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Application of BIM Technology in High Formwork Engineering

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Abstract

In recent years, frequent collapses of high formwork have happened all over China. This not only causes great harm to the people' s safety, but also brings huge loss to the country' s property. However, as time goes by, the study on the application of BIM technology in high formwork engineering has become increasingly profound, which has significantly improved its safety and quality. Based on the application of BIM technology in formwork engineering, this article focuses on the application of BIM technology in high formwork engineering, and explores its advantages and values. This article also discusses construction management, safety hazards prevention and construction plan optimization. Besides, the BIM technology also guarantees the smooth progress of a construction project, and thus prevents delays in a construction schedule.

Keywords

BIM Technology; High-formwork; Construction Safety; Application.

1. Introduction

In today's era, with the rapid development of economy, there are more and more high-rise buildings in China's cities, and the height of buildings is also increasing, which brings the safety problems in the construction of high-formworks to the great attention of all walks of life. However, at this stage, China's high formwork construction system is still not perfect, both design specifications and technical standards are difficult to meet the current needs of high formwork construction safety management. However, for a construction project, the high formwork construction is an important part of the building construction, and is also the basis for the smooth construction of the building, so we must pay attention to this part. In the face of the problems existing in the process of high formwork construction, through the full use of the advantages of BIM technology, but can effectively solve these existing problems, and maximize the quality and safety of engineering construction.

2. High formwork engineering characteristics

High formwork support system is generally used as the support structure for the construction of large cast-in-place concrete structures. According to the notice of "Safety Management Regulations for Dangerous Large Component Projects" issued by the Ministry of Housing and Urban-Rural Development of China (Decree No. 37 of the Ministry of Housing and Urban-Rural Development), it is stated that the formwork and support system of any cast-in-place concrete project that meets any of the following conditions can be called high formwork engineering: (1) Construction site The height of concrete member formwork support reaches more than 8m; (2) The erection span exceeds 18m; (3) The total construction load reaches more than 15KN/m2; (4) The concentrated line load exceeds 20KN/m; (5) The height is greater than the horizontal projection width of the support and relatively independent of the concrete formwork support project without associated members.

High formwork support system is usually used in some super conventional cast-in-place concrete structures; common structure types are.

(1) Large span, heavy load, large section of concrete frame structure.

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(2) Concrete conversion beam, conversion slab frame and other conversion layer structures.

(3) The concrete box girders of viaducts.

(4) Large overhang, large cross-section of concrete beams and slabs, etc.

Most of these structures have the characteristics of large span, high self-weight, high height and large structural area, so the mechanical properties and structure of the high formwork support system is very different from the ordinary formwork support system. Its bracket erection span is large, high height, the concrete structure in the formwork has not yet formed strength support system in addition to bear the concrete load, but also to bear their own self-weight, various construction loads, uneven settlement of the bracket Uniform settlement, wind load, etc., bearing the load is not only large and complex. And our country at this stage a large number of use of fastener scaffolding support system due to insufficient bearing capacity, which led to the frequent occurrence of high formwork collapse accidents.

3. problems in the safety management of high formwork construction

3.1 Construction plan preparation problem

Before the construction plan of high formwork is prepared, the relevant technical personnel do not give the corresponding calculation and audit to the site construction conditions and material usage, which leads to the situation that the site construction and the construction plan are separated from each other. In addition, the following problems existed in the construction plan of the high formwork.

(1) Its engineering overview does not clearly express the site construction conditions.

(2) The live load and constant load calculations did not take into account the unfavorable combinations.

(3) The base bearing capacity of the uprights was not tested.

(4) The material stiffness and strength are too idealized and do not match with the actual material conditions on site, such as the material is new or old, the thickness of the steel pipe and the size of the wooden square section.

(5) The bracket and formwork calculation does not consider the load taking value of the project construction thoroughly.

(6) The program is constructed without approval, thus making it difficult to rectify the program.

(7) Even after the approval of the program, the safety technical briefing was not given to the construction personnel on site in time.

These problems encountered in the construction program preparation bring greater safety hazards to the construction of high-formworks, which should be paid attention to.

3.2 Safety technical briefing problems

3.2.1 High-supported mold installation problem

In the time of high supporting form installation, the relevant technical person in charge does not seriously give the technical explanation of the plan in time; in the construction process, the construction operator only relies on the traditional experience to carry out construction, which has a relatively large arbitrariness, leading to a large difference between the actual installation and construction plan, which brings a certain safety hazard problem. There are also more safety and quality problems in the process of construction and erection on site, mainly in the following aspects.

(1) The foundation soil layer of the upright pole is not given compacted treatment, resulting in uneven foundation height, which brings impact to the stability of the upright pole. (ii) The base of the upright is not set, and the upper bracket is used as the lower bracket.

(2) The step distance of the horizontal rod and the row distance of the upright rod do not match the design requirements of the engineering program, when the beam is not taken any effective tie measures above the beam cross square on the side of the floor, but directly add short top. Its steel

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pipe uprights do not match with the specification requirements, and the lap joint method used has an impact on the direct force transmission of the uprights.

(3) Most of the horizontal rods are not tied with the soil columns of the concrete structure already poured, which makes the overall overturning resistance lower, and the distance between the sweeping rod and the ground exceeds the relevant specification requirements. (b) In the longitudinal and horizontal ties, the modulus of the beam-slab uprights was not uniform enough, so that they could not be pulled through to form a whole.

(4) The horizontal and longitudinal scissor braces are not set in accordance with the relevant specification requirements, which has a more serious impact on the overall stability of the formwork supports.

For some force members such as fasteners, steel pipes and wooden square and so on are not sent to the relevant departments for inspection and use directly, so that there is a wooden square cross-sectional size and design requirements do not match. Some units even use the old wooden square to replace the new wooden square, as well as steel pipe material because of the number of turnover or improper maintenance, these problems cause part of the steel pipe bending and rusting serious, resulting in a great impact on the strength.

3.2.2 High-supported mold removal problem

In addition to the problems in installation, there are also some problems in the dismantling of the high-formworks that need attention.

(1) Before dismantling, concrete test blocks should usually be sent to the laboratory for testing, only after the concrete test blocks meet the required strength and after the project supervisor agrees and delivers the bottom line can they be dismantled, but some construction units have dismantled without going through the relevant examination procedures.

(2) In the high support mold for removal, not in accordance with the relevant provisions of the order of removal.

(3) Side formwork demolition, there is no relevant safety protection device, so as not to ensure that the concrete corners and surfaces will not be damaged.

(4) When the formwork above 4m in height was dismantled, no protective railing and operation platform were set up, and the formwork was not dismantled piece by piece, which would easily cause piecewise loosening.

(5) When the bottom formwork of the floor is dismantled, the relevant staff does not do a good job of supervision, temporary support and caution area set up, which may cause casualties due to falling formwork.

(6) When the top formwork is removed, there is no warning sign, caution area or special personnel to be cautioned, or in the process of removal, the formwork and the supporting roof are not installed first and then dismantled and then installed first in the order.

For these problems, if we do not pay attention to management, it will lead to many safety hazards in the process of demolition of high formwork, and it will also threaten the personal safety of construction workers.

3.3 Site management problems

3.3.1 Safety management technology system is not comprehensive enough

At today's stage, it is difficult to really achieve good safety guarantee in the specific link of construction site high-formwork construction. Most of the grass-roots construction workers on site are laborers, and their technical knowledge level is not very high, and they rely too much on traditional experience and construction experience in construction, lacking certain scientific and systematic safety construction guidance, which may lead to the occurrence of accidents. At the same time, limited by the inadequacy of the construction personnel and technical personnel on site, the lack of comprehensive consideration of the environmental impact and hidden dangers around the high

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formwork system, coupled with the lack of advanced equipment for the construction personnel of the high formwork project and the lack of timely remedial measures in the face of unexpected accidents, all of these increase the safety risks in the construction process.

3.3.2 Weak safety awareness

For the majority of construction personnel, they are difficult to fully do self-safety prevention in many construction projects and links, and are generally weak in safety awareness and pay less attention to safety management. For some of the construction personnel with long working experience, most of them feel that they are experienced and will not produce any changes in the construction process, so there is a certain paralysis in the construction safety thinking, and they will not pay attention to their own safety protection, even in the construction links to their own operating experience, ignoring the normality of the operation links. The existence of these problems will pose a serious threat to the safety of construction personnel in the construction process.

3.3.3 Construction site supervision is not in place

At the present stage, China has not yet formulated perfect laws and regulations for high formwork construction system, and compared with other ordinary formwork support system, high formwork system is undoubtedly more difficult in construction, so it puts forward higher requirements for supervision. But in the construction site, for the vast number of engineering supervision units, supervision work is difficult to fully in place. Part of the construction unit in the construction site supervision process, for high formwork construction system is not mandatory to strictly require the supervision of the normative, but to take and ordinary formwork support system supervision strength, thus leading to the site for high formwork construction supervision is not in place, which for the entire construction process increases a certain security risks.

4. BIM technology concept and characteristics

The full name of BIM is Building Information Modeling, which is translated into Chinese as Building Information Model. The so-called BIM is an engineering data model based on three-dimensional digital technology, which integrates various information related to construction projects, and BIM is a digital expression of the physical and functional characteristics of the project facilities. A perfect information model, which can connect data, processes and resources at different stages of the life cycle of a construction project, is a complete description of engineering objects and can be universally used by all parties involved in the construction project. BIM has a single engineering data source, which can solve the problems of consistency and global sharing between distributed and heterogeneous engineering data and support the creation, management and sharing of dynamic engineering information during the life cycle of a construction project. BIM is also a digital method applied to design, construction, and management. This method supports an integrated management environment for construction projects, which can achieve the goals of improving efficiency and quality as well as reducing errors and risks throughout the life cycle of construction projects. And as a building information model, BIM contains the following features: (1) visualization; (2) coordination; (3) simulation; (4) optimization; (5) diagram ability. Based on these features, BIM technology can provide great help to the construction safety management of high-formwork project.

5. BIM technology in the application of high supporting mold engineering

5.1 Safety review of the construction plan

In the pre-construction stage of the project, all the construction plans and construction drawings should be reviewed comprehensively for safety. In view of the complexity of the pole erection in the high formwork project, it is difficult to review comprehensively and thoroughly in the process of review, and it is easy to miss some information of hazard sources, which will lay safety hazards for the later construction. Based on the visualization characteristics of BIM technology, it can combine various professional programs such as architecture, structure, and high-modular construction, etc. On the one hand, through Revit software to form a three-dimensional space model, the construction

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program model to export the collision detection report, and check and modify the existing collision points (such as Figure 1 and Figure 2); on the other hand, by taking photos of the construction site and then image recognition processing, to identify Whether the construction building matches with the construction plan, which allows the site safety officer to see the corresponding construction effect. This not only improves the efficiency of the safety review of the program drawings and verifies the rationality and correctness of the construction program, but also lays the foundation for the monitoring, elimination and prevention of safety hazards.

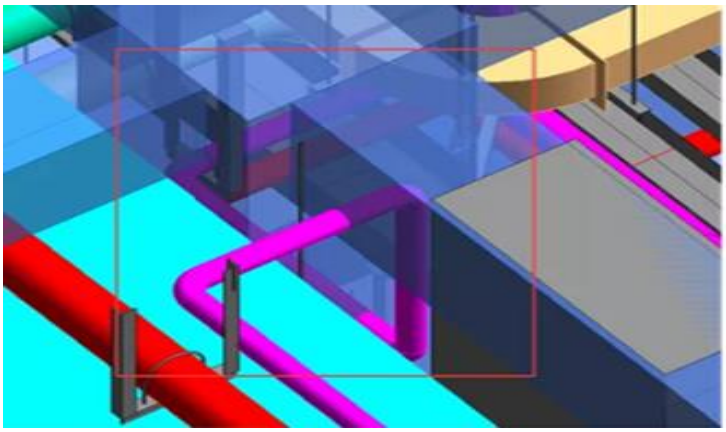

Figure 1. Collision of spraying with beam and column

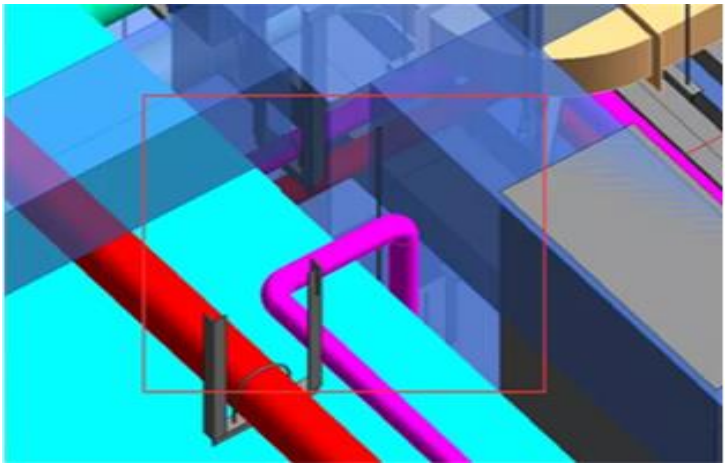

Figure 2. Suggested modification scheme

5.2 Safety technical briefing

In view of the three-dimensional visualization characteristics of BIM technology, it can transform the current two-dimensional plane form of construction measures under the CAD mode of handing out methods, accurately meet the requirements of the program indicators to ensure the smooth implementation of construction. In the traditional construction site safety management process, construction technology briefing mainly through two-dimensional plan and oral expression, there are problems such as misunderstanding of drawings, complex node description is unclear, cannot specifically reflect the detailed construction operation methods, especially in the construction drawings of the high supporting mold briefing, scaffolding bars are numerous, CAD drawings on the dense spacing of the bars marked, it is easy for erection personnel to see the wrong Data lead to the erection of the rod spacing is not reasonable to meet the force requirements and affect the safety. The introduction of BIM in the construction of the high support mold, not only can the construction process of its three-dimensional and animation display, so that the site construction personnel can all-

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round view the layout of each steel pipe points and specific space location (such as Figure 3), and combined with 4D construction simulation at any time to view the points and requirements of the erection, so as to ensure that the scaffolding bars can be completed in quality and quantity construction.

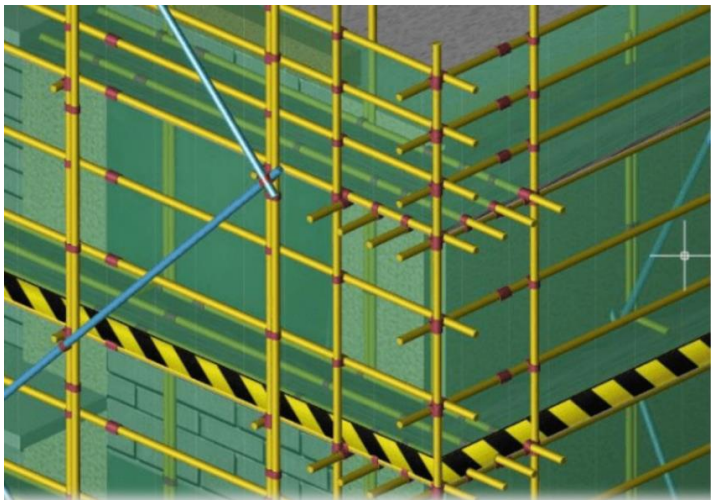

Figure 3. Schematic diagram of reinforcement model

5.3 Develop safety management measures

The traditional safety management mode is "empirical" as the main management mode, only after the accident occurs, will take corresponding corrective measures for the type of accident occurred, which means that after causing safety threats to the construction personnel also brings economic losses and reputation impact to the construction enterprise. However, the corrective measures taken for accidents are based on the manager's personal experience and the relevant codes, which are not relevant and cannot be adapted to all high formwork projects. With the complexity and uniqueness of modern construction, it is essential to develop a safety management system that meets the needs of actual high formwork projects. The introduction of BIM technology for safety management in the construction of high formwork projects can show the possible safety hazards in construction in 3D form, and develop corresponding safety management measures in combination with the actual project situation, and update and adjust them dynamically in real time. At the same time, the safety management based on BIM technology can be used as an important reference basis for safety management rules and safety measures, which can play an effective role in guaranteeing the safety of on-site construction.

5.4 Identification and monitoring of safety hazards

BIM system contains all the information of the project, and given its digital and simulation characteristics, it can effectively identify the safety hazards in the construction process. The information of safety hazards in different construction areas and construction stages can be displayed in 3D in the model and visually fed back to the site safety management personnel, providing them with a basis for taking corresponding adjustment and corrective measures to improve the construction safety management capability on site, thus ensuring the management objectives of the project operation process. Modern construction projects often use some information technology for safety monitoring to achieve the effect of analysis and monitoring of hidden objects, so as to facilitate the management to manage the safety of construction sites in real time, but this safety monitoring method is only local, incomplete and limited. Combining BIM technology with information technology monitoring technology, based on the simulation and visualization characteristics of BIM technology, simulating a three-dimensional model of the whole construction process, all relevant functional departments can visualize and manage the whole construction process, and compare the model with the actual construction situation on site, analyze and adjust the deviations in real time, and at the same time, the dangerous points existing in construction can be determined as well as real-time Monitoring.

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This can not only improve the efficiency of site safety monitoring, but also reduce safety hazards, thus ensuring the safety of construction.

5.5 Identification of safety areas and development of safety protection

For a construction project, building edges and openings are areas where safety accidents are likely to occur, and the opening areas include "four openings" and "five edges", which are time-consuming to find whether through drawings or on-site inspections, and are not easy to comprehensive discovery. The virtual construction through BIM technology can truly simulate the objective environment of the project construction and perceive the reality of the simulation, which can give full play to the role of safety education, site command and performance design of construction personnel. At the same time, according to the results of dynamic simulation of the construction process, the safety level of the area is marked in different colors at different progress stages of the project construction, and the construction activities allowed and prohibited in different safety areas are specified, such as the danger level of the adjacent area for the load that can be walked on it, etc., which provides guidance for the prevention of safety accidents during the project construction. And using the visualization and virtual construction technology of BIM technology, it is easy to find out the parts with safety hazards and mark them in the building information model or virtual construction environment, and then establish the safety protection model to prevent falling and import it into the total information model for testing, so as to eliminate all the safety hazards existing in the construction site layout.

6. Conclusion

With the development of the society, the scope of high-modular construction is becoming more and more extensive. The traditional safety management mode of high-modular construction has certain defects, which brings greater safety hazards to the construction process and leads to frequent safety accidents. The scientific high formwork construction and safety management mode can not only improve the beauty of building appearance, but also guarantee the quality of building construction to a certain extent. Therefore, the relevant departments should pay attention to the specific application of BIM technology in the high formwork project, make full use of the features and functions of BIM technology, and build the safety management mode of high formwork construction based on BIM technology. For a high formwork project, this can not only build a high formwork BIM model and establish a safety management system through BIM technology, but also can combine the model with on-site construction, which can timely find the hidden safety parts and carry out real-time monitoring, thus ensuring construction safety and construction quality.

Acknowledgments

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