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Application of Building Information Modeling Technology in Pile Foundation Engineering

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Abstract. The construction industry is currently in a period of profound transformation. In a market environment with a shrinking number of projects, improving construction efficiency, reducing production costs, and simplifying construction processes have become core survival issues for all construction units. Building Information Modeling (BIM) technology, with its advantages in visualization, collaboration, and digitization, is widely regarded as a key solution to these challenges. This paper focuses on two core research themes: first, systematically sorting out existing research results on BIM technology to verify its practical ability to improve construction efficiency, reduce costs, and optimize processes; second, in-depth exploration of the integration path between BIM technology and specific construction links to clarify practical methods for technology implementation. Taking pile foundation engineering as the research entry point, through analysis of practical cases and verification of technical applications, the core conclusion is drawn: BIM technology can effectively improve the construction of pile foundation projects. However, the application of the technology still faces practical obstacles. On one hand, construction workers have long relied on traditional operation modes, and adapting to BIM digital tools requires professional training and a transitional period of practice. On the other hand, the data interfaces between BIM systems and existing project management, equipment control and other systems are not unified, making it difficult to achieve full-process information integration. These issues require further research to break through.

Keywords: Building Information Modeling; Plie Construction; Engineering Management.

1. Introduction

At present, the construction industry is at its low point of the industry. Due to the economic downturn and the downturn in the real estate industry, how to improve efficiency and saving costs has become the primary goal of entrepreneurs to facilitate their survival. This change is more fatal for pile foundation engineering, because it is a project with low technical content. In the face of the reduction of projects, the method of low profit and high sales is no longer possible, so enterprises must cut production costs at all stages. In order to solve this series of complex problems, scholars are committed to researching an information model to provide a template for the reform of the construction industry, and BIM was born. BIM is the abbreviation of Building Information Modelling, which is a new design model based on three-dimensional digital technology that integrates and effectively manages various relevant information in the whole life cycle of construction projects. However, with the passage of time, the concept of BIM technology has also been further expanded. Information is still the core of BIM, but in addition to building information itself, BIM has covered more relevant information and the content of engineering construction itself, and the word Modelling has gradually begun to move from the original construction process to a more systematic management system. BIM integrates the effective resources of society to the greatest extent, improves efficiency and control, and helps us realise sustainable design and green design concepts to the greatest extent. Moreover, the advantages of BIM in the creation and processing of complex shapes have also brought more possibilities to our design. This is an unprecedented new era, which is a great change [1]. BIM technology helps to gradually eliminate the long-standing gap between construction companies, optimize the ease of construction, budget management, and the management process of the entire building life cycle, and also improve the production efficiency of all participating personnel [2]. BIM

maximises the integration of effective resources of society. It can visually display various parts of the construction project through three-dimensional models, so that designers of different majors can find conflicts and problems in the design in advance, and avoid the waste of resources and time delays caused by design changes during the construction process. At the same time, BIM technology can accurately simulate and analyse the use of building materials, helping designers choose more environmentally friendly and energy-saving materials, so as to achieve sustainable design and green design concepts. The research and application of BIM technology in China are still in its infancy. Although China has been researching BIM technology for a long time, it has not achieved remarkable results, especially in terms of data comprehensiveness and practical feasibility. The technical database is not adequate to cover all kinds of actual situations. Due to the complexity of China's economic situation, which covers various engineering projects, especially in pile foundation projects, different terrains and different geological conditions have different requirements for construction. For experienced practitioners, they can rely on their own experience to adjust the construction plan, but for BIM, the lack of a database. As a result there is no reference material, which leads to the inability of BIM to provide a reasonable construction plan. The general-purpose type is not enough to solve complex situations, which is a key reason why BIM technology has not been widely used for the time being. The research results of scholars can not be implemented in specific projects. For instance, in the pile foundation project, the worker installs the positioning system to locate the machine. However, the coordinates on the positioning system and the design drawings are not interoperable; workers are required to provide the specific coordinates manually, which greatly reduces the construction efficiency.During the construction of the new campus of the Hong Kong University of Science and Technology, workers need to find out the specific construction site through the GPS locator on site according to the design drawings. Due to the large area of the new campus and the tight construction period, it requires multiple groups of workers to work together. As a preliminary work of pile foundation construction, purely man-made construction will inevitably waste a lot of time. Based on the analysis of the current situation, this study need to study how to use BIM technology to improve the construction process and apply the technology to specific projects. Specifically, our research content is to analyse the problems encountered in construction from the two aspects of design and construction, and to think about whether BIM technology can solve the problem, and whether the construction of the whole project can be completed with a system.

2. Design Stage

2.1. Review of Construction Drawings

Construction preparation is the first step of prefabricated pile construction, including the investigation of the construction site, the formulation of pile foundation design schemes, and the selection of suitable construction equipment and materials. The construction site survey requires a detailed understanding of geological parts, groundwater levels and the surrounding environment to ensure the accuracy and adaptability of pile foundation design. According to the survey results and building load requirements, reasonably designed piles foundation layout scheme and specifications of piles. [3]The design review of construction drawings of housing construction projects is an important link in the quality management of construction. Design errors or defects in construction drawings directly affect the quality and effect of construction. The BIM-based construction drawing review aims to realise the automatic review of construction drawings and improve the quality and efficiency of construction by applying BIM technology to the construction drawing review process. The data information covered by the BIM model includes the geometric dimensions, material attributes, construction technology, schedule, etc. of building components. In the construction drawing review, the economy, feasibility and safety of the design scheme can be evaluated by analysing these data. For example, by analysing the material attribute data, it can be judged whether the selected material meets the design requirements; by analysing the construction process data, it is possible to find technical problems in construction in advance and provide a basis for rectification. In the review of construction drawings of housing construction projects, there are many advantages in the application of BIM technology.

At present, the main application advantages of this technology are manifested in the following aspects: 1) Through the reasonable application of BIM technology, it can Significantly improve the efficiency of the review of its construction drawings, and make the review results intuitively presented to the review staff in the form of a three-dimensional digital model, to effectively avoid interpretation errors and misunderstandings in the two-dimensional drawing review. 2) The BIM model implements collision predictions for various construction links in the housing construction project according to the design drawings, to find some conflicts in the actual construction in advance, and rectify the construction drawings in time to avoid the adverse impact of various conflicts on the subsequent actual construction efficiency and quality, and further reduce The rework probability of the housing construction project. 3) The BIM model has the characteristics of real-time updating. For the problems found in the review, the model can be updated in time after rectification, so that the overall construction drawing review and its changes are more flexible. 4) The BIM model covers all the data information of the overall construction project, which provides strong support for the data analysis of its construction drawing review and rectification, to further simplify its review workflow, reduce the intensity of staff operation, and save manpower costs. With these advantages, BIM technology has attracted much attention in the current review of construction drawings of housing construction projects [4]. BIM technology provides a multi-dimensional data environment, enabling the Housing and Construction Bureau to evaluate building performance through accurate visualisation and simulation, such as energy efficiency analysis and structural stability, greatly improving the accuracy and feasibility of the design. In the pile foundation project, the construction drawing needs to include the position and depth of the pile. The two-dimensional design drawings are not easy to intuitively identify the rationality of the scheme, but BIM can help establish a three-dimensional model and help the review staff understand the structure of the building more intuitively to judge the rationality of the design, which not only improves efficiency but also ensures safety.

2.2. The Adaptation of the Design Drawings and the Positioning System

It is necessary to find the precise location of the tubular pile, before the construction.According to the design drawings, high-precision measurement equipment such as total station meters or latitude and longitude meters are used to accurately calibrate the axis of the pile position at the construction site. The application error of the pile position must be strictly controlled within the range of ±10 mm to ensure the accuracy of the pile position.[5]Therefore, the connection between the BIM system and the positioning system is particularly important, which determines the construction speed of the wiring link. The traditional method is to find the location where had been marked in the blueprint by professionals. Not only does it take a long time, but it also requires a large number of workers, both of which reduce the efficiency of the project. BIM technology can transform the traditional construction site into an intelligent one. In the future, BIM technology may have the ability to transform the blueprint into the exact location. What the engineer should do is to add the location when he draws the blueprint. By combining the location information in the blueprint with the three-dimensional model, BIM technology can convert the abstract position in the blueprint into accurate actual coordinates by using advanced positioning algorithms and data processing technology. This not only greatly shortens the time to find the exact location of the pipe pile and reduces the error of manual marking, but also improves the accuracy and efficiency of construction and reduces the construction cost.

3. Construction Stage

3.1. Dealing with Complex Situations

What prevents the project from being carried out efficiently is the complex situation in the construction site. In the model composed of BIM technology, construction personnel can intuitively understand the construction progress, equipment layout, and personnel distribution, which helps to coordinate the relationship between various construction links [6]. For large-scale projects, the

progress of each process requires the coordination and cooperation of all personnel. Take the pile foundation project as an example. In the early stage of the project, there are geological exploration and hydropower supply, transportation pipe piles and quality sampling during the project, and the later stage of the project, there are owner acceptance and cost accounting. These are very complex procedures. If there is no it is easy to get into chaos at the scene with coordinated arrangements. The BIM system will analyse the site, assign different tasks to different sites, and ensure the site utilisation rate to ensure that each task will not be stopped due to site conflicts.

3.2. Monitoring of the Construction Process

Traditional construction progress management mainly relies on Gantt charts, network diagrams and other tools. Although these tools can show the logical relationship between the progress plan and tasks of the project, there are certain limitations in practical applications. It is difficult to intuitively display the spatial relationship in the construction process. For complex construction projects, it is difficult to accurately predict the mutual influence between different construction tasks, which makes it difficult to adjust the schedule [7]. Using BIM technology to assist in project progress management involves making full use of the comprehensive and highly relevant characteristics of BIM model information, combining traditional project management theories and ideas, and finally achieving the goal of BIM to assist the project, so as to achieve the best project management [8]. BIM technology can detect various data in the construction stage in real time. It is of great importance for the engineer and the worker to know what is going on in the construction so that they can find the problem in time and solve them.The construction quality control system mainly revolves around verticality deviation and pile top mark.Three core indicators of high and pile body integrity are deployed. Verticality control collection with the double verification mode of "process monitoring + final hole review", the pile sinking process use a latitude and longitude meter to measure the offset of the X/Y axis after connecting the pile in each section. Be equal when the cumulative deviation exceeds 1% of the pile length, the bias correction procedure must be started immediately. [9] The specific practical applications are as follows. First, data digital management, through electronic collection, storage and analysis of key engineering quality control files, to realize data statistics, intelligent query and abnormal early warning; Second, the quality inspection process is digital, using mobile terminals to record daily inspection, acceptance and actual measurement data, and realize the closure of quality problems through systematic analysis. Environmental management. The third is the intelligence of inspection and detection. The Internet of Things technology is used to record the whole process of witnessing sampling, and the test results are automatically analysed and reported. The application of these technologies has significantly improved the standardisation and efficiency of construction quality management [10].

3.3. Task Assignment of Personnel and Resources Management

A big event needs thousands of workers to coordinate with each other, the most significant challenge is that they don’t know what to do every day. The reason is that they only know when to finish the task instead of what to do every day. It may lead to the problem that some workers finish their tasks much earlier than others and they don’t know what to do next. It is a waste of the lab our The construction project application of BIM+ smart construction site aims to bridge the communication gap between each participating unit, eliminate the problems caused by poor communication and untimely communication in the collaborative process, thereby reducing unnecessary mistakes and rework in planning, design, construction and later operation, comprehensively improving the efficiency of project management, and greatly controlling project risks. , reduce the cost of project management. Based on BIM+ smart construction site technology, the management of the supervisor, the construction party and the construction party will be more convenient, thus improving the management efficiency [11]. In the pile foundation project, resource management is particularly important because the length of the pipe pile is fixed, and workers need to match the length to complete the task (a construction site should be 17 metres deep, which can be a nine-metre plus an eight-metre, or eleven-metre plus six metres). In the current engineering project, workers will the

matching plan is reported, and the workers can only build after the project manager reviews it. When each team lacks communication or the construction volume of the project is large, it will lead to a shortage of pipe piles of a certain length and reduce the construction efficiency. With the help of BIM, the project manager only needs to upload the number of pipe piles of various lengths and the daily work tasks of each team to the system, and the system can automatically allocate pipe piles and give construction plans. In this way, there will be no shortage of pipe piles of a certain length, leading to reduced efficiency, and there is no need to consider how to match the length before the construction of the team.

4. Conclusion

Before writing, the author visits the relevant enterprises, understands the specific difficulties encountered by enterprises at this stage, and then thinks about whether the technology related to BIM technology can solve these problems, and finally draws a conclusion. The author first thinks about the solution, and then looks for evidence that BIM technology can indeed realise this function.

According to the study, the author found that BIM technology can provide convenient and efficient solutions for drawing review, translation of drawings, handling complex situations, supervising the construction process, and assigning tasks. These problems are not only faced by pile foundation projects, but also by most engineering projects. Through analysis, this article puts forward the possibility of solving these problems.

This article only studies the solutions of BIM technology to specific problems, and does not study whether these solutions can be integrated into one system to achieve more concise and efficient construction. Moreover, in this article, the author does not think about whether these methods can be accepted by workers. At present, most construction workers have relatively low education. In the face of relatively novel construction and management methods, the author does not consider whether they can accept or use them skillfully.

In the future, the author hopes to study how to integrate various technologies into one system, truly realise intelligent construction, and make engineering construction digital, informationized and intelligent. The author will also devote himself to the study of the intelligent construction of engineering and explore the possibility of unmanned construction sites.

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