Application of BIM Technology in Prefabricated Housing Design

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Abstract. BIM technology applied to the architectural design industry builds a more efficient and scientific building structure model. BIM also improves the design quality of construction projects and ensures the safety and efficiency of building construction. According to the actual situation of a prefabricated residential project, this paper analyzes the BIM design and combination of architecture, structure and equipment on the basis of module system, and puts forward collaborative design and house type split mode. The target is to provide reliable reference for BIM design of similar projects.

1 Introduction

Nowadays, the scale of construction industrialization is expanding day by day, and the requirement of building informatization level is higher and higher. The application of BIM technology has become an inevitable trend to adapt to the follow-up development of construction industrialization. If the construction industrialization can be fully combined with Building Information Model (BIM) technology, they can complement each other and make the design achieve reasonable combination.

2 The function of BIM technology

2.1 Model integration

Using BIM Technology, architectural designers can quantify the data and information in the whole process of building structure design, elaborate the parameters of each engineering design unit, and summarize the data information to build a data information model covering the elements of building structure. The BIM model integration can realize the accurate display of the position and relationship of all the components in the building structure, such as the important supporting components such as walls, columns, beams, and so on. It can truly and accurately reflect the specific structural characteristics of the building design, and can also use the physical information processing technology in the design system to conduct dynamic simulation analysis of the design results. Using BIM Technology, architectural designers can more intuitively and comprehensively understand the specific situation of the building structure, more accurately predict and judge the effect of architectural design, avoid mistakes in the design of building structure, and prevent safety accidents in the process of building construction.

2.2 Parameter editing

The core of BIM Technology is to build the model database of building structure. The quantitative parameters formed in the process of building structure design are the model database. Therefore, editing and forming building structure model parameters has become one of the important functions of BIM Technology. In the process of parameter editing of the model database, it is necessary to ensure that the building engineering model and the structural entity can be accurately one-to-one, so as to help the architectural designers to use the architectural design model more conveniently and quickly. Thus, the actual construction of the building is consistent with the design scheme.

3 Modulus system

A public rental housing prefabricated residential project has 18 floors above the ground, with a storey height of 3m, a total building height of 56m.

In this design, first of all, the size characteristics of the components determine the appropriate basic modulus in combination with the human activity space. It is taken as the main reference basis for component size, bay depth, floor height and elevation design, so as to ensure the rationality of the size and achieve the optimal size matching. Then, the construction cost and energy saving should be considered to make the layout of the building meet the rules as far as possible, so as to reduce or avoid the concave convex change[1].

The plane grid of the project is divided into 600mm × 600 mm, and some positions can be modified according to the actual situation. In order to fully show the characteristics of modular design, the modular grid is also divided in the process of facade design. Except for window openings, other materials are staggered by 600mm×3000mm with two kinds of coatings, which can

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further highlight industrialization and modularization on the basis of rich appearance, as shown in Figure 1.

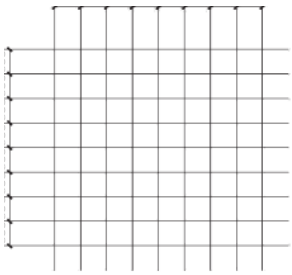

Fig. 1. Plane modular grid

4 Design of prefabricated house based on BIM

4.1 Architecture

4.1.1 House type design

According to the characteristics and functional requirements, combined with the project construction cost and industrial production requirements, based on standardized design, kitchen and toilet are designed according to modular and standardized concepts, so as to ensure the universality. According to the scheme proposed by the designer, the standardized model with reasonable size is selected from BIM module library for toilet and kitchen, and the parts layout that can meet the requirements of integrated production is used in the part library. In addition, according to the actual needs, make appropriate adjustment until the requirements of the house type assembly are met[2].

BIM is adopted based on the design technology of house type, the component modules of the house type are selected from the function module library, including the hall, bedroom and living room. On this basis, it is added with the modules of toilet and kitchen, strictly following the basic principle of module coordination, and dealing with the problems of interface between modules. According to the specific situation of the project, three house types are obtained as shown in Figure 2. The total building area of type A is 45m2, which is small, with one room, one hall and one bathroom, which is suitable for single people or couples. The total building area of type B is 60m2, which is large type, with two rooms, two halls and one bathroom, which is mainly suitable for families of two generations.

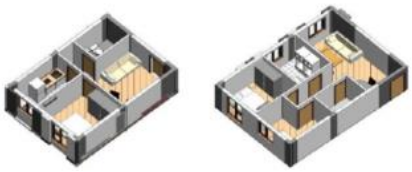

Fig.2. Module of standard house type

4.1.2 Graphic design

The building plan includes the modules of house type, corridor, traffic core, lobby and machine room. On the basis of the above three types of units, the necessary modules other than the house types are selected according to the combination requirements in the BIM model library. On the basis of size optimization and modulus coordination, the plane is combined in a variety of ways. The plane layout should be determined after comprehensive consideration of the nature, region, ventilation and lighting of the building, and the location and size of different functional modules should be coordinated to ensure the appropriate stress of the structure, so as to realize serialization and standardization of various prefabricated components[3].

According to the nature of the project, the plane layout should be as regular as possible to reduce concave and convex changes. Because of its relatively small house type, it has obvious economic applicability. Therefore, in terms of plane layout, internal corridor and point type are the main forms. In view of this, three schemes shown in Figure 3 are proposed.

In Figure 3, scheme 1 is a point type plane layout, which has significant advantages in land resource utilization rate and the number of households, but it will sacrifice certain lighting and ventilation. Scheme 2 are both inner corridor type layout, scheme 2 adopts a zigzag inner corridor. For the interior corridor layout, it has significant advantages in the depth and traffic area of the house type, but the ventilation and lighting effect of some house types is relatively poor due to the orientation problem[4].

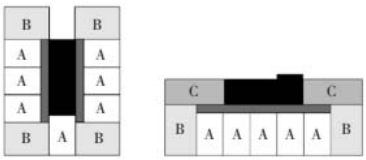

Fig.3. Plane layout scheme

According to the main characteristics of the project, based on the background of housing industrialization, considering the different economic and technical indicators comprehensively, the plan 2 is decided as the plane layout. According to the characteristics of the above three types of units, designers select other modules in the model library, including lobby, corridor and traffic core, so as to carry out plane assembly of machine room, first floor and standard floor.

4.2 Structure specialty

First of all, based on the basic unit type module, the designers carry out the preliminary layout of the components in the house type according to their own design experience, such as floor, shear wall, column and coupling beam. The corresponding structural model of different house types is preliminarily designed. Because there are different combinations of structural components in a house type, a house type often corresponds to several structural units.

In this regard, designers should fully combine the preliminary design results, select the modules as close as

possible in the house type library, and make necessary optimization and adjustment, so as to obtain the structural house types corresponding to different house types one by one, as shown in Figure 4.

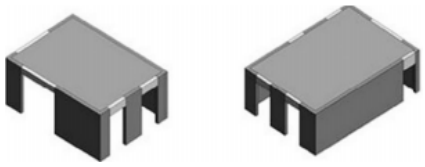

Fig.4. Structural unit type module

It is basically the same as the process of plane assembly. Designers first select other structural modules in the model library by selecting the house type, and then combine the structural unit types according to the plane layout to form the structural model of the floor. According to the overlapping interface of different modules, a re closing component can be deleted to ensure the perfect docking between modules[6].

The 2-18 floors above the ground of the project are all standard floors. During the overall structural design process, the structural model can be established by copying method, and the structural model can be partially adjusted to obtain the structural model of 1 floor above ground. Then considering the machine room model, the whole structure model is obtained by vertical assembly. Whether the model is reasonable or not needs further analysis.

The cross-sections of the components used in the project are relatively regular, and the structural model can be input into BIM software by using software interface program to complete the analysis and calculation without manual calculation. When the calculation results meet the design requirements, the follow-up design work is started. If the calculation results can not meet the requirements, it will return to the structural model, make appropriate modifications and adjustments to the model, and input it to the software for re calculation until the requirements are met.

4.3 Equipment specialty

For the equipment specialty of the project, the standardized design includes two parts: water heating and electrical, and modular design can also be adopted. Based on the above three types of units, the building's water heating model can also be divided into three types.

In the assembly design of the equipment model, the process and architecture are similar to the structure. Firstly, based on the house type, select MEP from the equipment library, and then put it into the model to adjust the specific position of the equipment and pipeline to make it match the house type well. After the plumbing model of each house type in a standard floor is placed, BIM software is used to draw the public area equipment model, including the riser position, fire hydrant pipe and each household pipeline. After that, the horizontal pipes between different floors are connected, and the riser is drawn at the appropriate position to connect the pipeline system of different floors,

The electrical model design of the project is relatively complex, which shows that there are many embedded parts. In the design process, the accuracy of all embedded reserved specific positions should be ensured to meet the basic needs of residents. The reserved line should be mainly soft connection at the connection part of prefabricated structure components and house type module.

4.4 Collaborative design

For the collaborative design of each specialty, it can be divided into real-time collaboration and late collaboration. Considering that the standardized design of prefabricated housing project has certain particularity, it is basically impossible to achieve real-time collaboration, so the future collaboration is the main, and BIM platform is used to implement coordination and optimization for the overall model. After forming the overall model through standardized design, the above specialties input it into works manager to start the model integration. At this time, the overall and detailed structure of the model can be observed intuitively. The cooperation of different specialties can check the errors of design model. In addition, the collision detection function of the software is used to check the collision between different disciplines, and adjust it according to the actual situation, so as to prevent the delay in the construction and increase the cost.

4.5 House type split

Professional software is used to repeatedly calculate and analyze the overall structure model. After obtaining the model meeting the design requirements, based on different structural models, the prefabricated part and the cast-in-place part of the house type are determined according to the splitting rules. The first mock exam is based on the size of prefabricated components and the reinforcement information is used to select suitable components in the component library. Then, the connection structure between the components is optimized according to the design conditions, and the layout and layout of the reinforcement are adjusted appropriately, and the number and location of the embedded parts are adjusted. For example, for structural house type B, it can be divided into internal and external wall panels, floors, beams and other parts. After splitting, the corresponding components are selected from the component library to implement deepening and production.

5 Conclusion

It is an important basis for the design of prefabricated housing projects to build a model that integrates component data and prefabricated components with BIM software. For the current construction industrialization, the modular and standardized requirements of building components and components can create good conditions for the introduction of BIM in the design process of prefabricated housing. The full combination of building

industrialization and BIM Technology can make the advantages of both complement each other and make the design realize the combination of building blocks.

As the most popular topic in construction industry research, BIM and housing industrialization will get faster development in a long time in the future. The application of BIM in the design of prefabricated housing can give full play to the advantages of BIM technology and form the standard system of prefabricated housing as soon as possible.

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