Research on Green Construction Mode Based on Intelligent Construction

Huixin Cui, Xiaoyu Ren*

School of Management, Shandong University of Technology, Zibo, 255000, China
*Corresponding author

Abstract: The development of construction industry in our country, while realizing the quantity scale growth, also faces the problems of high consumption of resources and energy, more pollution and low efficiency. Promoting high-quality development and green intelligent construction is the road of construction industry transformation. Green, efficient and intelligent construction has become the main trend of the current development of the construction industry. In order to integrate the concept of intelligence and environmental protection into the whole construction process, green construction technology shall be used as much as possible, and the standards for green construction shall be met in the process of intelligent construction, so as to realize the deep integration of intelligent construction technology and green construction technology. On the basis of combing "Intelligent + Green" construction technology, this paper puts forward the intelligent management platform of green construction, which supports the management of engineering projects from five parts: integrated planning, standardized design, intelligent production, digital construction and intelligent operation and maintenance, and provides a good idea for promoting the development of intelligent construction and building industrialization, and helps the green intelligent construction technology to integrate into the traditional construction mode more smoothly, and provides some theoretical and technical reference for the development of intelligent construction and green construction.

1. Introduction

In today's economic development, facing the dual pressure of environment and resources, the construction industry must pay enough attention to the problems of environmental pollution and energy consumption in the current industry. Therefore, green construction and intelligent construction should become the main melody of construction industry development in the new era. In 2021, the Opinions on Promoting the Green Development of Urban and Rural Construction clearly pointed out that green construction should be realized in the whole process of engineering construction, and prefabricated buildings should be vigorously developed to form a complete industrial chain and coordinated development of intelligent construction and construction industrialization[1]. The Opinions of The General Office of the State Council on Promoting the Sustainable and Healthy Development of the Construction Industry put forward that calls for vigorously promoting green

construction, and actively promoting scientific and technological innovation and engineering construction related to "double carbon". Strengthen the standard system, from its own development, to branch reform and other aspects of adjustment and work deployment. In such an environment, the implementation of smart, intelligent and green construction mode is not only an important path for the country to develop digital economy and promote high-quality economic development, but also an inevitable choice to achieve carbon peak and carbon neutrality[2]. Building green intelligentization has an important practical significance to promote ecological civilization and promote the green development of urban and rural construction.

2. Application of Green Construction Technology in the Whole Process of Intelligent Construction

2.1. Design Phase

In the design stage, the parametric design and the performance optimization design are combined based on the BIM technology and the simulation technology to make the design more scientific and rigorous[3]. BIM model is a carrier of all the information of a construction project. It provides a platform for the whole process, elements and participants of a construction project. Designers can interact with each other through the platform, the effective transmission of information, so that more accurate design information, design modification more efficient[4]. Performance optimization refers to the optimization of the design scheme based on the establishment of the building information model and the simulation of different building performance with the help of simulation technology, and the pre-simulation and analysis of the outdoor environment (light, sound and heat environment) and indoor environment (green, health and comfort degree as well as the building enclosure structure and building performance) of the project to be built, so as to optimize the site environment of the project to be built, significantly reduce the building operation energy consumption, reduce carbon emissions, improve the building quality and support green development.

2.2. Stage of Production

The industrial production of building components and fittings is the key link to realize intelligent construction, and also the core link of assembly construction. Compared with traditional construction, prefabricated construction can help reduce heavy wet work, shorten construction time, reduce waste of building materials and construction waste, and reduce energy consumption in the supply chain.

BIM, Big Data, Internet of Things and sensing technology play an important role in the intelligent production stage. The technology of the Internet of Things shall be used to digitize the production equipment and improve the capability of data collection and analysis in the whole production process[5]. For example, the production stage of steel structure is the stage that produces the most energy consumption in the whole building process, and the production equipment of steel structure is intellectualized upgraded to facilitate the monitoring and management of energy consumption of the production equipment; the arrangement of intelligent sensor devices in each production link is used to monitor the environmental conditions in the production stage by using sensing technology. For example, the dust monitoring system can monitor the dust concentration of the workshop in real time during the production period, and automatically adjust the ventilation system of the workshop when the dust concentration of the workshop reaches the preset value, so as to improve the production environment and ensure that the production environment is in a stable and good state; the BIM, cloud computing and big data technology shall be used to build an information management system for green production and high-quality production and promote the information management of the whole production process. For example, an energy consumption management platform for energy

consumption data monitoring and collection, data processing and dynamic analysis shall be set up, and water, electricity and gas of factories shall be subject to centralized supervision; an integrated quality inspection system shall be set up to sort out the standards for raw material inspection and product quality inspection, and the inspection batch data and the raw material data of the same batch shall be bound to form a traceable system for quality inspection results[6].

With the continuous progress of intelligent construction technology, the production stage is focusing on the combination of information technology and physical production technology, and gradually realize the whole process of automatic production, so that the design of building components becomes more scientific, the production process becomes more intelligent and automated, and the management mode becomes more modern.

2.3. Construction Phase

The construction stage is the most complex stage to control energy consumption and reduce environmental pollution in the whole process of construction. Digital technologies such as BIM, cloud computing, big data, Internet of Things and sensor technology are combined with construction process to improve the efficiency and level of construction management.

Intelligent management mode is used to monitor the environment and energy consumption in the construction process, and the monitoring data are transmitted to the server through the network. As far as possible to do a good job in the control of pollution sources, contribute to the construction site environment and energy consumption control, but also improve the operating environment, improve energy efficiency, reduce energy consumption. In terms of environmental management, the intelligent system will monitor a series of indicators such as wind speed, noise, dust concentration, environmental temperature and PM10 particles, and set the working mode as follows: if the real-time data monitored exceeds the limit, the system will automatically activate the alarm device, immediately notify the management personnel to check the situation on the site, and at the same time, devices such as automatic spraying and dust reduction will be activated; in terms of energy management, the energy control of the construction site can also be carried out by using the platform detection and remote transmission equipment, and an early warning value that can be used to monitor the energy consumption indicators will be set up in the system according to the project situation. When the water, electricity, gas and other data used on the site reach the early warning indicators, the system will make the same response as that in the abovementioned part of environmental monitoring and management, and during the monitoring process, the platform will continuously record data and regularly analyze and store the same so as to realize the effective control of construction energy.

2.4. Operation and Maintenance Phase

In the traditional thinking and research of building energy conservation, people pay more attention to the early design and construction stage of the building, but ignore the importance of operation and maintenance stage. According to the report on the Status of Global Buildings and Construction 2020, energy consumption in the running phase of buildings accounts for 30% of the world's total energy consumption. The carbon emission of buildings in operation stage accounts for 28% of the global total emission. According to this statistics, paying attention to the monitoring and management of energy consumption in the operation and maintenance stage is an important part of green intelligent construction.

At present, the operation and maintenance stage of the project with the goal of green construction has the problem of superficial operation work, and the real purpose and demand of green operation and maintenance have not been realized. For example, managers follow the traditional work flow and operation methods, but do not sincerely accept the new technology, the operation of intelligent system

equipment is not enough attention; The equipment and system are not maintained or updated regularly during the building operation and maintenance stage, which cannot guarantee the normal operation at any time. In order to realize the real green operation and maintenance, it is necessary to introduce intelligent technology to improve the efficiency of green operation and maintenance management, upgrade the management mode of operation and maintenance, and make a breakthrough in the technical bottleneck.

The Internet of Things technology is the core technology to realize intelligent and green operation. By integrating the Internet of Things technology with BIM, big data, cloud computing and other information technologies, the effectiveness of intelligent and green operation and maintenance can be improved by combining the building automatic control system with the intelligent operation and maintenance information management platform. The data information collected by the building automatic control system is linked with BIM to form an intelligent operation and maintenance information platform to realize intelligent operation and maintenance management as well as real-time synchronization and storage of information. The data collected from the equipment with different uses and characteristics are classified and sorted by the front-end sensor, and the dynamic energy consumption analysis report is obtained by item-by-item analysis. Each module of the building automatic control system can be used individually, or they can be combined according to the needs of users or managers, so as to obtain comprehensive monitoring data, so as to achieve the regulation needs in different situations. When the abnormal data of energy exceeds the limit value, the system will alarm online, and control and correct it. At the same time, in the process of control, the field control equipment will also transmit the control results to the central processor and information management platform through the network, so as to achieve the cooperative work of the whole system.

At present, various application technologies of intelligent operation and maintenance are still in their infancy. In view of the energy consumption and environmental control needs of green building operation and enclosure, which are most concerned about, there is still a lack of green building dynamic energy management technology that combines human behavior with real-time building performance prediction and environmental comfort regulation that integrates human satisfaction[7]. The dynamic control technology of BIM technology, building automation control technology and professional control of management personnel needs to be further established and upgraded.

3. Green Construction Process Intelligent Management Platform

At present, energy saving and carbon reduction and green construction are the focus of the national and relevant building departments. Combined with the relevant technologies of intelligent construction, an intelligent management platform for the whole process of green construction can be built in the aspects of project planning and design, intelligent production, digital construction, intelligent operation and maintenance, etc. The establishment of the intelligent management platform for the whole process of green construction means that the green management means has been upgraded from artificial supervision to digital enabling intelligent green construction management mode[8]. Based on BIM+ digital twin technology and combined with big data, Internet of Things, GIS and other technologies, the platform can realize real-time supervision, dynamic analysis and early warning of the whole process, and carry out comprehensive supervision focusing on "energy saving, land saving, water saving, material saving and environmental protection", so as to achieve fine management of green construction[9]. The intelligent management platform for the whole process of green construction is presented in the form of hybrid cloud. In each stage of the project, the relevant parties will actively use the method of "BIM+ digital twin" to undertake the integration platform with their own private cloud and unified procedures and interfaces, and carry out information interaction and collaborative work on the platform. The construction of intelligent management platform for the

whole process of green construction can be divided into five stages: integrated planning, standardized design, intelligent production, digital construction, and intelligent operation and maintenance.

(1)Integrated planning

Integrated planning is based on the internal needs of the project, combined with the external environment, to make a comprehensive analysis of the utilization of resources and technology methods, so as to determine the implementation path of green intelligent construction and new building industrialization. The integrated planning scheme should be consistent with the formulation standards of green planning and the overall goal of green construction, clear the implementation path of the project, and reflect the characteristics of green, intelligent and industrial. With the assistance of BIM and GIS technology, the required building information is provided on the intelligent management platform for the whole process of green construction. According to the planning content and various data and information stored on the platform, the simulation and analysis are carried out, and the planning is adjusted according to the feedback of the analysis results[10]. In the planning process, the platform is regarded as a facilitator to promote the linkage of resources upstream and downstream of the industrial chain, so as to provide services for the industrialization of new buildings.

(2)Standardized design

The green design module in the platform can meet the needs of green standardized design and form a better degree of resource integration, thus promoting the integration and collaborative design among the whole process, various specialties and various participants.

At the initial stage of platform investment, comprehensive and accurate data information should be collected as far as possible to build an information resource library to provide parameter basis for all parties involved in the design. The design module in the platform adopts a horizontal and vertical combination of operation. Horizontally, it serves for the collaboration of all designing parties, breaks away from the old mode, and implements the close cooperation of all majors through the architectural information model, so as to truly realize the integration and sharing of information in the design stage. Vertically, the project design is improved and optimized from multiple angles on the basis of the combination with all stages of the whole process, so as to be more integrated and more suitable for the whole life cycle of the building. With the operation of the platform, the information resources in the platform are enriched, and the accuracy of parameters in the later stage is improved, which plays a positive role in improving the quality and efficiency of green standardized design, and provides important and comprehensive information for the management of the whole life cycle of buildings.

(3) Intelligent production

The production of components is an important part of the whole process of green construction, and its manufacturing precision and quality are directly related to each link in the whole life cycle of the building. In addition, components will consume a lot of energy in the manufacturing process, which will cause pollution to the environment to a certain extent.

The module of intelligent production pays attention to the establishment and application of energy database. The intelligent production module on the platform is used to analyze and store the monitoring data of each link in the production process, so as to realize the continuous cycle update of data analysis results. The storage, analysis and comparison of these data will also contribute to future improvements in production processes and energy consumption controls. In the process of intelligent production, a BIM 3D component family library is established in the platform. On the one hand, it can help the upstream designer to obtain more design information resources; on the other hand, it can help the relevant parties of the project to provide convenient information channels for future maintenance and changes, and generally promote the standardization and fine development of construction industrialization.

(4) Digital construction

Digital construction is the follow-up work of green standardization design and standardization

design in the whole life cycle. In view of the characteristics of strong systematization, many interference factors and large capital input in the digital construction stage, an independent intelligent site platform is applied to serve the digital construction stage. At the same time, it is also necessary to build a convenient platform interface on the intelligent management platform of the whole process of green construction, so as to facilitate the collaborative operation of various systems between platforms. The digital construction system integrates BIM, Internet of Things, big data, AI, digital twinning and other technologies, with built-in building management norms and data analysis models, providing multiple aspects of technical support for the digital construction and meeting the management needs at all stages of construction.

Digital construction management system in accordance with safety, production, quality, BI. M and technology, green construction, digital site is divided into different blocks to carry out collaborative management of the project. Taking green construction as an example, in view of environmental monitoring, energy consumption monitoring, sewage detection and other problems, the monitoring construction site set up monitor and controller data for real-time recording, in the case of abnormal working parameters, the system will push the warning information to the relevant controller and person in charge, so that they can quickly take appropriate countermeasures. Using the data collected by the monitor, the environmental state or energy consumption state of different construction stages and different areas can be automatically analyzed statistically, and then fed back to the manager in the form of ICONS, curves and reports to assist the manager in fine management.

(5) Intelligent operation and maintenance

Operation and maintenance stage is the longest building life cycle stage with the largest amount of data. Therefore, the intelligent operation and maintenance platform must be separated from the intelligent management platform of the whole green construction process to operate separately. Then, standard technical protocols and interfaces are used to establish links with the intelligent management platform for the whole process of green construction, so as to form a unified management and control platform, so as to get rid of the limitations of business management of a single system.

The establishment of digital twin system based on BIM is to collect BIM data from various sources according to the building information model and real geographic information. The tool BIM lightweight engine automatically carries out the adjacent lightweight processing of BIM data, outputs the lightweight model after digital-to-analog separation, and generates interactive three-dimensional digital twin system through real-time rendering of computer. In this way, space, equipment, energy, security and other management of the whole life cycle of the building can be carried out to create a perceptible, visible, manageable and controllable digital three-dimensional management mode[11]. Intelligent operation and maintenance with the digital intelligent management platform, combined with user needs, to develop a set of effective operation and maintenance scheme, reasonable allocation of resources, improve the efficiency of management work, reduce management costs.

4. Conclusions

With the promotion of the national "double carbon" goal and the intelligent development of the construction industry, green intelligent construction will enter a golden period, bring new products, new technologies and new drivers to the transformation of the construction mode, and inject new momentum into the transformation and upgrading of the existing construction mode. China's construction industry needs to customize the development strategy that integrates with intelligent construction and green construction environment, and seek the bottleneck technologies and bottlenecks in practice, so as to completely change the current scattered, extensive, energy-intensive and inefficient construction situation. BIM will be fully integrated with the Internet of Things, big data, cloud computing, GIS and other technologies, constantly expand the extension of applications,

and gradually cover more work links with intelligent working mode. Continuous research and development and improvement of planning, design, construction, operation and maintenance of the whole life of the collaborative interaction platform, to create a working link in green construction technology and green construction management.

References

[1] Shang Shaoyan. Practice the new development concept and promote the coordinated development of intelligent construction and new industrialization. China Construction Informatization, 2021(24):10-11.

[2] Ding Lieyun. Intelligent technology promotes green city construction. Urban and rural Development, 2022(01):5.

[3] Xiao Xuwen, Feng Dakuo. The significance and strategy of promoting green construction. Construction Technology, 2013, 42(07):1-4.

[4] Xue Feng, Ling Suyang, Cui Dexin. Integrated collaborative design method for the whole process of green construction. Construction Technology, 2021, 50(13):113-117.

[5] Mai Yafeng, Zhang Qiwei, Sha Jianqi. Research on Intelligent Construction Integrated Management System based on BIM+ Internet of Things. Construction Economics, 2020, 41(06):61-64.

[6] Fan Qixiang, Lin Peng, Wei Pengcheng, Ning Zeyu, Li Guo. Intelligent construction closed-loop control theory. Journal of Tsinghua University (Science and Technology), 2021, 61(07):660-670

[7] Han Jihong, Zhang Ying. The key problems of green building operation management and the application value of BIM. Construction Science and Technology, 2019(12):12-16.

[8] Chen Jing, He Hongyin. Construction of intelligent construction platform for the whole industrial chain of prefabricated buildings. Intelligent Building and Smart City, 2021(10):96-97.

[9] Liu Wenfeng. Research on key technology system of Intelligent construction. Construction Science and Technology, 2020(24):72-77.

[10] Wang Shutao. Innovative application of intelligent construction technology in engineering construction management. Construction Economics, 2021, 42(04):49-52.

[11] Du Mingfang. Construction concept, theoretical prototype and key technologies of green digital twin. Construction Technology, 2022, 51(23):9-13.