Effective Application of BIM Technology in Construction Safety of High-rise Buildings

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Abstract: As one of the most common landscapes in modern cities, high-rise buildings have gradually increased in appearances in the construction industry. Being one of the difficult projects in high-altitude operations, high-rise buildings have certain risks and complexities, and longer cycles. Therefore, it is necessary to introduce BIM technology into the construction process of high-rise buildings, which can be beneficial to high-rise building construction projects economically, avoid possible problems and risks, and conserve resources. This paper introduces the concept and basic characteristics of BIM technology, analyses the safety hazards in the construction of high-rise buildings, and points out the applicability and effective application of BIM technology in the construction of high-rise buildings.

1. Introduction

Safety are one of the top priorities in high-rise construction site construction projects. With the rapid development of information technology in modern society, the construction field can be successfully rationalized with the help of modern technology. Taking BIM technology as an example, it is a highly efficient construction system that not only improves the efficiency of on-site construction of high-rise buildings, but also accurately grasps the difficulties of on-site construction. With its capabilities such as visualization, simulation and coordination, optimization, information normalisation, etc., as auxiliary tools, it may help the high-rise building site construction to achieve precise positioning, so that the construction reaches a higher level, hence worth learning.

2. The conception, emergence and basic characteristics of BIM technology

Building Information Modelling (BIM) is the modelling of building information. It refers to the presentation of various information in a building project in the form of a building model. It uses digital information to simulate various data and correlations in real life cases.

In the 1990s, BIM technology was emerging in the United States and Europe, used in ship design, automotive and other manufacturing industries in. Since 2004, BIM technology has spread to China and achieved rapid development in the construction field. Through in-depth analysis of the construction environment and conditions of the construction industry, it timely and accurately sorted out various relevant data, and finally established the basic model of completion information, thus ensuring the smooth implementation of the construction. It can also coordinate and generate data in the initial construction process and propose more optimized design schemes through its own simulation function, which reduces risks in building construction, so it is imperative to use BIM technology, and implements further upgrades.

The basic characteristics of BIM technology are as follows:

(1) Simulation capability. The biggest advantage of BIM technology lies in its simulation. It is exceedingly difficult to do high-altitude construction work, but the work dictates the safety of the whole building. Therefore, before the project construction, we can use BIM technology to do preliminary predictions of potential hazards, by the form of simulating experiment. It can simulate and predict such as the construction of scaffolding, cantilevered shelves, people's goods elevators, tower cranes, or the accuracy of deep pit operations, the evacuation of personnel in emergency situations, the height difference between buildings, etc., then the team may carry out inspection. In

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addition, in the calculation of engineering quantity, BIM technology can help carring out cost accounting on the amount of steel bars and the amount of concrete and the number of water and electricity pipelines at various levels on the construction site, thus creating greater economic benefits for the enterprise.

(2) Visibility. BIM technology can establish a visual 3D model of the on-site construction building, which enables the builder to visually see the prototype of the building, thereby reducing design errors, reducing the difficulty in construction, operation and maintenance, and reducing the cost of rework.

(3) Coordination. BIM technology has made outstanding contributions in coordination. Through collision inspection, it can detect the incorrect component position inside the building, help coordinate and improve it, to improve the design level of the building.

(4) Optimization, based on the above points, BIM technology can provide multiple optimization solutions for building units through the application of Revit software, accurately grasp geometric and physical information, and finally enable designers and builders to optimize their own decision making.

(5) Information output diversity. BIM technology can export all kinds of data information of buildings in various forms, such as using 2D drawings, collision checklists, improvement schemes, pipeline distribution maps, etc., which can then be used by builders to amend the established model. In addition, there are many related software for BIM technology, we can also import the required software by switching interfaces.

3. The major problems faced in the construction of high-rise buildings

The first is that construction is difficult. The construction of high-rise buildings is extremely dangerous, especially in places such as rooftops, stairs, windows, etc., as the difficulty of construction is increased by working at heights. Since construction technology in China is still suboptimal, the professionalism of construction personnel and managers is lacking and their experience is insufficient, in the process of design and construction, there are instances of unreasonable design and construction, waste of manpower and materials. This makes the construction of high-rise buildings face even more scrutiny.

Secondly, the complexity of the engineering system is high. The high-rise building adopts deep foundational structure, with many layers, large area, high cost and potential hidden dangers. Being a complex system, its various internal structure types and composite functions determine its particularity and construction difficulty. For example, the stability of water supply and power supply, the coordination of emergency measures such as fire protection, the difficult application of lightweight high-strength materials, the stability of the foundation, the lighting and ventilation inside the building, and the resistance to water and wind. These are all related to the user experience, and the interests of the company. Accurate measurement in these areas requires the help of professional modern technology.

Thirdly, there are problems in security management. A project is usually carried out by multiple parties. The situation of cross-operation is quite common, and as the progress of the project changes, the flow of personnel and the content of the job will change accordingly. Unfortunately, the management level and requirements of different enterprises are inconsistent, and their considerations on cost, quality, and efficiency of building materials are also inconsistent. This causes loopholes in the safety management of high-rise buildings construction, which directly affects Project progress and construction quality.

4. The applicability of BIM technology

First, the economic applicability of BIM technology. The application cost of BIM technology is comparably high. The commonly used software includes Autodesk's Revit Architecture, structure and system series, Bentley Architecture, structure and equipment series, Nemetschek's ArchiCAD/AllPLAN/VectorWorks, and Dassault's CATIA. Above software is applied in the field

of electromechanical engineering, structural engineering, factory design and infrastructure construction, construction, aviation, aerospace, automobile manufacturing, etc., its use is very extensive. BIM's internal software is costly due to the core technologies involved in various industries. However, despite all above technologies, in recent years, data analysis of safety accidents in the construction industry in China indicates that the number of deaths in housing construction is rising year by year, with a yearly growth rate of 32.67%. In the process of construction projects, there are often several forms of accidents or accident precursors: unsafe behaviour of people, unsafe conditions of objects, accidents, injuries, and the environment. With BIM technology, the chances of a security incident can be reduced, which can also reduce unnecessary losses hence reduce costs. Overall, it can eliminate 40% of the extra-budget change costs, and can shorten the cost estimate time by 80%, which is still more appropriate than not introducing BIM technology, despite its implementation cost.

Second, the technical applicability of BIM technology. It is prominently manifested in the two levels, security model establishment and information sharing communication. BIM technology can comprehensively analyse the potential risks, costs, manpower, materials and schedules in the construction process through the establishment of the safety model, so as to formulate scientific and rational project planning. BIM technology can also ensure the consistency of each building structure and system through information sharing, effectively help decision makers analyse the data, view the construction process from a global perspective, and make optimal plans to ensure the safety of construction projects.

5. The effective application of BIM technology in the construction safety of high-rise buildings

First, the BIM technology is used to safely arrange the construction site. The construction site is usually crowded, the items are messy, and the possibility of 'group tower operation' is quite high, so it is easy to have an accident. After the BIM 3D model's establishment, the coverage and operation of the construction site can be predicted and modelled, so that the equipment can be reasonably arranged, the friction between the various types of work can be reduced, and accidents can be avoided. At the same time, it is also possible to monitor the residential areas, streets and venues around the construction site, and to carry out safety protection measures and emergency evacuation of personnel in advance.

Second, use BIM technology to conduct safety inspections during construction. For example, in the construction process, BIM technology can be used to survey the site, and the weather, hydrogeological environment, human factors, material properties and other aspects, analyse and evaluate them to establish certain safety indicators. This can not only check for safety problems during the construction process, but also protect workers from danger, and ensure the safe and smooth construction. In addition, we should also use the visibility advantage of BIM technology, to model the safety hazards of the construction site, to formulate the corresponding construction plan, and submit the analysis data to the next stage of the constructor. It is even possible to develop automatic protection and security warnings by upgrading Revit's toolset to make security protection more proactive.

Thirdly, using BIM technology to improve security management capabilities. We can use the optimization of BIM technology to carry out rectification and improvement according to the relevant security measures issued by it, to ensure the dynamic management of the whole process. BIM technology has a lot of information related to construction safety. We can use this to carry out construction safety training for personnel, so that staff of different types of work can understand the safety hazards and countermeasures that may occur during operation, and conserve time, energy and money, so that the training is more flexible.

Finally, improve the level of use of BIM technology. China's application and research on the development of BIM technology started late, the professional equipment on the construction site was lagging, and the professionals in construction safety management were scarce, which made the technology not reaching the level it should. Therefore, we should improve the professionalism of BIM technicians to ensure that they can work properly, can understand the visual building

models presented by BIM technology, and can make reasonable analysis and judgment. At the same time, the BIM technology of the construction site needs to be updated in time to ensure that it adapts accordingly with the needs of the times.

6. Conclusion

As an important technological means emerging in China's construction field, BIM technology can greatly improve high-rise building site construction both safety wise and economy wise, by utilising its visualization, simulation and coordination capability. In the future of construction, we should focus on fully developing and rationally applying it.

Acknowledgements

Research on low impact sponge campus construction based on SMWW mode.

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