STUDY ON THERMODYNAMIC FUNCTIONS OF TRADITIONAL BUILDING WINDOWS BASED ON CHARACTERS

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The indoor light environment of the building has an extremely important influence on its own use function, and there are many factors that affect the indoor light environment of the building, such as the surrounding environment of the building, the interior decoration of the building, and the design of the window. The window is used as the building envelope. An important part of the structure is responsible for lighting and ventilation to meet the requirements of the indoor environment. It exists as a lighting device for the building. The lighting performance of the windows not only meets people's requirements for living comfort, but also consumes energy in the building. It will have a very important impact. A variety of window shapes start from different functional needs. The comprehensive use of these window shapes by traditional buildings together creates its unique thermodynamic function. This article analyzes cold regions based on the analysis method of thermodynamic functions. Solar heat gain from traditional building windows.

Key words*: Windows; Light environment; Daylight; Thermodynamic function.*

1. Introduction

With the rapid development of China's economy, the contradiction between insufficient energy resources and the deterioration of the ecological environment has become increasingly apparent. Protecting the environment and conserving resources have become a hot topic of discussion [1]. Windows are an indispensable and important part of residential buildings, and they are also buildings. The weakest part of the thermal insulation performance of the outer envelope structure. Therefore, it is undoubtedly an active and effective attempt to use the windows as a breakthrough point in building energy saving and to combine the actual geographical environment of the building with the energy saving design of the building [2]. Traditional Chinese architecture In the window, there are various shapes, including long windows installed between the upper and lower sills, and small windows used for ventilation on the upper part of the wall [3]. For general multi-storey residential buildings, traditional lighting The method is based on natural lighting. Usually, in order to meet the indoor lighting requirements, a certain area of windows is opened on the exterior wall of the building [4] A variety of window shapes start from different functional requirements. The comprehensive use of the window shape has jointly created its unique thermodynamic function. The window is the main channel for daylighting. The larger the window area, the more light is obtained [5]. In other words, the window floorThe larger plot ratio, the greater the value of the lighting system is currently expanding rapidly building size, out of consideration of building energy efficiency, make full use of natural light and provide good indoor environment for building construction can save a lot of energy [6].

Natural light, as a natural light source that people are accustomed to, can also maximize the comfort of building interiors and create a good working and living environment [7]. In view of the characteristics of hot, humid, rainy and strong radiation, some areas The traditional buildings in China proposed specific measures to adapt to the local climatic environment and meet the requirements of green energy saving [8]. Natural light has become a clean light source due to its reproducibility and pollution-free. A large amount of natural light can reduce the pollution of At the same time, it can save resources and have a positive effect on ecological protection and energy conservation [9]. In winter, in severe cold areas and cold areas, a large amount of indoor heat is lost due to cold wind penetration and heat conduction and radiation in windows. In buildings In daylighting design, knowing the two main elements of the building's main use and function and the window-to-ground area ratio, it is possible to calculate the accurate daylighting coefficient [10]. There are many factors affecting the natural daylighting of the building. To provide the best indoor environment for personnel, it is necessary for the architect to make full use of natural lighting through the size design of the window [11]. Natural light can be sufficiently utilized, can save energy and protect the environment play a role and rational design structure and windows of buildings, inside buildings can be fully appropriate and natural light.

Natural light is a light source that people are accustomed to. Human eyes have higher sensitivity under natural light than under artificial light [12]. In addition, natural light comes from the sun, which is a huge and safe clean light source. Cold regions in our country have the characteristics of low winter temperature, long duration, short time when the sun shines indoors during the day, low outdoor temperature at night, and a lot of heat energy lost through windows [13]. The design and application of windows that can meet the multi-functional requirements of lighting, ventilation, viewing and other energy-saving features will be the ineviTab. direction of future window development [14]. Energy conservation is an important part of a resource-saving society. Building energy consumption accounts for a large proportion of the total energy consumption and is the energy-using field with the greatest energy-saving potential. Therefore, it should become the top priority of energy conservation work [15]. Reducing the heat energy consumption of windows is of great significance to the energy-saving effect of buildings. With the further improvement of China's building energy efficiency standards, the energy-saving design of windows will become more and more important [16]. As an important part of building envelope, windows take on lighting and ventilation to meet the requirements of indoor environment [17]. How to do a good job in the huge and arduous task of building energy conservation on the premise of ensuring economic development and environmental protection is a serious challenge we will face [18]. Based on the method of thermodynamic function analysis, this paper analyzes the solar heat gain of traditional building windows in cold regions.

2. Parameter Selection and Model Establishment

The main purpose of architectural design is to provide a healthy, comforTab. and efficient working and living environment for people. Under the background of today's energy crisis, building energy conservation is also booming. The exterior doors and windows of buildings are important components of the building's exterior protection structure. In addition to the most basic enclosure functions, they also have the functions of heat preservation, lighting and ventilation. In order to increase revenue and reduce expenditure, people have turned their attention to clean energy sources such as solar energy. Natural lighting and related technologies are particularly important. In order to study the influence of exterior windows on building energy consumption and lighting environment, we must first

understand the influence principle and evaluation method of exterior windows on building indoor thermal environment and lighting environment, and then select appropriate software as analysis and research tools [19]. Because the hot summer and cold winter zone in China spans a large area, the climatic conditions may vary greatly between different cities in the hot summer and cold winter zone. The quantity of daylighting only meets people's visual function requirements for the light environment when they are indoors, while the quality of daylighting is the basic requirements for the safety, comfort and health of the light environment. As the name implies, the ratio of window area to floor area is the ratio of window opening area to floor area. Under specific lighting conditions, architects can make a preliminary estimation of the lighting coefficient of architectural design by comparing the area of windows and floors with different lighting forms. If you want to understand the indoor light environment and thermal environment of the building, it is necessary to analyze the factors that affect the intensity of solar radiation and the movement law of the sun's position.

According to the "Residential Design Code", the minimum daylighting standard for ordinary residential buildings is shown in Tab. 1. According to this specification, the ratio of window area to floor area is 1: 7, and the window area under the condition of minimum lighting can be calculated from the specific size of each room in the residential unit type. The specific calculation results are shown in Tab. 2. By comparing the data in Tab. 2 with the actual window size of the hole shown in Fig. 1, it can be found that the window openings on each wall surface in this example are larger than the minimum lighting area specified in the specification.

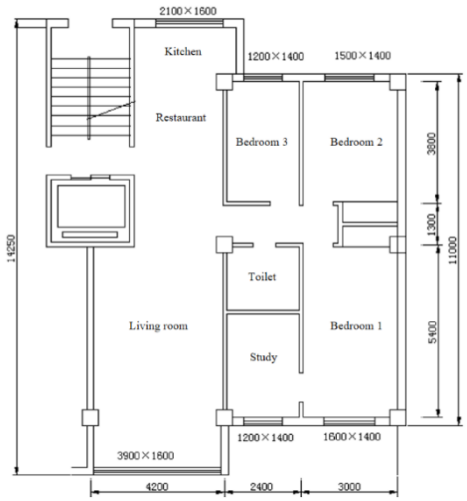

Fig. 1 Typical apartment

Tab. 1 Minimum indoor lighting standards

Room name	Side lighting	
	Use the lowest coefficient (%)	Window to floor area ratio
Bedroom, living room, kitchen	1	1:7
staircase	0.5	1:12

In order to ensure the use efficiency of construction engineering materials and reduce the cost of construction, project management personnel must strengthen the management and strict control of materials and their use at the construction site. Use the existing technology to establish a multi-mode collaborative working environment with integrated integration Collaborative work support platform of the multimedia mode. The cooperative design operation process is shown in Fig. 2.

Tab. 2 Minimum window area of each room

Room name	Bedroom 1	Bedroom 2	Bedroom 3	Living room	Study	Kitchen
Floor area (m 2)	15.46	11.17	8.48	30.95	7.42	15.89
Hole area (m 2)	2.36	1.61	1.18	4.55	1.1	2.29
Width × height (m × m)	1.6×1.3	1.2×1.3	0.8×1.3	2.9×1.5	0.8×1.3	1.5×1.3

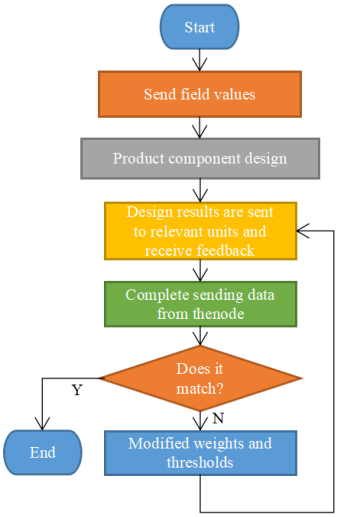

Fig. 2 Cooperative design and operation process of office building engineering

In the window structure, not only the heat loss caused by the temperature difference between the two sides of the air, but also the heat caused by the solar radiation and the heat loss caused by the radiation to the sky. The heat storage and heat release of the envelope structure, radiant heat exchange on all surfaces of the room, indoor equipment, lighting, and personnel are all constantly changing. In the traditional design method, the construction specialty and equipment specialty are disconnected, and the equipment engineer Need to use energy analysis software for energy analysis after entering building data.

Extraction and conversion based on specific information format in the building information model, to achieve the docking and sharing of different professional software data. Dimensionless processing of the comparison sequence and the reference sequence. In this paper, the mean method is used to process:

$$E_{cr} = \frac{C_p}{E}\int_0^{\tau}\sigma^2 dt \tag{1}$$

Difference sequence:

$$w_{0i} = \frac{1}{n}\sum_{k=1}^{n} r_{0i} \tag{2}$$

In the model, whether the internal, boundary, and external subsets of the objects intersect to describe the topological relationship between the two objects is expressed as:

$$F_{Adh} = F - \frac{4}{3} E^r \sqrt{R\left(d - d_0\right)^3} \tag{3}$$

For a healthy indoor light environment, in order to avoid the glare caused by strong brightness contrast in human vision, some commonly used principles should also be adhered to. The important source of heat on the earth is solar radiant energy, which has different effects on the earth. The regional climate has an extremely important role and is the main factor that determines the climatic conditions. All buildings on the earth are directly or indirectly affected by solar radiation. The factors that affect the indoor thermal environment of office buildings are divided into Internal disturbance and external disturbance are two types. External disturbance mainly refers to climatic parameters such as air temperature and humidity, solar radiation, etc [20]. Internal disturbance is mainly indoor indoor heat sources such as equipment, lighting and personnel. Compared with the climate in other latitudes, the average temperature in July in China is hotter in summer and cold in winter than in other regions at the same latitude, but the average temperature in January is 5-10 ° C lower than the same latitude in the world, which is the winter temperature in the same latitude in the world. The lowest area [21]. If we can determine the sun position for the design day or time at different seasons, we can determine the building distance, building orientation andRizhao building design. In addition, we also have to be calculated insolation heat and air-conditioning load, as well as building natural lighting design calculations.

3. Thermodynamic Function Analysis of Traditional Building Windows

3.1. Determination of Thermal Parameters of Windows

The forms of heat gain and heat loss of residential windows include: solar heat gain, heat exchange, and air penetration, and each of these forms has corresponding evaluation parameters, namely the solar heat gain coefficient, the entire window heat transfer coefficient, and air permeability. The larger the value of the daylighting coefficient, the larger the window area is, the more beneficial it is. Due to the health and psychological reasons of the residents in the northern hemisphere, they hope to get enough sunlight, especially for ordinary residential windows, it is best to face the sun or south. With the development of economy and the continuous advancement of technology, its development and evolution can be described with each passing day. Since the industrial revolution, the development of technology has changed the world. The amount of solar energy through the window includes two parts: one is the heat that enters the room directly through the window, and the other is After each layer of glass absorbs the amount of solar energy, it acts as an independent small heat source and indirectly radiates heat to the room.

The direct sunlight energy gradually accumulates, so that the indoor air temperature increases continuously, and is proportional to the solar energy transmission ratio of the window and the area of the window, which will definitely increase the air conditioning load in summer [22]. In winter, regardless of the south-facing window or north-facing The heat dissipation of windows and large-area windows must increase the heating load. Thus, the area of the lighting window is not as large as possible [23]. The structure of the window will develop in the direction of energy saving in the future, that is, a large number of double-layer insulating glass and three-layer hollow Glass, coated insulating glass, etc., to ensure certain energy saving requirements for heat preservation or insulation. Tab. 3 shows the standard value of the lighting coefficient on the reference plane of each lighting level.

Tab. 3 Standard values of daylighting coefficients on the reference plane of each daylighting level

Lighting level	Side lighting		Daylighting	
	Standard value of daylighting coefficient (%)	Standard value of indoor natural light (lx)	Standard value of daylighting coefficient (%)	Standard value of indoor natural light (lx)
I	5	780	5	750
II	4	580	2	420
III	3	460	3	320
IV	2	310	1	160
V	1	160	0.6	80

Building energy conservation based on BIM technology can solve the problem of data conversion in the process of building design and energy conservation design and improve work efficiency. Using BIM technology, data can be input into the model, thus establishing a virtual model. Fig. 3 is an optimization model of BIM construction engineering.

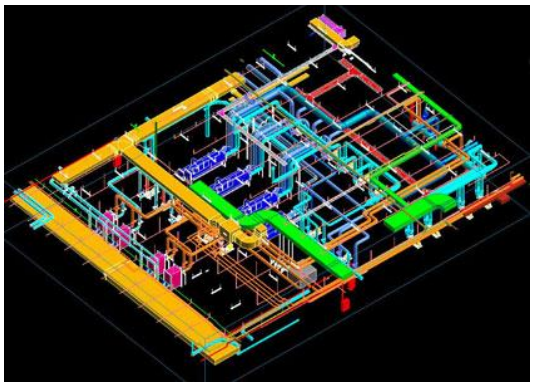

Fig. 3 BIM building engineering optimization model

The choice of parameters in the **BIM** system is critical to whether the algorithm converges. According to the initial conditions of **BIM**, for the convenience of analysis, only the discrete time is considered. It can be concluded that:

$$ES_i = \sum_j (1 - \sum_q p_{iq} m_{jq}), q \neq i, j \tag{4}$$

The iteration termination condition is generally selected as the maximum number of iterations or the optimal position searched by the particle swarm so far meets a predetermined minimum adaptation threshold. The position and velocity of each particle are changed according to the following formula:

$$\tau_b = \frac{\rho g n^2 Q^2}{A^2 R^{1/3}} \tag{5}$$

The size of the window area can directly affect the indoor environmental quality of the building, such as thermal insulation, heat insulation, and sound insulation, and ultimately affect the quality of life of people indoors. Architectural modeling considers the physical properties of objects when modeling. Fractal technology and particle systems. It is a typical physical modeling method. Fractal technology

can describe data sets with self-similar characteristics. Fig. 4 shows the comparison of algorithm performance before and after storage optimization.

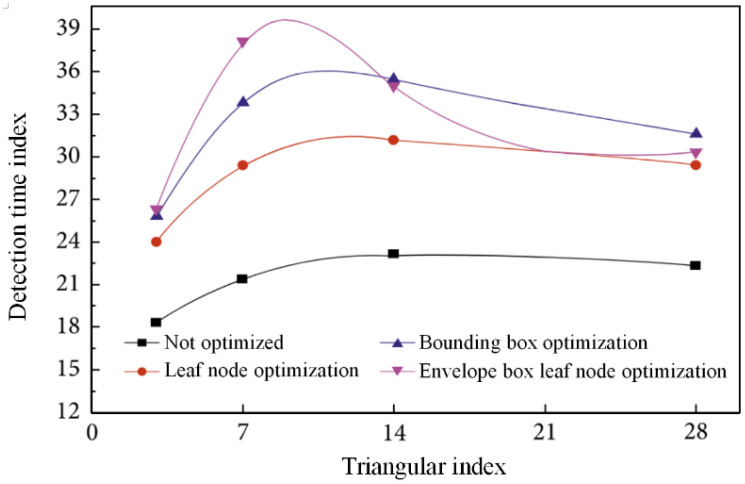

Fig. 4 Comparison of algorithm performance before and after storage optimization

When the building is in the stage of energy-saving design, the application effect of single energy-saving technology in the building cannot be simply analyzed. The comprehensive impact of various energy-saving technologies on building energy consumption and the impact level of energy consumption of various energy-saving technologies should be analyzed in detail. The structural design of building skin is optimized by combining high-strength load-bearing materials with light thermal insulation materials with low thermal conductivity. Due to the combined effect of solar radiation and temperature difference between indoor and outdoor, heat is transferred into the room through the window glass. After sunlight hits the surface of the window glass, part of it is reflected off and will not become the heat of the room. As the part that is closest to the outdoor environment, it is the key to calculate the building energy consumption to correctly calculate the unsTab. heat transfer of the wall thermal system under any disturbance. Geometrical modeling is the first development in the information design of window thermodynamic layout. Geometrical modeling deals with basic problems such as geometry and shape representation of objects, research on graphic data structure, etc. The path density, node number and center potential are analyzed. As shown in Tab. 4.

Tab. 4 Structural analysis of building layout information design

The internet	Path density	Number of nodes	Central potential
Encounter information	1411	2133	0.752
Interactive information	2024	2083	0.563
Weighted sum	613	2622	0.662

To determine the conditions under which exclusion and attraction operations are performed, we will introduce a diversity control method.

$$I_i = \left[\sum_{j=1}^{p} \omega_j^m y_{ij}^m \right]^{1/m} \tag{6}$$

The iteration termination condition is generally selected as the maximum number of iterations or the optimal position searched by the particle swarm so far meets a predetermined minimum adaptation threshold. The position and velocity of each particle are changed according to the following formula:

$$\theta(P) = Ln(\frac{P}{1-P}) = \alpha + \sum \beta_i X_i + \xi \tag{7}$$

The choice of parameters in the window thermodynamic layout system is crucial to the algorithm's convergence. According to the initial conditions of the building layout, for the convenience of analysis, only discrete time is considered. It can be concluded that:

$$K_{s,d} = \frac{1}{MN} \sum_{m=1}^{M} \sum_{n=1}^{N} \frac{\left| |W_{s,d}(m,n)| - \mu_{s,d} \right|^4}{{\sigma_{s,d}}^4} \tag{8}$$

In the case of solar radiation, ignoring the heat transfer of the window frame and the heat transfer of the glass edge and the window frame, it can be considered that the window in this example consists of only two layers of glass and a space between the layers. The actual building and system are auxiliary, Uncertain and non-linear, so we have to use assumptions, simplifications and approximations in the modeling process to get the calculation results. The theoretical value of the solar heat gain coefficient is 0 to 1, and the actual value is about 0.15 to 0.80. Under the same conditions, the smaller the value is, the less heat is generated by the solar radiation through the window. The development trend of the constituent materials of the window will be to choose eco-friendly energy-saving frame materials and connect the frame materials to the high-performance glass system through connecting members. Make windows have good air tightness [24]. Due to the introduction of new technology development and the actual need to save energy, the development of windows in the future will inevitably further develop from the development of its functions, composition materials, and construction [25]. The higher the accuracy of the requirements, the higher the requirements for the simulation, and the greater the workload of the simulation. Therefore, when modeling, you need to consider the trade-off between the two.

3.2. Calculation of Heat Transfer of Windows

The heat transfer methods of windows include: radiant heat transfer with indoor and outdoor environments, convective heat transfer between the inner and outer surface, radiant heat transfer and convective heat transfer between glass layers, heat transfer in the glass layer, and absorption of solar radiation heat by the glass. Part of the light directly enters the room through the windows, and part of the heat is transferred to the room by the absorption of solar radiation energy by the various layers of glass. The meaning of daylight is also constantly changing and rich, and the only way to open the window is also changing. The daylighting is to let the light enter the room through the window, which is a kind of passive lighting. Solar radiation encounters the scattering of gas molecules and dust in the atmosphere, and the radiant energy reaching the surface of the earth in a diffuse form is called scattered solar radiation. The relative value is the daylighting coefficient.It is the illuminance generated by the diffusely reflected light from a certain point on a given horizontal plane in the room under the illumination of the diffuse cloudy sky. The ratio of the illuminance caused by the diffuse reflection of

the sky on the horizontal plane. The use of modern lighting materials, such as glass curtain walls, prism glass, special coated glass, etc.Good lighting quality plays a role.

The window thermodynamic model based on the information design task can be used to solve the possible design problems and quality problems of the project in advance through collision detection and other forms. The optimization performance parameters of residential layout before and after optimization are shown in Tab. 5.

Tab. 5 Performance parameters of optimized topology for residential layout before and after optimization

	Before optimization	After optimization
Rows	31	46
Number of columns	21	31
Monitoring points	651	1426

The survey results for the transmission and distribution system show that the pumps in the sample buildings basically did not use the control strategy of frequency conversion adjustment. The various types of equipment were not cleaned and organized in time during the operation. There are certain energy-saving technical measures for the building envelope protection The energy-saving potential of existing buildings should continue to promote the energy-saving reconstruction of the outer envelope of existing buildings. Buildings are closely related to the environment in which they are located, and each base has its own unique characteristics. Although high-rise buildings have certain ventilation advantages, they are often subject to The direct and diffuse intensity of the sun is also higher.

In order to determine under what circumstances the repulsive operation and the attracting operation are executed, we will introduce a diversity control method:

$$F_{ij}^{t} = \frac{1}{N_c}\sum_{c\in N_c}\frac{f^{t}t_i n_j}{1+a_{kl}^{c}n_k n_l} \tag{9}$$

The training and learning process of the window thermodynamic model is a process in which the error value between the network output value and the expected value gradually decreases until the error meets the requirements. Define the error:

$$\sigma_{ij} = \frac{1}{V}\sum_{c\in N_c} f_i^{c} d_j^{c} \tag{10}$$

It is applied to window thermodynamic layout optimization. The following formula:

$$C_n^P = \frac{\sum N_S^P n_C^P}{N_S^P} \tag{11}$$

The particle speed is updated during the run as follows:

$$\Delta M = \left[\frac{\sum n_i \left(\Delta M_i\right)^m}{\sum n_i}\right]^{1/m} \tag{12}$$

The outdoor illuminance of a building often changes, which inevitably causes the indoor illuminance to change accordingly. It cannot be a fixed value, therefore, the requirements for the amount of daylighting use relative values. Scattered radiation is non-directional, and it only accounts for total radiation. A small part of the energy, and the direct solar radiation, because of its large proportion, is the main factor affecting the total solar radiation. After the solar radiation passes through the atmosphere, its intensity and spectral energy distribution both change to some extent. At present, the main types of daylighting are Side lighting, top lighting and both mixed lighting, with the increasing density of urban buildings, more and more high-rise buildings, the mutual shading is more serious, directly affecting the amount of light. In the design of buildings, sometimes use The inner wall lighting methods such as the patio lighting well or the reflector device can supplement the insufficient lighting of the outer wall, and also avoid the direct sunlight and dazzling spots of the sun. Human beings have been adapted to long-term life under the sun, both psychologically and physiologically. In order to obtain all kinds of information, and to seek environmental sanitation and physical health, light has become a necessity and tool for people's lives. At present, the meaning of daylight still refers to the establishment of naturalThe light environment, with the advancement of technology, the meaning of daylighting continues to expand. One day, daylighting is not only for the establishment of natural and artificial light environments, but also to provide cheap and clean energy for other uses.

4. Conclusion

The thermal design of the windows of residential buildings has always been a difficult point in energy-saving design. Opening windows of houses in severe cold areas cannot blindly increase the area. Energy-saving design must be carried out in accordance with local climatic conditions and local conditions. There are many factors that affect the natural lighting of the building interior. This article discusses the effect of window-to-wall ratio, window sill height, and window shape on the natural lighting of the building. The thermal design of the window part of a residential building has always been a difficult point in energy-saving design. Through the analysis of this case, we can conclude that The opening of windows does not blindly increase the area, and energy-saving design must be carried out in accordance with local climatic conditions according to local conditions. For areas where the latitude is not very high, solar energy is abundant, and the average outdoor temperature in winter is not very low, it is recommended to increase the area of south-facing windows Use as much solar energy as possible to save energy. In the vicinity of the window, the position of the window should not be too high. Although the window is too high to facilitate the lighting in deep and large places, it affects the overall average lighting effect and people's vision in the building. Comfort. In addition to the factors of the window itself, the factors affecting the natural lighting of the building interior are alsoThere are many, such as the blocking of the surrounding environment of the building, the interior decoration of the building, the design of the external sunshade of the building, and the setting of lighting auxiliary components.

Nomenclature

BIM -Building Information Modeling

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