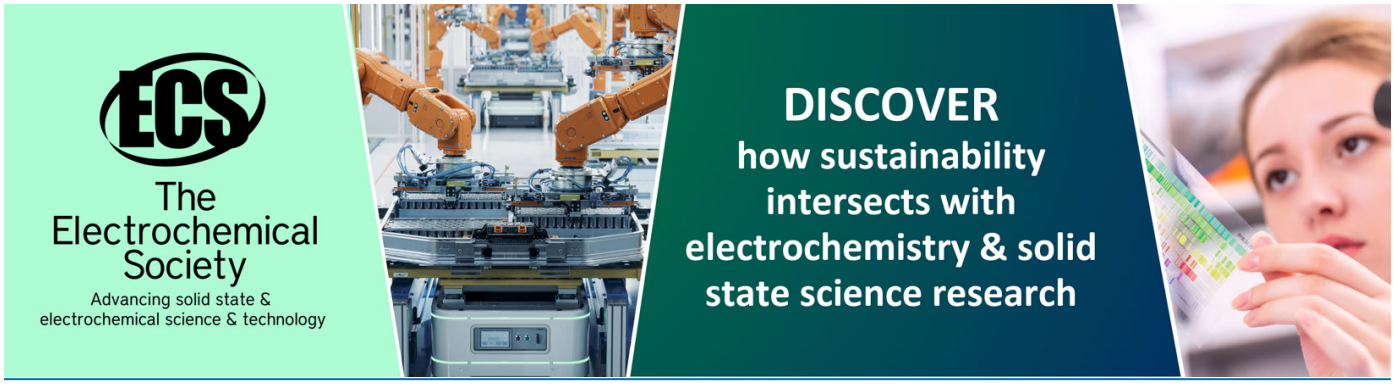
The Application of BIM Technology in a Comprehensive Experimental Building Project



The Application of BIM Technology in a Comprehensive Experimental Building Project

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Abstract. Taking an experimental comprehensive building project as an example, with BIM technology, an accurate virtual model of a building is digitally constructed. This model, known as a building information model, can be used for planning design construction, and operation of the facility. It helps architects, engineers, and constructors visualize what is to be built in a simulated environment to identify any potential design, construction, or operational issues. It explains the application value of BIM technology in engineering project, which indicates the application of BIM technology in engineering project is the trend of future development of construction industry.

1. Introduction

An engineering experimental complex building is located in the Economic and Technological Development Area of Hefei, occupying a total construction area of 6028 square meters, of which the civil defense construction area covers 4678 square meters. The basement of the building serves as a parking lot. The 23 stories aboveground are mainly for teaching and administrative purposes. The building adopts a reinforced concrete frame structure. Its nature as a teaching building requires it to be of high quality. Adopting the BIM technology in its design and construction not only accelerate the design, the construction and the fitment of the project, but also largely improves the quality of the building and reduces the production cost.

2. Cost management of the BIM technology in the experimental complex building

In the experimental complex building project, we estimated the workload and its cost through the BIM technology in order to calculate the composite cost. Then we compared and analysed similar data models from previous projects.

This project takes into account these models and the statistics they contain to determine the cost budget, which increases the accuracy of the budget and, at the same time, saves a great amount of manpower and material resources.

In the final phase of the design process, the BIM technology can quickly conduct an analysis of the building's structure, and determine whether or not it meets the actual requirements. It serves as an effective reference and may improve the overall level of the cost management.

During the cost management process of construction, most construction units tend to pay part of its bill first, and then pay the remaining at the end of the month based on the actual workload. This approach has certain shortcomings. The personnel departments in construction units usually find it hard to gather and calculate total workload precisely, leading to a series of financial disputes. Through the BIM technology, we can easily keep a record of the actual workload and calculate immediately to ensure the construction payment is issued correctly and in a timely manner [1]. During the final settlement phase of the project, in some cases, the drawings are problematic, or there is a lack of drawings or other engineering recourses. As a result, the project is hard to be settled. However, the BIM technology establishes a data model, allowing us to smartly manage drawings and other materials, store them permanently and find them precisely whenever needed. Therefore, with the help of the BIM technology, we ensure that all materials are complete, reduce the possibility of losing drawings and other recourses, and facilitate the efficiency the manpower. The technology benefits significantly the overall cost management of the project [2].

3. Application of BIM Technology in the Design and Construction Stage of Experimental Complex Building

3.1. Application in the design of engineering projects

In the design process of the experimental complex building project, the designer shall make relevant design plans and design drawings according to the requirements of the owner. Previous design drawings were presented in a 2D flat pattern, making it difficult for construction companies to determine whether they meet actual needs through 2D drawings. However, using the visualization function of the BIM method, the related software such as Revit is used to build the architectural model of the engineering project (Fig. 1), the structural model (Fig. 2), and the electromechanical model (Fig. 3). In this way, the construction company can observe the actual layout of the construction project more intuitively, and can communicate with the design department better. The designer will formulate a design plan that meets the requirements of the construction companies more closely [3]. In addition, during the design process, we transferred the established Revit model into the Navisworks software and used its collision check function to perform collision analysis (Fig. 4), look for possible design problems in 2D drawings, and then make corresponding adjustments to reduce the rework caused by later design conflicts [4][5]. We can also combine BIM technology with cloud technology so that designers of architecture, structure, and electromechanical can upload their professionally built BIM models to the BIM design platform, with which professionals can share information with each other, making it easy to complete the design efficiently and accurately, as well as reducing the labor intensity during the design stage and the time spent on design conflicts.

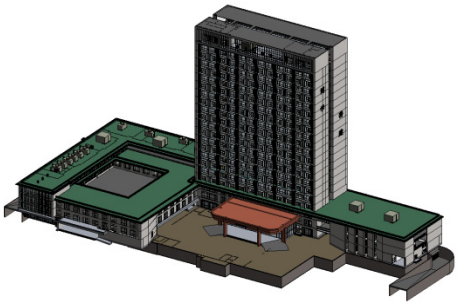

Figure 1. Architectural model

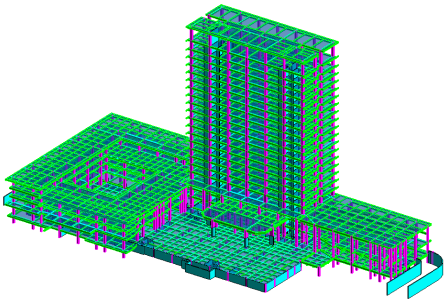

Figure 2. Structural model

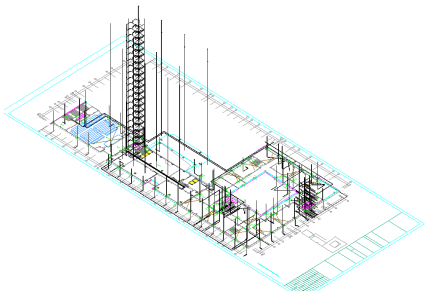

Figure 3. Electromechanical model

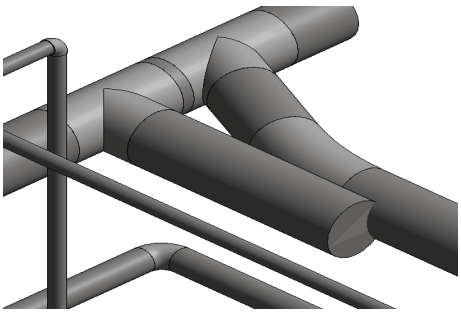

Figure 4. Pipeline collision

3.2. Application in the construction of engineering projects

During the construction stage of the construction project, due to the mechanical equipment, construction transport vehicles of the construction site, and complicated driving route of vehicles, therefore, through the simulation technology of BIM, we carry out 3D visual simulation of the construction process of the site (Fig. 5), simulating the tower crane transportation and construction process (Fig. 6). At the same time, we adjust and optimize them to ensure that there will be no errors during the construction process. We can also simulate emergencies that may occur during construction, optimize the established safety precautions, and eliminate potential safety hazards. It is also possible to optimize the driving route of the on-site vehicle to improve the construction efficiency of the construction project. In addition, we combine 3D-BIM technology with time and resource dimensions to further form 5D-BIM technology. Using 5D-BIM technology for construction simulation, we can understand the construction plan, construction progress and various resources in the construction process more intuitively. It is also possible to optimize the already completed construction plan rationally, thereby reducing the waste of resources and time in the construction process and saving the comprehensive cost of the project [6].

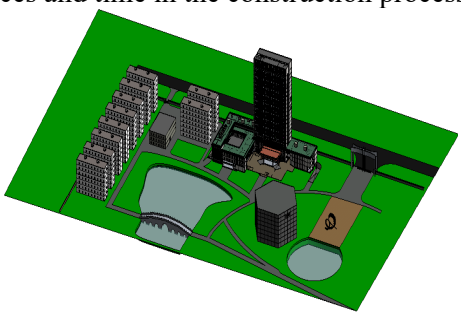

Figure 5. Site layout

Figure 6. Transportation and construction process of the tower crane

3.3. Application in the final account of the project completion

In the final account of the project completion, the usage of BIM technology can change the form of final account of completion. With BIM software, you can adjust the spatial position between components precisely, and change its geometrical dimensions and attribute parameters, which not only improves the quality and progress of the final account greatly, but also effectively reduces the workload of the designer [7]. Designers use BIM related software to parameterize the project engineering information, which greatly increases the transparency of the drawing review (Fig. 7). When you change the design drawing, you only need to change the parameters of the corresponding component in the BIM model, and the corresponding data in the component list will be updated accordingly. Therefore, the probability

of error in design caused by the slow update of engineering project information will be reduced, which saves a lot of manpower and material resources [8].

4. The Application of BIM Technology in the Decoration Project of a Comprehensive Experimental Building

In the decoration stage, the wall, column, floor and the ceiling could be rendered after the three-dimensional visualization model of each decorative component in the interior is established using BIM technology (Fig. 7). In this way, the project's decoration design could be carried out intuitively to meet the requirement of the project as cutting the architects' time and efforts to a great extent. As professional architects were not able to share information before BIM came into being, conflicts often occur during design. For example, decorative components and electromechanical components or other equipment were found conflicting with each other in the actual construction process, which requires rework, resulting in added construction costs. The probability of such problems can be greatly reduced with the use of BIM technology as architects can not only share information, but also carry out collision analysis using the visualization technology and the collision function to find and improve the components which may collide with each other so as to increase efficiency in design and construction.

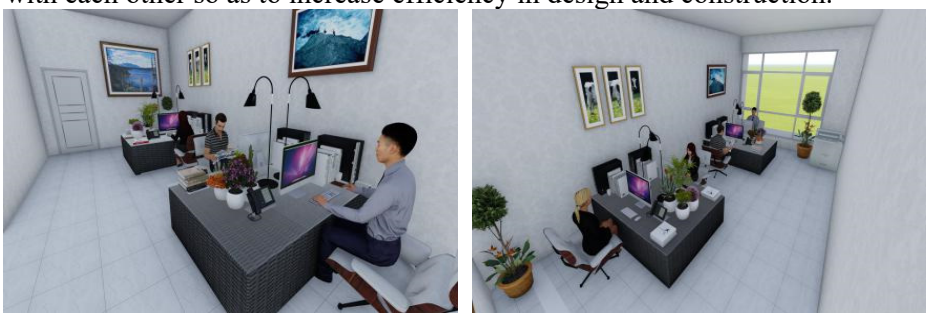

Figure 7. The interior rendering of the comprehensive experimental building

We can import the component base made by relevant software in BIM into BIM model. Then put furniture, electrical appliances and other equipment into place and complete the final three-dimensional renderings. In rendering BIM models, architects can carry out comparative analysis from different perspectives through changing the material, colors of the components and set up all kinds of light colors and adjust the anger of the light. And finally finish a high quality rendering. Details are crucial in rendering. The finer the detail processing not only make the decoration design more specific, clear and intuitive, but also make the final picture and animation more real. Otherwise it would fail to draw a real and vivid picture (Fig. 8). The rendering function of BIM technology fully demonstrates its visualization, coordination and simulation.

Figure 8. The outdoor rendering of the comprehensive experimental building

5. The application of the BIM technology in the operation and maintenance stage of the comprehensive experimental building project.

Firstly, the designer combine the BIM technology with VR virtual technology, which allow the related staff of constructing enterprise enter into the different parts of the inner building to observe the

arrangement of the equipment of all kinds of space as lobby, classroom, meeting room, office as well as restroom fictitiously, then they can require the designer to adjust the design scheme according to their own intention which can satisfy their own needs. Secondly, when the equipment of the building damaged or the leak of tube happened, the former ascendant analyse the program by the 2D drawing and related engineer materials, which is hard to find the problems correctly and rapidly. But we can find the broken equipment or the valve of tube by the technology of BIM, then according to the digital record of BIM to find the parameter of specification and size to maintain and protect it timely so that avoid the larger of the loss. Thirdly, the fare of the phrase of usage of general buildings will exceed the cost of building them after several year's use, so the energy consumption analysis of the building can provide huge economic profit for the operation and maintenance stage of the project. We can add the RFID label to the construction parts of the building, then combine with the BIM technology to find the high consume parts of the building and analyse and record of the data in order to maintain the building conveniently later. Fourthly, the technology of BIM can imitate the safe emergency accidents. We can make the proper scheme of the emergency solution by drill to improve the safety sense under the emergency accidents which can decrease the casualties and economy loss, for example, make the precaution measures to deal with fire and earthquake as well as the withdraw routine of staff and so on. The application of BIM technology in the operation and maintenance stage of this comprehensive experimental building project fully shows the characteristics of its sustainable utilization.

6. Conclusion

In recent years, BIM technology has been widely used in modern buildings, especially in the cost management, construction, decoration, operation and maintenance of project engineering. BIM technology provides architects with a 3D visualization model, in which architects can identify the problems that may occur in actual engineering projects through observation and analysis of the model. So they can solve problems in time and make reasonable adjustments to the design drawings. The technical construction simulation in BIM technology can provide virtual guidance for the actual construction process to help optimize the construction plan, eventually avoid the construction delay and economic loss caused by construction errors. BIM technology can quickly and accurately calculate the engineering quantity, which is convenient for the construction enterprise to follow up the construction progress and calculate the construction cost. BIM technology can also facilitate management personnel to carry out maintenance and repair in the later operation and maintenance of the project, and develop a reasonable and effective safety emergency plan. Therefore, architects should attach great importance to BIM technology. At present, the application of BIM technology is in an early stage, so only part of its application value in architectural engineering has been developed, which calls for more in-depth research and development. I believe that the application of BIM technology in architectural engineering will make full use of building information, and the value created by it will definitely lead to new changes in the construction industry.

Acknowledgments

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