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Application of Smart Construction Technology in Green Building Design

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Abstract. Against the backdrop of the rising global demand for sustainable development, coupled with challenges like climate change and resource shortages, the construction industry — a major sector in terms of energy consumption and carbon emissions, has embraced green building as a crucial direction in design. Intelligent construction technology provides critical support for the implementation of green buildings. This paper systematically explores the innovative use of Intelligent Construction Tech in Green Building Design Processes, analyzing its specific use in the initial design stage, design process, and result verification & optimization stage: In the initial stage, parametric design combined with BIM, big data, and intelligent decision-making systems lays the green foundation; in the process, intelligent algorithm optimization, automated generation, and auxiliary systems improve efficiency; in result verification, simulation, data analysis feedback, and sustainable evaluation tools optimize outcomes. This research provides a practical path for the green and low-carbon restructuring of the construction industry.

Keywords: Smart Construction Technology; Green Building; Design of Architecture.

1. Introduction

The support and development background of smart construction technology for the application of green building design as shown in Fig. 1.

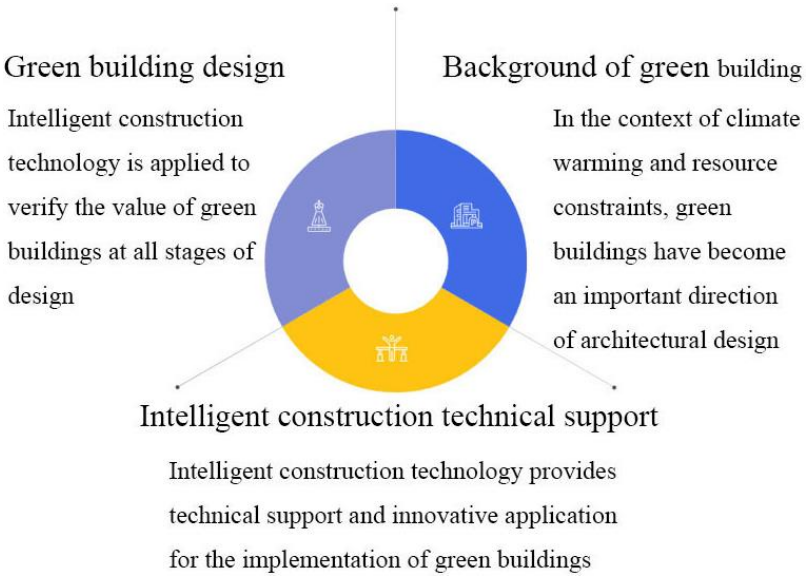

Figure 1. Intelligent construction and green building development

As global demand for sustainable development keeps rising, environmental problems—such as pollution and global warming driven by greenhouse gas emissions—have brought heavy focus to human activities that fuel environmental degradation, with China's construction and urban development being a notable case [1]. As a concept focusing on energy conservation, environmental protection, and health, green building has become an important direction in modern architectural design. Against the increasingly severe global challenges of climate warming and resource scarcity, the construction industry, as a key field of energy consumption and carbon emissions, has identified

intelligent construction and green building as critical directions for promoting industrial transformation and upgrading [2]. Meanwhile, the fast-paced advancement of intelligent construction technology is propelling the digital and intelligent transformation of the construction industry with groundbreaking momentum, offering unprecedented technical backing for the execution of green buildings [3].

This paper intend to explore the innovative application of intelligent construction technology in green building design, systematically analyzing its application in initial design, design process, and result verification & optimization, and verifying its value through simulation. The application of intelligent construction technology in sustainable design optimization not only brings innovative improvements from concept to implementation in green building design but also provides a feasible path for the sustainable development of the construction industry. Achieving carbon neutrality has now provided technologies and means for the green and low-carbon restructuring of the current construction industry [4].

2. Application of Smart Construction Technology in the Initial Stage of Green Building Design

2.1. BIM Technology

In the initial stage of green construction design, BIM (Building Information Modeling) technology integrates various types of building data and intuitively presents the appearance, structure, and systems of the building through 3D modeling. Relying on the BIM platform, design teams can simulate and analyze structural stability, ventilation, lighting, and heat flow to optimize energy efficiency and living comfort. Parametric design combined with BIM technology can not only visually present design effects but also ensure that design decisions are based on scientific calculations of detailed data [5], enabling designers to comprehensively consider energy conservation, emission reduction, material selection, and natural resource utilization at an early stage, thereby promoting the overall performance improvement of green buildings.

2.2. Big Data Analysis Technology

Big data analysis technology can collect, process, and analyze massive amounts of data from construction projects, providing designers with a scientific basis for decision-making and strengthening the data support for intelligent construction. Its application in design is widespread: in building performance evaluation, energy consumption prediction, material selection, and other links, it can optimize schemes to maximize the green performance of buildings. By collecting and analyzing multi-dimensional information such as site climate, environment, energy consumption, and population density, and extracting valuable content from databases, it can make up for the shortcomings of traditional design, which relies on experience and intuition and struggles to comprehensively consider various factors. In the initial design stage, it points out directions for designers and promotes scientific decision-making.

2.3. Intelligent Auxiliary Decision-Making Systems and Sustainable Design

The relationship between intelligent decision-making systems and sustainable design, as shown in Fig. 2.

Current studies related to green buildings are primarily centered on building technology, environmental influence, and energy efficiency [6]. In the initial stage of green construction design, intelligent auxiliary decision support systems integrate data on building energy efficiency, building material properties, climate, and renewable energy potential to provide designers with real-time recommendations for scheme optimization, helping to create schemes that meet green standards. The system can analyze design variables in real-time and evaluate and optimize them according to energy conservation, water conservation, and low-carbon goals to improve energy efficiency; combined with

the climate and resources of the building's location, it assists in material selection and construction method determination to reduce environmental impact. For example, when considering thermal efficiency, it proposes optimal facade and window designs for different climates; in water resource management, it provides water-saving suggestions and optimizes water systems based on water demand and regional water resources. This system provides strong data analysis and optimization capabilities for green building design, supports sustainable decision-making, and ensures that the green core value is highlighted in the initial design stage.

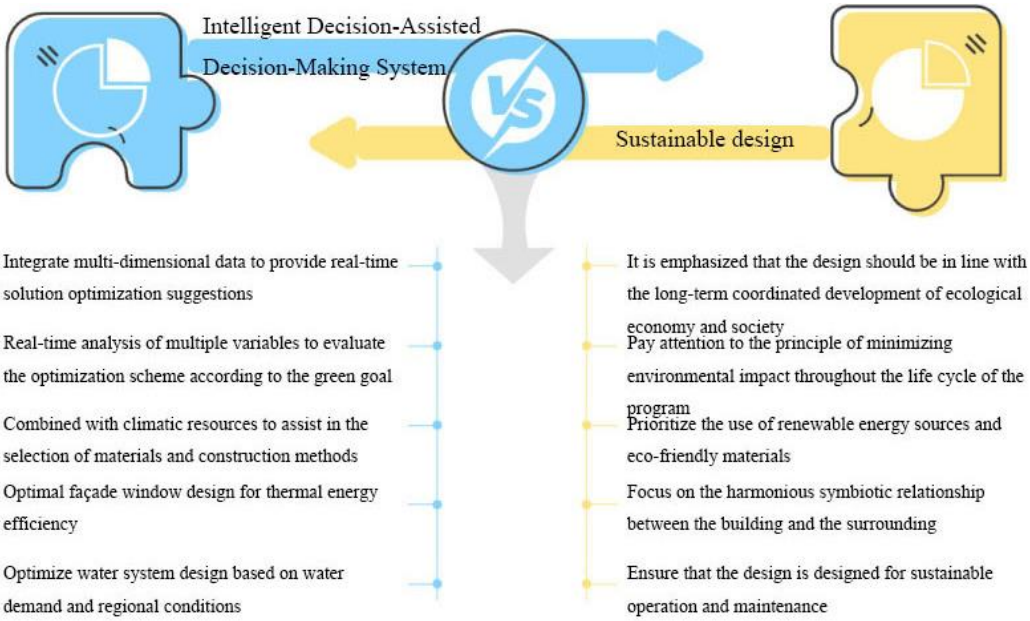

Figure 2. Comparison of the two systems in the initial stage of green building design

3. Application of Smart Construction Technology in the Green Building Design Course

Steps of green building design and application of intelligent construction technology, as shown in Fig. 3.

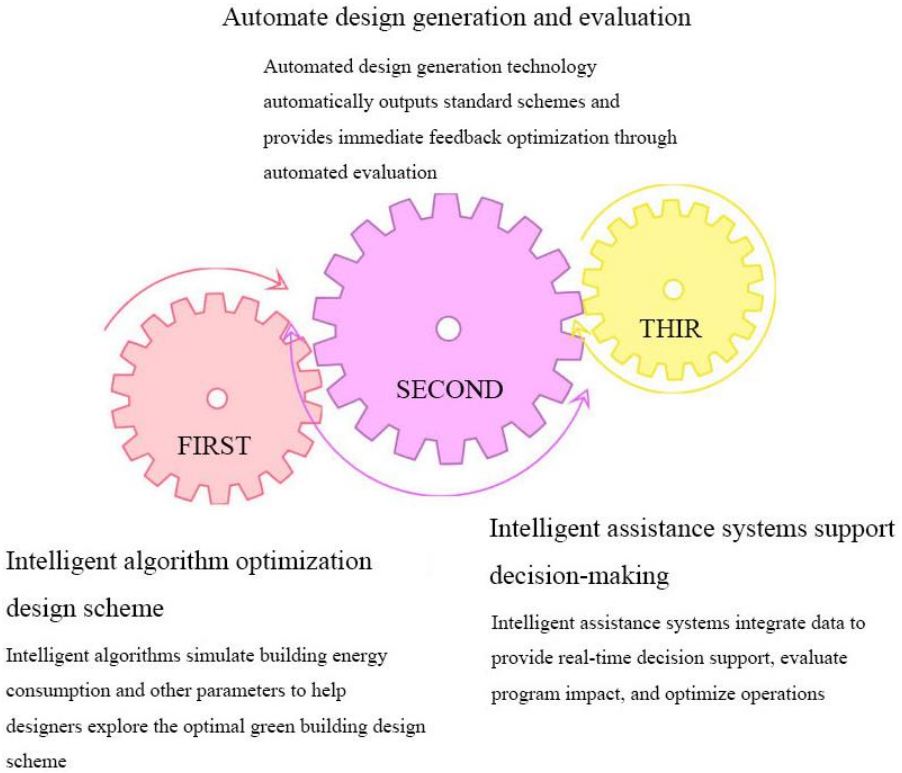

Figure 3. Green construction design and application of intelligent building technology

3.1. Design Optimization through Intelligent Algorithms

The integration of intelligent algorithms makes design optimization more accurate and efficient, enabling it to handle complex constraint conditions. By simulating parameters such as building energy consumption, thermal environment, and lighting, it helps designers explore optimal schemes. The introduction of smart optimization algorithms such as genetic algorithms and particle swarm optimization in intelligent construction technology can efficiently search in multi-dimensional design spaces to find schemes that maximize energy savings and resource utilization efficiency. It not only provides scientific design tools for green buildings but also promotes the development of design towards better and more sustainable directions [7].

3.2. Automated Design Generation and Evaluation

Automated design generation technology leverages intelligent programs and tools to automatically generate schemes that meet green building standards, and provides real-time feedback and optimization through automated evaluation processes. In traditional architectural design, designers need to spend a lot of time and energy on repetitive design calculations and adjustments, while automated design generation technology significantly reduces the complexity of manual operations, making the design process more efficient and accurate [8].

3.3. Intelligent Auxiliary Systems Assisting Decision-Making

Intelligent auxiliary systems integrate various types of data during the design process, providing real-time decision support and optimization suggestions to help design teams make scientific and reasonable decisions. In design, they can integrate information such as building material performance, climate data, and energy consumption data to provide comprehensive decision-making basis. The systems can help evaluate the long-term impact of different schemes through simulation and prediction functions. In the operation stage, they can monitor and analyze building usage data, optimize energy consumption management and maintenance strategies, extend building lifespan, reduce maintenance costs, and improve resource recycling efficiency.

4. Application of Smart Construction Technology in Result Verification of Green Building Design

Application and verification of results of smart construction in green building design, as shown in Fig. 4.

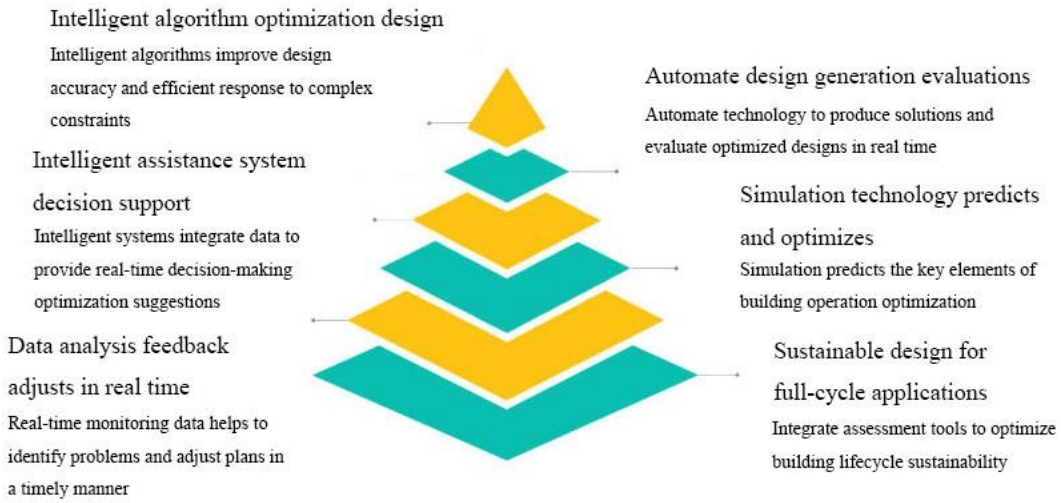

Figure 4. Intelligent construction application of green building design

4.1. Simulation Technology

Simulation technology uses computer models to simulate the actual operation of building designs and predict potential problems after completion. In green building design, it helps designers grasp key factors such as building energy consumption, thermal environment, lighting, and air flow during the design stage, identify potential deficiencies in advance, and optimize them. Through the analysis of energy consumption data, links with low energy efficiency can be identified and optimized, thereby further improving the building's energy efficiency and reducing carbon emissions [9].

4.2. Data Analysis and Data Feedback

Green building design not only requires optimization through simulation in the initial stage but also needs real-time collection and feedback of result data during the process. Intelligent construction technology helps designers promptly identify problems and adjust schemes, providing more accurate adjustment and optimization methods for green building design [10]. In result verification, IoT technology can collect data on temperature, humidity, lighting, and energy consumption of the building; after comparing with design goals, the design team can grasp the differences between actual and expected results in real-time. Analyzing operational data can verify whether the design meets standards, whether it can maintain efficient energy consumption control and good comfort; if there are deviations, management or operation methods can be adjusted in a timely manner to ensure the achievement of green goals.

4.3. Application of Intelligent Construction Technology in Sustainable Design

Sustainable design emphasizes efficient resource utilization, minimal environmental impact, and positive social contributions. Intelligent construction technology integrates advanced evaluation tools to assist design teams in optimizing sustainability performance at all stages of the building, ensuring it is environmentally friendly and economically efficient throughout the entire life cycle. In green building design, sustainability evaluation is a multi-dimensional process that needs to consider factors such as energy consumption, resource use, waste management, and environmental impact. Through the integration of BIM, IoT, and big data analysis, intelligent construction technology provides designers with comprehensive evaluation tools. For example, BIM-based evaluation models can comprehensively analyze the environmental impact of buildings from material procurement and construction to operation stages, enabling green building design to be optimized at all stages to meet the highest sustainability standards [11]. In summary, the use of intelligent construction technology in green building design is highly necessary and feasible [12].

5. Conclusion

When it comes to the application of intelligent construction technology in green building design significantly improves design efficiency, accuracy, and intelligence, making its application highly necessary and feasible. It is necessary to facilitate intelligent activities at all stages to enhance the intelligence and greenness of the entire construction process and support the sustainable development of buildings. With technological progress, its role in the field of green building design will become increasingly important, driving green building design towards a more intelligent and green new era.

In the future, the construction industry needs to continuously deepen the research and application of intelligent construction technology, promoting its in-depth integration with the entire process and multi-dimensional aspects of green building design. Through technological iteration to optimize tools and expand application scenarios, the potential of intelligent technology in energy conservation, emission reduction, and carbon footprint tracking will be further released, providing more solid technical support for the green and low-carbon transformation of the construction industry and helping to achieve sustainable development goals.

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