

Establishment of building energy conservation and green building model system and database based on the discussion of key technologies¹

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Abstract. The concept of green building aims to provide a safe, healthy and comfortable environment for people, make efficient use of resources and minimize the impact on the environment. Therefore, based on key technologies, the establishment of building energy conservation and green building model system and database was discussed and analyzed in this paper. By constructing the building energy conservation and green building model system framework and database, the environment required for building energy conservation and green building database was analyzed. Through the analysis of energy consumption of A building within the third ring road in Beijing, the conclusion that its efficiency of energy consumption equipment is high was obtained. In the future, it is necessary to strengthen the efforts to complete and update the green energy saving database, so as to provide the information technology support to the promotion of the development of green buildings around China.

Key words. Key technologies, building energy conservation, green building, model systems and database.

1. Introduction

A large number of energy consumption has seriously affected China's sustainable economic development strategy, so how to reduce building energy consumption and

¹The study was supported by the General fund of Inner Mongolia Education Department 2016" Quantitative Control on Energy Saving Reconstruction Technology of Buildings Thermal Environment in Inner Mongolia Universities" (Fund No. NJZY16088), the General Fund of Inner Mongolia University of Technology 2015" Research on temperature field model of building space in Hohhot Universitys " (Fund No. X201512), the Key fund of Inner Mongolia University of Technology 2015 "Research on envelope thermal performance optimization of low energy consumption buildings in Inner Mongolia" (Fund No. ZD201513).

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improve building energy conservation has become a problem that can't be ignored. China should reduce building energy consumption and improve building energy conservation, and also needs to find a powerful tool to promote the realization of this goal in the premise of the development of green energy-saving buildings [1]. At the same time, database is the latest technology in data management. As the core and foundation of information system, database technology has been widely used in all walks of life [2]. The development situation of building energy conservation and green building is relatively satisfactory, but there are still many problems, such as the lack of perfect laws and regulations and the neglect of technology integration and; at the same time, it has not yet formed a complete set of technical system and standard system; a comprehensive system of geographical and functional suitability for green building technology has not been formed; the promotion and demonstration scale of green buildings is still small; and it has not yet played a guiding role widely [3].

There are few researches on the actual operation performance of green public buildings in China, and the systematic analysis is deficient. Relevant research scholars have defined the incremental cost of green building technology, including the corresponding benchmark program of each technology and the impact of interactive costs [4]. In addition, scholars have calculated the energy per unit area of the green public buildings of different stars, and evaluated the commonly used energy-saving emission reduction technologies with the cost effectiveness. Cost effectiveness is the incremental cost of a single technology brought about by annual energy efficiency.

2. State of the art

The key technologies of building energy conservation are mainly embodied in the construction of buildings and the construction of artificial materials with very light and transparent textures. Low-E membranes can effectively block winter heat and prevent heat loss during the summer. This open and closed electronic chrome film can darken or completely opaque the building's housing. Placing ultra-thin photovoltaic cells on the outer surface of the building's skin structure can absorb 20% of the light, thereby providing the vast majority of the energy needs of the building [5]. Generally, the load-bearing structure of a building is made of carbon material. The load-bearing floor is made of lightweight carbon composite panels, and the intelligent floor which is used for installing electrical, water, fresh air and wire connections is located in the intermediate layer. In addition, it can be controlled according to the temperature requirement of the temperature board [6]. The design concept of green building uses the recycling of building materials in terms of the construction quality, so the environmental pollution and space utilization are forward-looking [7]. Green building is the product of the times, and the rise of green building is not only conducive to social harmony and stable development, but it also can improve the human living standards and maintain the ecological balance of the building. The consumption of natural resources will continue to decrease [8].

Therefore, the general idea of building energy conservation and green building database construction is: the construction of basic database, dynamic monitoring

database, database, business service database, model database and case database [9]. From building energy conservation to green construction design and to renewable energy applications, this process includes building structures, construction equipment, water supply lines, air conditioning, energy saving, low carbon emissions, and so on. A multi-scale, multi-resolution, heterogeneous, and multiple data source data platform and an efficient data update mechanism should be established [10].

3. Methodology

3.1. The establishment of building energy conservation and green building model system framework

For the establishment of building energy conservation and green building model system, first of all, the complete energy-saving operation system, management system, monitoring system, evaluation system and a series of system frameworks should be established according to the energy consumption in different buildings [11]. Secondly, the energy benefits of various functions should be built and constantly improved, so as to guarantee the reliable data of building energy conservation data and the smooth progress of energy saving [12]. The construction of building energy conservation and green building system model needs to be carried out step by step by using the hierarchical structure. After the statistical analysis of the judgment matrix and the weight of the index above, the consistency test results can be obtained. According to the results obtained, the building energy conservation experts can carry out analysis and judgment, assess the weight indicators of various energy-saving facilities, and obtain the final combination of weighted results. The system skeleton diagram is shown in Fig. 1.

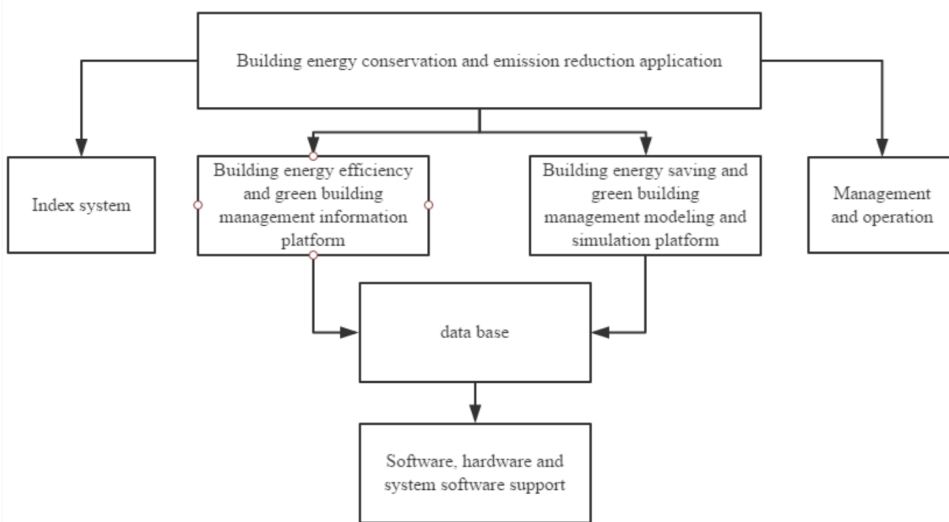


Fig. 1. Building energy conservation and green building model system diagram

The building energy conservation and green building model system framework requires the efficient operation of the platform, and it also has some configuration requirements for hardware and software facilities. Through the study of typical architectural features in various regions, the network remote transmission technology is used to carry out the analysis of the collection and storage of database data. The building energy conservation and green building management information platform and the building energy conservation and green building simulation platform can successfully complete the evaluation of building energy conservation.

3.2. The establishment of building energy conservation and green building model database

The construction of building energy conservation and green building system model not only requires the overall planning of the country, but also needs to gradually carry out all relevant indicators and standards, and various data categories formed can represent various building database systems, which can be gradually applied to the management information platform of building energy conservation and green building, so that the modeling and simulation platform built up is in good agreement with the current situation and the development trend and can make the model system always have a solid data base, which has a positive impact on building energy conservation and green building practices. Building energy conservation system needs to enter the basic characteristics, energy consumption, service direction and other information of different types of buildings in a database, so as to complete the energy assessment work according to different construction information. At the same time, according to the detailed data, the library model should be set up, and the data composition of the system model should be improved. In the building energy consumption assessment, positive conclusions can be obtained, and the building energy consumption assessment information needs to be incorporated into the building information management platform. Building energy conservation assessment information can provide corresponding data supports for building management emergencies. Building energy conservation system construction mainly needs to establish corresponding data simulation model and information service management model, so as to complete the demonstration and simulation work of building energy conservation link. In the process of building energy conservation emission reduction guidance, complete energy-saving emission reduction targets should be established; in all aspects of energy management and supervision, strict standards should be adopted; building energy conservation and green building model should be constantly improved. The database is subdivided according to Fig. 2.

In this paper, from the actual needs of green building energy consumption statistical work, the concept that the database should realize the use of green building energy consumption statistics was clearly defined, which was mainly used for the statistical management of green buildings. The required database tables, fields and keywords were determined; secondly, according to the demand analysis, the database system in the table was determined, and the fields and keywords in each table were also determined [13]. Each table contained only the topic of the relevant information, so that the table name based on the topic information was determined. In the

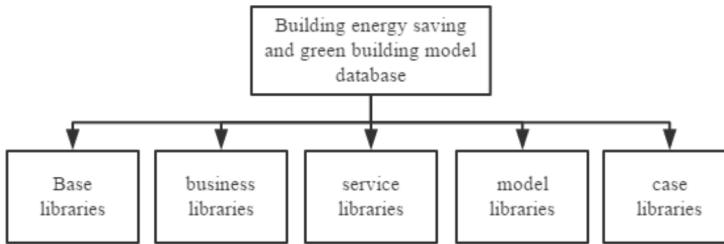


Fig. 2. Building energy conservation and green building model database

same database, tables should not have the same name; for the same table, fields should not have the same name. Then, by combining the main relationships in each table, the relationships between tables were determined, so that tables were linked to different topics [14]. Finally, the required tables, fields, and relationships between the main keywords and tables were designed to be completed; the overall design of the database was checked and the possible shortcomings for improvement were identified.

The design and implementation of green building energy conservation database system are the basic information and energy consumption based on the green public buildings, civil buildings and commercial buildings. According to statistics and summary analysis, from the point view of needs of managers, ordinary users and anonymous users, permissions settings are shown in Table 1

Table 1. Permission setting

View statistics	✓	✓	✓
Building information input	✓	✓	-
Data input of energy consumption	✓	✓	-
Data modification	✓	✓	-
Data upload	✓	✓	-
Audit upload information	✓	-	-
User information management	✓	-	-
Page maintenance	✓	-	-
Page upgrade	✓	-	-

With the rapid development of green building, the system needs to finish the data entry of green building timely, accurately and rapidly, input data of building information, enhance information sharing, and achieve the management of user information through password management. After the data is input, data review should be carried out to prevent and modify information errors, and then the data can be uploaded. The system can realize the data statistics management of green building energy conservation. Data statistics and query is the main part, so the query and

statistics function should be the minimum response time, and the efficiency of user queries and the accurate data provided by each query should be improved through the way of presenting form.

3.3. Energy consumption analysis of green building

Database technology plays an important role in the establishment of basic information, energy consumption information, statistical analysis of energy consumption and other energy consumption statistics. Through the establishment of such database of green energy-saving buildings, the actual operation of statistical personnel and construction owners can accurately grasp related buildings, so as to realize the building operation and effective management of energy consumption. At the same time, the green building energy consumption analysis and evaluation technology can be used to comprehensively analyze all kinds of energy-saving projects at all levels from microscopic to global views, and add energy analysis data to the building energy conservation and green building model database, so as to provide important data supports for the improvement of key technologies of energy-saving green building [15].

For the analysis of green building energy conservation, energy share analysis is an intuitive method which can be easily implemented. The method of analysis can be described by the following formula:

$$\text{Input} = \sum \text{Demand} \times \text{Share} / \eta. \quad (1)$$

Here, the Input and Demand represent the input power and output power of building energy consumption equipment, η represents the efficiency of energy consumption device output power obtained by the improved technology and share represents the total output power of the share of equipment.

In addition, the promotion of energy-saving equipment such as energy-saving lamps will reduce the indoor heat and heating requirements. Efficiency η is not constant. At this point, the construction group splitting method will be adopted.

First of all, according to the type of building, the type of office buildings, shops, hotels, hospitals and other heat sources systems, the size of buildings and the floor planning, the clustering is carried out. In each construction category, the building model of various building categories is chosen as a reference model. Secondly, the typical building model is used, and various representative energy consumption data can be counted through the energy consumption monitoring system, including the daily cooling, heating, power and other requirements of typical buildings; modeling and simulations of energy production and distribution systems are completed to quantify typical terminal energy requirements for building models such as power and winter heating coal. The energy consumption per unit area of each building category is calculated. Finally, the total energy consumption is obtained by a method of multiplying the total energy consumption (per unit area) by the typical building type and total area. Common green energy-saving building designs are as the following shown in Fig. 3.



Fig. 3. Green energy-saving building design

4. Result analysis and discussion

4.1. Requirement analysis of database platform for building energy conservation and green building model system

In order to ensure the smooth operation of the green building energy consumption database system, one or more servers that can be accessed through the extranet should be guaranteed. The client of the system can access the system server through the extranet, and analyze the basic performance and configuration requirements of the server and the client through the analysis of the characteristics of the system. The requirements for server and client for the basic performance and configuration of the system are as listed in Table 2.

Table 1. Permission setting

	System hardware configuration		System software configuration
	Memory	Hard disk	
Server-side	2 G	200 G	Microsoft SQL Server
Client	512 M	80 G	Microsoft Windows 2000/NT/XP above

Green building energy consumption database in A building within the third ring road in the city of Beijing stores all green building information in A building within the third ring road in the city of Beijing, including building details, energy consumption data, contact information and other important information. Therefore, it is necessary to do a good job of computer virus prevention work, and regularly maintain the anti-virus function and password management of the system.

4.2. Data analysis of building energy conservation and green building model system

The energy consumption data of the A building in the third ring road in Beijing was analyzed, and the annual energy consumption of the building was audited. During the test period, the elevator in the building did not run, and the restaurant only served as an employee's dining place and did not undertake the cooking functions of the kitchen. Therefore, the building functions were relatively simple. With references to the sub node setting of the metering model, energy consumption was divided into lighting sockets, HVAC systems, communication rooms and others. The communication room was generally outside the scope of the discussion, so this part was eliminated. The monthly change chart of energy consumption and the distribution of energy consumption are shown as in Fig. 4 (energy consumption was calculated by formula 1).

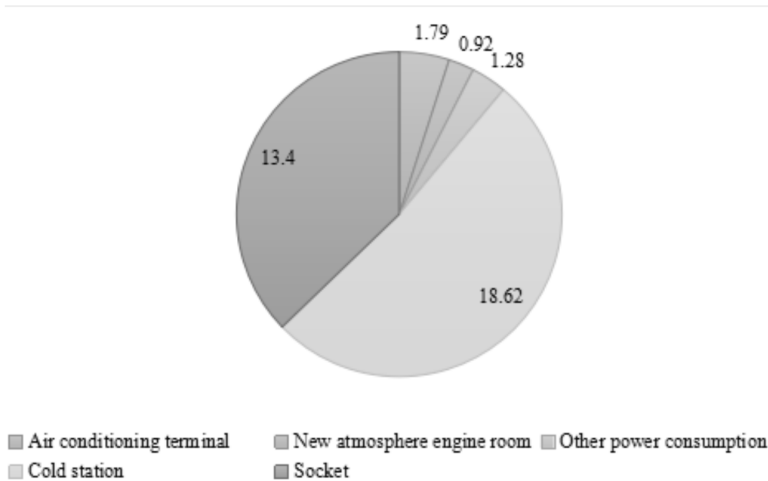


Fig. 4. Monthly energy consumption diagram of buildings and the distribution of energy consumption

Statistics show that the annual power consumption of the building was $46.03 \text{ kWh}/(\text{m}^2 \cdot \text{a})$. The total energy consumption of the operation was evaluated. First of all, with the database method, the electricity consumption data of 85 office buildings in Beijing were compared. Compared with 81% of the buildings in the sample, the energy consumption was lower, so the cumulative probability level was about 19%.

The efficiency of the building's yearly cooling and air conditioning system per-

formance is summarized in Table 3.

Table 3. Annual cumulative working condition, refrigeration and air-conditioning system, performance, efficiency

	Building refrigeration season	Survey mean	Limit
Accumulated cooling load	20.00	-	-
Air conditioning refrigeration power consumption	5.58	-	-
Air conditioning system integration	3.58	2.3	-
Cold station system EER	2.80	2.8	≥ 3.8
Chiller EER	4.79	4.6	≥ 4.2
Chilled water system	29.86	20.2	≥ 30
Air conditioning terminal system	18.87	18.7	FCU: ≥ 9 ; FCU: ≥ 24

The above data were obtained from the building energy conservation and green building model database. The building load level, the system integrated energy efficiency and subsystem energy efficiency were all analyzed, and a more specific and comprehensive understanding of the operation of the building was made. Based on the analysis of the operation of the case, it can be seen that the building did not use special system equipment, but adopted the most traditional air-conditioning terminal equipment. Through reasonable passive design, energy-saving operation mode and good design intention in operation, it reduced the system cold and hot load, and it did not pursue the efficient equipment operation alone, but made full use of low-grade energy for cooling and heating. At the same time, it adopted flexible terminal control equipment to meet the needs of the users during the overtime period, thereby saving energy. The energy consumption assessment of the case was summarized as follows: the total energy consumption level is extremely high; the load control of the building is excellent; and the system energy efficiency level is acceptable. Although further regulation of the equipment operation mode can improve the energy efficiency, the operation performances are satisfactory in terms of the whole system.

The green performance evaluation of building A was analyzed. In the case building, 89 valid questionnaires were reclaimed. Among them, in terms of the green performance of the building, the function, aesthetic, spatial layout and maintenance management of these four aspects were rated and evaluated. The statistical scores are shown in Fig. 5.

As can be seen from the above figure, building function, aesthetic and maintenance obtained 4 points; the spatial layout score was relatively low as 3 points.

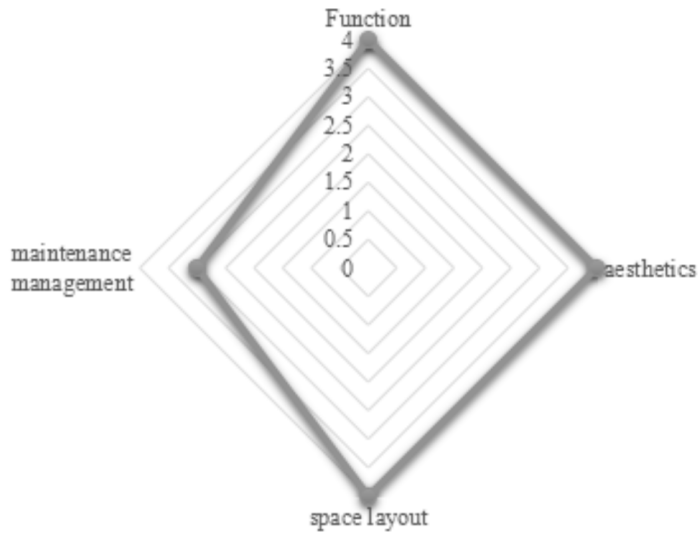


Fig. 5. Green performance Statistical score

As can be seen from data extracted from the green performance database, there were more open office spaces in the layout of the building space, so the user's space privacy and sound insulation were poor. In this regard, the user's satisfaction was relatively low. Therefore, all regions of the country should grasp the core technology of building energy conservation and green construction as soon as possible. A variety of experimental energy-saving technologies and green building technology must comprehensively utilize the building energy conservation and green building demonstration projects in different parts of China.

5. Conclusion

The establishment of building energy conservation and green building model system is conducive to promoting the promotion of green building throughout the country, so as to provide THE guarantee for the overall construction of green buildings in China. In the economic society where the building energy consumption is increasing constantly, the implementation of building energy conservation and green building technology can effectively reduce building energy consumption. Through the construction of building energy conservation and green building system, the construction of database and simulation platform, and the vigorous promotion of the green building model in various areas, a complete green energy consumption system can be constructed to achieve the energy saving and emission reduction effects. In this paper, the research on building energy conservation and green building model system and database based on key technologies was mainly carried out around the related technologies of reducing energy consumption and its detection database as the core. Through the establishment of building energy conservation and green building

system model framework and database, energy consumption of green energy-saving building was analyzed; finally, based on the building energy conservation and green building model systems and database of A building within the third ring road in Beijing, its energy consumption was studied and analyzed, and the conclusions that the energy efficiency of A building was high, and the building energy conservation methods were excellent were obtained. However, in the future database of energy-saving green building model systems, it still needs to strengthen the maintenance work, so as to provide data supports for the future green building projects.

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Received August 7, 2017