Analysis of Prefabricated Building Construction Management Based on Intelligent Construction Technology

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Abstract: The construction industry is currently accelerating its transformation towards industrialization and low-carbon development. Prefabricated buildings, due to their advantages of high construction efficiency and environmental friendliness, have become a key development direction. Intelligent construction technology is gradually maturing, providing support to address these pain points, and their integration has become a critical requirement for promoting the high-quality development of prefabricated buildings. Based on the background of the integrated development of intelligent construction technology and prefabricated buildings, this study analyzes the core elements of three types of intelligent construction technologies: the full-lifecycle application of Building Information Modeling (BIM), the application of intelligent equipment on construction sites, and digital construction management platforms. It summarizes the characteristics of prefabricated buildings, including factory prefabrication of components, on-site assembly, and green environmental benefits. Furthermore, it elaborates on the implementation paths of three construction management strategies: BIM technology for collaborative component management, intelligent equipment for enhancing assembly accuracy, and digital platforms for controlling construction progress. The aim is to solve the problems of low efficiency, poor precision, and difficulty in controlling progress in traditional construction management of prefabricated buildings. The results indicate that these strategies can effectively improve component management efficiency, assembly accuracy, and progress control level, providing practical reference for high-quality construction of prefabricated buildings.

1. Introduction

Intelligent construction technology is a new technological system integrating information technology, intelligent manufacturing technology, and construction engineering. With BIM, the Internet of Things (IoT), intelligent equipment, and digital platforms at its core, it spans the entire lifecycle of building design, construction, and operation & maintenance (O&M). It achieves automation of the construction process, refined management, and efficient collaboration through data driven, helping to improve project quality and efficiency while reducing costs and carbon emissions. It is a key support for the transformation and upgrading of the construction industry. As the construction industry moves towards industrialization and intelligence, prefabricated buildings have become a development focus due to their advantages of low carbon environmental protection and high construction efficiency. However, under traditional construction management models, they face challenges such as difficulty in tracing component information, insufficient assembly accuracy, and lagging progress control, which restrict industry development. The maturation of intelligent construction technology provides technical support to address these pain points. In this context, exploring how to deeply integrate intelligent construction technology with prefabricated building construction management, fully leverage the advantages of both, and break through traditional management bottlenecks is of great practical significance for promoting the large-scale and high-quality development of the prefabricated building industry. It also provides new ideas and

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directions for the transformation and upgrading of the construction industry.

2. Content of Intelligent Construction Technology

2.1 Full-Lifecycle Application of Building Information Modeling (BIM)

In the initial project design stage, designers use professional BIM software to build accurate and comprehensive 3D building models based on project planning and geological survey data. These models not only visually present the building's appearance and internal layout but also deeply embed key information such as detailed dimensions of various components and physical/chemical performance parameters of selected materials. Entering the construction preparation phase, the powerful clash detection function of the BIM model allows for cross-checking of the intricate internal pipelines, accurately locating potential conflict points in advance. This effectively avoids design changes and construction rework caused by pipeline clashes, saving significant time and economic costs [1]. During the construction process, simulating construction sequences through the BIM model optimizes the order of work, enabling tight connection between different trades and construction stages, reducing delays, and improving overall construction efficiency. After project completion and delivery, the O&M team can use this model to retrieve building component information at any time, assisting in equipment maintenance, facility replacement, and other O&M tasks, achieving seamless flow and efficient utilization of information throughout the building's lifecycle.

2.2 Application of Intelligent Equipment on Construction Sites

The application of intelligent equipment on construction sites is a powerful support for the implementation of intelligent construction technology. Taking unmanned pavers as an example, they are equipped with advanced sensors and intelligent control systems. During operation, sensors continuously collect road terrain data, and the intelligent system precisely regulates in real-time the paver's operating parameters based on preset paving thickness and flatness standards, ensuring even and smooth asphalt or concrete paving with minimal thickness deviation, significantly improving road construction quality. Intelligent vibration robots, through built-in vibration frequency sensors and intelligent algorithms, automatically match the optimal vibration parameters for different grades of concrete and different pouring locations, efficiently expelling air bubbles inside the concrete, enhancing concrete density, and avoiding quality defects such as honeycombs and surface pitting [2]. Using drones equipped with high-definition cameras and infrared thermal imagers for regular inspections of the construction site can quickly capture safety hazards such as tiny cracks in foundation pit slopes or slight tilting of high-formwork support systems. By transmitting data back in real-time, managers can grasp the site situation immediately and take timely countermeasures, nipping accident risks in the bud. This replaces manual inspection tasks that are high-risk and highly repetitive, enhancing construction site safety and management efficiency.

2.3 Digital Construction Management Platform

The digital construction management platform integrates data collected by various sensors on the construction site. Data from temperature and humidity sensors during concrete pouring are used to monitor the concrete curing status in real-time, ensuring it hardens under suitable environmental conditions and guaranteeing concrete strength meets standards. During component hoisting, positioning sensors provide real-time feedback on component location, enabling precise control of hoisting accuracy. Through the platform's visual interface, managers can intuitively view the entire construction panorama, with the progress and quality status of various construction areas clear at a glance. In terms of progress management, the platform automatically compares actual construction progress against the entered construction plan. If lag is detected in any area, it immediately issues an early warning, prompting managers to adjust resource allocation promptly, deploy more machinery and equipment, or increase labor [3]. Quality inspection reports can also be automatically generated by the platform, covering various testing indicator data, facilitating archiving, consultation, and analysis for managers, and providing detailed basis for project quality control. The platform supports remote operation and decision-making; even if managers are off-site, they can still grasp project dynamics in real-time through mobile terminals and issue instructions promptly, avoiding management loopholes caused by information delays, and comprehensively improving construction management efficiency.

3. Characteristics of Prefabricated Buildings

3.1 Factory Prefabrication of Components

Factories rely on standardized molds for component production. These high-precision steel molds ensure uniform dimensions for batches of components like prefabricated wall panels and composite floor slabs, effectively avoiding dimensional deviations caused by manual operation differences in traditional cast-in-place concrete. During production, automated concrete spreaders ensure even pouring, coupled with vibration tables (vibration frequency 50-60Hz) to ensure concrete density, followed by steam curing to accelerate concrete strength gain, increasing the rate of components meeting strength standards upon leaving the factory to over 98% [4]. Factory production allows for precise positioning of embedded parts in components, with positioning deviation not exceeding 1mm, avoiding rework caused by misplacement during on-site installation. Compared to traditional on-site construction, factory prefabrication reduces the amount of on-site concrete pouring by over 60%, significantly reducing the intensity of on-site wet work, controlling construction quality fluctuations from the source, and laying a stable foundation for subsequent on-site assembly.

3.2 On-site Assembly Construction

After components are transported to the site, they are assembled using professional hoisting equipment such as truck cranes and tower cranes. Before hoisting, total stations are used for precise setting-out of component installation positions to ensure accurate alignment. During assembly, grouted sleeve connection technology is relied upon to achieve firm splicing between prefabricated components and cast-in-situ nodes, and welding of embedded parts enhances the stability of component connections, avoiding delays caused by long curing times in traditional cast-in-situ structures [5]. On-site assembly does not require waiting for concrete curing like traditional construction; various component assembly processes can proceed in parallel, shortening the construction period by 30%-50% compared to traditional cast-in-situ. For projects with tight schedules, this efficient assembly mode can rapidly advance project progress, reduce on-site labor input and management complexity, and simultaneously minimize the impact of prolonged construction on surrounding traffic and residents' lives.

3.3 Green Environmental Advantages

During the factory production stage, processing reinforcement using automated cutting and welding equipment reduces the reinforcement waste rate from the traditional on-site construction rate of 3% to below 1%, minimizing construction waste generation. Concrete mixing uses enclosed mixing stations equipped with dust collection devices to avoid dust pollution. During the on-site assembly stage, the absence of large amounts of concrete pouring and wall masonry work reduces construction dust and noise, lessening interference with the surrounding ecological environment and residents' lives [6]. Prefabricated buildings prioritize the use of green building materials such as recycled aggregate prefabricated components and low-VOC coatings, reducing the consumption of non-renewable resources. After the building's service life ends, prefabricated components can be disassembled and recycled, avoiding the environmental burden caused by landfilling of large amounts of construction waste from traditional building demolition, truly achieving low-carbon environmental protection throughout the building's lifecycle and aligning with the national "dual-carbon" development strategy requirements.

4. Prefabricated Building Construction Management Strategies Based on Intelligent Construction Technology

4.1 BIM Technology for Collaborative Component Management

Input component information: Assign unique production numbers to each prefabricated component (e.g., wall panels, floor slabs) in the BIM model, linking component parameters, factory production progress, transportation information, and on-site installation location to ensure information is complete and traceable. Conduct full-process tracing: During the component production stage, view production progress in real-time through the model; during transportation, update location information by interfacing with the logistics system; upon arrival, scan codes to associate with the model and confirm component numbers and arrival status. This enables end-to-end tracking from factory to site, avoiding wrong or missing component deliveries. Perform clash detection: Simulate component installation scenarios in the model, focusing on detecting spatial conflicts between components and pipelines, and between components themselves. Mark conflict locations such as overlaps between pipelines and embedded parts in wall panels, and generate clash detection reports [7]. Optimize installation sequence: Adjust the component installation sequence based on clash detection results, installing main components without conflicts first, followed by components requiring pipeline avoidance. Combine component arrival times to develop an installation plan within the model, ensuring timely installation of arrived components, avoiding on-site pile-up and backlog, and reducing the risk of schedule delays.

4.2 Intelligent Equipment for Enhancing Assembly Accuracy

Positioning preparation stage: First, import the component installation coordinates from the BIM model into the total station, set up measurement control points on site, and calibrate the total station's accuracy. Simultaneously, attach reflective targets to the surfaces of prefabricated components to ensure stable measurement signals. Precise installation stage: The hoisting equipment lifts the component near the installation position. The total station captures the target coordinates in real-time, compares them with the model coordinates, calculates the deviation value, and guides the hoisting operator via walkie-talkie to fine-tune the component position until the deviation meets requirements, then temporarily fix it [8]. Quality control stage: Use intelligent grouting equipment for sleeve grouting. The equipment sets the grouting pressure and speed, monitors the grouting volume in real-time, and automatically stops when the sleeve is filled with grout, avoiding under-grouting or over-grouting. Data recording stage: Synchronize and upload the positioning deviation values from the total station, and the pressure and grouting volume data from the grouting equipment to the BIM model, associate them with the component number for archiving, forming a quality traceability record. This reduces manual recording errors and ensures the quality of each process is traceable.

4.3 Digital Platform for Construction Progress Control

Plan input stage: Input the overall prefabricated construction plan into the digital platform, break it down into weekly and daily progress, clarify time nodes for each process, and associate responsible persons. Real-time monitoring stage: The platform interfaces with the on-site clock-in system and equipment management system to automatically collect actual progress data, compare it with the planned progress, and generate progress deviation reports, marking progress status with different colors (green for normal, yellow for warning, red for lagging). Early warning and adjustment stage: When progress lag occurs, the platform automatically triggers an early warning, pushing messages to managers. Analyze the reasons for the lag; for production delays, coordinate with the factory for expedited production and adding production lines; for logistics obstacles, change transportation routes or activate backup transport vehicles [9]. Effect tracking stage: After implementing adjustment measures, the platform updates progress data in real-time to check if the lagging processes have caught up to the planned schedule (e.g., after components arrive, adding hoisting teams to ensure installing 2 extra wall panels the next day to compensate for the delay). Simultaneously, generate weekly progress analysis reports, summarize progress control issues, and optimize subsequent plan adjustment strategies.

5. Conclusion

The above research indicates that construction management for prefabricated buildings based on intelligent construction technology requires the synergistic unification of "technical support - characteristic adaptation - strategy implementation". Intelligent construction technology is the core support: BIM technology addresses the fragmentation of component information in prefabricated buildings, enabling full-lifecycle collaboration; intelligent equipment compensates for the shortcomings of traditional assembly accuracy, ensuring construction quality; digital platforms solve the problem of lagging progress control, improving management efficiency. The characteristics of prefabricated buildings are the adaptation basis: factory prefabrication requires BIM technology for component information traceability, on-site assembly construction requires intelligent equipment to ensure accuracy, and green environmental advantages require digital management to reduce resource waste. Management strategies are the key to implementation: the three types of strategies correspond to the core needs of component management, assembly quality, and progress control in prefabricated building construction, forming a complete management system.

References

[1] Lyu Xingliang. Analysis of Prefabricated Building Construction Management Based on Intelligent Construction Technology[J]. Intelligent Building and Construction Machinery, 2024, 6(11): 49-51.

[2] Chen Dong, Liu Yang, He Xiangrong, et al. Research on the Application of BIM Technology in the Management of Intelligent Construction Process for Prefabricated Buildings[J]. Technology and Innovation, 2023(18): 173-175.

[3] Liu Zhenzhen, Huang Renhui. Research on the Application of Intelligent Construction Technology in the Construction Management of Prefabricated Building Engineering[J]. Foshan Ceramics, 2025, 35(1): 173-175.

[4] Liu Yu. Research on Prefabricated Building Construction Management Based on Intelligent Construction Technology[J]. International Architecture, 2024, 6(6): 58-60.

[5] Ren Zhen. Research and Application of Key Technologies for Prefabricated Building

Construction Based on Intelligent Construction[J]. Brick and Tile, 2024(9): 112-115.

[6] Wang Xiaokang. Key Points of Intelligent Construction Technology for Prefabricated Buildings Supported by BIM Technology[J]. Green Construction and Intelligent Building, 2025(2): 168-171.

[7] Zheng Mancai. Research on Prefabricated Building Construction Technology and Multi-dimensional Collaborative Quality Management Driven by BIM Technology[J]. Brick and Tile, 2025(6): 108-110.

[8] Wang Yunsong. Application of Intelligent Construction Technology in the Construction Management of Prefabricated Building Engineering[J]. Outdoor Equipment, 2023(2): 151-153.

[9] Xiong Hao, Wu Jun, Cai Guoqing. Construction of an Intelligent Construction Technology System for the Full Life Cycle of Prefabricated Buildings[J]. Journal of Railway Engineering Society, 2023, 40(5): 96-101.