Application of BIM Technology in Prefabricated Buildings

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Abstract. The development of fabricated buildings has become the main trend of the development of modern construction industry in China. As the main tool of building information, BIM (building information modeling) has greatly promoted the development of construction industry. Based on the review of the papers about the fabricated buildings and BIM technology in recent years, this paper analyzes the advantages of fabricated buildings and BIM technology, then explores the application of BIM technology in fabricated buildings. It aims to realize the rationalization and scientification of project lifecycle management in fabricated construction projects, and finally form a coherent information platform in the fabricated building.

1. Introduction

In our country, with the sustainable development, energy saving and environmental protection concepts deepening, the fabricated building is gradually becoming the focus of attention. Compared with the traditional cast-in-place building, fabricated buildings could cost savings, shorten the duration, reduce noise, less construction and so on. And BIM technology has a great role in promoting the development of the construction industry in the information age.

In recent years, many scholars have studied the feasibility of BIM technology in the new type of assembly architecture: China's early BIM technology and assembly of the building is combined with Zhou Wenbo et al; And then the BIM technology in the assembly of the whole lifecycle management was discussed by Qi Baoku. Through the specific case study, they described the application prospects of BIM in the lifecycle management of assembly buildings; BIM and RFID technology in the construction process were promoted by Changchun Guang, Wu Feifei; Bai Shu analyzed the application value of BIM in various stages of assembly building. Combined with the development of BIM technology, and from the assembly of the design, production, construction, operation and maintenance phase to proceed, this paper analyzes the actual situation of the fabricated buildings and the application of BIM technology in the whole lifecycle management of assembly buildings to make the assembly architecture have a better development prospect under the combination of BIM.

2. The advantages of the prefabricated buildings

The prefabricated Buildings refer to buildings that are made of prefabricated components on the site. From the beginning of the 20th century, prefabricated buildings have been people's attention, the prefabricated building was able to achieve, until the 1960s, the United Kingdom, the Soviet Union, France and other countries made the first attempt. Because the prefabricated building can shorten the construction time and reduce the cost. So it can quickly develop around the world.
2.1. Construction period is short
The prefabricated building is the assembly of the prefabricated components in the factory directly on the site for assembly, most of the machinery is used in the operation, replacing a lot of manual operations, thus saving time. The prefabricated time at the factory is not included in the construction period. The operation on the site is to assemble the components, saving the steel bundles, plastering and other processes, thus greatly saving the construction time.

2.2. Energy saving and environmental protection, sustainable
Now the state has been advocating energy conservation and environmental protection. The Prefabricated Building is in line with this requirement was able to develop rapidly. A lot of material in the fabricated building can be recycled, like steel formwork, wood template and so on. This will achieve the purpose of saving resources. In addition, because the prefabricated components which produced in the factory are transported directly to the site for assembly, it reduces the construction noise and avoids dust flying in the construction site, so that environmental pollution has been effectively controlled.

2.3. Improve project quality and safety
There are always high-altitude operations in the traditional construction of the construction site. Due to the construction staff quality is not high enough, and the technical level is limited, leading to the quality of construction problems during the construction process, and even there are many security risks. This would threaten the construction site personnel personal safety. And in the prefabricated building to greatly reduce the emergence of the above problems, the production of prefabricated components at the factory is mostly low-altitude operations. There is no such phenomenon as falling objects and most of them are mechanized. Then the construction quality has been guaranteed. So the prefabricated building can be a good way to improve the quality of the project and reduce security risks.

2.4 Improve labor productivity and save costs
Because the prefabricated construction of the building is a large number of production in the factory, and then transported directly to the construction site to install, so the use of the scaffolding and template is greatly reduced. This not only saves construction costs, but also reduces some of the traditional building in the construction process.

2.5 Easy to construction, subject to climate constraints
A lot of processes of the traditional constructions must be stopped in winter and the rainy season due to weather conditions, which will affect the entire construction schedule. While most of the assembly works can be carried out indoors, the outer wall panels, inner wall panels, prefabricated beams, prefabricated columns, etc. are produced in the factory, free from external influences, and transported to the site for installation.

3. Principle and Characteristics of BIM Technology
BIM technology is based on building engineering projects in a variety of relevant information data, and through the establishment of building models, to simulate the real information of the building, in other words is a digital information simulation. BIM technology has the characteristics of visualization, coordination, simulation, optimization and outrageous.

3.1 The visualization of BIM Technology
Visualization is the form of seeing and getting, which prospects considerable the use of the construction industry. The traditional reading is to get the construction drawings, watching these lines to imagine the space, which is not realistic for today's complex and varied, different forms of architecture. The BIM technology changes the drawings of these flat lines to the three-dimensional, so that staff at a glance, to form a kind of through the interaction between components and feedback visual. In addition, with t
he help of BIM technology, the design, construction, operation, etc. of the project can be carried out in a visualized state.

3.2 The coordination of BIM Technology
Coordination in the construction industry is one of the most important elements. In the implementation of the entire project process, the design unit, the construction unit and the owners must always cooperate with each other and do a good job coordinating work. BIM technology coordination can be a good solution to the problem of communication not in place. BIM technology can provide coordination data, the specific operation is the construction of the building before the existence of different professional coordination between the collision issues, and then generate data. In addition, BIM technology can also solve the coordination between the elevator shaft layout and other design arrangements, and the coordination of underground drainage layout and coordination between other design arrangements and so on.

3.3 The simulation of BIM technology
The simulations of BIM technology are not just a simulation of a building model, but also a simulation of virtual things. It can be energy-saving simulation, thermal conduction simulation, sunshine simulation and so on in the design phase. And in the bidding phase, it can be 4D simulation (three-dimensional model + project development time), which is based on the construction organization design to carry out the actual construction of the simulation. There are also 5D simulations (based on 3D model cost control) to control the cost of the entire project. It can also be simulated at the later stages of the entire project, for example, for emergency evacuation of emergency personnel.

3.4 Optimization of BIM Technology
BIM technology can be better optimized in design, construction, operation of the entire project. In engineering, optimization is constrained by time, information, and complexity. Reasonable optimization is based on accurate information to do, and this is the advantage of BIM technology. It can not only provide all the information of the building, but also can provide information after the building changes. For now complex buildings, BIM and its various optimization tools can be optimized for its implementation.

3.5 Outrageous of BIM Technology
BIM technology cannot be pointed out that some of the architectural design drawings, but the visualization of the building display, coordination, simulation and optimization, out of the integrated pipeline, the overall structure of the hole in the map, in order to eliminate some error, and even can do some suggestions to improve the program.

4. Application of BIM Technology in the Whole Life Cycle Management of Fabricated Buildings
As a future development of the construction industry trend, the fabricated building also faces many difficulties and problems, the most prominent is about the life cycle management. First in the modern construction industry will involve a variety of prefabricated components. Because the more participation result the information concentrated, in the production of prefabricated components, transport and assembly will appear with the uncoordinated. Followed by the construction process, it is difficult to accurately and timely collection of the information of the components, making the entire project construction progress cannot be a good grasp, increasing the difficulty of management. Finally, for the finished building that has been completed, when a component is damaged or unqualified, it is difficult to collect and process the information in a timely manner, resulting in damage to the entire building. And the BIM technology applied to the assembly-building life cycle management, it will be very helpful to solve the above problems.

4.1 Application of BIM Technology in the Stage of Assembly Design and Planning
At this stage BIM technology has played a significant role, its main advantage is synergistic, interrelated, parameterized, which can be a good solution to the traditional building in the design of some conflicts caused by design changes. Firstly, BIM technology at this stage can be site planning and site analysis. The key role of the project is the site analysis, which affects the positioning of the construction project. The traditional method does not have sufficient quantitative analysis, nor can a large amount of data be processed scientifically. According to the proposed building space information and site conditions, with the help of BIM technology and geographic information systems, data modeling can be done. So that it can better help decision makers to site analysis and planning site selection; Secondly, we can use BIM technology to draw drawings and build models. Compared with the traditional drawings, the biggest advantage of BIM technology is that it draws the drawings of each element which has the meaning of the project, such as the spatial size of the component, the properties of the material, and so on, this has the relevance of the model parameters. In the model established by BIM, the model parameters of any of the components change, and then the components will change. BIM model can also be the actual construction simulation and find the problem in time to improve in the simulation process. At the same time, according to the visualization characteristics of BIM technology, each participant can communicate with each other on the design scheme. Thirdly, BIM technology can solve the design of the conflict check. The traditional method is based on the design drawings to restore the building of the three-dimensional map by imagination, there is no scientific method will inevitably produce some error. This will lead to the construction of the time will not match with the design, resulting in the program to re-modify, duration, cost increases. The BIM model will be displayed if the design process of pipeline conflict, and the structure can make timely changes by using BIM technology. Fourth, the use of BIM technology can be calculated cost. The traditional cost or manual to the amount of engineering statistics and calculation, so there will be a calculation error. With the BIM software, we can provide a lot of engineering information and fixed information for the cost of personnel, both to save time and reduce the error rate.

4.2 Application of BIM Technology in the Manufacturing Stage of Fabricated Buildings
BIM technology and RFID (radio frequency identification) technology are combined in the production of component building in assembly buildings, and the RFID chip containing the material type, the geometric size, the installation position, etc. of the member is implanted into various types of prefabricated members. Because RFID tag coding has a unique principle, so it can guarantee the accuracy of information in the component production, storage, transportation, hoisting and other processes. The role of BIM is reflected not only in the production management subsystem of the component, but also in providing information such as storage, quality monitoring, production, etc. of each prefabricated component to the BIM database. This combination of BIM and FRID technology, you can achieve the goals of the prefabricated components zero defect and zero inventory.

4.3 Application of BIM Technology in Construction Stage of Fabricated Buildings
In the assembly construction stage, the main application value of BIM technology has the following aspects: Firstly, it can be improved with inventory and site management of prefabricated components. In the actual construction site, it is the time that the components cannot be found or find the wrong situation, so only the strict management of the construction site can prevent such incidents. And at this stage using the effective combination of BIM technology and RFID technology can be tracked in real time. The advantage of their combination lies in the accuracy of information and transmission speed, which can reduce the error caused by artificial; Secondly, we can optimize construction, cost planning control the progress of the project by 5D construction simulation. Based on the 3D-BIM model, the time and resource dimension are introduced to form the 5D-BIM model. In order to simulate a variety of resources and the construction of the entire construction process about the prefabricated buildings, and can form a dynamic construction planning. Also in the simulation process, the existing construction planning problems are optimized to avoid the extension of the duration and cost increase. 5D-BIM simulation
can also make the entire project construction process and cost of resources into a more intuitive display in front of the construction workers and technical staff.

4.4 Application of BIM Technology in Maintenance Stage of Fabricated Building
In the operation and maintenance phase of the assembly building, the main function of BIM technology is to provide the use of buildings, the operation of the components and financial aspects of data and information. Firstly, BIM technology has played a significant role in property management. BIM software can provide the parameters of the building to determine its operation through the connection with the relevant equipment, so that property managers can make scientific management decisions timely. In addition, there are many applications about the combination of BIM technology and RFID technology in the facilities management and access control system. The staff in the maintenance of the time through the reader can quickly find the location of the relevant equipment after each building is installed on the electronic tags, the repair of the corresponding data is recorded in the electronic label, the information and then stored in the BIM's property management system. Then the staff can be more intuitive understanding of the operation of building equipment by forming a process about “Provide data - Maintenance operations - Maintenance records - Information integration”. Secondly, we can avoid structural damage by using BIM technology analysis and testing of the building structure of the indicators. BIM technology can also play a very good resource recycling role, it can be used to understand the end of life in which the building can also be used for the second use, both to reduce energy consumption and conform to the trend of sustainable development.

5. Conclusion
In order to respond to the concept of green and sustainable development in China, the prefabricated building is gradually becoming the benchmark for the development of the construction industry in the 21st century, and the integration of BIM technology to make up for the assembly of the building is difficult to collect information, processing and other shortcomings. The application of BIM technology in the whole life cycle management of assembly buildings makes the prefabricated buildings have a better development prospects. In the BIM technology application process combined with RFID technology can be more effective to improve the management efficiency of the design, production, construction, maintenance about the prefabricated building. So more in-depth studying of BIM technology in the prefabricated building of the application is our future main research direction.

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