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To cite this article: Gang Xu and Yabo He 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **242** 062073

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Research on Decoration Design of Green Building Based on BIM Technology

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Abstract. Sustainable development is the theme of common development of mankind in the 21st century. For urban architecture, it is necessary to change from high energy consumption mode to green energy saving mode, so green building is the inevitable trend of building development in the world today. According to the decorative design of green building, green building decoration design evaluation are put forward including the evaluation element, evaluation structure, evaluation tool and evaluation method, according to the relevant design specifications of China Green Building Standard and BIM design model feature. In this paper, the evaluation and analysis of the design of the city of Xiaogan City in Hubei Province provide the idea and reference for the construction of BIM platform for green building evaluation design.

1. Introduction

At present, China is in a stage of rapid development of industrialization and urbanization. It still has the potential for rapid growth in GDP in the next 10 years, but it faces enormous pressure from the shortage of energy and resource supply. The Chinese government has established a development strategy with energy efficiency and energy resource utilization as the core. Compared with the developed countries, Chinese per capita energy consumption is far less than the world level. Energy consumption per unit area and per capita energy consumption are 3 times that of developed countries. Chinese total energy consumption has ranked second in the world. According to statistics, Chinese current building energy consumption accounts for 30% of total energy consumption society, and the construction industry is basically a high energy consumption, high pollution industry, directly affecting the sustainable development of Chinese cities and buildings.

At present, green building is an important way for the sustainable development of the construction industry. Chinese construction industry is promoting the sustainable development through the research and practice of green building theory and technology.

Along with the sustainable development of the concept, the developed countries gradually shift focus from the perspective of building energy efficiency to building national capacity in resource conservation, improve air quality, enhance comfort and other fields. Many countries have established different type of rating system as green building development to today. Since 1990s, many countries have established different types of green building assessment system, making tremendous contributions to the practice and promotion of green buildings. At present, the international development of mature green building system is the United Kingdom BREEM, the United States LEED, Japan CASBEE, etc., and the framework of these systems and applications has become an



important reference for other countries to establish Green Building Rating System. In the late 1990s, China launched a number of research and practice on green building, and gradually formed a series of green building evaluation system, such as the green Olympic assessment system, green residential assessment system, green building evaluation system. However, the development of green buildings still has many constraints, such as the lack of effective information technology to promote the exchange platform for quantitative and qualitative assessment of green building design, construction, operation at different stages. According to the relevant requirements of green building design specifications, geometric information, material information, member information, device information and other related data are in the collective management by establishing BIM model, which provide the necessary analytical basis for the calculation and evaluation of green building decoration design. At the same time, the use of three-dimensional data of information technology, with green degree evaluation of proposed ideas, provide indicators of assessment and decision-making for energy consumption, material utilization, water use, air quality and other performance in the green building decoration design.

2. Green Building Decoration Design and BIM Application

The current evaluation system applied to the vast majority of the evaluation system, usually to be evaluated after the design is completed. Due to various factors affecting green building decoration often in the design and construction phase, the early results of the design of the building energy consumption, environmental quality space layout, materials, technology and equipment play an important influence. Then it is difficult to design assessment methods for qualitative and quantitative evaluation of the results, can't compensate for design flaws early. Based on the BIM evaluation system, on one hand, we can consider the various factors of the design stage and avoid the design problems. On the other hand, it can also serve as an effective technology platform for green building design, performance analysis, new materials and equipment into one, so that the designer can visually experience the impact of green building design. BIM (Building Information Modeling) technology is an important computer application technology in the construction field after CAD (computer aided design) technology. The importance of BIM is to re-integrate the architectural design process and its architectural life cycle (BLM) of the various information. A complete BIM design model contains a lot of building information, such as design, performance, materials, management and so on.

Truthful BIM data and abundant component information to a variety of green building analysis software with strong data support to ensure the effectiveness of the analysis. At present, REVIT and other BIM software has its model data exported to a variety of analysis software GBXML format. Green building design as an interdisciplinary, cross-stage integrated design process, and BIM model just to achieve a single data platform for different types of coordination design and data set, so that different stages of design and management are in the same information model. BIM build a variety of physical analysis information from the late design, in order to provide designers with the basis for performance design and evaluation.

3. Design Evaluation System Index Analysis

3.1. Design evaluation elements stratification

Typical aspects to be considered in green building decoration design include: (1) Reducing energy consumption; (2) Building water saving and water use; (3) Recycling of materials and materials; (4) Efficient use of space; (5) Air environmental quality.

In view of above problems, the green building decoration design evaluation system should cover the design process and evaluation data model system, as the basis for each profession to provide the corresponding design processing and analysis, and refer to the corresponding norms to check and evaluate to ensure that the assessment system control of different green building elements in the design process.

In the actual project design process, the design evaluation is divided into five aspects: energy saving and energy utilization, land use and space utilization, water saving and water resources utilization, materials and materials utilization, and air environmental quality. BIM models need to look at the level of granularity (LOD, Level Of Detail) and to determine the degree of richness of data is completed, thereby determining whether the evaluation requirements green design. Therefore, in the evaluation of green building decoration design, refer to the BIM model data information type, the evaluation elements are divided into type layer, information data layer and information management layer (Figure 1). In the type layer, considered with architectural design features, divided into design, performance, component, product four types, and in the information data layer were docked with. In type layer, binding architectural design features, they have designed, performance, component and product four types, corresponding with the data layer information. In the information management layer, combining with different needs of the five evaluation elements, analytical data were extracted from the corresponding data layer respectively.

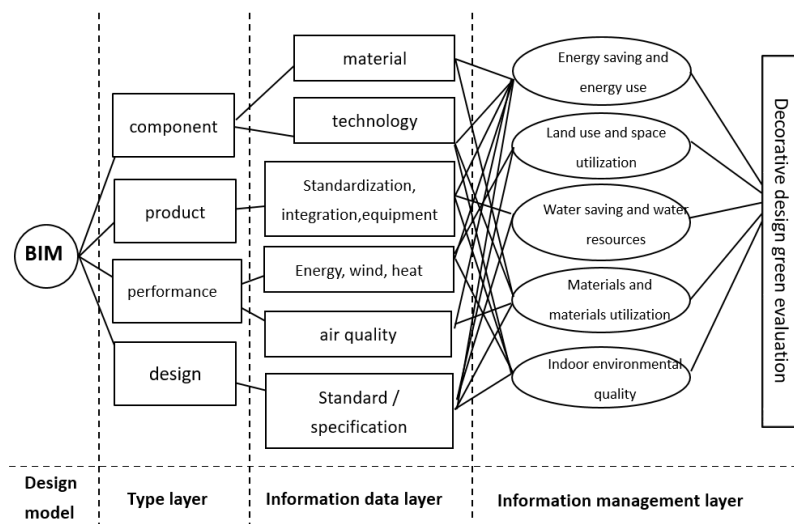


Figure 1. Green building decoration design evaluation elements stratification

3.2. BIM-based design evaluation structure

A prerequisite for an evaluation system that can be used for good data analysis is to establish a BIM base data system covering all stages of building decoration design and profession, which includes the building component information, material information, geometric information, professional information and other logical data relationships. The system includes:

(1) Three-Dimensional BIM Model

According to the concept of green building, refer to architectural design features, using BIM building information model as a data carrier, the building decoration design, material use, energy consumption and other aspects of the data will be stored and managed.

Using the established BIM model, from the perspective of green building decoration design evaluation, energy consumption, materials, equipment, air quality and other profession related data will be put into integrated management, as the green building decoration design and analysis of the basic basis.

(2) Building information data analysis and processing

Based on the BIM 3D graphics platform, the design, space function, component, material use, energy consumption and other aspects of the data are extracted, calculated and analyzed at the design stage. According to the architectural information model based on the professional data information, the design of lighting, illumination, ventilation, energy consumption, material quantity, equipment information and other factors are statistical analysis and quantitative analysed.

(3) Building performance data processing and analysis of information expression

Based on the BIM three-dimensional model, the data output can be output through the unified data standard format, the building performance can be simulated in the relevant green building design analysis software, and the analysis result can be visualized to provide the basis for the evaluation of the green building decoration design.

3.3. Performance Design Analysis and Evaluation Tools

BIM reintegrates the design process, and the data contained in the model provides data support for design and analysis. The BIM-based environmental performance analysis can be used to extract the relevant data from the BIM model to simulate the building's sunshine, energy consumption, thermal environment, wind environment and so on. And green building analysis software that can be converted by BIM software such as IES <VE>, Energy Plus, Green Building Studio, Autodesk Ecotect Analysis, etc. The main analytical factors are shown in Table 1.

Table 1. BIM-based Green Building Environmental Performance Assessment Tool

Analysis tool	Data information	Analysis factors
IES<VE>	Revit MEP	Heat load, lighting, CFD, Interior illumination, Ventilation
Energy Plus	CAD based	Thermal parallel load, concurrence of wind direction load, system plant calculation, HVAC system analysis
Green Building Studio	Revit	Web-based local climate, Building consumed energy, Carbon dioxide emission, Estimates
ECOTECH	CAD Revit, ect	Accumulated quantity of sunlight, A day-shade distribution, An air current distribution, Distribution, Distribution of Wind quantity, Phototacticate, Interior illumination, Luminance analysis

3.4. Design Evaluation System Application

Green building decoration design evaluation from the design evaluation and performance evaluation of two aspects, using qualitative analysis and quantitative analysis.

In terms of design evaluation, considering the number of information in the BIM design model, we can obtain the information data of components, products and materials directly, and evaluate the number of components, product performance and material utilization rate by quantitative analysis.

In terms of performance evaluation, according to BIM building information model data, with building energy consumption, sunshine, ventilation, lighting and other standard requirements, through the unified data information into the building environment performance analysis software, the building environment performance can be analysed in the building energy efficiency, building shade, building lighting and lighting, building indoor ventilation, etc. These performance analysis results can be visualized and quantified. Based on the correlation performance analysis results, compared with the green building design standards, these provide the basis for design optimization.

4. Design Case Analysis

4.1. Design evaluation elements stratification

In this research, we took the design of green building decoration of Xiaogan People's House as an example. Xiaogan People's Home is located in Xiaogan City, Hubei Province, with a total area of about 57,000 m². The main functions are administrative examination and approval, public resource transactions, press releases, social and convenience services, community network management, city investment management and so on. It is a multi-functional in one of the livelihood projects. In accordance with the requirements of Chinses green building design standards, it designed to reach the green building two stars. Through the actual design project, establish BIM information model, as

shown in Figure2. According to green building design requirements, two aspects of content was analyzed from design evaluation and performance evaluation.

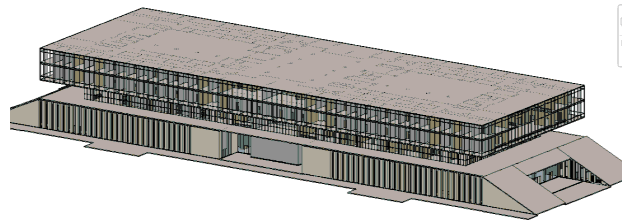


Figure 2. Xiaogan home BIM model

4.2. Design evaluation elements stratification

We can select the factory prefabricated materials, recyclable materials, finished products and other aspects from the BIM model information. In this study, select the factory prefabricated material analysis as an example (Table 2). From the data information, the total weight of the pre-project of decoration materials are 3088.622t, the total weight of construction decoration materials are 3511.308t, material factory prefabricated ratio reached 87.96%, in line with the green building design 80% requirements.

Table 2. Factory prefabricated material analysis

Type	Name	Spec ificat ion	Quantity (㎡)	Material Unit Weight (kg/㎡)	Weight (t)	Total weight of the factory prefabricated decoration materials(t)	Total weight of decoration materials (t)
Factory prefabricated decoration materials	Ceiling	200	51352	22.45	1152.852	3088.622	3511.308
	Carpet		44016	12.24	538.7558		
	Brick		14672	20.41	299.4555		
	Marble Floor		14672	57.14	838.3581		
	Door		2000	129.6	259.2		
Non- prefabricated decoration materials	Coating		97432	0.2	19.4864		
	Decoration wall		10000	40	400		
	Soft wall		4000	0.8	3.2		
Factory prefabricated weight ratio of decoration materials							87.96%

4.3. Building Environment Performance Analysis

During the course of this project, the performance analysis of the building environment was carried out using IES <VE> software. Through the data information into the IES <VE>, respectively analyze the building energy consumption, building lighting, building ventilation and other related building environment.

(1) Building energy consumption analysis

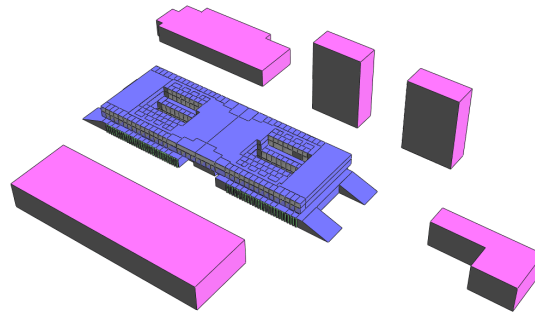


Figure 3. Building energy consumption analysis model

Convert BIM model into IES <VE> software, establish building energy analysis model (Figure 3). In the process of building energy consumption simulation, the design building envelope parameters are set and compared with the benchmark building energy consumption, so as to calculate the energy saving ratio of the building and compare with the building energy saving standard requirements to determine whether the design building meets the building energy saving requirements.

Table 3. Comparison of building envelope design.

Building contrast	Benchmark building		Design the building	
	Construction	U value	Construction	U value
Wall	Ordinary stone wall, no insulation	$2.0w/(m^2 \cdot K)$	250 thick aerated concrete block, the use of external 40 thick expanded glass beads insulation mortar insulation	$1.0w/(m^2 \cdot K)$
Roof	Ordinary roof, no insulation	$1.5w/(m^2 \cdot K)$	200 thick foam concrete	$0.7w/(m^2 \cdot K)$
Outside the window	Ordinary single layer glass	$6.4w/(m^2 \cdot K)$	Heat insulation aluminum frame, insulating glass (6low-e + 12 air + 6 transparent)	$2.5w/(m^2 \cdot K)$

Through the software simulation of the project building energy consumption, the design energy consumption of the building is 4946.2MWh, and the energy consumption of the reference building is 10985.9MWh, and the building energy efficiency rate is 54.98%. The building meets 50% of the current building energy saving.

(2) Building lighting analysis

Considered with IES <VE> performance analysis model, analyze the main indoor room for indoor lighting. The main function of the building in the total area of 9632.59 square meters, of which the standard area reached 6876.74 square meters, lighting area compliance rate reached 71.39%, reached 60% of green building requirements (result as figure 4 shows).

(3) Building ventilation analysis

Figure.5 shows the ventilation of the office lobby and the independent office. From the results of the analysis, in the case of natural ventilation the flow velocity of the personnel activity area (1.1-1.8m height) is about 0.85 ~ 1.55m/s, and the wind mainly enters the room from the north side. And such window position and form are reasonable, conducive to the formation of indoor air flow.

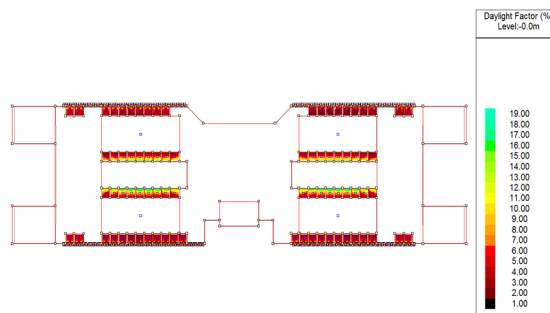


Figure 4. Building interior lighting analysis

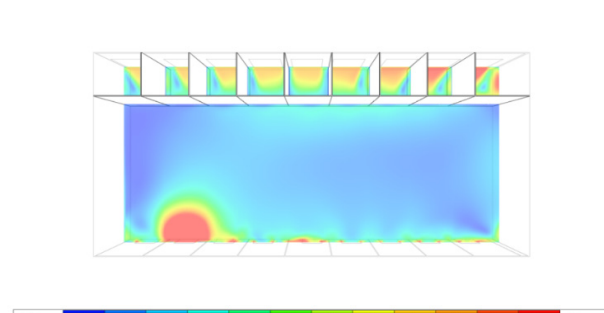


Figure 5. Natural ventilation in the building room

5. Conclusion

The BIM building information model fully reflects the building's various information, which is important for the life cycle management of green buildings. Through the complete building information model data system, to achieve the professional relationship between the topological connection. Meanwhile, these information data for the green building decoration design space, components, materials, equipment and other data calculation and evaluation provides the necessary basis. The use of three-dimensional data information visualization technology, establish multi-angle green technical indicators assessment and auxiliary decision-making mechanism which can effectively achieve the rational use of space, materials and other resources, reduce building energy consumption, to solve the building ventilation, lighting, noise and other environmental quality impact, and through the analysis of environmental performance indicators and assessment, put forward to reduce energy consumption and rational use of resources solution. Using a series of environmental performance information technology to establish a green building decoration design evaluation system to achieve the building "energy saving, materials, water, space and rational use" and provide strong technical support for the sustainable development of urban construction.

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