Exploration of the Development Strategy of Building Industrialization Based on the Application of Smart Construction Technology

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Abstract. Shishi Jianfa Jinhui and Ming Project is a smart construction pilot project in Shishi. In the process of project construction, the application of intelligent construction technology was explored based on BIM intelligent design, intelligent monitoring, intelligent testing, intelligent construction management platform, etc. The project application practice shows that through the extensive application of intelligent construction technology, the project production efficiency can be effectively improved, the on-site construction and operation costs can be reduced, the construction quality can be ensured, the project management efficiency can be improved, and the continuous integration and development of building industrialization, informatization, and intelligent technology can be promoted.The digital industrial upgrading of construction industry has always been the vanguard of promoting industrial economy. With the help of the Internet, the Internet of Things, big data and other information industries, the interconnection between the construction industry and the information industry has become a new wind vane of the construction industry.

Keywords: Smart Construction · Building Industrialization · Development Strategy · Exploration

1 Introduction

The 14th Five-Year Plan proposes to build a digital China. As an industry with weak digitization, the construction industry needs to strengthen technological innovation, improve informationization level, cultivate industrialization system, and actively promote green and intelligent construction. Shishi Jinhui and Ming Project is a local smart construction pilot project. In the construction of this prefabricated residential project, comprehensive application of intelligent construction technology was achieved, including BIM intelligent design, intelligent monitoring, intelligent testing, intelligent construction management platform, and so on, which reflects the active promotion of integration and development of industrialization, informatization, and intelligent technology and has achieved

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Fig. 1. Engineering Diagram

significant results.The purpose of this paper is to improve the technical cognition of smart site in the construction field; Promote the application of BIM technology in the whole life cycle of buildings; Help our country construction industry digital transformation and upgrading. Constantly promoting the standardization, informationization, and intelligentization of quality and safety management of construction enterprises and actively promoting the eight major elements to promote the smart site in the new era, highlights the importance of closely coordinating the development of intelligent construction and building industrialization.

2 Project Overview

Shishi Jinhui and Ming Project is located in the southwest of Shishi City, Quanzhou, with a land area of 32,000 square meters and a construction area of 106,000 square meters, see Fig. 1. The above-ground construction area is 83,000 square meters, consisting of 8 buildings and 27 floors. All building monomers adopt the assembled whole shear wall structure, of which buildings 2, 3, 6–7 are SPCS (prefabricated assembled sandwich thermal insulation shear wall structure) system buildings, and building 5 is an assembled fine decoration building. Precast components include precast exterior wall, precast interior wall, precast stairs, precast balcony slab, precast bay window structure, and precast assembled floor slab, with a prefabrication rate of 30%.

3 Application of Intelligent Technology in Project Construction

The Shishi Jinhui and Ming Project integrates concrete prefabrication technology and IoT material management technology, and uses intelligent and informationized equipment to achieve efficient automatic transformation programs from structural components on blueprints to finished products, improving the automation and informationization standards of the standardization production line of building components. The main links in template design, steel reinforcement binding, concrete pouring, and masonry construction have all been upgraded intelligently to achieve a high level of automation. In the construction process, the project team has widely adopted automated and intelligent

Fig. 2. Tower crane anti-collision system

construction processes and equipment to address project difficulties, quickly identify, upgrade, decide, process, and break through, improving efficiency and achieving land acquisition, supply, and opening sales in 125 days.

3.1 Application of Tower Crane Visualization, Collision Prevention, and Alarm Bolt Installation Processes [1]

The project uses tower crane visualization, collision prevention, and alarm bolt installation processes (Indexing Fig. 2–4). Seven tower cranes were required for the project, and the project team has developed a dismantling plan and organized experts to approve the anti-collision operation plan for the cluster of cranes. The project team also verified the qualifications and received safety technical disclosures from the assembly and disassembly units during the installation of the tower cranes. At the same time, the tower cranes were inspected and accepted, and registration tags were issued to establish a complete record for each tower crane. High-definition infrared spherical automatic zoom cameras are used for the cameras, achieving intelligent real-time tracking of the lifting hook operation footage to avoid blind spots in operation, reduce tower crane operation safety accidents.

Application advantages: The use of high-definition infrared ball automatic zoom camera enables intelligent real-time tracking of the hook operation screen, avoiding blind zone operations, and reducing tower crane operation safety accidents. The ball camera automatically zooms to ensure a clear picture of the hook operation in the driver's cab.

3.2 Application of Sound and Light Alarm System and Safety Indicator [2]

The sound and light alarm system is an alarm device that transmits warning signals to people through sound and light (Indexing Fig. 5–6). It can quickly respond to flashing warning lights and issue voice prompts. It is widely used in large lifting machinery, engineering vehicles, fire safety reminders, factory safety production reminders, banks,

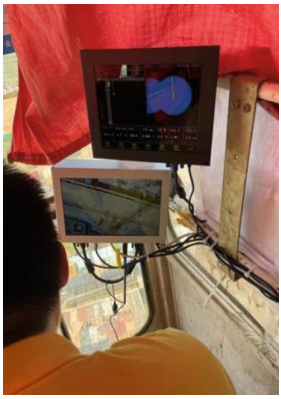

Fig. 3. Tower crane hook visualization system

Fig. 4. The bolt anti-loosening alarm system

schools safety reminders, government agencies, etc. It is solar-powered, with an alarm sound level $\leq$ 120db, easy to install, and has a waterproof rating of IP65.

Application advantages: To ensure a more standardized, scientific, and rational layout of the project, the project has set up a sound and light alarm system and safety indicator at the entrance of the construction site, allowing management personnel and workers entering the construction site to feel the importance of safety and to improve safety awareness. [4] [5].

3.3 Application of BIM and Simulation Simulation Construction Technology [6] [7]

Through the use of BIM technology, two-dimensional drawings can be transformed into three-dimensional layout methods at different stages of construction, allowing for flexible layouts of on-site processing tents, material storage areas, and large machinery locations. Simulation analysis can be conducted on traffic flow, pedestrian flow, and

Fig. 5. Sound and light alarm system and safety indicator

Fig. 6. Security and protection standardized construction special equipment

material transportation, solving problems such as narrow on-site spaces. This leads to the formation of dynamic and precise site layout plans, reducing the difficulty of on-site construction and management while effectively eliminating construction errors. The three-dimensional model technology used in mechanical and electrical integrated pipelines involves using specialized software on a computer platform to simulate and arrange various system pipelines, guiding construction operations.

Advantages: Multiple methods of communication using physical and electronic mock-ups make communication more efficient. Based on the Guanglian intelligence model, the precise arrangement of on-site masonry structures can be simulated and the pouring plan can be monitored and adjusted in real-time. The application of three-dimensional model technology greatly solves problems such as overlapping elevation, position conflicts, and space limitations of various professional pipelines during installation operations, not only controlling construction processes and quality, but also significantly reducing rework, as well as effectively saving costs and generating visible economic benefits.

3.4 Automated Centralized Steel Bar Processing

Centralized steel bar processing is an essential step in the industrialization of civil construction, offering both technical advancement and economic rationality. Automated centralized steel bar processing replaces traditional manual processing on-site. The steel bar automated centralized processing production line is designed to meet various functions, improve processing accuracy, reduce labor input, and facilitate overall on-site layout and space saving. [3].

Advantages: After adopting automated central steel bar processing technology, material costs and labor costs are reduced by about 10% compared to traditional steel bar processing methods used in similar projects, thus saving costs. The use of microcomputer digital control instead of human sensory control greatly improves processing accuracy and ensures semi-finished product dimensions and bending angles. This facilitates on-site binding and construction, minimizing the occurrence of rework and improving on-site pass rates, as well as saving time.

3.5 Application of Fully Automatic Dust-Free Wall Slotting Machine

Automatic dust-free slotting machines are used for water and electricity installation slotting in indoor masonry walls (Indexing Fig. 7). These machines are suitable for various wall materials, such as solid brick, sand brick, hollow brick, aerated brick, cement-covered walls, wall pillars, and more (Indexing Fig. 8). The main cutting dust is granular in shape and with low speed, thereby reducing pollution. Industrial dust removers are provided with the main machine to powerfully eliminate noise and dust.

Advantages: Dust-free slotting machines are easy to operate, with high processing accuracy and quick automatic one-pass slotting. The angle can be adjusted and rotated flexibly, creating beautiful patterns and control over the depth of cutting. This greatly reduces construction costs in terms of labor and time.

4 Issues Restraining the Development of Construction Industrialization

Construction industrialization is a revolutionary change in the way engineering construction is carried out, and its core is to prefabricate parts and components in factories and assemble and construct them on-site. Its main features include standardized design, factory production, assembly construction, integrated decoration, and information management, which have gone through the process of machine replacing labor, factory replacing site, and computer replacing human brain. However, with the development of society and the construction industry, many problems have gradually emerged, mainly including: a decrease in young people in the construction industry, an increase in the average age; continuously rising raw material costs; the expansion of business scope to the whole country and even overseas; and more stringent safety and environmental protection requirements. Specifically, these problems can be seen in the following three levels:

Fig. 7. The worker is cutting and operating the machinery

Fig. 8. The completed physical effect/result

4.1 From the Perspective of Urban Policy Decision-Making

Firstly, there is a need to further improve ideological awareness. Developing prefabricated buildings and promoting the development of construction industrialization is one of the measures to implement the national strategy of high-quality development and achieve the "double-carbon" goal. However, some decision-makers are unwilling

to adopt a prefabricated construction system by citing the reason of increased investment, and they tend to disregard the opinions of the housing and construction department during the land leasing and pre-project research and decision-making processes.

Secondly, there is a lack of comprehensive and coordinated development thinking. Some departments narrowly believe that promoting prefabricated construction is the responsibility of the housing and construction department, and that prefabricated construction is a technical issue within the scope of the housing and construction department only. As a result, there is a lack of work coordination, making it difficult to form a collaborative force to promote the development of prefabricated construction.

4.2 From the Perspective of Various Participating Units in the Construction Industry

Some construction units, design units, and construction companies passively participate in prefabricated construction, lacking proactive and positive thinking to influence the development quality of prefabricated construction.

Firstly, the level of standardization and modularization is not high. Currently, in our province's prefabricated construction, there is a lack of unified design standards and non-interchangeable components. All prefabricated component production is customized according to specific engineering contract orders, resulting in high factory production costs, low efficiency, and inconsistent component quality.

Secondly, the management level of construction companies is not high. Most participating units in prefabricated construction still use traditional management models, and design, production, and construction are all independent and disjointed, making it difficult to work efficiently and synergistically, and unable to effectively leverage the advantages of prefabricated construction in terms of short construction period, high quality, and high efficiency.

Thirdly, there is a shortage of talent reserves and training. Traditional construction workers are still operating on site, and industrial workers are severely lacking, which affects the safety and quality of prefabricated construction.

4.3 From the Perspective of Governance by Functional Departments Such as Housing and Planning

Firstly, the policy guidance is not strong enough. During the pilot period, prefabricated construction can enjoy the policy of invitation for bids, which has attracted some leading enterprises to participate. However, during the industrial chain construction and development in the pilot period, there was a failure to form a mechanism that transitions from government guidance to market dominance.

Secondly, there is a lack of macro policy guidance for industrial layout. PC factories are expanding rapidly, but the overall scale of prefabricated construction projects cannot meet the PC factory's production capacity needs, resulting in excess production capacity and disorderly competition among component manufacturing enterprises, with product prices going down and breaking through, affecting the industry's healthy development.

Thirdly, the quality control measures are not strong enough. There is a shortage of specialized technical personnel to supervise prefabricated construction sites, and

there are loopholes in the product quality supervision of prefabricated component manufacturers.

5 Thoughts on Promoting the Development of Construction Industrialization

As an important part of intelligent construction, promoting smart construction sites and continuously promoting the coordinated development of construction industrialization is crucial for the transition of the construction industry from high-speed development to high-quality development, [9] as well as for the green and low-carbon transformation and digital transformation of the construction industry.

5.1 Implement Prefabricated Construction Projects [11]

Strictly implement the new construction land leasing conditions, set the prefabricated building's new area ratio and assembly rate, and require the use of prefabricated construction methods when project construction is established. Establish a project list.

5.2 Improve the Standardization Level of Prefabricated Construction.

Combine 5G, artificial intelligence, the internet of things, cloud computing, big data, and other digital scene constructions to apply them practically to business management, continuously promote the standardization of precast concrete laminates, and improve the standardization level of prefabricated stairs. Establish a shared database of steel molds for prefabricated stairs in our city to reduce construction costs. [10].

5.3 Promote the Development and Application of Modular New Technology Systems

Promote the application of integrated modular electromechanical and pipeline systems, encourage the production and promotion of combined steel reinforced products, encourage state-owned enterprises to explore the introduction of the science and innovation partnership system, and accelerate the independent intellectual property technology system research and development.

5.4 Increase the Promotion of Modular Decoration

Give full play to the advantages of existing modular decoration bases, promote the implementation of modular decoration in state-owned investment and financing guarantee housing and public building projects, hold modular decoration observation meetings at all levels, pilot modular decoration in commodity housing projects, and increase the development and application of new green, energy-saving, modular decoration materials and other new building materials.

5.5 Promote Modular Steel Construction

Promote the use of modular steel structure systems in public buildings prioritized by government investment and financing, encourage pilot steel structure modular construction in guarantee housing projects, speed up the trial of full steel structure modular systems in some high-rise buildings, guide enterprises to take the initiative to adopt modular steel structure systems for design, and introduce investment to build modern steel structure production bases.

5.6 Improve the Information Management Level of Modular Construction

Clarify that the entire process of modular construction adopts BIM technology, and submit digital files upon completion, set up an architectural industrial internet platform, connect design, production, construction and other links, and improve the efficiency of modular construction project construction.

5.7 Promote the Coordinated Development of Industry and Education Integration

The competent department shall mobilize the research and teaching forces of colleges and universities in various regions, combine with the indigenous demand of enterprise industries, establish a "production, study, research and application" coordinated development mechanism, select a group of industry-leading backbone enterprises to sign three-party cooperation agreements with the government, schools and enterprises, and jointly promote the industrialization and industrialization process of building.

6 Conclusion

The wide application of intelligent construction engineering is of great significance for promoting the transformation and upgrading of the construction industry and promoting the development of high-quality industrialization of the construction industry.

This paper takes Shishi Jinhui Heming Project, a pilot project of intelligent construction and industrial construction, as an example, and conducts intelligent exploration and practice from the aspects of production, construction, testing and management of prefabricated projects, and draws the following conclusions. The construction of smart site system is still in the early stage, and there is still a lot of space to explore in the field of digital construction in the future. At present, China is in the era of rapid development of science and technology, and the information explosion makes the future come to us. We should learn from and integrate new technologies, new materials and new processes, and gradually apply them to practical projects, so as to make a contribution to the industrialization, informatization and intellectualization of China's building field. [8] Through the wide application of intelligent construction technology, it can effectively improve the industrial production efficiency, reduce the operating costs, ensure the quality of project construction, improve the efficiency of project management, and promote the continuous integration and development of construction industrialization, information and intelligent technology.

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