Research on Virtual Simulation of Modern Residential Buildings Based on BIM and Two-Dimensional Code Technology

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Abstract. Natural environment, construction, transportation and other factors have a great impact on the construction process of modern residential buildings. The interaction of these factors is the reason for the uncertainty of concrete dam pouring environment, but the traditional method is not suitable for this uncertainty. Therefore, discrete event simulation (DES) is widely used in construction simulation, rather than actual construction. This is because most simulation models are created by professionals and require manpower and material resources. Even if there is a small change in the simulation process, it should be introduced into the simulation model to adjust in order to adapt to the new environment. With the help of DES technology based on BIM to construct the framework of concrete dam, this paper fully studies the relationship between concrete structure and BIM and the two-dimensional code technology, solves the problem of information expression, and plays an important role in the application of simulation technology in the research of construction progress and reasonable design of construction scheme.

1. Introduction

The outbreak of the COVID-19 epidemic has also posed new challenges to the future architecture: how to optimize the design process to reduce the spread of the epidemic and protect people's health has become an urgent issue. Based on "BIM+ two-dimensional code technology", this paper carries on the application and virtual simulation research on the construction and design of modern residential buildings, combined with the commonly used two-dimensional code technology, realizes the lightweight technology embedding, and provides a three-dimensional sense of appearance for the virtual simulation model of modern residential buildings. At the same time, the needs of people for a better life, the needs of modern urban residents for architecture have changed from meeting the basic life to aesthetic cognitive needs, virtual simulation experiential services can show more combination possibilities, making up for the disadvantages of traditional housing space experience. Due to the special multi-functional needs of residential space, such as life, production, entertainment and other requirements, reasonable design and planning not only improve living conditions, but also have a significant impact on the mental outlook of residents, therefore, the study of this project will be of great significance in the follow-up stage of urban reform. At the same time, with the combination of BIM technology and daily QR code technology, the overall characteristics of modern architecture can be displayed quickly and intuitively.¹[1]

At the same time, through BIM5D technology, civil engineering, steel structure, mechatronics, curtain wall and other fully professional BIM models are integrated, construction progress, contract,
cost, technology, quality, safety, drawings, materials, labor and other information to achieve data sharing and operation and maintenance, combined with BIM software and QR code to achieve virtual simulation of the whole process, shorten the construction period to a certain extent, and can watch the overall building effect in advance. As long as a simple operation, you can move everywhere, as if in the future modern architectural space or beautiful community environment; on the other hand, you can feel the communication and interaction with the environment, virtual simulation is a new way to subvert the traditional visual feeling. Therefore, it will be a huge renewal for low-and middle-income cities with low cultural and technological requirements, and a technological transformation for the establishment of harmonious and stable urban construction.\[2-3\]

2. State of the Art

At present, the popular design methods of building information model include building structure design and building information design. Building information modeling (BIM) is an important technical means to manage the whole process of building, and it is a management mode that integrates all building information uniformly. Through the analysis of the basic properties of building components, BIM determines the collection elements of the structure. These attributes include functions and institutions, no matter which basic attributes change, the relevant information will be adjusted at any time. Because in the actual construction process, the continuous timely adjustment according to the design requirements of the original scheme is beneficial to the construction. In addition, BIM can provide project participants with a variety of project information, such as quantity, budget, schedule, materials and other related information during the construction process, to help project personnel make quick judgments, make reasonable plans, and even quantitatively analyze the data according to environmental factors and building structure.\[4-5\]

BIM is an important product of the development of CAD technology. Before the improved version, the Center of Integrated facilities Engineering of Stanford University put forward the research of BIM technology represented by 4D model in 1996, and applied this model to the construction of management infrastructure. They also developed a CIFE 4D-CAD system, which can simulate the construction process through a 4D model to find problems in the dynamic demonstration. In 2003, Fischer and Kam put forward the model theory of PM4D (Product Model And Fourth Dimension) and perfected the corresponding system. In addition, researchers at the University of Salford in the UK developed the ND model by integrating planning, construction schedule, construction cost, potential risk, maintainability, sustainability, energy saving and environmental protection.

In China, BIM has basically completed its basic research and made some achievements in the promotion of IFC. 4D field management model (4D Site Management Model, 4D Site Management Model)) was put forward by Zhang Jianping, M.Anson, Qian Wang and others in the 20th century. This is the first time at Tsinghua University. Subsequently, Zhang Jianping, Wang Hongjun (2002), Zhang Jianping and Wang Hongjun (2003) extended the 4DSMM model to 4DSMM floor + based on the 4DSMM model. The improved model can dynamically show the construction progress, materials and on-site facilities of the building, and realize visual simulation; at the same time, the concept of collaborative design of industrial buildings is put forward and applied to the design of industrial factory buildings.\[5\]

The application of BIM and 4D technology in project monitoring and cost control can timely monitor and grasp the whole dynamic process, including how people, materials and mechanical equipment operate in the construction process. Xu Wenxi also put forward a new method to realize the IPD collaborative management model of scientific research projects, that is, the delivery management model based on comprehensive project delivery theory and centered on BIM. In order to ensure the smooth implementation of the construction process, scholars headed by Li Heng put forward the method of combining with simulation technology, and carried out a forward-looking
analysis of the construction process according to the application mode and state of BIM in the construction field, in order to achieve the rational allocation of resources.

3. Methodology

3.1. System and System Simulation

Only on the basis of understanding and understanding the concept and scope of the system can we have the ability of simulation. Schmidt and Taylor defined the system in 1970. They believe that the system is a group of objects connected together according to certain rules, and these objects interact with each other to achieve a certain purpose. In fact, the existence of the system is determined by the purpose of the research. If the existence state of the system is regarded as a set of variables, then the set of the whole system studied in one study is likely to be a subset of another system. Therefore, these variables are very important for the system of the research object.

Generally speaking, a system can be divided into two states, one is discrete system, the other is continuous system. The former refers to a system in which the state variables suddenly change in a set of discrete time points. The latter is a system in which the state variable changes over time. Take banks as an example. As shown in Figure 1, the number of bank customers does not change until the customer actually arrives at the bank or leaves the bank.

![Figure 1. Discrete System State Variables.](image)

The theory of modeling and simulation is the premise of system simulation, and the establishment and utilization of the model is a complex technology with multi-discipline. It uses computers, simulators, physical effects and other high-tech performance equipment as information processing tools to complete the dynamic tracking process of the changes of the research object.

As the three important parts of system simulation, system, model and computer are indispensable. The three basic activities related to these three important components are the establishment of system model, simulation modeling and the implementation of simulation experiments. The specific relationship is shown in Figure 2.
System simulation, as the name implies, refers to the simulation experiment of system. The specific operation process of simulation experiment is carried out in following steps.

First, model building. First of all, the system to be studied should be carefully analyzed to determine its type. If it is a mathematical model, the simulation model needs to be built and run by computer before verification. If it is a physical model, also known as external model, it needs to cover the parts corresponding to the function and performance of system according to its working principle, so as to combine the subsystems of each element and become a simulation experimental model of the whole system.

The success of model is positively correlated with the correctness of final simulation results. Therefore, the most critical and important part of system simulation is modeling.

Second, the model established by experiment. After modeling, a series of plans and tests should be made to control model simulation experiment as a whole. In the process of testing, the results should be recorded truthfully to summarize its pattern.

Third, analyze experimental results. Analyze the results of model experiment reasonably, correct the problems found in time, and repeat above steps.

3.2. Construction System Analysis

For example, cracks are a common problem in concrete construction, especially in large area concrete construction, the change of temperature will affect the solidification process of this area. This situation can usually be avoided by placing horizontal and vertical seams in the structure. In the process of pouring, concrete aggregate, cement, mortar and other materials are mixed into the final concrete according to a certain proportion, and the concrete is transported through the conveyor and through the process of concrete bucket transportation and horizontal cage vibration according to the plan. Finally, it meets the design requirements of concrete formwork pouring parts. The complex construction process is inevitably affected by a variety of conditions, which are mainly divided into two categories, one is structural differences, construction technology, construction organization, lack of technological capacity of concrete mixing or pouring equipment and other factors; the second is the uncertain factors of the natural environment and its influence in the construction process. Therefore, in a sense, the construction process is a system located in a specific environment, but has its unique organizational structure.\(^6\)

The whole construction process of concrete pouring can be divided into three stages: concrete production, concrete transportation and concrete pouring. The specific construction system is divided into three subsystems corresponding to the above three parts. The construction system is a multi-level service system with random service. In this multi-level service system, the superior subsystem of each link serves as a service part to provide services for the subordinate subsystem. For example, the horizontal concrete transport subsystem is both the recipient and the provider of the service. As the service object of the uplink, it accepts the services of the hybrid subsystem, while as the service provider of the downlink, it provides services to the vertical transmission subsystem.
As a part of the multi-level service system, the subsystem is the service receiver of each link. Each link does not exist independently and is closely related. In addition to the fact that the actual environmental conditions of the construction system will affect each link, the computer simulation technology can also be used to simulate the actual behavior of the concrete pouring test. Through analysis and calculation, the arrangement of dam pouring data and reasonable planning construction progress are obtained, so that the actual construction can be carried out smoothly.\footnote{7}

Therefore, in a sense, the construction process of concrete structure is a system located in a specific environment, but it has its unique organizational structure. The concrete schematic diagram of the pouring concrete construction system is shown in Figure 3.

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\end{center}

**Figure 3.** Schematic diagram of concrete construction system.

### 4. Conclusion

With the wide application of simulation technology in various large-scale projects, many problems have been exposed in the modeling of simulation technology, such as poor versatility, great complexity, easy to make mistakes, difficulty in construction simulation modeling, low level of professional knowledge of related personnel, and so on. These problems limit the application and development of simulation technology model construction in practical engineering to a certain extent, in order to improve the versatility of simulation model in modeling technology. Reduce the difficulty and complexity of simulation model modeling, and improve the intelligent degree of simulation. The simulation modeling in the process of concrete construction simulation modeling is deeply analyzed and studied by BIM and Two-Dimensional Code technology. Taking concrete structure BIM and discrete event system simulation as the preliminary combination framework, the whole process simulation system of building construction is developed. The information of the system comes from the BIM model established by three-dimensional digital technology, and the simulation model is more intuitive, intuitive and convenient for project managers to use. The construction process simulation system based on BIM framework improves the automation and efficiency of simulation modeling.
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