Research on the Application Value of Green Intelligent Construction Technology

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Abstract. With the rapid development of China's construction economy and the transformation and upgrading of the construction industry, the innovation and application of green building technology are constantly driving the rapid development of the future construction industry. The diversified application of green intelligent construction technology has become an important means to improve the efficiency, construction quality, and sustainable development level of construction projects. This article aims to explore the research significance of the development trend and application of green intelligent construction technology, analyze the influencing factors of green intelligent construction technology such as environment, energy, personnel management, construction costs, etc. Through model analysis and data exploration, form a green construction evaluation model based on variable fuzzy set theory for analysis and evaluation, and conduct in-depth research through engineering examples of the application of green building intelligent technology. Through the research and application analysis of green intelligent construction technology, valuable reference and promotion can be provided for the intelligent development in the field of construction engineering.

Keywords: Building construction; Intelligence; Green construction technology; Energy conservation and consumption reduction; Sustainable development

1 Introduction

With the continuous development of technology and social progress, people's demand for work and living environments is increasing, emphasizing green and low-carbon living environments. However, traditional construction methods have increasingly serious problems in safety, efficiency, environmental protection, and other aspects, bringing new and huge challenges to the development of the construction industry. The construction technology of green and intelligent buildings in China started relatively late, and there are already mature evaluation systems for green and intelligent building construction technology internationally, such as LEED in the United States, BREEM in the United Kingdom, GBC in Canada, and other green building evaluation systems. They have developed excellent green and intelligent construction facilities and equipment systems on the intelligent control system, which can coordinate well with building design. At present, the green energy-saving technology of newly built buildings in China

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only adopts partial intelligent control technology for a certain function, and fails to comprehensively and systematically adopt green intelligent construction technology[1].Therefore, in recent years, China has conducted extensive and in-depth research on the application and development of green intelligent construction technology in construction, exploring more suitable and sustainable intelligent construction plans, and continuously accelerating the modernization process of the construction industry. By utilizing modern technological means to achieve automation, intelligence, and greenness in the construction process, we aim to promote the transformation and upgrading of the construction industry and provide more efficient, safe, and environmentally friendly solutions for construction.

2 Factors influencing green and intelligent construction technology

2.1 Environmental factors.

The natural, social, and economic environment in which green and intelligent construction is carried out can have a certain degree of impact on it. For example, the dust, dust, and residual construction waste generated during excavation, stacking, transportation, backfilling, and leveling of the site are also prone to water waste, air pollution, and noise disturbance during the construction process. Therefore, corresponding measures must be taken to reduce the occurrence of these adverse phenomena.

2.2 Energy factors.

The various materials and equipment required for green and intelligent construction projects require a large amount of water and electricity as support. Building construction requires a large amount of water, such as the production, pouring, and later maintenance of concrete. Many mechanical equipment also requires the consumption of diesel and other fuels. If clean energy can be reasonably utilized to replace traditional energy, it can not only reduce energy consumption, but also help protect the ecological environment[2].

2.3 Personnel management factors.

Human beings are one of the elements of productivity. Strengthening the management of construction personnel and improving their living conditions can help improve construction efficiency. Wearing safety helmets and prohibiting high-altitude throwing behaviors can avoid environmental pollution and ensure construction safety production.

2.4 Construction cost factors.

In engineering and construction, construction project cost refers to all expenses incurred during the implementation process of the project. Normally, reasonable planning is carried out in construction projects based on design intent and requirements[3].The green impact coefficient of construction cost is shown in equation (1).

$$\varepsilon = \frac{C_g}{C_n} \tag{1}$$

In the formula: ε-----Green Intelligent Impact on Construction Cost and Construction Coefficient;

C_g------The engineering cost of the constructed project;

C_n------Cost of construction for non construction purposes.

The adoption of green construction technology and green construction management in each sub project during the green construction process will result in different green impact

coefficients. Therefore, for each engineering project, its total green impact coefficient, as

shown in formulas (2) and (3):

$$\varepsilon_T = \sum_{i=1}^{N} \rho_i \, \varepsilon_i \tag{2}$$

$$\rho_i = \frac{C_{ni}}{C_{nT}} \tag{3}$$

In the formula: ε_T-------The impact coefficient of green and intelligent construction on the construction cost of the entire engineering project;

ρ_i------The proportion of the i-th sub project to the cost in the non construction state;

C_{ni}------The cost of the i-th sub item project in the non construction state;

C_{nT}------The total construction cost in the non construction state.

Substituting formula (3) into formula (2), the green intelligence impact coefficient of the total construction cost is the ratio of the total green construction cost to the total cost calculated under the condition of not implementing green construction. Formula (4) is obtained as follows:

$$\varepsilon_T = \frac{C_{gT}}{C_{nT}} \tag{4}$$

In the formula:C_{gT}------The total cost of green intelligent construction projects that have been constructed;

C_{nT}------The total cost of green intelligent construction projects that have not yet been constructed.

2.5 Green construction evaluation model based on variable fuzzy set theory.

This study is based on actual construction projects and introduces the theory of variable fuzzy sets into the green construction evaluation system (see Figure 1). Through more than 300 questionnaire surveys and data analysis, the model is established, and the weights of each indicator are determined and calculated to obtain the scores of each

indicator. Meanwhile, considering the differences in different engineering projects, the weighted average method is adopted for comprehensive evaluation of expert opinions[6]. From the experimental results, it can be seen that the green construction evaluation model based on variable fuzzy set theory in this study has high accuracy and reliability, and can objectively reflect the environmental impact factors involved in the actual construction process and the level of sustainable development.

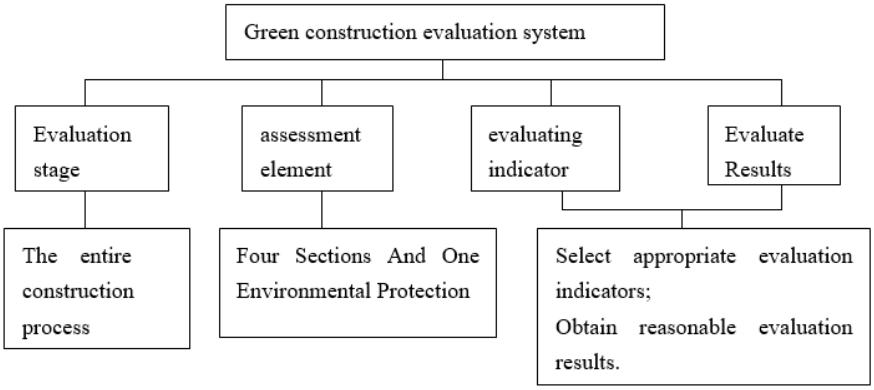

Fig. 1. Green Intelligent Construction Evaluation System

3 Analysis of application cases of intelligent technology for green buildings

3.1 Project Introduction

The development project of a certain real estate company is the first residential project in a provincial-level region to obtain a three-star green building design logo. The project plans to have 8 buildings with a total construction area of 186308 square meters, of which Building 1 is for affordable housing and Building 3 is for commercial use. The project fully utilizes green and intelligent construction technology[8].

3.1.1 Water saving construction.

The project has a large scale and site area. Based on the geological conditions of the construction site, drainage ditches and a settlement pool are set up around the surface and foundation pit. The rainwater collected on site flows into the reservoirs on both sides of the site through drainage pipes and sedimentation tanks, and then flows into the reservoirs through sedimentation tanks to establish a rainwater collection and utilization system[7].It can be used as water for site greening, road spraying, and fire protection, as shown in Figure 2.

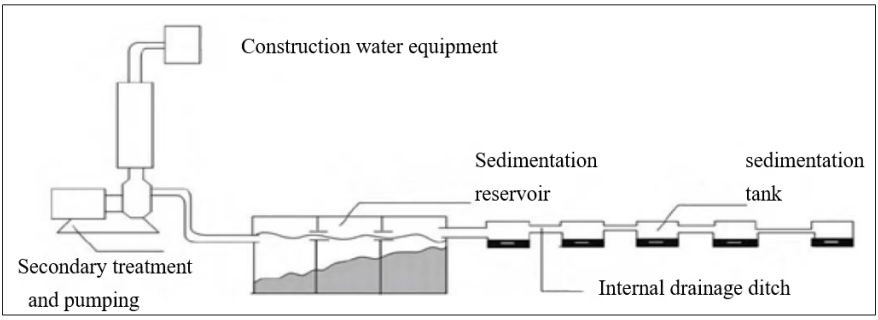

Fig. 2. Water saving construction system

3.1.2 Ground source heat pump system.

A ground source heat pump system is a heating and air conditioning system composed of a water source heat pump unit, a geothermal energy exchange system, and a building interior system that uses rock, soil, groundwater, or surface water as low-temperature heat sources. The project adopts a vertical buried pipe system, which buries high-quality enclosed PE pipes into the well to obtain geothermal energy. This system is energy-saving and environmentally friendly, belonging to renewable energy utilization technology, with significant economic and environmental benefits. Received strong support from government departments in many countries, especially in the northern regions where summer is hot and winter is cold, the effect is more obvious[10]. A ground source heat pump is versatile and can provide heating, air conditioning, and domestic hot water. The power consumption of the ground source heat pump unit is relatively low, which can save more than 40% compared to air source heat pumps and more than 70% compared to electric heating. Its heating efficiency is about 50% higher than that of gas boilers and about 75% higher than that of gas boilers, making it suitable for green and energy-saving heating in residential buildings.

3.1.3 Canopy radiation system.

The end of the cold and hot system in this project adopts a structural buried pipe ceiling radiation system[9].The ceiling pipe is connected to the ground source heat pump heat exchange system, which heats or cools the concrete floor slab through circulating water inside the pipe, forming a radiation surface and exchanging heat with the indoor human body and air to achieve heating or cooling effects. This system can create a high comfort indoor environment with constant temperature throughout the year. The ceiling radiation system can provide both cooling and heating, greatly saving initial investment and energy consumption.

3.1.4 Full displacement fresh air system.

This project adopts a full displacement fresh air system. The fresh air unit filters the outdoor air and has functions such as heating, cooling, humidification, and dehumidification. It enters the room through the fresh air duct at a speed of no more than 0.56

m/s from the ground outlet of each room. The fresh air entering the room quickly diffuses on the ground, rises through the heating of the human body or other heating objects, and systematically discharges the original polluted air (gases exhaled by the human body, formaldehyde, benzene, TCOV, etc.) into the top exhaust outlet of the bathroom or kitchen. The heat is recovered by the fresh air unit and then placed outdoors. The system can complete a complete indoor air replacement every 2.3 hours, ensuring fresh and healthy indoor air. The ultra-low wind speed does not generate wind noise, ensuring indoor quietness and creating a constant and livable environment[5].

3.1.5 Energy saving technology for lighting systems.

In the design process of lighting systems, green and energy-saving technologies should be fully utilized to save energy. Firstly, lighting equipment with better light source effects should be selected to ensure the high efficiency of the lighting fixtures. Secondly, in the application process of energy-saving technology in lighting systems, scientific lighting control methods should also be selected, and the optimal lighting time should be formulated to avoid energy waste caused by turning on lighting equipment while natural light is shining. Once again, adopt a centralized control and energy-saving method for the lighting equipment in public spaces, group and manage them, and achieve flexible management of different public areas[4]. The lighting equipment is uniformly controlled, and automatic induction lighting is installed in public spaces such as corridors and garages to achieve unmanned lighting, strengthen the intelligent control ability of the building, and effectively save electricity. See Figure 3.

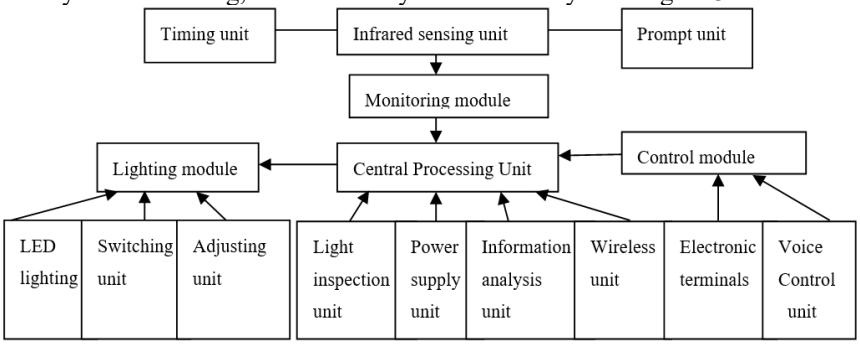

Fig. 3. Intelligent Lighting System

4 Conclusion

Green intelligent construction technology plays an important role in current construction projects, achieving new development trends of intelligence, digitization, sustainable development, and collaboration, maximizing the utilization of resources and energy, achieving green construction, energy conservation, efficiency, and environmental protection. Through new green building intelligent technologies such as water-saving construction, ground source heat pump system, ceiling radiation system, full displacement fresh air system, integrated FS technology for exterior wall insulation, and energy-

saving lighting system, green and environmentally friendly construction technology resources can be recycled and reused. By implementing intelligent energy management and energy-saving measures, we can achieve efficient energy circulation, create and optimize a more comfortable living environment for humanity, and accelerate the promotion and application of green, healthy, and intelligent construction technologies.

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