

# *Research on Simulation and Optimization of Construction Technology Based on BIM Technology*

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**Abstract:** This research is based on BIM technology and focuses on the simulation and optimization of construction technology as the research goal, aiming to improve construction quality and efficiency. By introducing the development history of BIM technology and its application in the construction industry, the importance of simulation and optimization of construction technology and the current research deficiencies are explained. Methodologically, this study will combine three-dimensional modeling and construction process simulation methods to establish a BIM-based construction technology simulation and optimization process, and propose corresponding optimization plans by analyzing the simulation results. The results of this study will help promote the application of BIM technology in construction technology, improve the visualization of the construction process, optimize the construction process, and reduce construction errors.

## **1. Introduction**

### **1.1 Rsearch Background**

In the construction industry, simulation and optimization of construction processes are key links to improve construction quality and efficiency. Through construction process simulation, various factors in the construction process can be simulated, including material selection, component assembly, personnel scheduling, etc., so as to discover potential problems in construction in advance, avoiding errors and disputes in construction. Construction process optimization, on the other hand, can improve construction efficiency, reduce costs, and reduce waste through reasonable planning of the construction process and resources<sup>[1]</sup>.

However, there are still some deficiencies in the current research on construction process simulation and optimization. Firstly, traditional construction process simulation methods mainly rely on two-dimensional drawings, which cannot accurately simulate the actual situation of the three-dimensional construction site, limiting the accuracy and reliability of the simulation results. Secondly, traditional construction process optimization methods are mostly empirical rules, which cannot fully consider the comprehensive impact of various factors and lack scientific quantitative analysis. In addition, the current research mainly focuses on theoretical aspects and lacks verification and application of actual cases.

## 1.2 Research Purpose and Significance

The purpose of this research is to study BIM-based construction process simulation and optimization methods aimed at improving construction quality and efficiency<sup>[2]</sup>. Its significance includes promoting the application of BIM technology in construction processes, improving the visualization degree of the construction process, optimizing the construction process, reducing construction errors, etc. The results of this research can contribute to achieving the goal of digital construction and promote the development of the construction industry.

## 1.3 Research Content and Technical Route

The research content of this study mainly includes research on BIM-based construction process simulation and optimization methods. Specifically, the research content includes BIM-based construction process simulation methods and BIM-based construction process optimization methods, as shown in Figure 1.

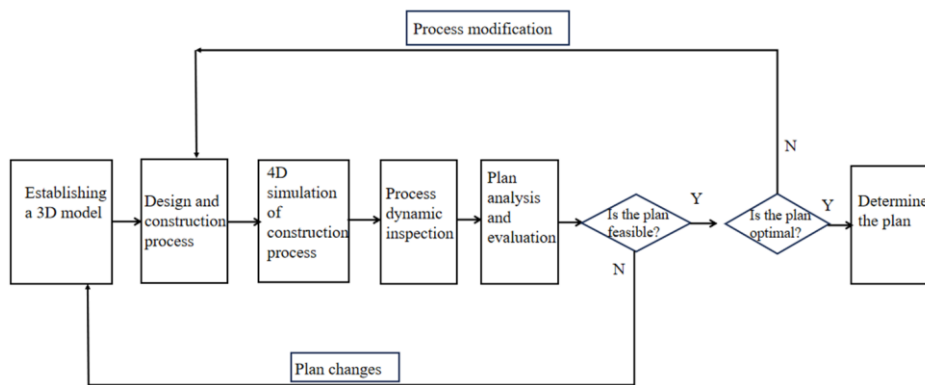


Figure 1: Simulation and optimization process of BIM technology construction plan

## 2. Application of BIM Technology in Construction Process Simulation

### 2.1 Overview of BIM Technology

BIM technology is an abbreviation for Building Information Modeling technology. It is a building design and construction management technology based on digital building models. By integrating various information such as geometric information, attribute information, time information, cost information into the building model, BIM technology realizes the management and collaboration of the entire life cycle of the building project as shown in Figure 2.

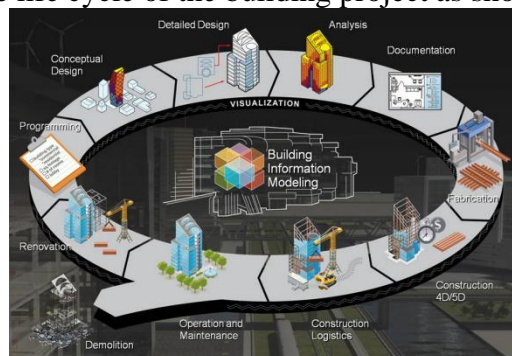


Figure 2: BIM-based full lifecycle of building

## **2.2 Advantages of BIM Technology in Construction Process Simulation**

BIM technology has a significant advantage in the construction process simulation. First of all, it can realize the visualization of the construction process, and intuitively display the structure and construction process of the building through the BIM model<sup>[3]</sup>. Secondly, BIM technology can improve the coordination of the construction technology, and coordinate the construction technology through comprehensive analysis and collision detection. Finally, BIM technology has optimizable ability, it can find the best process scheme in the simulation process and then improve the construction efficiency and quality.

## **2.3 Feasibility of Combining BIM Technology with Construction Simulation Methods**

Combining BIM technology and construction simulation method is feasible. BIM model provides a large amount of accurate data to support the construction simulation, and the visualization function of BIM technology can show the simulation results, and help the construction personnel to intuitively understand the possible problems in the construction process. In addition, BIM technology can be combined with other related technical methods to further enhance the feasibility of construction simulation. However, there are still some difficulties and challenges in the implementation process, such as the establishment of BIM model requires a lot of time and energy, and the calculation and data processing involved in the construction simulation process requires certain computer technology and expertise.

## **3. Simulation of Construction Technology Based on BIM Technology**

### **3.1 Principles and Methods of Construction Technology Simulation**

With the rapid development of the construction industry, the traditional construction technology has been difficult to meet the needs of the complexity and high efficiency of modern architecture. In order to improve the construction quality and efficiency and reduce waste and cost, the construction process simulation and optimization based on BIM technology has become an important development trend. Through the application of BIM technology, we can manage the construction process more finely, and realize the visualization, coordination and optimization of the construction process. BIM-based construction process simulation is a method of virtual simulation of building construction process through BIM technology. It uses the three-dimensional visualization characteristics of the BIM model, combined with the time, resources and other elements in the construction process, to make a comprehensive simulation and prediction of the construction process.

#### **3.1.1 Principle of the construction process simulation**

The principle of construction process simulation mainly includes two aspects: 3D modeling and construction process simulation. First, through BIM technology, establish the 3D model of the building, including the geometry of the building, component properties, material information, etc. Then, according to the requirements of the construction technology and the construction plan, the three-dimensional model simulates the construction process, including the construction sequence, construction method, resource allocation, etc. By simulating the construction process, the potential problems and risks can be predicted, and the corresponding solutions can be formulated in advance.

### 3.1.2 The process of the construction process simulation

The construction process simulation process based on BIM mainly includes the following steps:

(1) We can collect the relevant data and establish a BIM model: collect the architectural design drawings, construction drawings, equipment parameters and other relevant data, and use the BIM software to build a three-dimensional model of the building.

(2) We can determine the construction technology and parameters: according to the characteristics of the building and construction requirements, determine the construction technology and construction parameters, such as construction sequence, construction method, resource demand, etc.

(3) We can establish the construction process simulation scene: establish the construction process simulation scene in the BIM model, including the layout and configuration of the construction equipment, personnel, materials, etc.

(4) Construction process simulation: use the simulation function of BIM software to simulate the construction process, including the visual display of the construction process, time schedule simulation, resource consumption simulation, etc.

(5) Analysis of the simulation results and optimization scheme: according to the simulation results, analyze the problems and risks existing in the construction process, and put forward the corresponding optimization scheme and improvement measures<sup>[4]</sup>.

### 3.2 Construction process optimization based on BIM

BIM-based construction process optimization refers to the process of using BIM technology to improve and optimize the construction process. Through the visualization, coordination and optimization characteristics of BIM technology, the problems in the construction technology can be analyzed and solved more effectively, and the construction quality and efficiency can be improved.

#### 3.2.1 Principle of construction process optimization

The principle of construction process optimization mainly includes process optimization and resource optimization. Process optimization is to improve the smoothness and efficiency of the construction process through the analysis and improvement of each link in the construction process. Resource optimization is to reduce resource waste and cost expenditure through the rational allocation and utilization of the resources needed in the construction process.

The establishment of an optimization model includes the following steps, as shown in Figure 3:

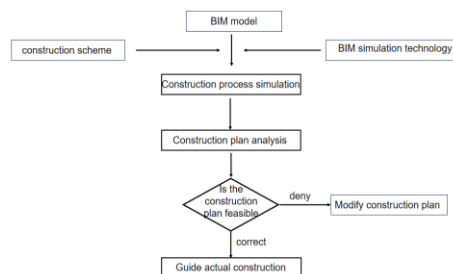


Figure 3: BIM-based Construction Process Optimization Flowchart

#### 3.2.2 Method of construction process optimization

Construction process optimization methods based on BIM mainly include the following types:

Using BIM model for visual analysis: through the visual function of BIM model, the problems existing in the construction process are intuitively analyzed and identified, and the corresponding

optimization scheme is put forward.

We can clash detection with BIM technology: use the collision detection function of BIM technology to check the possible conflicts and collision problems in the construction process, and coordinate and optimize in advance.

Using BIM technology to conduct construction progress simulation: through the construction progress simulation function of BIM technology, we can predict the possible delays and problems in the construction process, and make corresponding solutions in advance.

Using BIM technology for resource optimization: through the resource optimization function of BIM technology, the resources needed in the construction process are reasonably allocated and utilized to reduce resource waste and cost expenditure.

### **3.3 Implementation and effect evaluation of the optimization scheme**

The construction process simulation and optimization based on BIM technology aims to improve the construction quality and efficiency. To achieve this goal, we need to implement the proposed optimization scheme and evaluate the effect of its implementation to verify its feasibility and effectiveness.

The implementation of the optimization protocol is a critical step to ensure that the scheduled schedule is followed and with full consideration of existing resources and conditions. In the implementation process, we will make corresponding adjustments and improvements according to the actual situation to ensure the smooth implementation of the optimization scheme.

After the implementation of the optimization program, we will evaluate the implementation effect. The purpose of the evaluation is to verify the feasibility and effectiveness of the optimization scheme and the improvement of the construction quality and efficiency<sup>[5]</sup>. We will use scientific and objective methods to ensure the accuracy and reliability of the evaluation results.

Evaluation methods include but are not limited to data collection and analysis, effect measurement and comparison, feedback from engineers and users, etc. By collecting and analyzing the data after the implementation, we can quantify and evaluate the improvement effect of the construction process. In addition, we will communicate and interview with relevant engineers and users to obtain their opinions and feedback on the implementation effect of the optimization program.

Through the implementation and effectiveness evaluation of the optimization scheme, we will be able to fully understand the feasibility and effectiveness of the construction technology simulation and optimization based on BIM technology. This will provide strong support for the future research and practice, promote the application of BIM technology in the construction process, improve the visualization degree of the construction process, optimize the construction process, and reduce the construction errors.

## **4. Case Analysis of Construction Process Simulation and Optimization Based on BIM Technology**

### **4.1 Example of BIM technology application**

#### **4.1.1 Chengdu Changjian Xingyue City Commercial Complex**

The project includes high-rise residential and commercial buildings with an all-cast-in-place reinforced concrete frame shear wall structure. Through the BIM technology, we have performed the following work:

- (1) 3D modeling and construction drawing generation: use BIM software to establish an accurate

building information model, generate construction drawings and material list, and find and solve the problems in the design in advance.

(2) Construction technology simulation: simulate the construction process, including the construction method, sequence, material selection, etc., in order to optimize the construction process, improve the efficiency and quality.

(3) Collaborative design and construction: realize the collaborative design and construction among various majors, and reduce changes and rework.

(4) Construction progress simulation: clearly understand the construction content and time nodes of each stage, and assist the construction progress management.

(5) Cost management and control: use BIM model to prepare and review the bill of quantities, material procurement and cost control.

#### 4.1.2 Guangzhou Metro Line A Metro Station Project

This project is an underground station, facing problems such as small site, difficult traffic relief and difficult pipeline relocation. Through the BIM technology, we have performed the following work:

(1) Comprehensive optimization of 3 D pipeline: check the spatial relationship between various majors in the 3 D view to solve the pipeline collision situation.

(2) Optimization of complex node design: conduct reinforcement and collision inspection of complex nodes, optimize the design and guide the site construction.

(3) Optimization of the construction scheme: compare and optimize the construction scheme to improve the rationality, sophistication, feasibility and economy of the scheme.

(4) Progress optimization: timely feedback the deviation between the actual construction and the schedule, and use BIM technology for visual dynamic simulation to facilitate the analysis of the reasons and take countermeasures.

The above two cases show the practical application effect of BIM technology in construction process simulation and optimization, and provide reference and reference for similar projects<sup>[6]</sup>.

#### 4.2 Practical application methods and processes of construction technology simulation and optimization technology based on BIM

In the above two cases, we adopted the construction process simulation and optimization technology based on BIM, as shown in Figure 4, mainly including the following steps:

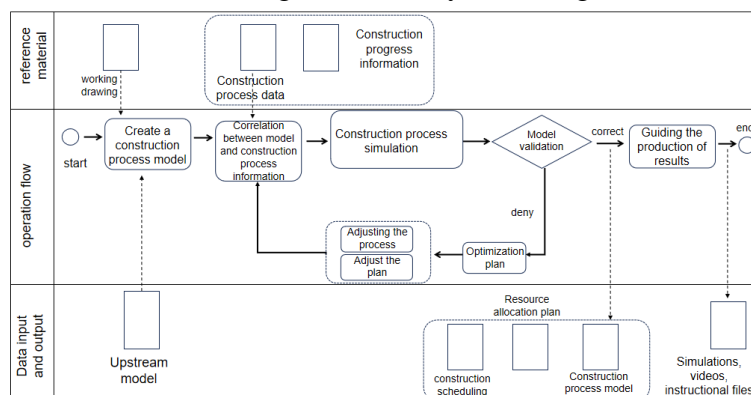


Figure 4: BIM-based construction process simulation and optimization

(1) Establishing the BIM model: according to the design drawings and the actual construction environment, we need to establish the BIM model of the building, including building, structure,

electromechanical and other professional models.

(2) Adding construction information: we need to add construction information to the BIM model, including construction sequence, construction methods, construction materials, construction equipment, etc.

(3) Construction process simulation: use BIM software to simulate the construction process, observe the problems and risks in the construction process, and adjust and optimize them in time.

(4) Optimization scheme design and adjustment: according to the simulation results and the actual construction situation, the design scheme is adjusted and optimized, including the construction method, material use plan, etc.

### **4.3 Practice application effect evaluation method and result analysis**

To evaluate the practical application effect of BIM-based construction process simulation and optimization technology, we used the following methods:

(1) Comparative analysis method: BIM based construction technology simulation and optimization technology and traditional methods, evaluation and analysis from the aspects of construction cycle, construction quality, construction cost, safety risks and so on.

(2) Questionnaire survey method: a questionnaire survey was conducted on the projects using BIM-based construction technology simulation and optimization technology to understand the evaluation and feedback of the parties involved in the project.

(3) Cost-benefit analysis: conduct cost-benefit analysis of projects using BIM-based construction technology simulation and optimization technology to evaluate the economic and social benefits of the technology.

Through the comprehensive application of the above methods, we have obtained the following evaluation results: the use of BIM based construction technology simulation and optimization technology can significantly improve the construction quality and efficiency, reduce the problems and risks in the construction process; and can optimize the design scheme and material use plan, reduce the construction cost and safety risks; the technology has been recognized and praised by all parties involved in the project, and has wide application prospects and development potential.

## **5. Conclusion and Outlook**

### **5.1 Study conclusions**

This study focuses on the application of BIM technology in the construction process simulation and optimization, aiming to improve the construction quality and efficiency. By introducing the development and application of BIM technology in the construction industry, it highlights its important value in the construction process simulation<sup>[7]</sup>. The discussion of the advantages of BIM technology and the necessity of combining with the construction simulation method, further verifies the rationality of using BIM technology for the construction process simulation.

In terms of methodology, this research is based on BIM technology, integrating 3 D modeling and construction process simulation methods, and constructing a BIM-based construction process simulation and optimization process. The principle and method of construction process simulation are described in detail, including 3 d modeling and construction process simulation. The construction process simulation process based on BIM is shown, covering the steps of BIM model establishment, simulation parameter determination and simulation calculation. Through the simulation results, the construction process problem is identified and the corresponding optimization scheme is proposed.

At the practical level, this study verified the effectiveness of construction process simulation and

optimization based on BIM technology through case analysis. Meanwhile, the promotion plan of the method is discussed. The credibility and application value of the research are enhanced through the research of evaluation method selection, data collection and analysis, result display and application promotion.

## 5.2 Research deficiency and prospects

Although this study has made some achievements in the construction process simulation and optimization based on BIM technology, there are still the following deficiencies:

(1) The comprehensiveness and detail of the construction process simulation method need to be improved to meet the needs of different projects and working conditions.

(2) Construction process optimization has not covered all possible optimization dimensions, such as cost, time and risk.

(3) Practice case verification is limited by the conditions and quantity of the actual construction project, which cannot represent all the circumstances.

Looking into the future, the applicable scope and accuracy of the construction process simulation method can be further expanded, and more diversified and accurate simulation means can be explored. At the same time, different aspects of the construction process optimization methods, in order to achieve a comprehensive construction process optimization. In addition, expanding the scope and sample size of practice validation and improving the reliability and universality of research results are also important directions for future research.

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