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To cite this article: Xiaojie Wang *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **234** 012007

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Research and Application of Dynamic Construction Management based on BIM5D

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Abstract. With the development of the construction industry, traditional construction techniques and management methods can no longer meet the requirements. In recent years, BIM technology has become a hot technology in the construction industry, which has been greatly promoted and supported by the country. In this paper, BIM5D technology is comprehensively applied to the three-dimensional (3D) model construction, construction dynamic simulation, schedule planning management, engineering quantity calculation and cost management, quality and safety management of practical engineering. The results show that construction dynamic management based on BIM5D can reduce construction changes, shorten construction period, control cost and improve quality.

1 Introduction

With the increasing complexity and technology content of the project, the traditional construction technology and management method cannot meet the requirements of the project. In recent years, BIM technology has become a hot technology in the construction industry, which has been greatly promoted and supported by the country. Building Information Model (BIM) is defined by international standards as "shared digital representation of physical and functional characteristics of any built object" [1-2]. During the 11th five-year plan period, "research on the next generation building engineering application software based on BIM technology" was listed as the key research work. During the 12th five-year plan period, "accelerating the application of new technologies in engineering such as building information model (BIM) and collaborative work based on web" was listed as the development focus[3]. During the 13th five-year plan period, it is proposed to comprehensively improve the informationization of the construction industry, enhance the integrated application capability of BIM, big data, cloud computing and other information technology, establish project management information system based on BIM, carry out BIM foundation application and high-end composite application in the construction stage. The government's emphasis on BIM applications and the launch of relevant national standards indicate that the application of BIM in China's construction industry will develop rapidly. In the next few years, the application of BIM in China will show a big promotion and development.

The United States is the earliest country to develop BIM. China's BIM technology started relatively late compared with the United States, but it has developed rapidly. The SATI3.2 software was used to analyze the relevant literature of BIM in CNKI database and Web of Science database from 2016 to 2018. The results show that the research hotspots of BIM in China include BIM technology, application, informationization, deepening design, high-rise building, management, visualization, steel structure, construction, Revit, collision inspection, construction simulation, green construction, collaborative design, GIS, IFC and etc. The research hotspots of BIM in foreign include construction,



interoperability, IFC, management, BIM technology, modeling, collaboration, sustainability, point cloud, GIS, analysis, laser scanning, HBIM, green building, virtual reality, photogrammetry, cloud computing and etc. With the development of the construction industry, BIM technology should mainly go through three stages in the construction industry. The first phase is 3D-BIM, which is used for program review, fire simulation and energy analysis in the planning and design phases, and facility management in the operation phase ; the second phase is 4D-BIM, which is used for schedule, cost, quality, safety and carbon emission measurement in the construction phase(3D+time)[4]; the third stage is 5D-BIM, which is used for construction simulation, quality tracking and management, schedule control and cost control in the construction phase (4D +cost)[5].

Construction dynamic management based on BIM5D can provide data support for project progress, cost control and material management make use of the visualization and computable analysis of the BIM model. It can realize information sharing and assist the fine management and effective decision-making through the mobile phones, PC and Web three-terminal so as to achieve the purpose of reducing construction changes, shortening construction period, controlling costs, and improving quality[6]. In this paper, BIM5D technology is comprehensively applied to the three-dimensional(3D) model construction, construction dynamic simulation, schedule planning management, engineering quantity calculation and cost management, quality and safety management of practical engineering.

2 An application Example of Dynamic Construction Management based on BIM5D

2.1 Engineering Situation

The project is a ten-storey office building. It is reinforced concrete frame structure, and the exterior wall of the building is mainly composed of glass curtain wall and aluminum curtain wall. There are 9 floors above ground and the building height is 48.9m, and one floor underground and the building height is 4.5m. The total construction area of the project is about 79,947 m², of which the above-ground building area is about 68,080 m², and the underground building area is about 11,867 m². The project uses BIM5D technology for dynamic management of engineering construction. The Autodesk Revit software was used to establish three-dimensional model, the Glodon GCL and GGJ software were used to calculate engineering quantity, the Glodon GBQ software was used to calculate cost, the Glodon GCB software was used to carry out the construction site layout, the Microsoft Project software was used to prepare the construction schedule, the Glodon BIM5D software was used for model integration, construction simulation and schedule management, cost management, quality and safety management, etc. The dynamic management process of BIM5D is shown in figure 1.

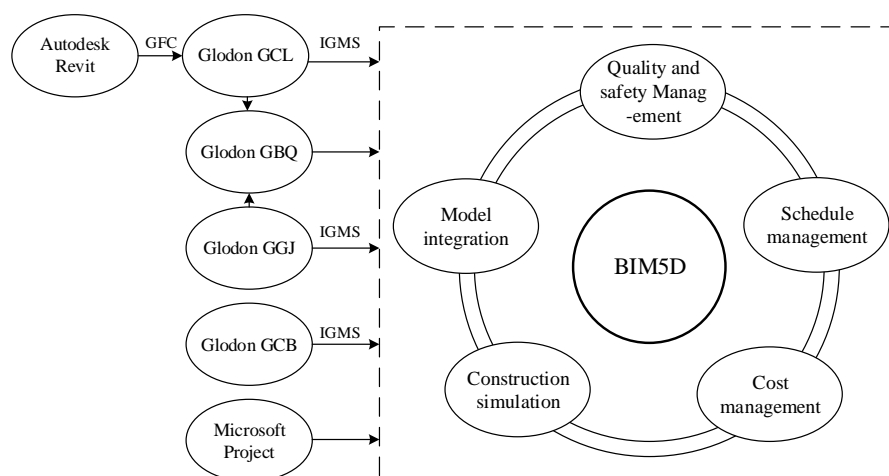


Fig.1. The dynamic management process of BIM5D

2.2 Building the 3D model

Fig.2 is the 3d model established by the Autodesk Revit software. It is the basis of BIM, which can automatically generate all kinds of drawings and part list by the project. The 3d model includes engineering data of various information related to the construction project. This information is used in the project whole life cycle, which greatly saves the repeated input time of all information and improves the utilization rate of all information. The visualization of the 3d model makes it easier for project involved parties to understand the design intention. It is conducive to the command and operation of the construction site. Collision check of 3d model can find modeling errors or drawing design problems, timely eliminate various kinds of collisions and communicate with the designer to solve drawing problems. It reduces design changes and prevents rework.

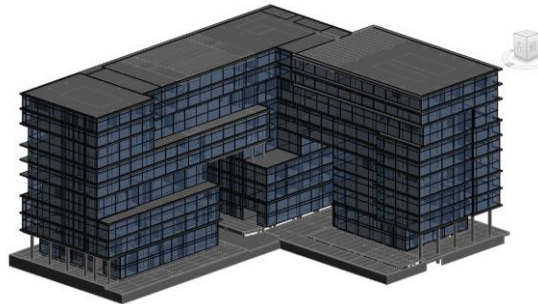


Fig.2. The 3d model established by the Autodesk Revit software

The Glodon GCB software can arrange the construction site according to the principle of construction plane layout, view the layout of components in three dimensions, automatically generate engineering quantity and conduct a reasonable check on the layout of the site. According to the results of the inspection, check the problems in the site layout, adjust and modify the existing problems and continuously optimize the layout of the construction site. Construction site layout based on BIM solves the problem that the traditional construction site layout cannot meet the requirements of each construction stage at the same time. It also solves the problem of rearranging the temporary construction sites during the construction process, avoids putting more manpower and material resources into the transportation and demolition work, saves the construction period and reduces the cost at the same time.

The Glodon calculation model and construction site layout model were imported into BIM5D software in igms format for matching and integration. The completed integration model is the application basis of BIM. It forms a deliverable completion model for the owner. It is a mobile project data station and a precious project file for the construction unit.

2.3 Construction Dynamic Simulation

According to the construction characteristics and requirements of the project, the Microsoft Project software was used to compile the construction schedule, and reasonably allocate personnel, materials and machinery resources. The schedule prepared by Microsoft project was imported into BIM5D software. The construction process of the model in BIM5D is divided according to schedule document. The construction schedule is associated with the model in BIM5D to achieve construction simulation, capital consumption and cost analysis.

The dynamic simulation of construction can find out whether the progress plan is reasonable in advance, so as to optimize the adjustment and reduce the construction period. It can also automatically generate capital and resource consumption curve, intuitively feedback funds and resource consumption, and understand the changes in people, materials and machines in real time. Therefore, we can arrange in advance as needed to ensure a balanced supply of resources.

2.4 Construction Schedule Management

The project visual elevation drawing corresponds to construction schedule work area to implement the schedule management. After the actual working time is entered, the work area will display the

completion status of the project, and different completion status will display different colors. The schedule management can keep track of the progress of each production task and accurately grasp the state of the components. The actual completion status is compared with the planned completion status of the project construction. It can accurately understand the progress deviation, prevent the abnormal status of progress and production in advance, so as to reduce the idling of the labor force and the risk of construction delay. When the progress problem is found, the relevant data should be sent to the cloud, notify the responsible person to deal with them in time. After the problem is solved, the relevant data should be sent to the cloud for the convenience of progress management and query. The schedule management can visually see that the state of the project during the entire construction process. It can also adjust the project construction in time to ensure the smooth completion of the project.

2.5 Engineering Quantity Calculation and Cost Analysis

The Revit model transformed by the GFC plug-in is imported into the Glodon GCL software. It matches the list and the quota, and performs the summary calculation of engineering quantity to form the calculation model. After the summary calculation of the engineering quantity is completed, the quantity of the components and the engineering quantity can be obtained. The calculation file formed by the summary calculation of the engineering quantity is imported into the Glodon GBQ software. The rate and tax are filled in and the price is calculated. The reports are exported and the bidding documents are compiled. The cost documents formed by Glodon GBQ software are imported into Glodon BIM5D to implement cost management.

The cost budget is associated with the 3D model. It can analyze the engineering quantity of components, the material consumption and budget cost in any construction section. Materials and funds can be inquired according to time, floor, construction section, schedule, etc. The materials department can conduct material procurement and guide materials approach according to statistical tables of different requirements. It avoids secondary handling, reduces material loss, saves capital and labor costs, and improves work efficiency.

2.6 Quality and Safety Management

Quality and safety management is an important part of project management. Quality and safety correspond to time and model according to different classifications to implement problem tracking. When meeting constructing quality and safety problems, the relevant data should be sent to the cloud, notify the responsible person to deal with them in time. It can automatically produce rectification notices, record the whole process and share the information in real time. Therefore, it greatly improves the efficiency of the project's alteration. According to the collected shared information, statistical analysis is carried out on multiple problems to improve the construction plan. It can prevent similar problems from appearing again, reduce rework and improve construction quality.

3 The Application Value of BIM5D in this Project

3.1 Reduce Rework

Through the collision check of 3D model can find problems in the design ahead of time to reduce design changes and avoid rework. The reasonable solution to the problem can be proposed before the construction, which reduces the possibility of manpower, material loss and rework caused by mistakes or inefficiencies in the construction process. The 3D model solves the problems of serious crossover of different majors' design, low production efficiency, low construction efficiency, high construction cost and serious waste of resources in the traditional construction process.

3.2 Shorten Construction Period

The construction site layout based on BIM can check the rationality of the field layout. It can avoid putting more manpower and material resources into the transportation and demolition work, and save construction time. Through the construction dynamic simulation, it can find out whether the schedule is reasonable in advance, so as to optimize the adjustment and reduce the construction period. Through the progress management can promptly grasp the progress of each production task, accurately

understand the progress deviation, and prevent the abnormal status of progress and production in advance, so as to reduce the idling of the labor force and the risk of construction delay.

3.3 Reduce Costs

Through the construction dynamic simulation can automatically generate the capital and resource consumption curve. It can intuitively feedback the consumption of funds and resources, and understand the changes in demand for funds and resources in real time, so that arrangements can be made in advance to ensure the balance of resources supply. Through the cost management, materials and funds can be inquired according to time, floor, construction section, schedule, etc. The department of materials can conduct material procurement and guide materials approach according to statistical tables of different requirements. It avoids secondary handling, reduces material loss, saves capital and labor costs, improves work efficiency and reduces the cost.

3.4 Improve Quality

Through the collision check of 3D model can find problems in the design ahead of time and correct promptly. The reasonable solution to the problem can be proposed before the construction, which improves construction efficiency and project quality. Through the visualization of 3D model, the construction personnel can accurately understand the design intention and the detailed nodes, construction difficulties and safety hazards are clear at a glance, so as to improve construction quality and management efficiency. In quality and safety management, statistical analysis is carried out on multiple problems according to the collected shared information to improve the construction scheme. It can prevent similar problems from appearing again, reduce rework and improve construction quality.

4 Conclusions

In this paper, BIM5D technology is comprehensively applied to the 3D model construction, construction dynamic simulation, and schedule planning management, engineering quantity calculation and cost management, quality and safety management of practical engineering. The research shows that construction dynamic management based on BIM5D can identify problems and solve problems in advance, reduce rework and improve project quality. The construction schedule can be finely controlled to shorten the construction period and reduce the risk of construction delay. The materials can be quickly and accurately extracted and purchased as needed. It avoids secondary handling, reduces material loss, saves capital and labor costs, improves work efficiency and reduces engineering costs.

Acknowledgments

The study was partly supported by the National Key Research and Development Program of China (2016YFC0401409), The National Natural Science Foundation of China (51509201, 51679188), Natural Science Basic Research Plan in Shaanxi Province of China (2018JM5031) and Teaching Research Project of Xi'an University of Technology (xjy1774, xqj1514).

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