Key Elements of Building Information Modeling Technology (BIM) and Green Building Design

Zhangqi
Dalian Vocational & Technical College Dalian, Liaoning Province, 116035

Abstract: In order to promote the smooth transformation and transformation of China's construction industry and achieve sustainable development, green building design has become one of the main development trends of architectural design. Designers should enhance their awareness of energy conservation and environmental protection, actively apply advanced technical methods, optimize design solutions, and improve the energy saving and consumption reduction effects of architectural design. BIM building information modeling technology can highly integrate a variety of building information through 3D modeling, providing technical support for green building design because of its good visibility and intuitiveness.

1. Introduction
In the green building design stage, designers should organically integrate environmental protection concepts, and actively apply advanced techniques such as building information modeling to optimize design solutions, reduce energy consumption of construction projects, and reduce environmental pollution. Because BIM building information modeling technology can integrate all the data information in the building project through the construction of the 3D model, and can provide real-time feedback on the dynamic changes of relevant information, and it can visually visualize the building information and design scheme. To help designers easily improve and perfect the green building design. Therefore, designers should accurately grasp the key points of green building design, master the BIM technology, and strengthen the application of BIM technology in green building design.

2. Overview Building Information Modeling Technology (BIM)
Building Information Modeling Technology BIM is a technical method for simulating the architectural design by constructing a digital 3D model. It not only highly integrates the information content of the building engineering, but also can update the data information in time using BIM technology. Improve and create convenient conditions for communication and coordination between different professional projects, thus providing effective technical support for the realization of architectural green design [1]. The application of BIM technology in green building design mainly relies on the related software of BIM system. The software has the powerful functions of assisting the green design analysis of buildings. They can not only integrate the special data of construction projects, but also summarize their information. It is very convenient to adjust the profile, plane and elevation design parameters in the architectural design in the 3D model, and can visualize the design according to the design parameters. The core software application in the BIM system can be seen in Figure 1.

Designers can use Revit and other related software in BIM technology to carry out comprehensive simulation analysis of lighting, lighting and energy consumption of buildings according to the actual situation of the project.
3. Analysis of Key Points in Green Building Design

According to the green building standards promulgated by China (see the evaluation criteria in Figure 1), green buildings should be able to effectively save construction land resources, save energy, water resources and other material resources during their entire life cycle, and prevent pollution of the environment. In order to improve people's space environment and achieve harmonious development between people and nature.

| Grade | Land and outdoor environment (6 items in total) | Energy conservation and energy utilization (16 items in total) | Water conservation and water use (6 items in total) | Material and material resources utilization (8 items in total) | Indoor environmental quality (6 items in total) | Operation Management (7 items in total) | Preferred Items (14 items in total) |
|-------|-----------------------------------------------|---------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------|---------------------------------------------|-------------------------------------|-----------------------------------|
| ★     | 3 4                                          | 3 5                                                            | 3                                                 | 4                                                           | 4                                           | -                                   | 4                                 |
| ★★    | 4 6                                          | 4 6                                                            | 4                                                 | 5                                                           | 5                                           | 5                                   | 6                                 |
| ★★★   | 5 8                                          | 5 7                                                            | 6                                                 | 6                                                           | 6                                           | 20                                  | 14                                |

Figure 2: China Green Building Evaluation Standard Level Item

3.1. Green Building Design Should Attach Great Importance to the Protection of Ecological Environment

In the design of green buildings, the designer should fully understand the hydrogeological characteristics of the building area and the environmental factors such as plant ecology, so as to make full use of the original topographical and geomorphic conditions, which can not only reduce the engineering quantity of the project, but also reduce the ecological Environmental impact. If it is
subject to objective conditions and needs to be reconstructed from the original environmental factors in the project area, the landform and the restoration of the ecological environment should also be fully considered in the design plan.

3.2. Green Building Design Should be Rationally Developed and Utilized to Save Resources
In the green building design, it is necessary to make full and reasonable use of limited resources, and to minimize the waste of resources to improve the energy-saving effect of building design.

3.2.1. Rational Use of Land Resources
With the development of China's social economy, the construction land resources are increasingly scarce, and the shortage of land resources has become an important bottleneck factor restricting development. Therefore, in the green building design, the building structure should be rationally selected to improve the utilization of land resources.

3.2.2. Rational Use of Water Resources
In the design of green buildings, the recycling of water resources should be fully considered. In the design of buildings, precipitation and sewage centralized recovery and treatment devices should be reasonably set according to the characteristics of the building structure and functions. Besides corresponding treatment measures should be taken to produce the water, like use medium water as water for building cleaning, greening irrigation, and flushing toilets.

3.2.3. Rational Use of Material Resources
In the design of green buildings, designers should adopt local engineering materials according to local conditions and effectively control the recording of building materials, thus reducing the construction cost. At the same time, designers should actively use waste as building materials and use recyclable materials as much as possible to reduce the resource consumption and waste discharge of construction projects in order to effectively control the pollution of construction projects to protect the ecological environment.

3.2.4. Rational Use of Energy to Reduce Energy Consumption
One of the key points of green building design is to reduce building energy consumption and reduce energy waste. Therefore, designers should timely understand and apply advanced energy-saving design methods to improve the efficiency of building emission reduction. At the same time, designers must actively apply new types of renewable clean energy to reduce the consumption of traditional non-renewable energy and reduce environmental pollution.

3.2.5. Improve the Environmental Protection of Building Interior Design
The environmental performance of the indoor space environment design is also an important part of the green design. Designers should make full use of natural lighting and natural ventilation conditions for lighting and ventilation, and optimize the air conditioning system design, using variable frequency air conditioning equipment and adjustable air monitoring. The system and the shading system to improve the energy saving effect of the indoor space.

3.3. Green Building Design Should Strengthen the Attention to the Energy-saving Effect of the Whole Life Cycle of Construction Engineering
In the green building design, the full life cycle of the construction project needs to be fully considered. It is necessary to consider the energy-saving effect in the project design stage. According to the topographical characteristics and environmental conditions of the project area, the building materials should be reasonably selected to improve the utilization of various resources. Reduce resource and energy consumption. At the same time, we must also consider the energy-saving effect of the construction project after it is put into use. By adopting intelligent management and maintenance
methods to achieve water-saving and energy-saving effects, and to improve the utilization rate of renewable energy such as solar energy and wind energy [2]. In addition, recyclable building materials should be used in the design to reduce the amount of waste discharged during the construction of the building and to avoid environmental pollution.

4. Application of Building Information Modeling Technology (BIM) for Green Building Design

4.1. Main Application of Building Information Modeling Technology in Green Building Design

4.1.1. Simulating the Actual Sunshine Conditions of the Building
Because building information modeling technology has a visual rendering function and can perform comprehensive statistical analysis on various data information, designers can use BIM technology to analyze the terrain characteristics, building volume and climatic conditions of the project area, sunshine influence range, and through the software of Ecolect in BIM model to simulate the change of solar radiation value, building energy consumption and thermal insulation effect, to ensure that the architectural design can meet the green design specifications.

4.1.2. Building A Three-dimensional Model of the Outdoor Environment
Designers can also use BIM technology to simulate the outdoor situation of the building to accurately grasp the wind pressure and wind speed parameters of the building project, and provide a reliable reference for the optimization of the green design of the building.

4.1.3. Simulated Building Interior Lighting Design Effect
Designers can also use BIM technology combined with CAD technology to simulate the lighting in the building interior to improve the rationality of building door and window opening specifications and material type selection, thus achieving the purpose of green design [3].

4.1.4. Green Design of the Entire Life Cycle of Buildings Using BIM Technology
Through the application of BIM technology, designers can better carry out the green design of the whole life cycle of the construction project. This is mainly because the BIM model can highly integrate and analyze the micro and macro data, overall and local detail data of the construction project, and also cover the relevant data of each sub-project of the construction project, so as to accurately understand the construction project for the designer. The technical situation of energy consumption at different stages provides strong technical support.

5. Application Practice of BIM Technology in Green Building Design

5.1. Basic Overview of A Construction Project
A construction project is a scientific research base project on a university campus. It has many functions such as teaching, academic exchange, and experimentation. Because the project is located in the severe cold region of Northeast China, it puts higher requirements on the insulation and energy saving effect of the green design of the building.

5.2. Applying BIM Technology to Optimize Green Building Design

5.2.1. Application of BIM Technology to Optimize Green Design of Building Envelope
In the design of green buildings, the design of the envelope structure such as the exterior wall of the building is an important part of achieving energy saving and consumption reduction. Since the project is located in the northern part of China, there is a high requirement for the thermal insulation effect of the building. Therefore, on the basis of improving the thermal insulation effect of the external wall of the building, the green design also strengthens the attention to the heating effect of the wall. A heated wall system with a circulating function is formed by connection with a power energy system. At the
same time, the designers not only applied new wall materials with better energy-saving performance, but also made full use of renewable materials, and comprehensively considered the thermal insulation, sound insulation and decorative effects of the building walls, thus optimizing the green design effect the wall. In order to ensure the strength of the door and window of the building project, the designer used the reinforced concrete excess and the design of the structural column in the hole part, and adopted the block with the thickness of 200mm and the two-layer graphite polystyrene board with the thickness of δ=140mm as its the thermal insulation layer of the west, east and north walls. Wherein the thermal conductivity coefficient of the graphite polystyrene board material is: \( \lambda = 0.035 \text{ [W/(m·k)]} \), and the mean heat transfer coefficient of the building engineering wall is about 0.12. According to the formula: \( R = \frac{\delta}{\lambda} \), the thermal resistance of the single-layer structure can be calculated [4].

Due to the large number of composite materials used in the building envelope, BIM technology is needed to optimize the green design of the laminated wall. The designer should first use the BIM software to name the basic components of the wall, and establish the corresponding construction table. Then input the basic information such as the thermal information and material performance indicators of each structural level into the table, and finally the analog design of the laminated wall can be automatically completed by the BIM software. The green design of the south wall of the building project uses the wall structure of the heat collecting regenerator, which mainly uses solar energy as a heat source to store the corresponding heat. The design method can make full use of renewable solar energy to provide heat to the building, meeting its actual needs for heating and insulation. The roofing part of the building is made of extruded board material and is divided into three layers with a total thickness of 300 mm and a heat transfer coefficient of about 0.106 [W/(m²·k)]. In the roof of the building and the wall of the parapet, a 300mm thick rock wool is installed to improve the fire performance of the building. In the slab design of the building, the structural descending plate is used, and an epoxy layer, a concrete layer and an insulating layer are sequentially arranged on the structural layer to ensure that the waterproof performance can reach the design standard [5]. At the same time, the roof and the mandatory connection design are strengthened to ensure the tightness and integrity of the connection. In the design, BIM software can be used to automatically complete the connection design of the roof slab and the wall to ensure that the connection of the building structure nodes meets the design specifications.

Because BIM software can provide real-time cut-out of the design, it can show designers and related departments a complete and intuitive design effect, and integrate various data such as building member names, specifications, thermal properties and material performance parameters. Within the 3D model, it facilitates the designer's query invocation.

5.2.2. Application of BIM Technology to Optimize Green Design of Architectural Detail Nodes

The application of BIM technology can visually present the effect of architectural detail node design through visual 3D model, thus helping designers to find out whether there are problems such as thermal bridge effect in green building design, thereby improving the energy saving effect of green building design. For example, in the design of the parapet wall of the building, the height of the wall is designed to be 1.8m. Through the simulation of the temperature stress and other factors by the BIM software, the design of the insulation layer is adopted to improve the thermal insulation effect of the parapet thermal bridge. The metal brackets are placed on both sides of the parapet wall to provide support for the metal cover to prevent the insulation from being eroded by rain. In addition, in the design of building sunroof and roof joints, according to the design specifications, the sunroof airtightness should reach 8 or more. Therefore, a composite aluminum-clad wood composite sunroof with a three-glass tempered single-frame sandwich is used. The heat transfer coefficient is about 0.1 [W/(m²·k)], and an intelligent control method is adopted to control the opening of the mid-suspension sunroof and the outer sunshade to improve the energy saving effect.
6. Conclusion

With the industrialization process of human society, environmental resources have become an important factor restricting the sustainability of development. Therefore, in the fields of architecture and other fields, upgrading and transformation are needed to realize the green development of the industry. Consequently, designers should use the green building concept as a guide, actively apply advanced BIM and other technical methods. We should pay attention to the whole life cycle of construction projects, in order to optimize green building design, improve the energy-saving and consumption-reducing effect of architectural design, reduce pollution to the environment, and promote the modernization of China's construction industry.

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