adopts the project management system developed by the project manager. We use the Naviswork software, to enter the completed project document into the BIM and cluster it on each component. Then, we simulate the progress of the project through BIM technology. The final results include BIM model, simulation video, schedule and coordination data. These results can help us to better understand the actual situation of the project and improve the efficiency and accuracy of the project, as shown in Figure 3.

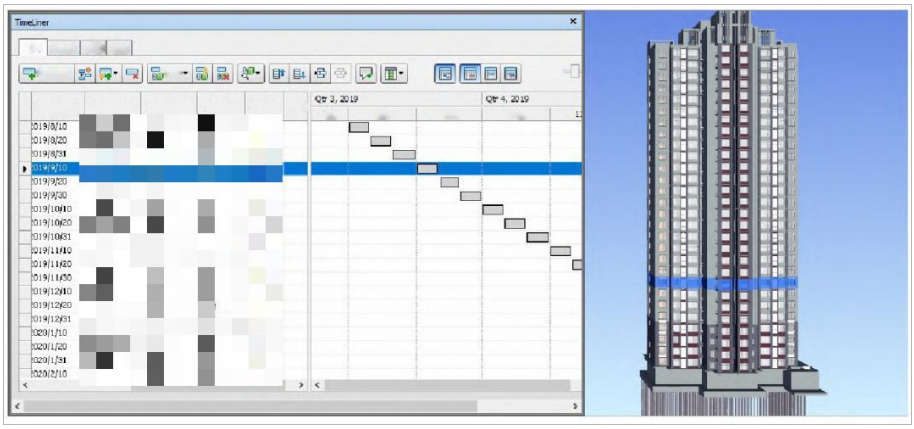

Fig. 3. Optimum construction scheme determination process.

3 Example analysis

3.1 Prefabricated building project overview and BIM virtual modeling

This study takes the development of a real estate as an example, which belongs to the prefabricated industrialization high-rise residential building, which is a typical urban residential building complex. The project includes 20 units with a construction area of about 2573262 m^2, and below 5F and above are cast-in-place structure layer and prefabricated structure standard layer respectively. PC components include laminated beam slab, prefabricated internal partition wall and prefabricated shear wall. The fire prevention is classified as high class I, the grade is Class I fire prevention; the service life is 50 years; the civil air defense project is Class A; the resistance level is nuclear civil air defense. There are many difficulties in the project, first, the poor construction among specialties is difficult; second, the electromechanical system is complex, the hoisting construction and pipeline optimization are difficult; third, the installation accuracy of PC components and the sleeve node grouting requirements are too high; fourth, the accuracy of BIM simulation should be strictly controlled; fifth, the project scale is large and the construction period is very tight; sixth, the engineering management coordination is very difficult.

On this basis, we use BIM technology to control and optimize the whole process of engineering construction. First, we built a series of class libraries using Revit software and created a PC family class. This family is designed for the true size of the construct, and based on its structural features, we created a programmable library of components. In China's building structure, the composite structure has various forms, mainly including composite plate, composite board, composite beam, exterior wall board, internal wall board and shear wall panel. In Revit, we built the BIM model based on the parameters in the design plots, as shown in Figure 4. Through this model, we can better understand and control the whole process of construction, so as to optimize the construction process and improve the construction efficiency and quality [12].

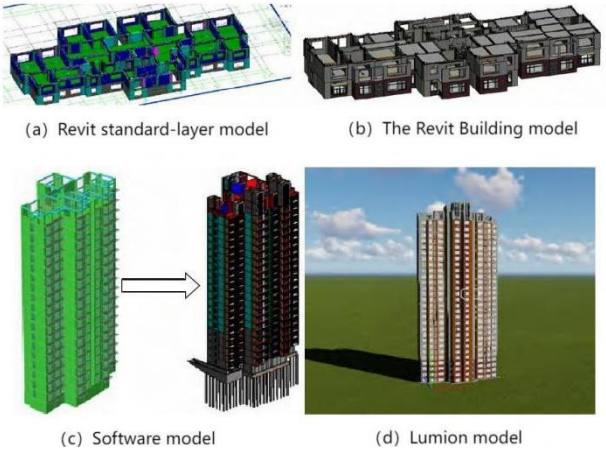

Fig. 4. Prefabricated building models.

3.2 Example analysis of construction efficiency management

3.2.1.Construction plan layout. Use the Revit program to set the site, arrange the outdoor inverted pipeline, main structure and basement top elevation, and arrange the vertical conveying equipment. Build a family library of all kinds of buildings to ensure consistent specifications and enhance the layout effect. Check component quantity, weight, formwork and concrete consumption, material and equipment delivery. BIM technology is used to carry out 3D modeling of walls, temporary roads, human and cargo elevators, tower crane layout, stacking site of components, etc. The division method is used to dynamically control the building process, such as modeling the components and pipe materials, and 3D modeling using Navisworks software. When arranging the PC parts transmission lines, consider the surrounding lines comprehensively, and use special support to prevent component damage. Comprehensively analyze the turning radius, slope and width of the temporary pavement. The construction general layout model and BIM dynamic management diagram are shown in Figure 5.

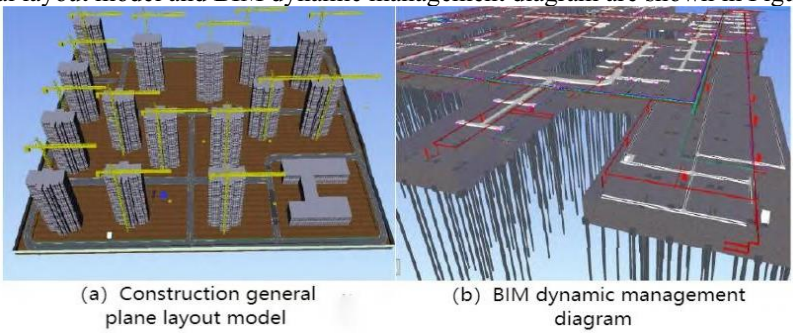

Fig. 5. Optimum construction scheme determination process.

In order to ensure the lifting capacity of the crane, each unit is equipped with a set of tower crane (QTZ6518), and each tower crane has been verified several times to ensure the rotation radius of the crane. These steps are designed to better control the construction process and improve the construction efficiency and quality.

3.2.2.Construction quality, safety and schedule management. Using BIM technology to model the project, we can analyze the irrationality in the engineering drawing and improve it to ensure that the lifting plan meets the needs of the project. Based on this, we use Revit software to integrate the models established by each disciplines and use the Navisworks software to determine the location and number of problems. The specific study content is shown in Figure 6. The research shows that the integration of the model and the building model can better realize the building simulation display, so as to better understand the key points and difficulties of the building, and ensure the quality of the building.

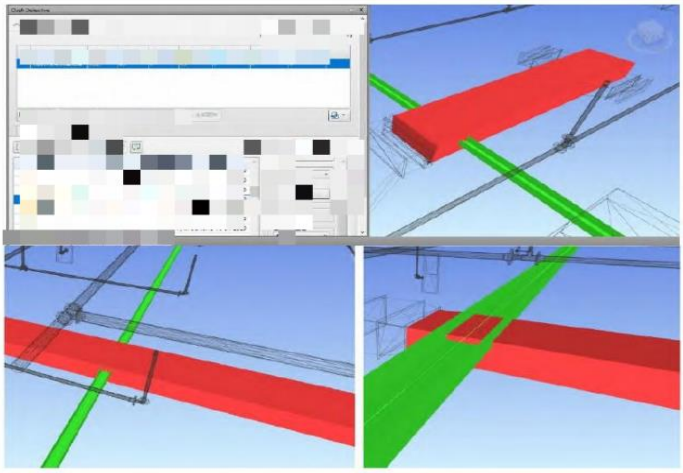

Fig. 6. Impact simulation diagram of the bridge and the air duct.

In order to solve the safety problems existing in the construction engineering, this project adopts BIM technology to provide technical guidance to the 3D virtual reality scenes and employees. Through the simulation scenario, we can find out the key security risks, and take them as the main content of the subsequent construction. On this basis, we use the assembled bracket to ensure the stability of the wall panel. Through BIM technology, we simulate the vertical ality of the stent to ensure the accuracy of its assembly and improve the rationality of its layout.

This paper proposes a project schedule planning method based on engineering examples. By analyzing the construction progress and optimization strategy of similar projects, combined with the specific situation of the current project, this method works out a more reasonable and effective construction schedule. On this basis, we dynamically optimized the whole construction process using Timeliner software. Simulation diagram of the construction progress, as shown in Figure 7.

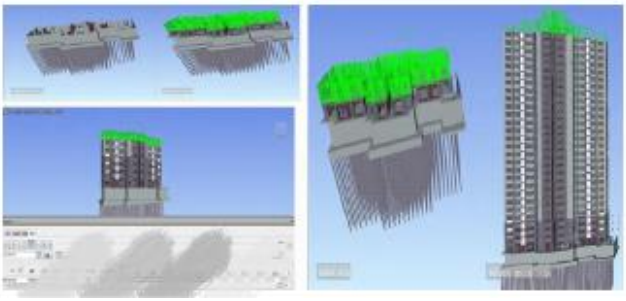

Fig. 7. Simulation diagram of the con-struction progress.

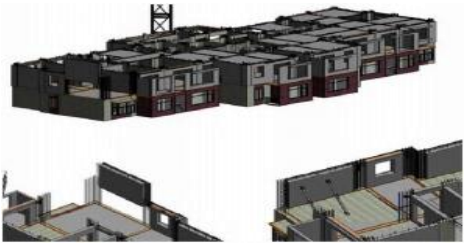

Fig. 8. Demonstration diagram of the PC component installation.

3.2.3.Construction simulation. Introduce Revit modeling into Navisworks, it can be introduced into 3D modeling and then 4D modeling. On the basis of 4D modeling, 5D modeling can be obtained by adding cost parameters. Based on the BIM project, the BIM model is used to simulate the lifting process. Through simulation, we can find the problems in the process of prefabrication and propose corresponding solutions. In addition, we also use three-dimensional visualization technology to disclose the problems in the lifting process, so that the relevant personnel can more intuitively understand the problem, so as to better solve the problem. See Figure 8 for the installation demonstration diagram of PC components.

4 Conclusion

This topic studies prefabricated buildings in China and adopts the virtual modeling method of BIM. The results show that combining the building model with the building model can better realize the simulation display of BIM building, help understand the key and difficult points and difficulties of the building, so as to ensure the quality of the building. At the same time, BIM technology is used to simulate the vertical adjustment of each rod, which ensures the assembly accuracy of each rod, and improves the rationality of the diagonal support positioning of each rod. In addition, the BIM simulation method can be used to find potential problems in real time, and make 3D visualization technology disclosure through BIM to provide reference for subsequent engineering construction.

Acknowledgments

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