Application of BIM technology in green scientific research office building

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Abstract. BIM technology as a kind of information technology, has been along with the advancement of building industrialization application in domestic building industry gradually. Based on reasonable construction BIM model, using BIM technology platform, through collaborative design tools can effectively improve the design efficiency and design quality. Vanda northwest engineering design and research institute co., LTD., the scientific research office building project in combination with the practical situation of engineering using BIM technology, formed in the BIM model combined with related information according to the energy energy model (BEM) and the application of BIM technology in construction management stage made exploration, and the direct experience and the achievements gained by the architectural design part made a summary.

1. Features of building project design
The Scientific Research Office Building of China United Northwest Institute for Engineering Design & Research Co., Ltd. is designed with novel shape, complete functions, diverse and varying spaces, to become a green and energy-saving building on the whole. The project plans to occupy a total land area of 39.093mu (1mu=666.67m²), and a total floor area of 63,644m². The design of the project has the following features:

1). Construct and improve the BIM model for all professions gradually from the beginning of design stage to satisfy the needs of applying the BIM technology in different stages.
2). Write the energy information into the BIM model to convert it into an integrated “Energy Model” for analyzing and assessing all kinds of green building indexes.

Figure 1. General View of BIM Model
3). Combine the high-precision BIM model with iTWO software to realize the real-time and interactive management of the project, including progress reporting of key schedule nodes, management of request for payment, and management of application for change at construction site, etc.

2. Establishment of building energy model (BEM) based on BIM model and energy information and data

The BEM model aims to create the electronic energy file of the project with computer technology, and calculate its operations and consumptions related to energy on this basis, so as to simulate the actual operation of the project. The model normally contains the detailed data including geographical and meteorological information, energy properties of components, lighting, temperature control and circulation system, etc. As an ideal carrier, the BIM model classifies all detailed data and implant them category by category into the related materials and components of the project, so as to construct an accurate digital energy model, which provides great convenience and advantages for simulation computing.

Figure 2. Schematic Diagram of Implanting Thermal Properties of Components

A scientific research office building involves complex functions and varying internal spaces, so computer simulation is often utilized to analyze and assess its green building indexes. The common solution is to building models separately with different analysis software (Ecotect for indoor natural lighting analysis simulation, PHOENICS for indoor natural ventilation simulation, PHOENICS for outdoor wind environment simulation and Airpak for indoor airflow organization simulation) for simulation analysis. However, the accuracy of analysis results is often unsatisfying due to the differences between models. In the design, energy information can be written into the BIM model to generate an energy model (BEM), and GBXML format file suitable for all kinds of green analysis software is exported for the purpose of one model for all and accurate information. The analysis results by importing GBXML format file into different simulation analysis software are presented as follows:

Figure 3. Schematic Diagram of Work Process Flow
3. Real-time and interactive project management through combining high-precision BIM model with iTWO platform software

The BIM model is vivid, visible and informative, providing the basic conditions for its application in project management. There are very high requirements for precision of the BIM model in project management. In the modelling stage, we develop the requirements for information granularity and information precision in compliance with iTWO software. Information granularity reflects what components the model consists of, while information precision demonstrates how accurate the information on the components of the model is. Meanwhile, the overlapping relationship between architectural components is defined as well.
Figure 7. Information Granularity and Information Precision of Window Model

High-precision BIM model is combined with iTWO platform software to realize the three-dimensional and dynamic management of transactions generated by the changes of project. In the traditional model of project management, a project change transaction must be completed by multiple participants one by one, including development unit, design unit, costing unit, construction unit and supervision unit, which results in a long cycle and easily causes errors. With this iTWO platform software, multiple participants can work with the same system and the same model to noticeably improve the efficiency. The practice has the following features: 1. Changes are managed by coloring differently; 2. If any change occurs, the corresponding part of project schedule is adjusted to update the revenue and profit of the project automatically; 3. A bill file is generated correspondingly by filling the progress of completing the requested change to the plan; 4. The quantity of changed works and estimated cost can be presented visually to realize the traceability of data; 5. The influence of change can be reflected through 5D simulation; 6. The management of various changes is supported, including hole digging, size change, material change, construction change, demolition change, and list change.

Figure 8. Comparison of Equipment Pipe before and after Change (removal in red and addition in yellow)
Through combination of high-precision BIM model and iTWO platform software, the application for project progress payment can be managed accurately. In the traditional model of project management, the progress payment transaction may be handled after the application is jointly confirmed by multiple participants including development unit, construction unit and supervision unit, etc. and the costing unit determines the specific amount. With this iTWO platform software, all these participants can work with the same system and the same model to improve the efficiency considerably. The practice has the following features: 1. The account is kept based on 3D model and bill of quantities calculated, and the receipts and payments are made visibly; 2. Accounting data and project data can be connected consistently; 3. It can automatically calculate the time needed and the budget of planned activities, and automatically create the file of progress payment application; 4. The statement can be customized as regards requests for payment.

![Diagram of Construction Status of Equipment Pipes](image)

**Figure 9.** Diagram of Construction Status of Equipment Pipes (constructed pipes in green and not constructed pipes in red)

4. **Conclusion on BEM and Real-time and Interactive Project Management**

As revealed in the practices, the BIM technology can be greatly expanded into all aspects of building project. To guarantee the transmission and addition of data and information in the whole life cycle of building project, work must be carried out under the unified standard, so the standard followed in the design stage should be based on the unified standard.

At the design stage of the Scientific Research Office Building of China United Northwest Institute for Engineering Design & Research Co., Ltd., the energy information is written into the BIM model for green building simulation analysis, and this application is also expanded into the construction stage. With the 3D model, the design is optimized to improve the quality of design and reduce the unnecessary cost. By combining the high-precision BIM model with iTWO software, the real-time and interactive project management is realized to achieve the intuitive cost control during the process of project implementation.

The application of BIM technology has changed the traditional architectural ideas, and the successful implementation of the project has provided precious experience for the application of the BIM technology in all kinds of comprehensive public buildings.

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