Research on Comprehensive Application of BIM in Green Construction of Prefabricated Buildings

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Abstract—In the process of sustainable development of the construction industry, green construction is an important means. However, in the application and development of prefabricated buildings, the design of green construction evaluation standards is not obvious enough, and there are even problems such as vertical division of the whole process. Based on previous work experience, this article summarizes the content of the comprehensive application of BIM in green construction of prefabricated buildings. The author discusses the specific application of BIM in the construction of prefabricated green buildings from four aspects: application in scheme optimization design, application in construction layout, application in construction management, and energy saving and control cost.

1. INTRODUCTION
The prefabricated green construction work is mainly based on the green concept. With the help of prefabricated assembly form, it can not only avoid the impact of the construction process on the surrounding environment, but also ensure the effective conservation of project construction resources. At this stage, the prefabricated building green construction method is widely used in the housing construction system, but it is not common in the construction of municipal water works. This is mainly due to the fact that the carrier of the municipal water engineering project itself has a strong particularity, and the actual structural water tightness requirements are extremely high, which increases the difficulty of the main construction. For this reason, in the subsequent operation project, the manager should ensure the optimal design of the BIM technical solution.

2. PROJECT OVERVIEW
In order to strengthen the pertinence of the research, this paper uses the target of a sewage treatment plant's upgrading and renovation project to understand the situation of underground sewage treatment facilities, and sets up an underground two-story structure system. Among them, the upper structure is an empty box structure, acting as a patrol operation layer. The lower structure design is mainly based on the pool structure, which is on the top of the concrete empty box, and the depth of soil covering is between 0.5 and 2.0m. Comprehensive greening operations are implemented to realize the in-depth design of the green landscape. Otherwise, the main content involved in the actual structural design includes biological response systems, high-efficiency response systems, etc., as well as pump rooms and power distribution rooms. For the execution of foundation pit excavation, the total area is about 150,000 square meters, the length is about 289m, and the depth of foundation pit excavation is about 12.8m. In the actual implementation of green construction of prefabricated buildings, relevant staff need to use the upper box as the implementation part of the assembly plan according to the specific underground sewage plant structure and its own application function characteristics. In the design of
outer walls and columns, the most commonly used form is cast-in-place, and the beam-slab form is a laminated beam version. The most important thing is that the manager should ensure that the connection between the pool wall and the ceiling is wet. In actual construction hoisting, the weight of a single component cannot exceed 5t, which creates favorable conditions for subsequent transportation and hoisting operations. Due to the large load on the roof, the design of the secondary beam should be based on the horizontal design. This allows the prefabricated slab and the beam to always be in an overlapped state, and then the prefabricated structure can be established with the help of post-cast laminated layers [1].

3. OVERVIEW OF BIM COMPREHENSIVE APPLICATION IN GREEN CONSTRUCTION OF PREFABRICATED BUILDINGS

3.1 BIM Related Software and its Technical Content
With the gradual update of modern engineering technology, a larger span has appeared in the level of building structure development. It can be seen from the building structure design and analysis software that it can also be upgraded and updated. In this process, BNIM software can present powerful structural design and analysis functions, which has been recognized by more construction workers. Otherwise, in the application of BIM software to perform structural design and analysis, the analysis effect presented is not achieved by other structural software. BIM software can not only carry out structural design, but also carry out architectural design, truly digital integration. Moreover, a full interaction of "two-way information" can be achieved between the two. To this end, people can build the BIM building model as a basis, and use various analysis software to reasonably apply structural components such as steel bars. In this way, the overall optimization of the structural design can be ensured.

3.2 Overview of Green Construction
Several industries have contributed to the essential improvement of human living standards, which has also led to a significant increase in resource consumption and ultimately caused great damage to the environment. From the perspective of the development of my country's construction industry, the extensive management mode was mainly used before. This will cause serious environmental pollution and extremely low material utilization. Therefore, the development model of the entire construction industry should be fully innovated. In the actual implementation of green construction technology, it is necessary to save energy and resource consumption, avoid serious pollution to the surrounding environment, and reduce the rate of construction errors. In general, green construction is not a new form of construction technology, it is mainly an extension of traditional methods. In the actual construction process, relevant staff need to use this technology to make environmental pollution control work procedures more complete.

In general, if you want to truly realize green construction, the staff can start from the following aspects. Firstly, the staff should establish a new comprehensive construction management decision. Especially in the whole life cycle of the project, the specific work plan should be designed, the construction, cost and other requirements should be presented, and the schedule, safety and other factors should be fully managed. Secondly, the staff needs to develop a more targeted construction plan. Due to the special characteristics of green construction itself, different construction plans must be designed for different projects. Thirdly, the staff should clarify the key points of the project construction, with the aim of saving resources and protecting the environment, and avoid the overall goal of green construction being affected. Fourth, each management and staff need to perform their duties, improve the work plan in the project node, and improve the target responsibility system. To show the completion of green construction, the staff should establish a complete evaluation system to clarify the effectiveness of resource conservation and environmental protection. This will help maintain the standardized operation of green construction [2].
3.3 The Relationship Between Prefabricated Buildings, BIM and Green Construction

The prefabricated building mainly realizes the on-site installation and splicing operation of PC components. For node processing, the main application is the cast-in-place wet connection. From the perspective of actual work, the prefabricated building construction mainly involves two stages. The first stage is the production of PC components. The second stage is the transportation of PC components, which perform corresponding installation and lap operations after arriving at the site. What’s more, in order to ensure the labeling of prefabricated residential units and accessories, relevant companies have to establish a library of prefabricated components and prefabricated units to reduce the error rate of design projects. In contrast, there are many similarities between prefabricated buildings and BIM technology. People can use BIM technology in prefabricated buildings to show the role of each other. For example, managers can set specific prefabricated component family libraries in the BIM model. When working, people can directly choose a design plan from it. When the design work is completed, the main component information includes material category, specific size, etc., and 3D visualization technology can also be applied to component design.

The industrialization development of prefabricated buildings is mainly based on the standardized construction of component family libraries. The entire green construction content should also be effectively implemented in the design of prefabricated houses. This is also an important part of green buildings. In the actual green development of residential industrialization, all resources should be recycled. Only in this way can it be regarded as green construction. In general, BIM, prefabricated buildings and green construction belong to a closed chain, and the final carrier is prefabricated buildings. It needs to be applied to BIM technology in the actual architectural design to point out the direction for subsequent green construction operations, and finally get the prefabricated building content. It can also be seen from this that prefabricated buildings are carriers. While BIM design is a specific method and means, green construction is an important promotion condition for the implementation of results. The specific relationship diagram is shown in Figure 1.

![Figure 1. Green Construction Overall Framework](image)

4. Research on Green Construction Process of Prefabricated Building

To show the green construction effect of prefabricated buildings, relevant staff need to start from the specific construction links and construction process, and systematically study its memory. This helps to determine the specific construction rules and characteristics of prefabricated buildings, and clarify the specific factors that affect prefabricated green construction. Furthermore, the application of BIM technology to carry out technical simulation of construction process is also a prerequisite for green construction of prefabricated buildings [3].

4.1 Energy Saving

In contrast, the construction industry is large in scale and involves a wide range, and its energy consumption ranks first among all industries. Relevant data shows that current building consumption accounts for one-third of the country's total energy consumption. With the acceleration of urbanization, consumption in the construction sector is still on the rise. In this process, the level of relevant
supervision and green construction implementation is not high. Some construction units also meet their own development needs at the cost of wasting energy. This leads to unreasonable consumption of energy, a long production cycle and far insufficient comprehensive performance. For this reason, in the development of the entire prefabricated configuration building, the enterprise should formulate a unified prefabricated component, and perform assembly operations in the construction site to ensure effective energy saving. In this way, fuel consumption and power consumption can be controlled under standard conditions. With the help of the above content, the actual utilization rate of construction resources is in line with the requirements for efficient utilization of resources in the specific "Green Construction Guidelines". This will not only improve resource utilization as much as possible, but also strengthen the proportion of renewable energy applications.

4.2 Land Saving

The gradual deepening of urbanization in China has led to a gradual decline in the area of domestic arable land. This has also led to a lower and lower per capita land occupation, prompting land conservation to become a link that must be paid attention to in urban development. In the actual construction process, some companies have problems with the arrangement of the construction machinery and construction materials entering the site. The materials are stacked at will, and the mixing site and earthwork arrangements are not planned in advance. This greatly affected the overall construction progress, and the land occupancy rate of the construction workers’ on-site living and office areas also decreased. What’smore, in the implementation of specific green construction operations, people also need to pay attention to the reasonable placement of components in the yard to ensure the orderly arrival of materials. This can avoid any impact on the subsequent work.

4.3 Water Saving

At this stage, China's overall water resources reserves are very limited. Relevant departments should increase management efforts in water conservation and prevention of water pollution. Water consumption in the construction industry is also high, and the main content involved is production water and domestic water. For example, in urban groundwater suppliers, in 2014 alone, the total amount of groundwater pumped by foundation pit projects in the construction industry reached 21 trillion m³. From the perspective of the development of prefabricated buildings, the reduction in water consumption is mainly reflected in the on-site concrete curing and wet work water. Meanwhile, due to the increase in construction management operations and construction personnel, domestic water consumption is also in a state of decline. Besides, in order to meet the basic needs of green construction, people need to fully consider the application of water-saving devices and non-traditional water sources, such as water reuse and rainwater harvesting [4].

4.4 Material Saving

For a long time, the development of China's construction industry has mainly focused on on-site construction methods. Many processes are in a wet state and are all completed by on-site staff. The labor intensity is very high, and the construction site is also chaotic. This further increases the consumption of building materials, and some abandoned building materials can be seen everywhere in the construction site. With the help of green construction, the efficiency of material use can be effectively guaranteed to avoid increased material waste due to human factors. Since component production sites are mainly concentrated in factories, if refined design and production can be achieved, material consumption will be greatly reduced. In the meantime, prefabricated components are mainly assembled and installed in the prefabricated construction site to reduce the processing and use frequency of raw materials on site. In this way, effective saving of building materials can be achieved, and the amount of construction waste can be controlled, creating favorable conditions for the implementation of green construction operations of prefabricated buildings.
5. THE CONCRETE APPLICATION OF BIM IN PREFABRICATED GREEN BUILDING CONSTRUCTION

5.1 Application in Scheme Optimization Design
In the actual project roof area design process, the main use is the combination of prefabricated laminated slabs and prefabricated beams, and the joint design is based on cast-in-place mode. It can be seen from BIM modeling that people need to focus on structural load requirements. However, in the process of structural reinforcement, it is easy to cause over-density of steel bars at the intersecting nodes of the primary and secondary beams and columns, which reduces the passage of concrete aggregates. In the end, this will affect the on-site pouring and vibrating effect, increase the difficulty of construction, and it is difficult to guarantee the quality of construction. In general, the construction of this type of project can use BIM modeling to reasonably compare and select the reinforcement schemes at the nodes. Simultaneously, we should use the node prefabrication mode to rationally optimize the roof area, and apply the prefabri cated laminated board + cast-in-place beam form. For the design outside the engineering entity, the original design ratio can be used to establish a 3×2m single-span experimental structure, the ratio value is 1:1, and the constructed ballast experiment operation can be carried out. It can also be seen from the actual experimental data that when the relevant design scheme is optimized, the structural load can also meet the requirements of the previous design scheme, and the effect is extremely obvious. The study of construction process such as lifting in the BIM simulation construction plan can not only help the staff understand the construction difficulties in advance, but also formulate more targeted solutions. Due to the high difficulty of hoisting, relevant staff need to reasonably optimize the prefabricated joint components. In this way, it is possible to appropriately design the lifting beams while ensuring the quality, thereby providing convenient conditions for subsequent hoisting operations [5].

5.2 Application in Construction Layout
During the design process of the project, the design scale of the northern box body is 250,000 t/d, the entire earthwork volume is 500,000 m³, and the entire construction area is 14m deep. There are a large number of engineering vehicles entering and leaving the site during construction. Generally speaking, the traffic frequency is 45 vehicles per hour. As a result, people need to effectively design the construction site and access channels to avoid a drop in construction efficiency. In the early stage of the project construction arrangement, the staff can rely on BIM simulation to ensure the completeness of the arrangement work. This will not only integrate the specific processing area, but also make the overall layout more reasonable and maintain the smooth progress of construction operations. In the preliminary construction planning, the staff can also use BIM to establish a land planning model for temporary construction facilities. This can make the layout plan more optimized and intuitive, and make good use of the large temporary site to meet specific engineering needs. After that, we will use BIM simulation to establish site layout models at different stages to improve construction efficiency.

5.3 Application in Construction Management
The implementation of the green construction operation of the entire prefabricated building should be based on the green concept. The construction staff can reduce the frequency of use of formwork and the number of supporting rows during construction of the project structure through prefabricated assembly. People can strengthen the role of mechanical construction while reducing labor input, and can also avoid severe impact on the surrounding environment. Besides, the construction personnel can also introduce the formwork support system in the cast-in-place beam section of the precast beam node through the beam node prefabrication method. Accurate BIM modeling and load-bearing calculations of the support system can maintain the safety of the entire support, and the structure and size of the tool formwork can also be refined. The actual BIM simulation construction process can not only help the staff choose the best construction path, but also accurately judge the number of prefabricated tool-type templates, so as to achieve better cost control and optimized design effects. In the construction of the project, the top of the cast-in-situ column should be reserved for the corresponding insert positioning
and grouting position on the top of the column and beam node. This process is very complicated and requires the help of BIM to simulate the prefabricated component hoisting process. Finally, researching the key and difficult problems in the construction of the project can not only reduce the probability of errors in hoisting operations, but also avoid a significant drop in construction efficiency.

5.4 Conducive to Saving Energy and Controlling Costs
The actual green prefabricated construction project should ensure the maximization of resource and energy conservation during the green construction. This includes material saving, energy saving, etc., to truly achieve green construction. All on-site construction personnel must also fully control the magnetic therapy inventory and construction schedule, and do a good job in the procurement of construction materials. The construction personnel also need to make an orderly arrangement of the time and sequence of materials entering the site, and do a good job of cost control during the construction process. At the same time, the three-dimensional visualization operation of the BIM model can not only help the staff understand the amount of materials in each area in time, but also realize the point-to-point transportation of the components and speed up the construction progress [6].

6. CONCLUSION
In summary, it can be seen from the actual application process that BIM technology can achieve a comprehensive simulation of the design scheme in the design stage of prefabricated construction projects. Meanwhile, it can be combined with specific construction technology to verify the rationality of the design plan and put forward specific opinions and suggestions. For those major projects, the need to use BIM technology before the construction layout is conducive to the verification of the site layout plan and ensures the smoother construction of the entire project.

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