Application of BIM Technology in the Construction of Vanke Industrial Dormitory Building

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ABSTRACT

This paper systematically introduces the comprehensive application of BIM technology in the whole life cycle of pre-fabricated building. The background project is Vanke industrial dormitory building and the main application points include: BIM design, business management, technology management, progress and cost management, quality and safety inspection, personal management and BIM maintenance.

BACKGROUND

Pre-fabricated buildings differ greatly from traditional buildings in construction methods. They require more work to be pre-positioned and have high requirements for coordination of design, production and assembly construction. At present, due to the unequal or discontinuous transmission of information in the construction process of pre-fabricated buildings, many problems exist, e.g. component products are difficult to be assemble accurately, the delay of component delivery, the mismanagement of components in the field, workers are not well skilled and et.al. Therefore, many construction resources are wasted, together with the raised construction cost and reduced quality of construction. BIM technology can reduce the occurrence of the above phenomena to the greatest extent by pre-positioning all the work, using virtual methods to simulate construction process before the actual work, and realizing information storage and management through cloud technology.

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Pre-fabricated buildings have the characteristics of modularization and standardization, and they require unified management of the whole process and life cycle, which coincides with the life cycle management concept of BIM technology. BIM technology can efficiently cope with the information sharing, transmission, coordination and decision-making of all parties in the construction process, and it is a perfect application tool for pre-fabricated construction.

INTRODUCTION

The Vanke industrial dormitory building is a demonstration project of BIM comprehensive application in the whole life cycle of building. The total building area of the project is 3647.66㎡. It has six floors above ground and the type of structure is pre-supported frame-seismic structural wall. The prefabricated components of dormitory building are: structural columns, partial shear walls, external walls, concrete stairs, steel stairs and steel structure boxes. The prefabricated components are made of light self-insulating concrete, steel structure boxes are produced in factory and assembled on site. The balcony is made of steel and the interior walls are made of concrete slab partition (with cavity) without plastering after installation. Structural beams, structural floors and some external shear walls are cast-in-situ concrete components.

During the construction process, the owner, the designer and the constructor work together to build a comprehensive application demonstration of BIM in the whole life cycle of the building. The Design Institute is required to have strong modeling ability, the general contractor needs to have a strong civil engineering background and the ability to apply BIM management on site. In terms of subcontracting selection, the subcontractors are required to have BIM capabilities, including deepening design, BIM model viewing, file modification and corresponding management capability. BIM technology application covering all stages of design, construction and operation and maintenance has been realized through strictly technical control.

Figure 1. Rendering of Vanke Industrial Dormitory Building.
BIM APPLICATION IN THE STAGE OF DESIGN

This project is designed by BIM. The average drawing rate of architecture, structure, water supply and drainage, HVAC and electrical parts is 80%, and that of mechanical and electrical parts is 90%. The specific requirements for assumed component design are as follows: The vertical columns above the second floor are prefabricated concrete components, and designed by Allpan software. The prefabrication rate can be quickly calculated as 35% by using the model. The prefabricated components can be effectively split, classified and numbered by using component compilation of BIM model. Batch modification and deepening design are realized. The BIM models of PC components, such as reinforcement bars, embedded bolts, horizontal and vertical distribution bars, are presented to facilitate the processing and production of components. The efficiency of industrial production is also improved due to the application of BIM in classifying steel bars.

![Figure 2. Deepening Design of Vanke Industrial Dormitory Building.](image)

Deepening Design by BIM: The owner provides the list of the requested deepen products and establish the unique technical standards according to the requirement of deepen design. By using BIM models of construction drawings, manufacturers can directly deepen the design of railings, suspension brackets, doors and windows. Each manufacturer can achieve real-time updating design effect. It is more reasonable to deepen the construction of water pipes through steel beams, wind pipes, steel beams and fan coil units to avoid structural arrangement.

BIM APPLICATION IN THE STAGE OF CONSTRUCTION

Business Management

Using BIM5D platform, construction drawing model, calculation model and budget list can be flexibly converted and interacted, which greatly reduces the workload of manual identification of component information. The BIM model is
used to calculate the amount of project. The time of data export is 80% less than that of traditional manual calculation and the accuracy of data are up to 97%. Contract management runs through the whole process of construction and is the key of project management. In this project, the management platform records the general contract and connects the model with the owner’s report in the following construction nodes. The subcontracts are also uploaded to the platform timely, the subcontracts can be evaluated and risk pre-control according to the corresponding data. As for the project payment, the amount of completed project is selected in the digital model monthly, and the progress payment declaration and approval are completed on the platform, which makes the project payment more realistic.

**Technology Management**

A large number of drawings will be produced in the operation process of enterprises, including design reports, final design products, contracts, statements and other information, and the requirements for the process are very high. Enterprises often need to invest a lot in the management of drawings. The BIM collaborative management platform adopted in this project will input all professional drawings into the platform and directly manage different versions of drawings. Due to the inevitable design changes in the construction process, the system provides the function of drawings auditing to track the process of reporting in real time and provide early warning for the uncompleted content as planned. The system supports changing design diagrams and dynamic tracing of deepening design drawings. All kinds of construction schemes are declared through the platform, and approved by owner and supervision on the platform.

**Progress and Cost Management**

In engineering project management, schedule and cost are two modules that must be strictly controlled. In the progress management system of this project, the actual information is input mainly through the module of construction daily, which mainly includes: the completion of the day, plan of the next day, conditions of mechanics, conditions of materials, technical management, quality management, safety management, main problems and rectification measures. With the progress of the project and accumulation of actual progress data, we can inquire about the completion of each process of its sub-nodes by choosing any node in the schedule plan, give the proportion of the processes completed on time, delayed and ahead of schedule by pie chart and list form, and highlight the delayed process. The warning and early warning of work tasks can be realized by early warning mechanism. The project management and the specific operators can directly see the early warning information pushed on the desktop, and deal with the tasks in a timely manner. At the same time, through the project management system, managers can dynamically view the output value and capital input of different time nodes of the schedule plan.
The time-varying curve of project schedule, resources and cost information provides a powerful data support for the macro-control of project personnel.

**Quality and Safety Inspection**

Quality and safety management of construction project is to locate and record the quality and safety problems on three-dimensional model. The problems found on site can be directly recorded on BIM model. The platform can assign the responsible persons and track the status of problem processing in real time, realize the visualization and traceability of quality and safety process management. Unified management and real-time monitoring can be achieved by problem positioning, problem recording, problem tracking and problem display.

**Personal Management based on BIM**

Personal management is realized by using Z-POS platform (wireless positioning system). The platform can combine all the daily workers' efficacy and safety management, and provide evidence with the amount of settlement each month and the project settlement.

**BIM APPLICATION IN OPERATION AND MAINTENANCE STAGE**

The basic information and maintenance information of equipment based on BIM model will be updated in time, which provides data basis for equipment management, is convenient and fast. The system we use in this project can reduce depreciation rate, prolong service life and reduce the cost of equipment renewal and maintenance. The function of "task automatic reminder" similar to daily operation and management can be realized by using BIM technology. The models can show the spatial information of each function in the building. The operation and maintenance information can be directly imported and matched with BIM model. 3D model visually shows equipment access, engineers can rapidly locate the error, analysis the affection of equipment failure and make reasonable decisions in advance.

The following BIM applications in operation and maintenance stage will be as follows: Achieving intelligent management of building by combining properties and facility management; Achieving intelligent control of building by precise management of various facilities and equipment; Realizing space management capacity through accurate allocation calculation, to improve space utilization, reduce space use costs and optimize space usage; Realizing effective energy consumption management by employing energy acquisition, energy monitoring, energy consumption index quantitative management, and comprehensive evaluation of energy consumption cost.
CONCLUSIONS

BIM technology has been used in the whole life cycle of Vanke industrial dormitory building. The active communication among owner, designer and constructor in the design stage ensures the smooth completion of project design; The application of BIM in the construction process standardizes the contract and drawing management, effectively controls the project progress and cost, and guarantees the quality and safety on the site; Meanwhile, preliminary exploration of BIM application in operation and maintenance stage has been carried out in the project.

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