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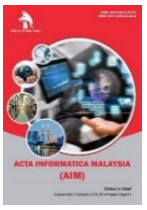

RESEARCH ARTICLE

APPLICATION OF INTERACTIVE VISUALIZATION IN THE PREFABRICATED BUILDING CONSTRUCTION PROCESS

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ABSTRACT

With its advantages, prefabricated building has become a new development trend in the construction industry and has been vigorously promoted. However, the construction problems in its construction process have not been effectively solved. Prefabricated components have blind spots in the connection, rebar positioning is difficult to achieve accurate, when hoisting, the position of tower cranes is uncertain, and the sequence of using tower cranes is not clear for each shift and group, the layout is not reasonable, the adverse effect of construction environment is not considered, which affects the transportation and connection of components on roads and other issues. The development of interactive visualization transforms data information into a three-dimensional view with obvious visual effects, enhancing the information exchange between users. Through a large number of literature collection, the existing prefabricated building construction methods are summarized and analyzed, knowing that there are few studies that combine interactive visualization with prefabricated building construction technology. This paper tries to apply interactive visualization technology to the construction process of prefabricated buildings, and organically combine. Building information modeling technology and related technology with construction technology, through the establishment of virtual information model to achieve the purpose of visualization, building parts model information base, to achieve real-time interaction between users and building model information. Combined with the construction site conditions to determine a reasonable and feasible structure form, optimize the construction technical scheme, and then effectively improve the construction quality, achieve visual management of the construction process, promote the construction of assembly building information and digital level.

KEYWORDS

Interactive Visualization, Construction Technology, Prefabricated Buildings, BIM

1. INTRODUCTION

In recent years, with carbon peaking and carbon neutrality goals, prefabricated buildings have developed rapidly with the advantages of high efficiency and green. In an effort to win the battle against environmental protection, Cease Work Order has led many industries, including traditional construction and building materials, to declare work stoppages. The transformation and upgrading of new infrastructure have become a hotspot of industry research. The white paper "Made in China 2025" has promoted the transformation and upgrading of the traditional construction industry, efficient and green construction methods are more favored by the industry. As an emerging construction method, the construction period of prefabricated buildings is substantially reduced compared with traditional cast-in-place buildings, with improved labor efficiency and more green construction methods (Pu and Zhu, 2019). The existence of some problems in prefabricated buildings also has a great impact on the whole construction process. Ma et al. optimized the lifting progress, constraints, and lifting process through the multi-objective optimization model of lifting construction (Ma et al., 2020). Li et al. submitted a numerical simulation analysis method for constructed building elements to decrease errors by computing the bearing range of components (Li et al., 2021). Lu and Zhu optimized the layout of construction site facilities by establishing CSLP model to optimize safety risks and transportation efficiency (Lu and Zhu, 2021). The realization of real-time interactive experience through the establishment of 3D models is slowly evolving. Li et al. used BIM to build models for 3d visualization research, and established interactive visualization display technology between multiple devices, so as to better realize visual interactive experience (Li et al., 2022). Li et al. developed a 2D and 3D scene interaction system to simulate forest fire spread (Li et al., 2008). Wang et al. composed interface software by utilizing the information interaction method and directly called the database for graphic processing (Wang et al., 1995). At present, the application of interactive technology in prefabricated buildings is minor, and the construction technology of interactive visualization and prefabricated buildings is not completely merged. This paper will evaluate the application of interactive visualization to the construction of prefabricated buildings, solve the problems in the construction process of prefabricated buildings and optimize them to enhance the quality of the whole process.

2. CURRENT SITUATION AND CONSTRUCTION DIFFICULTIES OF PREFABRICATED BUILDINGS

2.1 The State of Prefabricated Buildings

The traditional cast-in-place construction process is jumbled and the

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construction time is long, which cannot meet the needs of developers. At present, the vigorously promoted prefabricated building conforms to the national policy of energy conservation and emission reduction. Compared with cast-in-place, it has multiple advantages and has become the development trend of the construction industry. But now the assembly technology is not perfect, assembly building in the process of design, construction, management there are some problems that need to be resolved.

Some construction parts are pre-made in the factory in the form of assembly line operation, and then these elements are transported to the construction site. At the site, precast walls, floor composite boards, beams, columns and other components form a complete overall building through pouring, spliced, welding and other technologies. Buildings built in this way of production are called prefabricated buildings. The main prefabricated buildings are prefabricated concrete structure and prefabricated steel structure. The construction process of prefabricated building is quicker and involves less labor than conventional cast-in-place construction, so it has been widely promoted. Taking the construction process of a concrete structure as an example, all elements piled up flat, according to the stress characteristics and the overall structure, calculate the way of stacking, to preserve a somewhat stable state. Before the installation of the corresponding quality inspection, check the position of reinforcement after wiring measurement, according to the construction sequence lifting corresponding members, placed in a fixed position, after correction to cast, set up support, and other components attached. Install outer wall panels, inner wall panels, laminated boards, stairs and other components in turn. The key nodes and other parts shall be fixed connected by means of binding reinforcement, pouring concrete, mortar and so on, and protective measures shall be taken (Liu and Yang, 2020).

2.2 Construction Difficulties of Prefabricated Buildings

Prefabricated buildings have a full life cycle of design, production, construction, decoration and management. Nevertheless, at present, the prefabricated development technology has attained maturity, and there are certain problems in the entire construction process of prefabricated buildings. The hoisting process of different construction sites is incompatible, and the order of tower crane use for each hoist is not discussed in advance. These problems delay the hoisting process and affect the construction progress. A large number of prefabricated components are stacked on the construction site, causing congestion in some places on the site, and the components cannot be transported on time. The position of the embedded steel bars in the components deviates, and the steel bars cannot be bound on time to connect the corresponding components, and the deviated steel bars need to be corrected, which seriously delays the construction progress. Due to factors such as different construction conditions when making building components, the size of prefabricated components deviates, and some components may collide, which has a significant impact on the safety of the structure (Zhang and Cheng, 2018). During the grouting process of the sleeve, a blind area is formed because the internal grouting cannot be directly observed, and this part bears a large load, which has a great impact on the bearing capacity of the structure. In the construction of prefabricated buildings, problems such as hoisting and component connection can be prevented and solved through interactive visualization.

3. Technical Application of Interactive Visualization

3.1 State of The Art of Interactive Visualization

The application of interactive visualization makes data processing, analysis, processing, dissemination and sharing more accessible, making it involved in different fields. Interactive visualization visualizes the input of physically meaningful values, graphics, etc. to accurately measure data. The interactive visualization between humans and machines has further promoted the development of virtual reality technology. Visualization technology facilitates users to observe data information in an intuitive way, convert data into images and other forms, and users can recognize the content represented by visual data in a comparatively short period of time. Through the interactivity between them, users can interact with the visualized objects and scenes by providing different aspects of data, and immerse themselves in the virtual visualization environment to retrieve visual information in real time (Zudilova-Seinstra et al., 2009).

BIM is generally used in the construction process of prefabricated buildings. By establishing a 3D model of the building structure to collect varied digital information of the building, the appearance, physical performance and other characteristics of the structure are demonstrated in a visual form, which provides a driving force for the development of prefabricated buildings. It is incorporated into the site layout, component hoisting and other links in the prefabricated construction process, and the corresponding data is entered in real-time interaction to grasp the information at each stage of the construction process.

3.2 Advantages of Interactive Visualization

Interactive visualization shows users the current state of the data and possible future trends more intuitively through images and other methods, making it easier and faster for users to obtain target information and take corresponding measures in advance. The visualization of big data incorporates the entire operation process, and information is retrieved from all aspects of the entire operation framework, which enhances the connection between the whole and promotes the management of the entire process. Users interact with the visual scene in various ways, upgrade the user's sense of experience, arouse great interest, and experience a feeling close to the genuine in the virtual visualization environment. Data interaction is carried out from multiple aspects to retrieve data presented from different perspectives, which improves the efficiency of data utilization.

3.3 Disadvantages of Interactive Visualization

At present, the presentation of most visual data is a static form dominated by graphics, which only realizes some basic functions of visualization, and demonstrates information from a fixed perspective and thinking analysis, and the scope of the transmitted information is restricted. Visual data in static form cannot facilitate all users to extract effective information from the visual view, which increases the difficulty of user interaction with visualization tools (Chen et al., 2019).

4. The Application of Interactive Visualization in The Construction of Prefabricated Buildings

The current way to solve the problems in the construction process of prefabricated buildings will consume too much labor and capital and affect the construction period. The application of interactive visualization facilitates all parties in the prefabricated building project to work together, and utilizes the visualized 3D model to coordinate varied work in the construction, recognize the transmission and sharing of information, and effectively enhance the construction efficiency and benefits.

In view of the problems in the construction process of prefabricated buildings, the application of BIM technology has solved this difficulty. According to the relevant construction materials provided by the project, combined with the conditions of the construction site, a series of models are created to simulate the prefabricated construction process. Input the data information of each element, create an information database of building components, recognize the transmission and sharing of resource information, and realize real-time interaction between users and equipment in the whole process of construction.

Through the simulation of the site plane, combined with the environmental factors of the site, the prefabricated components are placed in an orderly manner to ensure that there is no congestion during the delivery of the components. Set up a tower crane to simulate the whole process of hoisting elements, so as to precisely calculate the position of the tower crane, reasonably allocate the construction time and space occupied by each hoisting process, coordinate the order of use of each unit, and continuously optimize the hoisting process to prevent time delays in the hoisting process. Before the elements are hoisted, the steel bars are pre-bound. If they cannot be linked normally, the misaligned steel bars should be corrected in advance to essentially reduce the unreasonable application of time and money. Using the simulation crash analysis software, the parts that may collide with the component installation are simulated in advance, and the optimal connection method is selected by adjusting the hoisting and installation connection methods. Using the input data information to identify the plumpness of the grouting of the key parts of the concrete member sleeve, real-time transmission of the detected data, to comprehend the interaction between the information and the model and further visual management (Huang et al., 2018).

5. Conclusion and Discussion

The strongly endorsed prefabricated building conforms to the energy saving and emission reduction policy recommended by the state and is a green and environmentally friendly building. Interactive visualization in the prefabricated construction process can effectively improve construction quality and efficiency and contribute to the further development and expansion of prefabricated buildings. Based on BIM, the construction of prefabricated buildings can recognize visual management,

and users can realize the interaction between building models and information through the input data information of building elements. By simulating the construction process in advance, some unexpected accidents in construction can be effectively ignored. In the construction, such as hoisting elements and node pouring, visual management is also accomplished through BIM technology. Sharing information is easy to conclude efficient construction processes, formulate reasonable construction plans, take safety precautions, reduce the total construction period, and improve the overall efficiency and benefits of construction.

In the future, the construction technology of prefabricated buildings should be progressively incorporated with information technology, comprehensively promote the application of interactive visualization in the entire process of production and construction of prefabricated buildings, and promote the development of construction industrialization. The construction party and technical R&D personnel work together to recognize the improvement of prefabricated building construction technology, widen the application field of interactive visualization technology, and promote the realization of prefabricated building information and digitization.

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