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Analysis of Green Building Energy Efficiency Based on Building Information Modeling Design

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Abstract. With the gradual implementation of the concept of energy conservation and environmental protection, the development of the construction industry is more and more in favor of green environmental protection buildings, and there are more and more studies on the energy conservation methods and ways of green buildings. The starting point of the concept of green building is energy saving, land saving, water saving and material saving. China's requirements for the goals of green sustainable development and ecological environmental protection are constantly improving,Simulation with powerful computing modules, export simulation reports, Include climate data, interior and exterior wall and window materials, shading component parameters, use time and use, and even consider the number of future activities within the building to make the analysis should be.BIM software model can realize multi-directional energy saving through its advantages of visualization and simulation.

Keywords. Energy saving, green building, BIM model design

1. Introduction

With the continuous development of China's economy, in 2000, the building area was only 7.659 billion square kilometers, but in 2006, this figure jumped to 17.452 billion square kilometers. From the perspective of the total electricity consumption in the country, the proportion of building electricity was increasing. In 1997, for example, the proportion of building electricity was 18.9%, while in 2006, the proportion of building electricity increased to 21.4%. [1] Therefore, the analysis and transformation of building energy conservation is conducive to better energy conservation. The 21st century is the era of modern information digitalization. In the field of architectural design, how to carry out architectural design and energy conservation and environmental protection more efficiently requires intelligent software in different fields, including engineering equipment, to comprehensively improve the level of intelligent management. Among them, programmers provide reference for the decision-making of construction engineers. They rely on intelligent management to ensure that various modern problems can be handled. During the development of modern

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architecture, building automation system plays an increasingly important role. The system can control and manage the whole building elevator, water supply, lighting, power supply and other fields. The system mainly involves automatic control technology, sensors and computers. In addition to monitoring the startup of equipment, the intelligent system can also achieve an energy-saving and environmental protection state in different ways.

In the analysis of this article, the author uses BIM software model technology to select a multi-storey building in Wuhan as the analysis object, and focuses on the use of BIM Technology in the design of building lighting, energy saving and other aspects. With the help of BIM Technology, the author makes a systematic analysis of the building in green energy saving and other related contents, and shows the problems of building energy performance in detail and flexibly, and adjusts the deficiencies, and tests and analyzes the design scheme.Second paragraph.

2. BIM model building energy efficiency display

The project is an office building in Wuhan, Hubei Province, with a total construction area of 2112 ㎡, an area of 710 ㎡, and a building height of 170m. In the project design, the corresponding elevation is ± 0.000m, corresponding to an absolute elevation of 25.462m, and there is an absolute elevation difference of 0.5m between indoor and outdoor. In Figure 1, we are introduced to the corresponding three-dimensional drawing of the building:

Figure 1. 3D view of an office building in Wuhan.

The drawings can be directly imported into the BIM application software to complete the input of engineering information. At the same time, combined with the relevant provisions of the design standard for energy efficiency of public buildings, the software will automatically complete the setting of building parameters, and import the information such as the area and volume of the drawing into it. Table 1 introduces the relevant contents of green energy-saving design parameters.

Table 1. Green energy saving design parameter information of the project

General setting Meter parameters	Fire resistant design	second level
	roof waterproof	Class I
	structure	Reinforced concrete frame structure
	Seismic fortification intensity of buildings	Seven degrees
	Usage time	50 years
Green building Building energy conservation design parameter	Building volume	9351.34m ^{3}
	Building surface area	3125.17m ^{2}
	Northward angle	60 $^\circ$
	Solar radiation absorption coefficient of exterior wall and roof	0.65
	Light climate zoning	III
	Light climate coefficient K	1.00
	Surface reflectance	Ceiling 0.75, ground 0.30 Wall 0.60, outer surface 0.50

By describing the conditions that directly affect the energy-saving effect, such as the ground thermal resistance and roof heat transfer of energy-saving buildings and ordinary buildings, output the energy-saving data of cooling and heat consumption of buildings, and check whether they meet the standards and specifications, as shown in Table 2.

Table 2. Comparison of energy saving calculation parameters

Category	Energy saving building	Ordinary architecture
Roof heat transfer coefficient	0.78	0.35
External wall heat transfer coefficient	1.24	0.51
Ground thermal resistance	0.06	0.15

In the case of roof design, 120mm reinforced concrete and 20mm extruded polystyrene board were applied; In the design of exterior wall, 200mm reinforced concrete and 20mm extruded polystyrene board are applied. In the design of exterior wall and peeling curtain wall, 6mm air hollow glass plastic window is applied. The building energy consumption is calculated according to the building energy consumption standard. See Table 3 for details.

Table3. Comparison of energy saving calculation

	Energy saving building	ordinary building
Cooling and heat consumption	105.04	123.17
Cooling consumption	28.98	42.21
Heat consumption	59.87	69.54
Standard basis	Hubei public building energy efficiency design standard Db42/t559-2022	
Standard requirements	The energy consumption of energy-saving buildings is not greater than that of ordinary buildings	
conclusion	satisfy	

BIM technology, that is, simulating the building information model, can visually present the real space form after architectural design to people, and people can adjust the architectural form by changing the information, and the adjustment times are unlimited until all the requirements of architectural design are realized. In the management of green building materials, we should pay attention to the need to coordinate the content of the management link. In order to ensure that external factors will not interfere with the material transportation environment and restrict the performance of materials, the material suppliers must actively strengthen the relationship with the construction users. At present, some domestic manufacturers of green building materials will use electronic labels to mark materials. Through RFID technology, material users can know the relevant information of green materials through scanning and identification. For users of materials, BIM technology can also be used to store the use data of materials to ensure that the next construction work can be carried out efficiently. At the same time, BIM technology can record the information during the transportation of building materials in detail, mainly involving material procurement, transportation location tracking, etc. Relevant staff can determine how to transport materials and corresponding transport nodes in combination with data information, and it is not allowed to transport for a long time, so as to control the transport cost to a reasonable level, and ensure that building materials can fully meet the construction requirements of green building projects before entering the site.

3. Energy saving path analysis

3.1. Passive energy saving technology

On the basis of clarifying the type and purpose of buildings, passive design is mainly based on the analysis of the layout, type, shape, orientation and other aspects of buildings, so as to determine the best building to complete the design. When selecting the building form and determining the building direction, it is mostly based on the probability of ventilation and lighting under the given climate in the given area [2]. Reasonably determining the orientation of buildings in space helps us to efficiently complete the internal layout of buildings. At the same time, based on the analysis of building shape and terrain, the pressure of the development area is clear, and the white hot wind system can be constructed. If the energy-saving building is installed in the perennial high-temperature area, how to resist the sun should be focused on and considered. In this context, it can be achieved by shading with the help of greening, or by covering the window. Combined with the previous research and analysis, it is not difficult to find that there is a common deficiency. Solar panels are common on the roofs of public buildings, which helps to complete the collection of sunlight and protect the indoor from heat. In Figure 2, we are introduced to various ways. Vertical greening and roof greening are common in daily life. In addition, greening can also play a good role in purifying air, reducing noise and many other aspects [3].

Figure 2. Different shading methods: a) greening to achieve shading; b) Shading and covering; c) Multifunctional mask

(image source: according to Internet Statistics)

Among the different technologies applied in energy-saving buildings, the energy-saving technology of building envelope is common. It is mainly carried out with the help of the enhanced characteristics of energy-saving building materials. The thermal insulation effect of the building envelope is improved, just like people wear an extra coat. Accordingly, the advantages of using this technology are mainly shown in the use of energy-saving technology and its application to the design of building envelope, maintaining the indoor conditions at a scientific and reasonable level, which is conducive to creating a good environment for human health. [4] At the same time, building envelope energy saving technology can also control building energy consumption to a reasonable level and reduce building operating costs. The shortage of this technology is mainly reflected in the high investment scale in the early stage considering the high cost of energy-saving materials. Considering the lack of understanding of the technology and materials used, it is inevitable that there will be many deficiencies in the process of building operation.

$$q_{H.T} = (t_1 - t_e)(\sum_{i=1}^{m} K_1 - F_1)/A_0 \quad (1)$$

When calculating the heat consumption of the enclosure structure, it is generally calculated according to the above formula Eq.(1).With the help of the heat consumption value of the envelope, the different factors that affect the design parameters of the building energy consumption form are clarified. In this formula, the indoor average temperature of the building is used to expresst_1, the outdoor average temperature of the building during the heating period is used to expresst_e, the heat transfer system of the building envelope is used to expressK_1, the office building area is used to expressF_1, and the envelope area is used to expressA_0. According to the formula, the building heating energy consumption will be affected by different factors, including heating intensity, envelope area, outdoor temperature and envelope heat transfer coefficient. All kinds of architectural morphology adjustments have different degrees of relationship and affect the building heating energy consumption. For office buildings, considering that arc and diagonal design are rarely used in design, rectangular design is generally used in office building design in severe cold areas. In addition, the building orientation will be affected by factors such as the direct sunlight area and the sunlight incidence angle. The change of concave and convex of the building surface will also

increase the maintenance structure area and volume coefficient. There are large differences between the heat transfer coefficient of the external wall heat transfer system and the external window.

$$WWR = \text{abn/HW} \tag{2}$$

This calculation formula is the calculation of building window wall ratio WWR Eq.(2). The length, width and height of the external window of the office building are a, b and c respectively, and the unit is m. The height of the office building is H, and the wall width is W.

Determine the value range of office building storey height between 3-4.4 meters, and take 0.01 meters as a step to simulate how the building storey height affects the building energy consumption. Accordingly, increasing the storey height will also increase the energy consumption of office buildings, and there is a positive correlation between the two. This is mainly due to the fact that the building surface area will be increased with the increase of the building floor height. Considering that the window to wall ratio remains unchanged, the area of external windows of the building will be increased, the level of building heat dissipation efficiency will be improved, and the building heat loss will be increased. In addition, increasing the area of the external windows of the building will also increase the sunshine radiation heat. In the analysis, the corresponding depth scaling coefficient is determined to be 0.5-1, with 0.05 as a simulation step, so as to obtain how the depth scaling system affects the building power consumption. In addition, there is a reverse relationship between depth scaling system and building energy consumption. If the depth scaling system is higher than 0.8, the building energy consumption is at a stable level. The main reason is that when the building shape coefficient changes due to the depth scaling system, the building shape system will be reduced, and the heat transfer loss of the enclosure structure will be reduced, which will also reduce the building energy consumption.

Exterior windows have always been a serious problem in the construction field, and experts and scholars in the industry have also conducted a lot of debate and Analysis on the quality and thermal conductivity of exterior windows. Most of the window problems are reflected in the window glass and window frame. From the comparative analysis of the market, we can see that the window market has undergone tremendous changes in its current development. Under the background of continuous breakthroughs in relevant technologies, the types of windows are increasingly diversified. However, how to select and use different types of windows is the main issue we should pay attention to and discuss. Based on a large number of documents, it is pointed out that the following two types of windows are common, one is the two-way ventilation window, and the other is the "double skin" curtain wall system.

Double skin wall" system is very common in buildings. This system consists of two curtain walls with an air layer in the middle. Considering that the air inlet and exhaust facilities can be controlled, the air temperature can be adjusted to avoid overheating of buildings in summer and control the ventilation system load to a reasonable level. In winter, heat accumulation can be realized to control the heating system load. At the same time, the system can also control the noise pressure. [5] The disadvantage of this system is that it can not clean the incoming and outgoing air. Buildings are prone to vortex in winter, which increases the cost of cleaning the facade

of buildings. At the same time, compared with the installation of traditional facade, the installation of "double skin" curtain wall usually needs to pay twice the price.

3.2. Active energy saving technology

With the rapid development of urbanization in China, water resources and aquatic environment will face increasing pressure. The utilization of rainwater is an effective measure to eliminate the contradiction between water shortage and economic and social development, alleviate urban water crisis and improve urban water environment. The problem of water shortage is particularly important for large and super large cities, as is the case in many cities in China. Most developed countries have laws on the collection and reuse of pollution and rainwater [6]. Private house owners, public building owners and the entire enterprise may face water problems. At present, according to the requirements of economic development, social development and scientific and technological development, the comprehensive utilization of rainwater needs more attention. The concept of rainwater reuse system is shown in Figure 3.

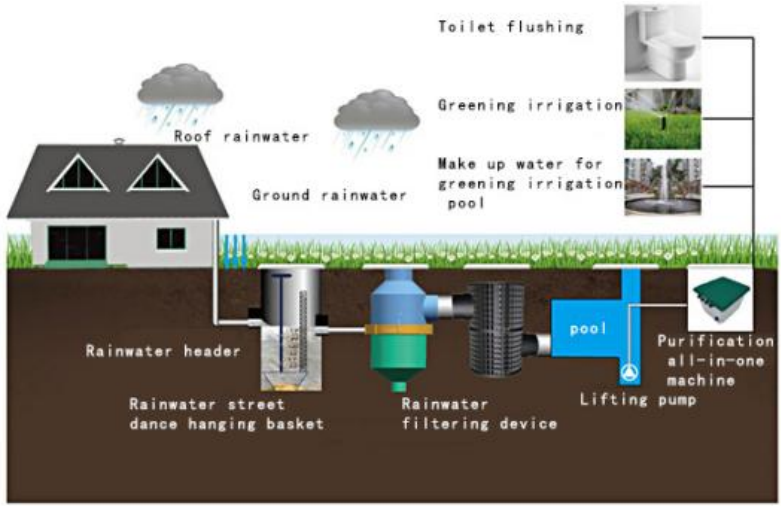

Figure 3. Building rainwater collection system (image source: according to Internet Statistics)

The building rainwater collection system is mainly used to collect rainwater and treat rainwater at the same time to make it conform to the design standards. The purpose of using this system is to achieve multiple utilization of rainwater and domestic wastewater. According to the different rainwater resources, it can be divided into two categories: roof rainwater and ground rainwater. The roof rainwater is relatively clean, and the ground rainwater has many impurities, which must be purified and precipitated before entering the reservoir. The specific rainwater collection and treatment process is determined based on the area, population and greening rate of green building residential areas. Generally, the rainwater in the roof, square, parking lot and road can be collected in high-rise building residential areas due to the complex

location of rainwater, so as to improve the utilization efficiency of reclaimed water. However, due to the different quality of rainwater in various regions, the pollution degree is different, so special treatment and comprehensive utilization of rainwater are required. One collected rainwater is purified by a filter, and then stored in a clean water pool, thus entering another cleaning stage, and then transported to other areas with the help of a lift pump. The backwater system is usually widely used in parking lots, industrial parks and other locations. Determine the process of rainwater collection. Due to the relatively small pollution of rainwater, it can only be applied to greening irrigation after precipitation and disinfection. If there is water landscape in the residential area, the treated rainwater can be put into the landscape water body, which can not only supplement the landscape water body, but also achieve the effect of rainwater storage. At the same time, in order to ensure efficient use of energy, energy-saving water appliances need to be applied to buildings. The rainwater reuse system has distinct advantages, mainly shown as the ability to use rainwater for many times; However, its disadvantages are mainly that it has higher equipment procurement pricing and needs to pay higher installation costs. On the whole, the rainwater reuse system can alleviate and control the shortage of urban water resources, and reduce the probability of urban water logging and urban flood. The rainwater collection system helps to save energy and reduce emissions.

4. Conclusion

The accuracy of building energy conservation consumption based on BIM model technology can meet the engineering requirements, and the use efficiency is higher, which is more in line with various indicators of energy conservation. It can be popularized in practice, and is suitable for the development of green buildings.

Normative building energy consumption model can compare and analyze different building energy-saving transformation strategies. Compared with the detailed building energy consumption model, even though there are differences in the comparison scope, there are strong differences in the analysis speed. The speed of BIM software model is more effective.

BIM technology is more convenient, accurate and comprehensive than traditional technology in the implementation of projects in the construction industry. BIM technology centralizes the information needed for green building analysis.

It is imperative for China's construction industry to be low-carbon. Thanks to BIM technology, which has been widely used in traditional building construction, the development of low-carbon buildings will achieve remarkable results. In practical application, this paper emphasizes giving full play to the comprehensive data integration ability, continuous data updating ability, flexible data processing ability and visual data management ability of BIM technology on the basis of software use, focusing on green building application and carbon emission monitoring of building materials, focusing on serious links of carbon emission, and saving energy, reducing carbon and reducing consumption from all dimensions.

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