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Application of BIM Technology in Prefabricated Green Building Construction Management

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Abstract:

Increasing the research on BIM Technology of prefabricated energy-saving green building construction can promote the process of prefabricated green construction in the construction industry. Firstly, this paper analyzes the characteristics of prefabricated housing and BIM green construction. Secondly, BIM Technology is applied to the design and processing of prefabricated components in prefabricated residential design. In this paper, a family library of prefabricated components is established, which can improve the design accuracy of prefabricated components and assist to realize lean production. BIM Technology improves the design efficiency from four aspects: preliminary planning, scheme design, scheme deepening and collaborative design. Combined with the relevant characteristics of BIM Technology, this paper discusses the role of BIM Technology in the first two aspects of prefabricated residential green construction. The test results show that the application of BIM Technology in the design and construction of prefabricated housing can not only improve the design efficiency, but also greatly improve the green construction of buildings.

Keywords: *BIM Technology, Prefabricated Building, Green Construction Management, Prefabricated Components.*

I. INTRODUCTION

BIM (building information modeling) is the abbreviation of building information model. With the help of the rapid development of computer technology, BIM has brought changes to the construction industry. BIM Technology can shorten the cycle of architectural design and improve the quality of engineering design through its own collaborative platform, which has a broad prospect in the industry. BIM is proposed by Professor chuck Eastman of the United States. He thinks that in the future, we can simulate real buildings through computer virtual, and this system is named building description system. In 1986, Robert ash, an American scholar, put forward the concept of building modeling. Soon after that, the concept of building information modeling was put forward [1-2]. BIM is a digital technology originated from the construction industry with the human entering the information age. It simulates the real information of buildings through digital information simulation. BIM refers to not only geometric information of length, width and height, but also non geometric information, such as fire resistance rating, heat transfer coefficient, cost of components, procurement information, etc. [3]. It analyzes the functional relationship and physical characteristics of the building in the form of digital model, and presents the building in the virtual

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environment, so as to create more accurate architectural drawings, better guide the construction and improve the construction quality.

BIM Technology is applied to the design and construction of prefabricated housing. The parameters of components are set in BIM software, the model is established, and the standardized component library is formed. According to the needs, it is matched, and combined with the building water and electricity model to form the final residential model. On the one hand, the establishment of parametric model is conducive to improve the efficiency of modeling, on the other hand, it can carry out virtual building construction, check the problems that may occur in the construction process in advance, so as not to affect the construction progress.

II. APPLICATION OF BIM TECHNOLOGY IN THE DESIGN OF PREFABRICATED HOUSE

2.1 The influence of BIM Technology on the thinking mode of architectural design

In the era of CAD, 2D drawings are used to explain 3D architecture, which is prone to errors in the process of transformation. With the improvement of design level and the increase of construction project complexity, this situation is becoming more and more serious. BIM provides an innovative design tool for the construction industry, and brings great changes in the construction industry [4-5]. Under BIM Technology, all participants in the project can work on the same platform and exchange information, which solves the problem of poor cooperation of various disciplines under the traditional mode. BIM will bring the second revolution to the design industry after CAD, and it will play a role in the whole life cycle of construction engineering

The American buildingSMART Alliance summarized 25 kinds of BIM applications in each stage of the whole life cycle of buildings. It can be seen from this that in the early stage of the project, using BIM technology to coordinate the whole project can improve its economic, social and environmental benefits [6]; The application of BIM in the design stage can not only meet the basic design function requirements of buildings, but also play a huge role in improving their quality and controlling the construction cost [7]; The application of BIM technology by the construction unit can control the project progress and improve the construction quality; After the project is completed and put into use, BIM can monitor relevant data and give feedback, so that the building can better serve the owners [8].

BIM has great value advantages in controlling the design quality of buildings, managing the project cost and adjusting the construction period. According to the statistical analysis of 32 BIM projects conducted by the center for integration of Facility Engineering (cife) of Stanford University, the specific BIM benefits are as follows:

(1) Reduce project change by 40% and control construction budget;
(2) Improve the accuracy of cost estimation and reduce the error to 3%;
(3) The time of cost estimation is reduced by 80%;
(4) Collision inspection reduces design errors and saves 10% of contract cost;
(5) The average construction period is shortened by more than 7%.

2.2 Key links of prefabricated housing design

Modularization is conducive to unifying the order of housing industrialization, Promoting Standardized housing development and component production, and is the basis and key to the promotion of prefabricated

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housing. The international modular sequence is arranged by using the differential mathematical theory, with M = 100 as the basic value, 2M and 3M series of expanded modules upward, and M / 2, M / 5 and M / 10 series of sub modules downward. It is recognized as a highly coordinated modular system.

The modular network can be divided into architectural modular network and structural modular network, as shown in Figure 1. The architectural modular network coordinates the organization of architectural space, and the structural modular network provides the basis for the unification of structural forms. Building modulus network and structural modulus network can be a set of modulus system or two different systems, which depends on whether the function of building space division is consistent with the load-bearing function of the structure.

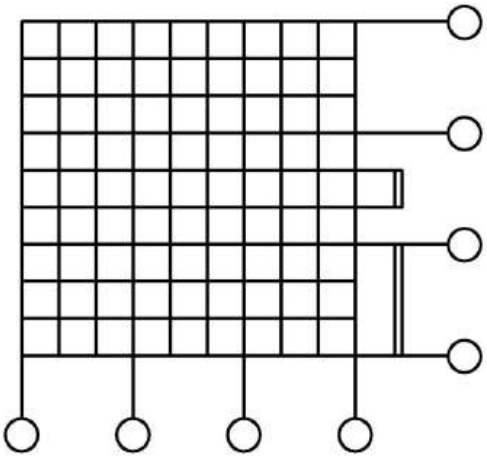

Fig 1: Architectural modulus network and structural modulus network

In order to realize the industrialization of prefabricated housing, the determination of component module is particularly important. There are many factors that determine the module of prefabricated housing, including residential scale, structure selection and construction technology. Residential scale is the basic unit of measurement in building system. As the basis of architectural design, it is determined by common building components and building size. Bay and depth as the most important residential scale, they have largely determined the scale of the building, the main structure selection is also based on this.

III. APPLICATION OF BIM TECHNOLOGY IN GREEN CONSTRUCTION OF PREFABRICATED HOUSE

3.1 Energy saving and utilization of prefabricated residential resources based on BIM Technology

The bill of quantities is a detailed list showing the names and corresponding quantities of divisional and subdivisional works, measure items and other items of the proposed project. The bill of quantities shall be prepared by the bidding unit under the unified calculation rules according to the construction drawings and the actual situation of the project. The bidding unit starts from itself and fills in the quotation item by item under the condition of comprehensive engineering practice, market price and enterprise strength. Through the bill of quantities to standardize the whole process of engineering practice, the bidding, project contract and completion settlement are based on, and the separation of quantity and price is realized.

Using BIM Technology to assist the design and construction of prefabricated house is helpful to improve the accuracy of bill of quantities. Starting from the design of prefabricated housing, BIM model is established on the platform of Autodesk Revit, and with the gradual deepening of the project, a complete

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project model is finally formed. The model includes the building materials, prices and quantities in the early stage of the project and the construction process. It is a parametric model, through which the construction quantities can be directly summarized and the bill of quantities can be generated. When the project changes, modify the model directly, and the bill of quantities will be updated. As shown in Figure 2, the bill of quantities of a prefabricated villa produced by Revit can clearly show the summary of building information such as building area, walls, doors and windows. On this basis, the project cost management department can regulate the pricing behavior, and provide the social average scale of resource and energy consumption for construction enterprises, so as to avoid the blindness of construction enterprises in the use of resources, reduce unnecessary waste, and realize green construction.

Fig 2: Bill of quantities of a prefabricated villa project

3.2 Simulation of prefabricated housing construction scheme

In the era of two-dimensional design, it is difficult to identify the design conflicts between architectural specialties on the drawings. When the construction is carried out to a certain stage, it is too late to find out, so it is necessary to correct the errors and then re construct, resulting in waste. Under the unified BIM platform, all specialties cooperate with each other in the design stage, and the design conflicts can be corrected in time to avoid bringing design errors into the construction. This not only improves the design efficiency, but also greatly speeds up the construction progress, and avoids the waste of construction materials caused by design errors. Using BIM Technology to simulate the construction scheme can optimize the construction scheme. With the help of BIM software, the project construction schedule can be added to the model as the fourth dimension, so as to dynamically analyze the construction process and simulate the site conditions.

With the support of BIM Technology, the traditional paper construction drawing is replaced by virtual 3D model. The construction personnel can simulate the construction scheme with the help of the model, and determine the optimal construction scheme on the computer by adjusting the BIM model. In this way, the traditional construction method experiment is avoided, the manpower, material and financial resources are saved, the engineering quality is improved to a higher level, and the rework caused by construction errors is reduced. During the disclosure of the construction scheme, the construction scheme is displayed to the workers through the three-dimensional BIM model, which is convenient for them to understand and improve the quality and safety of the construction. As shown in Figure 3, the construction scheme of cantilever scaffold is given, which is visual.

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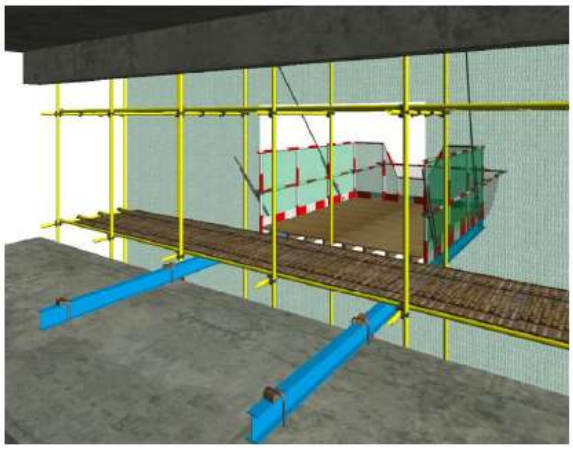

Fig 3: Construction Scheme Simulation

IV. APPLICATION OF BIM TECHNOLOGY IN DESIGN AND CONSTRUCTION OF PREFABRICATED HOUSING

4.1 BIM provides production information of prefabricated components

The BIM model completed in the design phase contains all the information of the building, and the processing information of the prefabricated components can be directly extracted from the model, which ensures the accuracy of the component data transmission and makes the lean production of the component factory truly realized. The prefabricated component factory splits the required components from the BIM model, deepens them according to the production requirements, and then transfers them to the structural designer for structural design and verification with the help of the collaborative platform. After the final design, the prefabricated component factory can use the BIM to estimate its cost. BIM model can directly export 2D construction drawings to guide factory to process prefabricated components. BIM can automatically generate the mold of prefabricated components, summarize the production resources and make the factory production plan, control the quality of components, and improve many disadvantages of the traditional production mode of prefabricated components. By embedding the RFID chip into the prefabricated components, the numbering and positioning of components are realized, which is convenient for the subsequent construction and fixed-point hoisting. At the same time, the whole life cycle information management of components from production to construction to later operation and maintenance is achieved. Taking the prefabricated stairs of Zhijiang Chengpin 13-2 building as an example, the two-dimensional design drawings of stair components are derived from BIM model, which are submitted to the factory for detailed design and production. The actual components are shown in Figure 4.

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Fig 4: Hoisting of prefabricated stairs of no.13-2 building of Zhijiang Chengpin

4.2 Collision inspection to eliminate design errors in advance

With the help of BIM 3D visualization technology, not only can the building form be viewed in the macro, but also the connection and combination of a certain construction node can be analyzed in micro level. After the model is built, the reinforcement configuration of the component can be viewed even from it. The prefabricated components are processed and produced in the factory, and the quality of the components is guaranteed. The collision occurs between different components during construction and installation. There are usually more reinforcement at the joint of components. Once collision occurs, it will bring great trouble to the construction. The problem should be solved at the construction site as far as possible, and it is not allowed to return to the factory for modification. After BIM model building 13-2 of Zhijiang Chengpin was built, Tekla structures was used to carry out collision detection. BIM lists the details of collision parts in the model in the manager. Click to view the type, component and code of each collision object. The collision entity in BIM model is highlighted, which is convenient for designers to modify. After collision detection, it is found that 14 "steel bar fights" appeared in the design of jiangchengpin 13-2 building. According to the test results, BIM model was modified to avoid model error brought into construction and reduced the loss. As shown in Figure 5, the collision of reinforcement occurred at the joint of beam and column, which was avoided after later modification.

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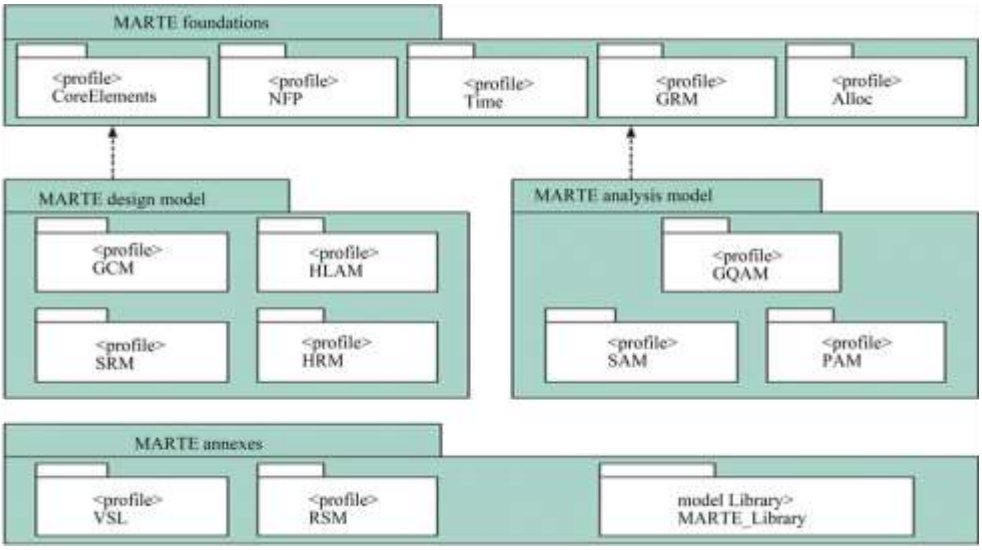

Fig 5: Analysis on collision inspection of Zhijiang Chengpin no.13-2 building

V. CONCLUSION

This paper takes prefabricated house as the research object, introduces BIM Technology in its design and construction process, discusses the application of Bim in the whole process of prefabricated house design and construction, and reveals the digital design thinking for the construction industry by combining with the example of Zhijiang Chengpin building 13-2

1. With the support of BIM Technology, design enterprises can establish their own prefabricated residential model library and corresponding prefabricated component product library, and directly select standardized products from them when carrying out residential design. The degree of standardization is improved, the design errors are reduced, the drawing efficiency is improved, and it is conducive to the factory processing and field installation of components.

2. BIM Technology brings the thinking mode of digital architecture, which provides a collaborative platform to connect all participants of the project and facilitate timely exchange of information. The application of collision inspection eliminates the design errors and reduces the engineering rework, which is an important contribution of BIM Technology to the realization of green construction.

3. The comprehensive evaluation of green construction is mainly carried out from three aspects: the conservation and utilization of resources and energy, the comprehensive management of green construction, and the impact of construction on the environment. BIM Technology can generate the bill of quantities of residential buildings, count the material consumption of construction sites, reasonably allocate construction materials, formulate accurate procurement plan, control the construction cost from three aspects of construction preparation, construction process and completion settlement, and save resources and energy in construction. Through BIM model, the construction scheme can be simulated in advance to control the progress of the project. BIM can simulate the layout scheme of scaffold, which is convenient for safety disclosure to construction personnel.

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REFERENCES

[1] Zheng, R., Jiang, J., Hao, X., Ren, W., Xiong, F., & Ren, Y., (2019). BcBIM: a blockchain-based big data model for bim modification audit and provenance in mobile cloud. Mathematical Problems in Engineering, 2019, 1-13.

[2] Hu, Z. Z., Tian, P. L., Li, S. W., & Zhang, J. P., (2017). BIM-based integrated delivery technologies for intelligent mep management in the operation and maintenance phase. Advances in Engineering Software, S0965997817302533.

[3] Karan, E. P., Irizarry, J., & Haymaker, J., (2016). BIM and GIS integration and interoperability based on semantic web technology. Journal of Computing in Civil Engineering, 30(3), 04015043.

[4] Zhang, J., (2020). Interaction design research based on large data rule mining and blockchain communication technology. Soft Computing(5).

[5] Peng, Y., Lin, J. R., Zhang, J. P., & Hu, Z. Z., (2017). A hybrid data mining approach on BIM-based building operation and maintenance. Building and Environment, 126(dec.), 483-495.

[6] Lee, S. I., Bae, J. S., & Cho, Y. S., (2012). Efficiency analysis of set-based design with structural building information modeling (s-BIM) on high-rise building structures. Automation in construction, 23(May), p.20-32.

[7] Diao, Y., Kato, S., & Hiyama, K., (2011). Development of an optimal design aid system based on building information modeling. Building Simulation, 4(4), 315-320.

[8] Fortino, G., Messina, F., Rosaci, D., & Sarne, G. M. L., (2019). Using blockchain in a reputation-based model for grouping agents in the internet of things. IEEE Transactions on Engineering Management, PP(99), 1-13.