

Construction Safety Management Mode with BIM as Its Core

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Abstract: With rapid development of economy in China, the construction of the project has been increasing continuously. In the process of construction, accidents occurred every year, and loss of life and property are difficult to estimate. The traditional model is unable to accurately report the real situation of real-time construction. Thus, it is necessary to have a more efficient, high-tech security integrated management approach to conduct a comprehensive, systematic and modern management, which is BIM as the core security management model.

Key words: Construction, safety, management, BIM

According to the Ministry of Construction website, in 2016, there are a total of 634 housing safety accidents, and 735 deaths, an increase of 192 cases from the same period last year, the number of deaths increased by 181 people with increase of 43.44% and 32.67%, respectively. The safety accidents in construction industry are after the dangerous chemicals and mining industry, seriously hampered the sustainable development of the construction industry. In the process of project construction, we should strictly implement the principle of “safety first, prevention first, and comprehensive management”, adhere to the standardization of safety production as the basis, and adhere to the technical and technological guidance. So that the safety accidents frequency will be reduced. Therefore, it is necessary to use Building Information Modeling (BIM) as the technical means to construct the time and space model of the construction project in the process of the safety management of the construction project, and to carry out time and space management of the safety management of the construction project.

1. Origin and characteristics of BIM technology

1.1. BIM origin

BIM originated in the United States¹. The object of BIM is the building, which is a technology to improve management

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efficiency. BIM will fundamentally solve the problem of information fault at all stages of planning, design, construction and operation, realize the effective utilization and management of engineering information in the whole life period, and seek to change the traditional design way to meet the market demand of construction information. In Europe and the United States, the number of BIM projects have exceeded traditional projects and have developed their own design standards, such as the US BIM Project Implementation Plan Guidelines, the UK BIM Industry Application Standards, and the Australian National Digital Simulation Guide.

1.2. BIM technical characteristics

The BIM is a basic engineering model based on 3D digital technology. The BIM integrates various related information of construction projects. It is a detailed digital representation of the project information. Each participant of the construction project can obtain the management information needed by the model in the whole life cycle of the project and can update, insert, extract and share the project data, so as to realize the collaborative management and improve the efficiency of project management.

BIM is essentially software for the construction and related industries, and the future development of BIM depends on the development of technology. Technical support of BIM mainly includes two aspects:

- **Uniform data standards.** BIM needs to exchange information among various software in the whole life cycle of the building, such as CAD software, performance analysis software, construction management software, operation management software and audit WEB platform. The software may be developed by different software vendors and built on different technology platforms. To make these softwares extract the data from each other, it is necessary to form and adopt a unified BIM data standard.
- **Powerful software platform.** Provides an integrated interface for a variety of software.

2. BIM technology in the application of construction safety management

As a result of long cycle, large investment, involving a wide range of work and other characteristics, any neglects in the construction process may cause quality problems, delay, and more likely to lead to security incidents. BIM as the core of the security management model aims to reduce the accident in the construction process. The traditional way is unable to accurately report the real situation of real-time construction. Hence, it is necessary to have a more efficient, high-tech security integrated management approach to the construction project. Comprehensive, systematic and modern management are the security management models of BIM.

2.1 BIM and temporary facilities

Temporary facilities for the construction of the service, and its layout will affect the construction of the safety, quality and production efficiency. The 3D model of all the virtual temporary facilities are useful for the construction unit and can be achieved by the temporary facilities and the use of arrangements. Moreover, it helps the construction unit to accurately estimate the required resources in advance, and to assess the safety of temporary facilities, whether it is easy for construction, and to find possible design errors. According to the construction plan, the safety production process is decomposed into maintenance and working materials to build the model, size, weight, connection, and layout form directly to the form of modeling to express the choice of construction equipment. The equipment determines the construction method equipped with personnel through modeling and can help the construction staff in advance to have an intuitive understanding on how to study and install in-depth study (Figure 1).

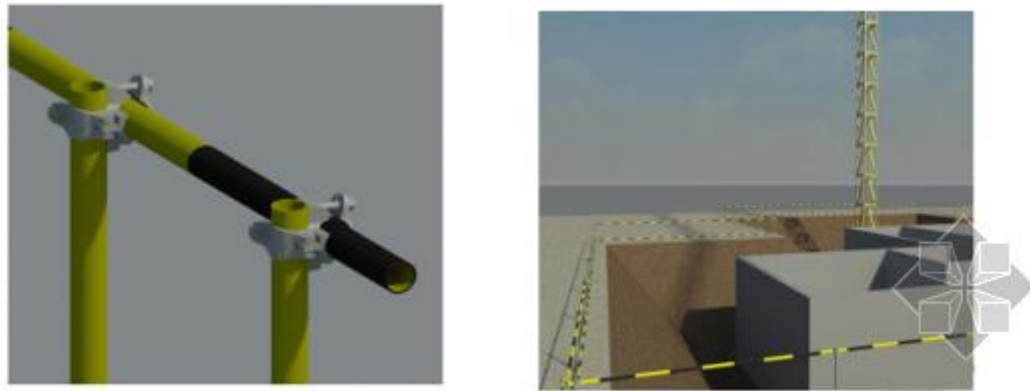


Figure 1 Schematic diagram of the installation of the fence of a pit

2.2 BIM and the construction site layout

Before the operation, the first detailed construction site survey is conducted according to the program to focus on the construction site to solve the overall planning, site entry location, the location of the material area, the location of the lifting machinery and dangerous areas and other issues to ensure safety of building components in the lifting machinery during operations. The use of 3D modeling, model construction process, component hoisting path, dangerous areas, vehicle access to the scene, loading and unloading situation.

Construction site virtual 3D model can be intuitive and convenient to analyze the limitations of the scene to identify potential problems, the development of feasible construction methods which is beneficial to improve the efficiency, reduce the possibility of loopholes in the traditional construction site layout method, early detection of construction design and construction program problems, and to improve the construction site productivity and safety. The construction of the overall plan is a more important one in layout, the tower crane arrangement will directly affect the progress of construction and safety. Tower crane layout mainly considers the coverage, installation conditions and removal. In the layout of the process, the general construction unit of the first two are generally done relatively well, and often overlooked the final removal. As the tower crane can be a section of their own rise, the rise of the process without the constraints of the building, and when the demolition is not the same, the cantilever constraints, weight constraints, road constraints, and some unexpected factors. Some of these factors may not be considered in the construction project and there is no overall layout of the space. Through BIM, the tower crane in accordance with the entire building space to arrange and demonstrate, will greatly improve the rationality of the layout. Then, by linking other models, such as construction roads, temporary processing sites, raw material storage sites, temporary office facilities, drinking water, toilets, temporary power supply facilities, lines and so on. The use of BIM technology will make the construction of the general layout plan is like a canvas. According to different programs using different arrangements, the effect is more intuitive, more quickly and more accurate, but also greatly reduced the previous construction of the total floor plan of the huge modified workload (Figure 2).

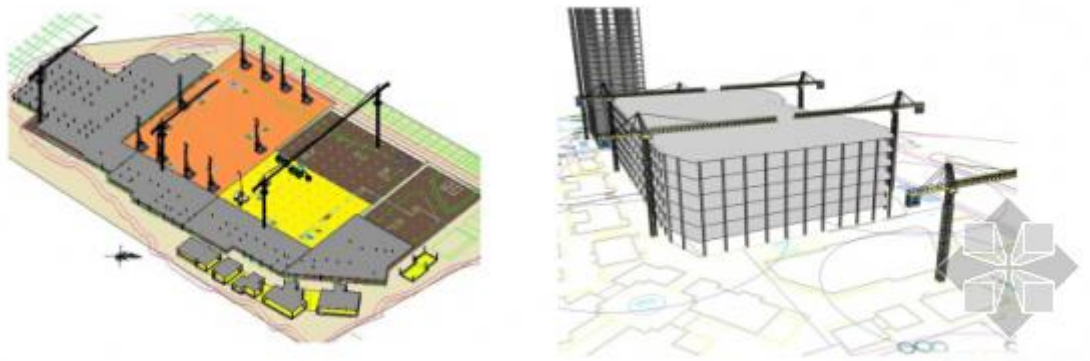


Figure 2 On-site layout and tower layout

2.3 BIM and remote video monitoring

2.3.1 Monitoring of construction site by using BIM 3D simulation

Through the BIM 3D simulation platform, the virtual engineering safety construction of the entire project during the construction of the security management can be visual management to achieve true simulation. Through this method, the project manager can make it clear before the next step of the construction, and understand their work functions to ensure that the safety management process can be orderly managed in accordance with the construction program for organized management. To understand the use of resources on the scene and to control the scene of the safety management environment, it will not only increase the predictability of process management, but also promote effective communication in construction projects. It can effectively assess the construction methods, identify problems and solve problems. The real use of PDCA cycle is to improve the safety and control of engineering capacity. So that it can change the original traditional construction organization model, work processes and construction plans.

2.3.2 Modeling of BIM technology

The simulation of the whole process enables the safety, technology and construction management of the project to understand each step of the construction process, the whole process into a step by step construction activities. The process of thinking clear can find the problem and put forward a new method of solving, and for its new method to simulate the feasibility of verification, so that the construction can be done before the vast majority of construction risks and problems can be identified, make effective control in advance, and successfully solve the existing problems.

2.3.3 Modeling

The modeling of the construction process allows the entire process to be visualized, and the 3D effect allows the person who does not have the ability to understand it to see what is going on. This will greatly facilitate the exchange of information among project participants. It can also increase the project participants in the project content and complete the project with understanding of measures. Visualization of the construction process makes BIM a platform for communication to facilitate the participation of all parties. This visual simulation shortens the site staff familiar with the project construction content, method of time, and reducing the site staff in the early construction. In addition, it speeds up the depth of the training of engineers to participate in the speed and depth of the real quality, safety, progress, cost management and control of everyone involved.

2.3.4 BIM Visualization

BIM can also provide visualization of the construction space. BIM visualization is dynamic, where the construction space with the progress of the project will continue to change. It will affect the efficiency of workers and construction safety. By visualizing the construction status of the staff, you can visually see the situation of the construction work

surface and the construction machinery position and evaluate the usability and safety of these work spaces in the construction progress.

In conclusion, many construction units have not yet clearly recognized the BIM to improve the industry safety. However, many construction enterprises have further understanding on the BIM for building safety. They generally believe that BIM can effectively improve the quality of construction and control the rework rate, which will reduce the occurrence of accidents to some extent. Besides, it will reduce the construction costs to achieve a safe and secure construction. To the construction process through the model information management, the construction phase of the process can be controlled. At the same time, through the application of information model, the establishment of preventive mechanisms can intuitively regulate the safety of production behavior, so that all aspects of production in line with the relevant safety laws and regulations and standards of the requirements, to promote people, machines, materials, the environment in good condition and sustained, improve, and constantly strengthen the use of enterprises in the safe production process standardization of construction.

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