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Exploring the Interaction and Impact of Green Building Design on People and Space

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Abstract: With the progress and development of society, people's living standards improve at the same time, environmental pollution and resource shortages environmental problems also come. Construction engineering is one of the largest energy-consuming industries in China, and the implementation of a sustainable development strategy has become a top priority. Therefore, the state put forward the concept of 'greening' and sustainable development, and green building has become a mainstream design concept. The purpose of this paper is to elaborate on the principles and design points of green building design and to study and discuss the application cases of green building design. Analyze the interaction and impact of green building design on people and space by analyzing the effects and impacts of the implementation of different designs in green building design cases, including focusing on siting design, ventilation design, energy efficiency design, recyclable design, plant design, and lighting design. Summarise the importance of applying green building design concepts and effective designs that have a positive impact on people. The results of the study can provide practical suggestions on improving the sustainability and eco-friendliness of green buildings for green building design stakeholders, such as architects, policymakers, and related stakeholders, and this study has certain reference values and significance.

Keywords: Green building, sustainable development, people-oriented, eco-friendly, healthy.

1. Introduction

With the progress and development of society, people's living standards improve at the same time, and environmental pollution, resource shortages, the greenhouse effect, and other environmental problems also arise. Therefore, the state put forward the concept of 'greening' and sustainable development, and green building has become a mainstream design concept. The construction industry, in turn, is the number one energy-consuming industry, and the implementation of sustainable development strategies has become a top priority. This study is very relevant for practical recommendations to improve the sustainability and eco-friendliness of green buildings. This study focuses specifically on the principles and design points of green building design. Using the literature analysis method to find and read relevant information and literature, the advantage of this method is that it can well analyze the application of green building design in residential buildings, and understand the interaction and impact of green building design on people and space, which is conducive to the research. The ultimate research objective of this paper is to analyze the interaction

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and impact of green building design on people and space by analyzing the effects and impacts of the implementation of different designs in the case of green building design, including focusing on siting design, ventilation design, energy efficiency design, recycling design, plant design, and lighting design to reduce resource energy consumption. This paper summarises and collates the importance of the application of green building design concepts and effective designs that have a positive impact on people, and provides practical advice and certain reference values on green building sustainability and eco-friendliness for those involved in green building design.

2. Green Building Concepts

2.1. Definition

Green buildings are environmentally friendly buildings, designed on the principle of applying scientific principles and standards to buildings and rationalizing the use of natural resources based on protecting the natural environment and maintaining ecological balance. For example, energy-saving and environmentally friendly designs such as recyclable materials, rainwater recycling systems, lighting designs, and ventilation designs are adopted to minimize environmental pollution and energy consumption. This is one of the key principles of green building, and sound green design has a positive impact on the protection of the environment and the development of the construction industry. The green building concept is in line with the national environmental policy, and its goal is to create a healthy and comfortable environment for people to achieve sustainable development in harmony with nature. And to achieve this it is necessary to adhere to the concept of energy saving and environmental protection, and integrate environmental design into green buildings [1].

2.2. Design Concept

Throughout the design process of a building, large amounts of resources are consumed and environmental pollution is caused. In this context, green building, as a new type of architectural design idea, can reduce resource consumption, mitigate environmental pollution, promote the country's sustainable economic development, and provide people with a healthy, green, and comfortable life. Green building is a new building design concept integrating appropriateness and locality, energy saving and environmental protection, and health and comfort.

2.2.1. Suitability and Territoriality

The design of green buildings must be in line with environmental protection guidelines. When designing green buildings, the first thing to consider is the appropriateness of following scientific principles and standards is the core, and must fully take into account the local topography and landscape, and make reasonable use of all kinds of resources to ensure that the building can meet all the needs of sustainable development and environmental protection. Secondly, green building design should take into account the locality, the geographical location and climate of each city are different, and appropriate architectural styles and technologies must be selected according to the local actual situation. Green building combines the concept of environmental friendliness with the design of the building, aiming to achieve the harmonious development of man and nature, produce energy-saving and environmental protection effects, and comply with the national environmental protection concept.

2.2.2. Energy Conservation and Environmental Protection

What makes green building different from other architectural styles is the important concept of energy conservation and environmental protection, the more scientific and rational use of renewable materials, and the conservation of water resources and materials, such as rainwater harvesting systems

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and water recycling design, to mitigate pollution [2]. Green building design can save energy and reduce emissions, and the reasonable use of energy-saving and environmentally friendly building materials in interior decoration is a fundamental guarantee for the protection of the environment, which is directly related to the construction quality of green building projects, the surrounding environment, and the user's living experience. Therefore, when designing green buildings, the main point is to reduce energy consumption, efficiently use energy-saving and environmentally friendly materials, combine sustainable development and environmental protection, and constitute a green, environmentally friendly, and healthy indoor environment [3].

2.2.3. Health and Comfort

'Human-centred' is the core concept of green building design. As living standards improve and society progresses, people are placing more and more emphasis on health and comfort. Therefore, green buildings should be designed with comprehensive consideration of people's functional needs in all aspects, taking into account the building structure, physiological and psychological scales aesthetics, and practicality. For example, lighting design, ventilation design, and plant design are the most basic design elements for ensuring people's health and making their lives healthier and more comfortable. The green building must also follow a series of scientific green building design ideas, in the decoration of the space and the selection of materials, are to pursue the green environmental protection materials that are beneficial to the human body, to ensure that the room has the appropriate humidity, temperature and lighting, to design a comfortable and healthy environment [4].

3. Green Building Design Case Study

3.1. Site Selection Design

Reasonable siting design is the first thing to be considered in green buildings, the geographical conditions of different regions make green buildings face many difficulties in urban construction, so the development status of green buildings is limited. Firstly, green buildings should be comprehensively thought out and rationally designed in terms of thermal insulation issues and heat insulation problems. In the southern region the residents of more consideration about environmentally friendly materials and insulation materials, because of long-term exposure to strong sunlight radiation, in the issue of insulation should be well planned to prevent excessive exposure to the sun; while in the northern region of the residents of the thermal insulation system is more important, because the winter snow for a longer period, the temperature is low, the building materials should be the correct choice of insulation materials. The use of solar energy is a very effective way to save energy, so choose solar energy more often to save energy and provide residents with an environmentally friendly heating system. In the case of the renovation of the Green Technology Centre in Chicago, for example, a solar power system was used to reduce energy consumption in response to the city's relatively abundant sunshine hours [3]. Currently, the main thermal insulation materials used are vacuum insulation panels and composite silicate insulation, which Yanni Huang has shown to be able to maintain the temperature and humidity of the room well, to save energy [5]. The use of modern processing technology and environmentally friendly refractory materials to reduce the pollution of the environment, such as gypsum is an energy-saving material, has a good fire insulation effect, rubber-plastic insulation material has excellent thermal insulation properties, and can create livable environment. At the same time, the architectural design must be in line with the trend of the times, using modern ideas and advanced construction technology to design green buildings, and should be designed to meet the needs of people to design energy-saving and environmentally friendly green buildings [6].

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3.2. Energy Efficient Design

Energy-saving design is an important part of green building design, which is in line with the national policy of energy saving and emission reduction, and is one of the main methods to mitigate the greenhouse effect. Low carbon, environmentally friendly, energy-efficient, and energy-saving are the hallmarks of energy-efficient design, including water conservation and material conservation, the use of rainwater harvesting systems, recycling design, energy-saving technologies, and environmentally friendly materials to reduce energy consumption. The green building centered on energy-saving design has diversification, breaking the limitations of the previous single building material, with a minimum of energy consumption and effective use, to achieve the rational use of the built environment can be designed according to the needs of different occupants, to create a safe and healthy environment [7].

Energy saving, environmental protection, and water saving are the important concepts of green building, low energy consumption, and low pollution are the primary characteristics of energy saving and environmental protection materials, and most of them are made of environmentally friendly glass, such as vacuum glass, foam glass, and Low-E glass, which have energy saving characteristics. Firstly, taking the building renovation of the Chicago Green Technology Centre as a case study, the irrigation of the landscaped green space of this project is designed using rainwater recycling, which is a complete set of wastewater reuse and incorporates solar power technology to conserve resources [3]. Secondly, the façade of the new Harris Centre for Conservation Education also uses recycled local and environmentally friendly materials and uses solar panels to save energy instead of other electrical installations. The Lotus Pavilion in Changzhou City, Jiangsu Province, on the other hand, is a two-star national green building mark and is low-carbon and sustainable with a large number of new materials, green roofs, and solar energy-saving devices. Another example is the Melbourne Parliament House Phase 2, which is designed with energy-efficient and environmentally friendly materials and rainwater recycling to ensure that the interior is warm in winter and cool in summer and energy efficient [3].

Eco-friendly materials are less shocking and harmful to the human body. Wu Jiayu's research ‘bamboo house’ design found that the main material for bamboo can be biodegradable recycling, to achieve the effective use of resources, emphasizing the role of energy saving and environmental protection and recycling combined to provide people with a healthy space [8]. Green buildings use energy-saving technologies, renewable materials, energy-efficient and environmentally friendly materials, and water recycling systems that play an active and important role in both the humanities and the environment. Liu Dejian's research also showed that the advantage of introducing the concept of energy conservation into the design of green buildings is that energy-saving and environmentally friendly materials can be recycled to increase the efficiency of using renewable energy [9]. Energy-efficient design in green buildings reduces the impact on the environment, helps to reduce carbon emissions, lowers production costs, and achieves economically sustainable development.

3.3. Ventilation Design

Ventilation design plays a unique and crucial role in green building design, where protection of the environment, reduction of pollution, and effective energy saving are the goals of green buildings [10]. Firstly, studies have shown that ventilation design is significantly related to human health and is an important part of green building design [10]. Zhang Xiaoyun establishes an air circulation channel space through simulation, and the experimental results show that the way the channel is arranged has a great influence on the air circulation speed and human comfort inside the building. When the wind path of this channel is farther away from the central functional area, the surrounding wind flow velocity is lower and the spatial comfort and satisfaction are higher [11].

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Secondly, studies have shown that reducing the use of air-exchange devices and making full use of natural air to save energy can maintain the temperature and humidity inside the building [12]. Unreasonable ventilation design can negatively affect the air quality of the space and even create some odors. Lu Yansong's study showed that odors originate from different places and can affect the comfort and air quality inside the building, as well as being harmful to people's health [13]. The results of Yang Xiaoxue's study also found that using exhaust devices to discharge odors from the room to the outside can create a clean and hygienic living space for people [10].

Meanwhile, Kai Wang's study showed that the building structure in a space is significantly and positively correlated with ventilation performance. Increasing the range and number of windows and regulating the angle of the wind with the building produces healthier air when the age of the air is less than 600 seconds, increasing the speed of wind flow and creating a comfortable and healthy environment [14]. Good ventilation design can provide good air quality and realize the concept of environmental protection, health, and energy saving.

3.4. Plant Design

Plant design for green buildings is an important design point if want to promote physical and mental health. Firstly, plants are designed to reduce stress and relieve anxiety. Leng Hong found that natural plant environments can improve human psychological state and relieve tension [15]. Yang Shuqiu's findings are in line with them, people who live and work in the city are prone to psychological stress, and designing plants in buildings can reduce anxiety and enhance physical fitness [16]. Yao Yanan showed that the results of a study in the IT industry group in Beijing verified that green plants were positively associated with mental health [17]. Experimentally, people's stress decreased as the amount of greenery inside the building increased. Wang Ni Yan's study also showed that the higher the frequency of adolescents' daily exposure to greenery, the lower the level of depression, anxiety, and tension, with a significant negative correlation between the two [18]. This suggests that plant design in green buildings is effective in reducing stress and anxiety.

Secondly, some of the plants have oxygenating, sterilizing, and health-giving properties that create a healthy environment. Yang Shuqiu's research shows that green buildings can enhance the ecological environment of the city to a certain extent, and reasonable plant design is necessary [16]. On the one hand, a large number of green plants produce certain antimicrobial substances of their own, which have antibacterial and antiseptic effects; on the other hand, the aroma of some of the green plants has health benefits, relieving fatigue and anxiety and maintaining good health.

Finally, plants can cool, store moisture, and maintain humidity inside the building. Wu Jiayu studied the case of ‘Air Tree’ and found that installing sprinklers in the building and planting plants on the facade to increase humidity to alleviate high temperatures [8]. Instead, this piece of vegetation covers the entire building, allowing the energy within the plants to continue to circulate, which emphasizes the role of plant design in combining environmental protection and sustainability, and embodies the design ideas of energy conservation and recycling. Therefore, plant design in green buildings plays an important role in effectively regulating human physiological and psychological health, reducing anxiety and tension, and providing a healthy environment for people.

3.5. Lighting Design

Research has shown that good lighting design is necessary in green building design to maintain comfort, mental and physical health and to conserve resources. Studies have shown that sunlight exposure is beneficial to mental health and that there is a negative correlation between light exposure and depression [19]. Adequate lighting enhances people's positive actions, and the lighting design of green buildings is closely linked to human actions, with the two influencing and promoting each other.

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Lighting design can be analyzed for optimal floor spacing and orientation, and sufficient light can be ensured using a large range and amount of glazing [12]. Reasonable lighting design gives the space enough light and light, can reduce the use of lamps and lanterns, people can live more comfortably, reduce energy consumption, and meet the concept of green.

Taking the Design North Building of Nanjing Engineering College as an example, the classrooms on both sides of the corridor do not have tall windows due to the lack of reasonable lighting design, resulting in poor lighting in the corridor [20]. Analyzed from a psychological point of view, when there is enough light, people get positive actions, which have a positive effect on the human body and psyche; when there is not enough light, people feel uneasy and negative, showing negative attitudes. Therefore, rational lighting design in green buildings brings a positive impact and pleasant mood to people.

4. Conclusion

This study analyses cases of green building design by describing the concept of green building and the three aspects of design philosophy. The results of the study are that green building design interacts with and positively affects people and space, site selection and design should meet local people's needs, ventilation design, lighting design, and plant design can ensure that people have sufficient light and fresh and healthy air to alleviate anxiety and stress, and energy-saving and environmentally friendly design promotes economic and environmental sustainability, maximizes the saving of resource consumption, and creates a healthy and comfortable space. From this, the study further concludes that the design concept of green buildings should be adhered to in the long term that green buildings are closely related to people, and that they should be designed around the connection between green buildings and people and their needs. It should also continue to insist on optimizing the design of new green buildings and discovering more socially and ecologically friendly green buildings. This study provides many valuable references for future research in this direction, and the main findings can be of reference value and significance to those involved in green building design, such as architects, policymakers, and related stakeholders, by providing practical advice on how to improve the sustainability and environmental friendliness of green buildings. Finally, future research should focus more on in-depth studies to analyze the role and direction of influence that other design elements of green buildings play between people and space for in-depth investigation.

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