Research on Optimization of Prefabricated Construction Building Process Based on BIM Technology

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Abstract. At present, the application of prefabricated buildings in China is not perfect, and more problems are exposed in the actual production of engineering projects, which seriously affects the quality of engineering projects. Therefore, research on the quality of prefabricated construction engineering is particularly important. BIM is a new model that can simulate the real information on buildings through 3D digital technology. It can achieve mutual cooperation of various operations. Therefore, in order to improve the engineering quality of the prefabricated building, this papered will study the literature on the quality of prefabricated buildings, and determines the main quality problems of the prefabricated building. And the design, manufacturing and transportation, and construction phases of the prefabricated building are optimized by the application of BIM technology.

Keywords: BIM; Prefabricated Construction; Engineering Quality

1. Introduction

At present, China is in the crucial period of vigorously developing the prefabricated buildings and promoting the adjustment and upgrading of industrial structure, However , due to the backward assembly construction technology and the lack of uniform standards of the industry , a series of problems have arisen , in which the quality problem of each stage of the construction project bears the brunt . The first one is the quality of each phase of the project. If the quality problem of the prefabricated building cannot be effectively solved, it will bring many adverse effects of the whole project. At present, domestic scholars have also carried out related researches, such as Cao Jianghong analyzed and summarized the advantages of BIM technology in engineering project management at home and abroad, and studied the whole process quality management of prefabricated building based on BIM technology [1]. Su Yangyue used the fishbone diagram method to analyze common quality problems with five aspects: personnel, machinery, materials, methods and environment based on a prefabricated building production - construction site. She proposed a BIM automated quality management platform for assembly structure supported by the Internet of Things, 3D laser scanning technology and information processing technology. This platform can promote intelligent, scientific and standardized quality management [2]. Zhu Weixiang introduced BIM technology for the characteristics of prefabricated buildings, and explained the application of BIM technology in design, construction and construction. It effectively improves the overall construction and management level of the prefabricated building [3].

In foreign studies, Zulfkar *et al.* studied a BIM platform that allows participants to participate in project management through visualization and remote control. BIM data is connected to cloud storage through a proxy server. This platform transfers graphics to the user interface through a desktop sharing and communication system. Participants can participate in interaction and remote control through computers and mobile devices. It improves the traditional communication mode and makes full use of BIM visualization [4]. Lieyun D and other technologies combine cloud storage and BIM technology to solve the problem of massive data processing and information security, and build a BIM-based lifecycle information integration management system to realize the sharing of resources among various departments [5].

By summarizing the domestic and foreign literatures, this paper explores and analyzes the practical problems in the process of prefabricated building construction in China. And it will use BIM technology to optimize the irrationalities in the design, manufacture and transportation, and construction phases of the prefabricated building. Then this paper will propose specific improvement methods of each stage.

2. Summary of quality issues with each stage

Through the analysis and research of relevant literature on the quality of a large number of prefabricated buildings, this paper analyzes the three aspects of the design, manufacture and transportation, and construction of the prefabricated building. And it summarizes the following problems.

Table 1. Problems and causes at each stage

phase	Problem			Cause Analysis
design phase	It is difficult to communicate in the early stage of process design and to modify the construction drawings.			All drawings from the planning stage to the construction drawing stage are designed and reviewed by the traditional design institute in a cast-in-place manner.It is then submitted to the process design unit or PC component manufacturer for further design.
	When the components are split, the size of the conversion layer air conditioner is too small.			Design standards and design methods are not rigorous.
Manufacturing and transportation phase	Installation size deviation problem	Personnel aspect	Workers have less practical experience and are not skilled in operation	Compared with concrete structures that have been developed and experienced in engineering practice, there are fewer existing assembly projects.
		Mechanical aspect	Large errors in wall panels, width of joints, and even misalignment.	Lack of practical precision control tools.
		material	Dimensional error, component flatness error, component embedded component position error, disassembly failure, etc.	Failure to meet the quality of the component itself can lead to accumulation of installation errors.
	Quality problems on the production line	Personnel aspect	There are irregular operating procedures, inaccurate dimensional accuracy, insufficient smoothness of the parts,	Workers lack training and are unskilled and incomplete in their operations.

			insufficient thickness of the protective layer, and lack of inspection and inspection of parts that pass the inspection.	
		Mechanical aspect	It is difficult to find problems with the inaccuracy of the template and the improper vibration of the concrete.	There is no effective and practical quality inspection tool before the component is molded.
		material	The concrete mix ratio before concrete pouring is improper.	Insufficient experience in related configuration.
		Technical method	Slurry problem	The template size is uneven, the template is displaced, and the template is unevenly strengthened.
		Environmental aspect	Material quality is affected	The temperature and humidity of the air affect the quality of the component mold. The ambient temperature also affects the worker's behavior. The comfortable temperature is beneficial to the standard operation of the worker.
	Finished product protection	Personnel aspect	The operation process is not standardized, and the experience and operational skills of the workers at this stage need to be improved.	Construction workers lack training, skills are not skilled enough and the bottom is not deep enough, and industrial workers are lacking.
		material	It is easy to damage during exercise, the mortar is easy to enter the casing.	The wall panels are thin and large, and some non-load bearing members are not designed to be strong, and the grouting sleeves are not sealed or blocked during production.
		Technical method	There is a lack of a holistic approach to solving the problem of finished product protection. The protective measures for the transportation, storage and lifting of prefabricated parts are not sufficient.	Premature demolding of components and inadequate maintenance, lack of special protective equipment.

		environment	The surface and quality of the construction are affected.	The storage time of the prefabricated parts and the ambient pH also affect the strength of the prefabricated parts. The longer the storage time, the easier it is to damage parts.
construction stage	Sizing - grouting quality problem	Personnel aspect	The time and amount of mixing slurry and grouting material did not reach a precisely controlled level.	Construction workers do not pay attention to construction quality and lack training in relevant operational skills. It is not strictly in accordance with the standard in mud and grouting. Insufficient grouting and mud make it difficult to remedy afterwards. When the upper and lower wall sleeves deviate too much from the reinforcing bars or when the reinforcing bars are not inserted, the workers often bend or cut off the lower bars, which may cause structural failure.
		Mechanical aspect	There is a need to develop inspection tools that are suitable for the thickness of the slurry layer and the unsaturation of the sleeve grout. In addition, the grouting machine sometimes becomes damaged and does not work.	There is a lack of scientific and effective quality self-testing tools, and quality management is less efficient.
		Material aspect	The quality of the slurry and grouting is not up to standard.	The quality and ratio of the slurry and grouting materials are improper.
		Technical aspects	The bonding strength between the wall and the floor is not enough.	At the bottom of the prefabricated wall, the debris at the bottom of the prefabricated wallboard is not cleaned or the floor is not in place.
		Environmental aspect	The surface quality of the component is damaged.	It is affected by high temperature
	Post-casting quality problem	Personnel aspect	The connection of the T-joint is difficult, and the worker bends or cuts the steel bar.	The deepening design of the steel bar did not fully consider the difficulty of on-site assembly, nor did it fully consider the production precision of the prefabricated components.

				Further analysis, workers lack a sense of quality responsibility, skill levels are not up to standard, and the operation of mold and steel workers is easily deviated.
		Mechanical aspect	The template engineering inspection tool is missing here.	
		Material aspect	The thickness of the laminate is too thin to match the mix ratio. It is easy to rotten.	It is not rigorous when mixed and has too much coarse aggregate.
		Technical aspects	The vibration and snoring of concrete cause the flatness of the slurry, the table, the root and the surface to be out of the standard, and the yin and yang angle.	The template foundation cleaning is not in place, the template is not tight, and the steel bars are not good.
		Environmental aspect	The quality of the concrete is affected.	It is affected by the temperature

3. BIM application in quality improvement process

3.1. Application of the design phase

3.1.1. Optimization designed. In order to reducing the error rate, it is necessary to optimize the design in the early stage of construction. When building a building model, the software should be the more common REVIT software in the BIM system. First, according to the characteristics of the prefabricated building, the standardized parameters of the prefabricated components are set and then it can perform the simulation installation [6].Then combined with the previous construction experience, it should check the components that may have problems, and determine the degree of connection between the ribs, and find the collision between the vertical reinforcement and the reserved wall. Then it will modify the construction design, and adjust the model. So It can guarantee the optimization of the construction plan.

BIM technology platform can organize and store data information and build a database for young designers. Designers can use these data to form a reasonable size standard, and it can effectively standardize design standards. Relevant designers can use the BIM technology to carry out a very detailed design of the prefabricated building structure and prefabricated construction, which can reduce the deviation problems that are easy to occur in the design settlement. Relying on BIM technology, the parameters of the prefabricated construction are very accurately designed and positioned. In view of the BIM model, the designer can directly check the fit of the prefabricated components, and it can perform a detailed analysis of the reliability of the joints of the prefabricated components through the function of detection. Therefore it can reduce assembly conflicts that may occur to prefabricated components. Ultimately, it will reduce the waste of materials caused by construction delay and design error.

3.1.2. Realize resource sharing with prefabricated buildings. By incorporating BIM technology into a prefabricated building, it can connect every aspect. So it changed the previous situation of each link. The BIM technology is used to organize and store the information on each stage and upload it to the unified platform to ensure the continuity and integrity of the upstream and downstream. This is also an innovation for prefabricated buildings, which successfully solves the problem of multi-link, multi-organization and long-term resource sharing in prefabricated buildings. BIM technology also allows

professionals to participate in the design and give reasonable advice on different designs. Not only can it enrich itself, but it can also make the country's construction industry better develop and progress.

3.2. Application in the manufacturing and transportation storage phase

3.2.1. Improve inventory and site management. The construction site has limited space. In order to ensure the timely supply of materials and keep pace of the construction progress, it is necessary to use BIM technology to strengthen the construction site management. It is necessary to scientifically store the construction materials, but also to strictly control the rotation radius of the tower crane, and also ensure that the on-site transportation is normal. This requires building a construction site model in the software, clarifying the stacking range of different materials, and determining the amount of material purchased in combination with the construction plan and construction schedule. Under normal circumstances, the stacking of PC components on the construction site cannot exceed 1.5 layers. The amount of on-site material stacking should be determined according to the actual demand of different construction areas, and the difference between planned and actual consumption should be analyzed to strengthen management and transportation. In the production of prefabricated components, the production of classification, classification and storage in the production and need a lot of manpower, and very easy to appear problems. Through the effective combination of BIM technology and RFID technology, these problems can be well avoided. In the process of prefabricated building construction, relevant personnel can directly view the information on related prefabricated components through RFID technology. It is then compared to the installation location to improve the quality level and efficiency of the prefabricated component installation.

3.2.2. Collision checked. In order to avoid conflicts between components in the actual construction process, collision inspection is required. Compare with the plane design, with the aid of BIM technology to build three-dimensional model, can be more intuitive and clearly show the relationship between the component, and then combined the prefabricated completed collision check, find the position is not reasonable or non-standard components, by adjusting the accurate location and then be fixed, can effectively solve the problem of component conflict, avoid the waste of model templates. When the components cannot be adjusted, the standard parameters should be resetting according to the construction requirements, so as to re-produce the prefabricated components with reference to ensure the construction quality.

3.3. Application in the manufacturing and transportation storage phase

3.3.1. Improve the efficiency of relevant personnel. In the absence of BIM technology in China, the design of the prefabricated building has always been carried out in a 2D environment, and professional personnel are required to follow up during the design. If it does not meet the actual or customer requirements, it must be changed accordingly, including modifications to the plan, perspective and section. It may be that a link does not meet the standard and will be redesigned. Over time, it will increase the designer's task. This situation not only wastes energy but also wastes a lot of time, which will result in prolonged construction time, reduced construction efficiency, and possibly increased cost. But the emergence of BIM will quickly solve this problem. Relevant professionals upload their design materials to the BIM database, and the database automatically stores and generates a simulation model. It can draw the corresponding drawings according to the model. It avoids conflicts and conflicts during design, and greatly improves the efficiency of designers, and speeds up the overall project.

3.3.2. Process connection and technical communication. Node connections are the key to prefabricated construction. If small errors and displacements occur when assembling the PC board, it will affect the precise installation of other components and reduce the construction quality of the entire project. Therefore, it is necessary to do a good job of process connection and technical communication. By

utilizing the visual characteristics of BIM technology, it is possible to enlarge the engineering nodes, facilitate the precise control of the construction, and strengthen the synergy between different types of workers. It can ensure the good connection of the process, and can also complete the technical delivery, which can ensure the construction accuracy to the greatest extent and avoid the occurrence of component positioning error and offset phenomenon [7].

4. Conclusion

Through comparison and synthesis, this paper collates and lists the quality problems that lead to the various stages of assembly architecture according to the characteristics of assembly architecture, and applies BIM technology. This paper optimizes the quality problems of assembly construction from three aspects: design, manufacturing, transportation and construction. Then specific suggestions for preventing quality problems in the process of prefabricated building construction are putting forward. The research in this paper lays a foundation for the application of BIM technology in the field of prefabricated buildings, but there are also some shortcomings. These shortcomings mainly include overcoming the quality of the assembly structure of management means; the standardization of the procedure is relatively concentrated on the quality standards, and there are few studies on the technology, especially the technical guarantee measures for the joint quality of the joints. Therefore, we will continue to explore in future research.

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