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. Combining the background of integrating intelligent construction technology and prefabricated building development, this paper analyzes the core elements of three different intelligent construction technologies, including full-lifecycle yousturation-invasive application to Building Information Modeling (BIM), Application software classificationstolerance for architecture industries intelligence application to smart case studiesaggregate on construction sites and digital management platform. It summarizes the features of prefabricated buildings, such as factory prefabrication of components and on-site assembly, along with green environmental benefits. In addition, it explains three construction management methods of collaborative component management based on BIM technology, improving assembly accuracy through intelligent equipment, and controlling construction progress using digital platforms. It aims to overcome the problems of low efficiency, poor precision and difficult progress control in traditional construction management of prefabricated buildings. These results suggest that these strategies prove beneficial in respect of raising efficiencies relating to the management of components, assembly accuracy and controlling progress respectively, which provide practical reference for facilitating the 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. centers on BIM, IoT, intelligent equipment and digital platforms lifecycle including building design, construction and operation & maintenance (O&M). All of this is accomplished by improving the quality, speed and efficiency with which projects get completed while lowering costs and carbon emissions through data driven construction process automation & project collaboration. It is an important support force to promote the transformation and upgrading of the construction industry. Recognizing the characteristics of low carbon environmental protection, high construction efficiency and industrialization of prefabricated buildings, it has quickly become a development focus as the construction industry moves toward industrialization and intelligence. But in the traditional construction management models, they cannot get rid of the problems because component information is difficult to trace, assembly accuracy is inadequate and progress control lags behind, which hinders industry development. The development of intelligent construction technology is providing technical support for the solution to these pain points. From this perspective, how the intelligent construction technology can be thoroughly integrated with prefabricated building construction management, complementary advantages of both be brought to full play, and breakthrough traditional management bottlenecks is a topic with great practical significance that has guided the large-scale and high-quality development of prefabricated building industry. And new perspective and ideas for transformation and upgrading of construction industry.

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2. Content of Intelligent Construction Technology

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

When the design of a project is in its initial stages, designers use professional BIM Software to create precise and solid 3D building models according to geological survey data and project planning. These models not only visualize what the building will look like and how it will function internally but also capture key information such as precise dimensions of various components and physical/chemical performance metrics of chosen materials. Then, when about to enter the construction preparation stage (the BIM model has strong clash detection ability), it can cross-check with the complex internal pipeline and locate potential conflict points beforehand. This is an effective way to avoid design changes and construction rework due to the pipeline clash, which saves a lot of time and economic costs [1]. Singularly, during the construction process simulating construction sequences through the BIM model optimizes the order work, allowing for tight connection between all trades involved as well as stages of construction to avoid delays and improve overall construction efficiency. When the project is complete and delivered, this model can be referred to by the O&M team at any time for information about building components in support of equipment maintenance, facility replacement and other operations & maintenance (O&M) tasks, accomplishing smooth flow and optimal use of information over the entire lifecycle of a building.

2.2 Application of Intelligent Equipment on Construction Sites

The intelligent equipment application on construction sites is an effective support for its implementation of intelligent construction technology. For instance, unmanned pavers are outfitted with sensors and retain a swath of intelligent control systems. In the process of operation, the sensors constantly detect the parameters of road terrain data and in real time intelligently control all operational parameters of paver based on preset paving thickness and flatness standards that are regulated to make asphalt or concrete paving even and smooth with a tolerance about 1 cm difference from surrounding course, which improves road construction quality dramatically. Intelligent vibration robots utilize built-in vibration frequency sensors as well as intelligent algorithms to automatically match the optimal vibration parameters suitable for different grades of concrete and different pouring positions, so they have a good ability to expel air bubbles inside the concrete so that it can improve the density of concrete, reducing quality defects such as honeycombs and surface pitting [2]. Drones equipped with high-definition cameras and infrared thermal imagers regularly inspect the construction site, which can quickly catch safety hazards like small cracks in foundation pit slopes or subtle tilting of a high-formwork support system. Managers can understand the situation of the site in real time and take timely preventive measures to plug the hidden dangers of accidents. In this, it replaces high-risk and highly repetitive manual inspection tasks with superior construction site safety and management efficiency.

2.3 Digital Construction Management Platform

The digital construction management platform collects data from an array of sensors deployed onsite. We collect temperature and humidity data from concrete pouring sensors to monitor the real time status of curing concrete, allowing it to harden in appropriate environmental conditions, ensuring compliance with strength standards for execution processes. Positioning sensors, during component hoisting, supply real-time feedback about the position of components and in turn helps to control hoisting with precision. Managers use a visual interface to quickly see the entirety of constructing panorama clearly at-a-glance about construction status and quality progress. Regarding progress management, the platform automatically evaluates the actual construction progress in comparison to the entered construction plan. If the lag is detected in some sections, early warning is immediately released and managers will adjust resources allocation timely or they can dispatch devices and implement more labor [3]. The platform can also automatically generate quality inspection reports, including a variety of testing indicator data, which can be archived and consulted by managers, so that analysis is no longer difficult, and with detailed basis for project quality control. It can be operated remotely, managers can understand the dynamics of data on site even if they are off-site in real time through mobile terminals, and give instructions at any time, which eliminates the management loopholes caused by information lag and comprehensively improves construction management efficiency.

3. Characteristics of Prefabricated Buildings

3.1 Factory Prefabrication of Components

Manufacturers use standardized molds to produce all parts of a component. These steel molds, with accuracies in the range of millimeters, allow the production of identical-sized batches of components — such as prefabricated wall panels and composite floor slabs that avoid size deviations seen when several cast-in-place concrete elements are laid by hand. On the one hand, in production, even pouring is ensured by concrete automatic sprayers; vibration tables (vibration frequency 50–60Hz) are used to achieve a density of concrete; then steam curing is performed to accelerate the growth of strength and increase the number of components meeting custom strength standards—the percentage exceeds 98% at power up [4]. In the factory, since there are embedded parts built into the factory components where you can keep the positions not exceeding 1mm deviation between the ideal position and real position of components over on-site inserted/installed ones to avoid rework or waste due to misplacement in company's construction site, Reduce on-site concrete pouring by more than 60% compared with traditional on-site construction, effectively reduce the intensity of wet work on site, essentially control the fluctuations in construction quality from the source, and provide basic conditions for subsequent simple and rapid assembly of components on site.

3.2 On-site Assembly Construction

When the components reach the site, they are assembled using professional hoisting tools such as truck cranes and tower cranes. Total stations are used to set out positions for hoisting in exactly the right positions so that everything aligns. During construction, the technology of fully grouted sleeve connections is used to provide firm splicing between prefabricated elements and cast-in-situ nodes, together with the welding of embedded parts enhancing sliding stability for component connection and eliminating time delays associated with traditional cast in situ structures due to longer curing ages [5]. Compared with the traditional cast-in-situ way of filling, on-site assembly does not wait for concrete to solidify; different component assembly processes can be carried out simultaneously and the construction cycle is shortened by 30%-50% relative to the traditional method. This efficient assembly mode can quickly promote project progress, saving on-site labor input and management complexity, while also reducing the impact of long-term construction on surrounding traffic and residents' life for tight-scheduled projects.

3.3 Green Environmental Advantages

In the factory production stage, through the processing of automated cutting and welding equipment, it can reduce the reinforcement waste rate from 3% at construction site to less than 1%, avoiding a large amount of construction waste generation. In concrete mixing, dust pollution is reduced by installing closed mixing stations and dust collecting devices. With less concrete pouring and wall masonry work during on-site assembly stage, construction dust and noise are limited thus there is less interference of the ecological environment with residents lives [6]. Prefabricated buildings are more environmentally friendly, as they prioritize the use of sustainable building materials such as recycled aggregate prefabricated components and low-VOC coatings during construction to reduce the consumption of non-renewable resources. As prefabricated components can be disassembled and recycled, after the building's service life is over, low-carbon environmental protection in the whole lifecycle of building materials can be realized through the materialization of traditional buildings' demolition into large amounts of construction waste heading to landfills, which also follows our 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: Each prefabricated component (wall panels, floor slabs, etc.) is assigned a unique production number in the BIM model; links between model parameters of the components and their attachments such as factory production progress, transportation information, on-site installation location can ensure that this information is complete and traceable. Do full-process tracing: production phase, visualizing the status of the model in real time; logistics phase: obtaining location information through docking with logistics system; arriving at destination: scanning codes to bind the receiving model and verifying component quantity and arrival status. This allows for tracking from end to end, right from the factory onto site, limiting the chances of wrong or miss deliveries. Conduct clash detection on the model: Place simulated installation conditions, such as in what order are components installed to detect spatial conflicts between a component and a pipeline, as well as between multiple components. Identify conflicts at overlap locations of pipelines as well as embedded parts in wall panels and generate clash detection reports [7]. Installation sequence optimization: According to the clash, each component is installed sequentially, and first install without conflict components, then install conflicts components. Combine component arrivals to design an at-model installation plan that will install all arrived components on time, avoid pile-up and backlog on site, and decrease the risk of schedule delays.

4.2 Intelligent Equipment for Enhancing Assembly Accuracy

Positioning preparation stage: import component installation coordinates from the BIM model into the total station, set measurement control points controlled by point "three post / re-adjustment , finally calibrate the accuracy of total station. Simultaneously, attach the reflective targets on surfaces of prefabricated components to guarantee stable measurement signals. Precise installation stage: The hoisting device lifts the component to a position close to installing. The total station automatically obtains the coordinates of the target in real time, compares them with the model coordinates, calculates the deviation value, and speaks to the hoisting operator vía walkie-talkie as both parties adjust slowly until it arrives at a position where it meets requirements. The operator then temporarily fixes components in place [8]. Quality control stage: Intelligent grouting equipment, sleeve grouting. It can set the grouting pressure and speed, record the grouting volume in real time, and stop automatically after the sleeve is filled with grout to prevent under-grouting or over-grouting. Stage of data recording: The positioning deviation values measured by the total station, along with pressure and grouting volume data tested and recorded by the grouting equipment, are uploaded to the BIM model for archiving in association with hardware component number, generating a quality traceability record. This not only minimizes human errors in recording but takes traceability and verifiability a level up to ensure quality of each process.

4.3 Digital Platform for Construction Progress Control

Input of overall prefabricated construction plan into digital platform, broken down by week and day, time node for each process is clear, responsible persons are associated. Real-time monitoring stage: The platform connects with on-site clock-in system and equipment management system to automatically collect real progress data, compare it with planned progress, output progress deviation report, and mark the status of projects by green for normal condition yellow for warning condition red for lagging. Early warning and adjustment stage: When there is lagging progress, the system will issue an early warning automatically, pushing messages to managers. Investigate the causes of the delay, if it is due to production delays, work with the factory for an expedited production and installation Line; if it is due to difficulties in logistics, then modify transportation routes or activate backup transport vehicles [9]. Effect tracking stage: After adjustment measures are taken, the platform would automatically update an ongoing progress data to see whether corrective processes have been able to catch up on planned schedule (Example, new components arrive => add hoisting team to install 2 additional wall panels next day morning for recovery). At the same time, report on weekly progress analysis, summarizes deliverables progress control issue and optimizes measures for subsequent plan adjustment.

5. Conclusion

The above research shows that intelligent construction technology-based prefabricated building construction management should coordinate the unification of "technical support - characteristic adaptation - strategy implementation". Intelligent construction technology is the main support: BIM technology solves a major pain point in prefabricated buildings — it helps to solve the problem of fragmentation of component information, achieving full-lifecycle collaboration; intelligent equipment compensates for the shortcomings of traditional assembly accuracy and significantly improves integration quality; digital platforms help solve lagging progress control, enhance management efficiency. The above characteristics of prefabricated buildings are the basis for adapting to build:factory prefabrication requires BIM technology to achieve component information traceability; site assembly construction requires intelligent equipment to ensure accuracy, and green environmental advantages require digital management capabilities to reduce resource waste. The accessibility of management strategies is based on the fact that three types of component-level strategies corresponds to the basic needs of prefabricated building construction, including production assembly quality and progress control, developing 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.