THERMAL INSULATION PERFORMANCE ANALYSIS OF HIGH RISE BUILDING ENVELOPE BASED ON FINITE ELEMENT ANALYSIS

by

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The current analysis method of thermal insulation performance of building envelope neglects the optimization of temperature control parameters, which leads to poor thermal insulation performance, low thermal insulation rate and weak convincing results. Therefore, a finite element analysis method for the thermal insulation performance of high rise building envelope is proposed. Compton backscattering technique is introduced to analyze the influence of the scattering intensity and the ratio of window width on the heat transfer coefficient of the enclosure. Based on the objective function, the thermal performance parameters of retaining wall are calculated and fused. An adaptive iterative optimization method is used to control the thermal performance of the enclosure using the thermal performance parameters of the enclosure. Through the Compton backscatter detection technology, the decision variables of energy consumption of the thermal insulation materials are obtained, and the temperature control parameters of the walls are optimized. The finite element model of enclosure structure is established by using finite element software. The results of finite element model experiments show that the proposed method has ideal heat preservation rate and energy consumption. Compared with the traditional method, the proposed method can keep the preset temperature.

Key words: *high rise building, compton Backscatter detection technology, temperature control parameters, finite element analysis, thermal insulation performance, building envelope*

Introduction

At present, the energy consumption of high rise buildings [1] accounts for a large proportion of the total energy consumption of the society. In the developed countries in the west, the energy consumption of high rise buildings accounts for 30-45% of the total energy consumption of the society. In order to reduce the energy consumption of high rise buildings, the state has actively implemented energy-saving standards and enhanced the thermal insulation capacity of high rise buildings [2]. In order to reduce the energy consumption of high rise buildings, the wall should be energy-saving, so the optimization of the wall insulation thickness has become the focus of current research. While increasing the insulation capacity of the exterior walls would reduce heating costs for high rise buildings, it would increase investment in the construction of the exterior walls and increase overall construction costs for the builders [3]. At the same time, the service life of insulation layer is very limited [4], so it is impossible

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to increase the thickness of insulation layer of exterior wall indefinitely and reduce energy consumption cost. Scientific selection of the thickness of insulation layer of exterior wall of high rise building will make the energy consumption cost of heating insulation layer in the service life and the investment of insulation layer sum minimum. Based on this purpose, researchers in this field have proposed relevant methods.

In Han *et al.* [4], a four-story commercial multi-storey building is taken as the research object, and the energy consumption model is constructed to analyze the overall change curve of air conditioning energy consumption of buildings with different insulation thickness in one year. The simulation results are except for the parameters of the remaining enclosure components of the exterior wall remain unchanged, there is a minimum energy consumption insulation layer thickness. If it exceeds the thickness, the energy consumption of air conditioning in one year will increase, which will lead to high temperature. If we change the thermal performance of a certain enclosure component, such as the external window or roof, the thickness of the external wall insulation layer with the lowest overall energy consumption of building air conditioning will change to a certain extent, and the minimum energy consumption of air conditioning will also change accordingly. In Zhao *at al.* [5], considering the effect of wall moisture transfer on heat transfer load, an unsteady heat and moisture coupling model was built to simulate the whole process of wall heat and moisture transfer. According to P1-P2 economic analysis model, the thickness of different insulation layers of four typical urban external walls in hot summer and cold winter was analyzed, and the optimal thickness was determined. However, the aforementioned traditional methods ignore the optimization of the temperature control parameters of the enclosure wall, resulting in poor thermal insulation performance, low thermal insulation rate and weak persuasion. Therefore, the analysis method of high rise building envelope insulation performance based on finite element analysis is proposed.

Analysis model of high rise building envelope insulation performance based on finite element analysis

Objective function of thermal insulation performance

In the optimization process of the thermal insulation performance of the high rise building envelope, the method of reaction coefficient is introduced. Assuming that the disturbance quantity is treated discreetly every 55 minutes, then the process of heat [6] being transferred to the room through the high rise building envelope is expressed:

$$N = Rt\alpha - t_r \tag{1}$$

where α is the heat transfer coefficient [7], R – the thermal effect of all external factors on the high rise building envelope, t_r – the indoor temperature, and t – the discrete processing time.

According to the calculation results of eq. (1), the relationship between N and the heat transfer coefficient is established:

$$\frac{N}{\alpha_\kappa} = \frac{d_\varepsilon(1-\varepsilon)}{\int\limits_0^z (z-1)\,d_z} \tag{2}$$

where z is the heat transfer coefficient [8] and ε – the surface temperature of the high rise building envelope.

Based on the eq. (2), the influence of Compton backscattering intensity and window width ratio on the heat transfer coefficient of the high rise building envelope is analyzed:

$$\sum_h \frac{IA_w}{d_z} = \frac{\rho_d}{\varepsilon} - \frac{m_c \cdot \text{width}}{K_w(1-\varepsilon)} \tag{3}$$

where I is the Compton backscattering intensity, w – the window width ratio of high rise buildings, b – the window-wall ratio, m_c – the thermal bridge area, width represents opening width, and K_w – the heat transfer coefficient limit.

With the support of Compton backscattering detection technology, the thermal insulation performance limit of the heat transfer coefficient of the high rise building envelope is calculated:

$$\infty K = \frac{Q}{S\left(t_i - t_e\right)} \tag{4}$$

where ∞K is the thermal insulation performance limit of the heat transfer coefficient of the high rise building envelope [9], S – the area of external environmental heat passing through the high rise building envelope, t_i – the indoor temperature of the high rise building, t_e – the outdoor temperature of the high rise building, and Q – the heat flux on the surface of the high rise building envelope [10].

According to the calculation results of eq. (4), when the limit value of thermal insulation and heat transfer coefficient of the high rise building envelope is at the maximum, the objective function of the optimization process of thermal insulation performance of the high rise building envelope is established, which can be expressed:

$$F = \frac{\infty K \dfrac{t_s}{\alpha_e}}{t_i - t_e} \tag{5}$$

According to the outdoor heat retaining wall by high rise building is passed to the indoor quantity of heat, analyzed the Compton backscattering intensity and window width ratio effect of retaining wall heat transfer coefficient in the high rise buildings and high rise building retaining wall heat transfer coefficient by calculation of thermal insulation performance limit, established a high rise building objective function of the retaining wall heat preservation performance optimization process.

Calculation and fusion of thermal performance parameters of enclosure wall

Through space distributed fusion and feature extraction method for retaining wall heat insulation performance test in the process of the fuzzy degree of characteristic analysis, fuzzy equilibrium under limit search scheduling method for retaining wall insulation thermal performance test of ambiguity characteristic scale decomposition, retaining wall insulation thermal performance test model of optimization design. The characteristic quantity of thermal performance distribution of the enclosure wall is

$$\hat{R}_{r1}\left(T_{r1}^0\right) \le \overline{R}_{2r}\left(W_2^0\right) \text{ and } \hat{R}_{r2}\left(T_{r2}^0\right) \le \overline{R}_{1r}\left(W_1^0\right)$$

To transform the thermal insulation performance test problem of the enclosure wall into an optimization problem:

$$\begin{aligned} &\min_{\{W_1, W_2\}} && Tr\left\{W_1 W_1^H + W_2 W_2^H\right\} \\ &s.t. && R^{mac}\left(W_1, W_2\right) \ge \hat{R}_{r1}\left(T_{r1}^0\right) + \hat{R}_{r2}\left(T_{r2}^0\right) \end{aligned} \tag{6}$$

In combination with characteristics of spatial fuzzy degree detection method for retaining wall heat insulation performance testing the operational parameters in the process of analysis, extraction of retaining wall heat insulation performance testing [11] correlation characteristic, get the best optimization parameters T_{r1}^0 and T_{r2}^0, the convergence constraint method, carries on the retaining wall heat insulation performance testing process control, for all the characteristics of the solution, satisfy $R^{mac}(W_1, W_2) \geq R^{bc}(T_{r1}^0, T_{r2}^0)$. The characteristic variables μ_1, μ_2, and μ_m of the thermal insulation performance test of the enclosure wall make the optimization problem of the thermal insulation performance test of the enclosure wall meet the requirements:

$$\lg\left\{1+\left[\frac{1}{\mu_1}\frac{\left|\omega_{r2}(k)\right|^2}{\sigma_2(k)^2}-1\right]^+\right\}=\bar{R}_{1r}\left(W_1^0\right) \tag{7}$$

$$\lg\left\{1+\left[\frac{1}{\mu_2}\frac{\left|\omega_{r1}(k)\right|^2}{\sigma_1(k)^2}-1\right]^+\right\}=\bar{R}_{2r}\left(W_2^0\right) \tag{8}$$

$$\lg\left\{1+\left[\frac{1}{\mu_m}\frac{\left|\omega_{ri}(k)\right|^2}{\sigma_i(k)^2}-1\right]^+\right\}=R^{mac}\left(W_1^0,W_2^0\right) \tag{9}$$

It can be found that the fuzzy control function [12] of the insulation and thermal performance test of the enclosure wall is $1/\mu_m < \max\{1/\mu_1, 1/\mu_2\}$. The mechanical model of insulation bearing capacity of the retaining wall was built, and the thermal performance of the retaining wall was tested under the ultimate load.

The spatial representation model of the thermal insulation performance test of the retaining wall is: $1/\mu_m < \min\{1/\mu_1, 1/\mu_2\}$. The optimal strategy of thermal insulation performance test of the enclosure wall meets the requirements:

$$\begin{aligned}&\min_{\{\mathbf{T}_{r1},\mathbf{T}_{r2}\}} && Tr\left\{T_{r1}T_{r1}^H+T_{r2}T_{r2}^H\right\}\\&s.t. && \hat{R}_{r1}\left(T_{r1}\right)+\hat{R}_{r2}\left(T_{r2}\right)\geq R^{mac}\left(W_1^0,W_2^0\right)\end{aligned} \tag{10}$$

The optimal solution this problem has a closed form and can be obtained by using the Deep Reinforcement Learning method [13] to obtain a process control function for the thermal performance test of the enclosure wall:

$$p_{ri}(k)=\left[\frac{1}{\mu_m}-\frac{\sigma_i(k)^2}{\left|\omega_{ri}(k)\right|^2}\right]^+,k=1,\ldots,r_{ri},\ \forall i \tag{11}$$

where μ_m satisfies the convergence solution. The fuzzy characteristic quantity of the insulation and thermal performance test of the retaining wall was extracted, and the optimization of the insulation and thermal performance test of the retaining wall is carried out, and $1/\mu_i \leq 1/\mu_m < 1/\mu_j \leq \lambda_0$ was obtained. By adopting the adaptive parameter fusion method, the deep learning function of thermal insulation performance test of the enclosure wall is obtained:

$$\begin{aligned}&\min_{\{\mathbf{T}_{r1},\mathbf{T}_{r2}\}} && Tr\left\{T_{r1}T_{r1}^H+T_{r2}T_{r2}^H\right\}\\&s.t. && \hat{R}_{r1}\left(T_{r1}\right)+\hat{R}_{r2}\left(T_{r2}\right)\geq R^{mac}\left(W_1^0,W_2^0\right)\end{aligned} \tag{12}$$

The optimal solution of the problem has a closed form, and the optimal characteristic quantity of the thermal insulation performance test of the wall is T_{rj}, so the fuzzy degree control method can be used to test the thermal insulation performance of the wall. Combined with the fuzzy parameter optimization method, the wall insulation parameter optimization fusion model is designed.

The thermal performance of the enclosure wall is quantified

An adaptive iterative optimization method [14] was adopted to control the thermal performance of the enclosure wall. Through spatial distributed fusion and feature extraction method, the fuzzy degree of thermal insulation performance of the enclosure wall was analyzed. The fuzzy degree of thermal insulation performance test of the enclosure wall:

$$R^{bc}\left(T_{r1},T_{r2}\right)=R_{r1}^{bc}\left(T_{r1}\right)+R_{r2}^{bc}\left(T_{r2}\right) \tag{13}$$

According to the measured value of lateral deformation corresponding to cracking load [15], the learning rate of thermal performance analysis can be written:

$$R^{tw}=\min\left\{R^{mac}\left(W_1,W_2\right),R^{bc}\left(T_{r1},T_{r2}\right)\right\} \tag{14}$$

The characteristic sampling value $X_p(m/\Delta x)$ of the thermal insulation performance test of the enclosure wall is obtained, and the stable solution of the thermal insulation performance test equation of the enclosure wall:

$$\mathrm{E}\left[\tilde{e}_{sk}\right]=0\ \ \forall s=1,\ldots,n,\ \ k=1,\ldots,p \tag{15}$$

$$\mathrm{E}\left[\tilde{e}_{s1k1}\tilde{e}_{s2k2}\right]=\begin{cases}\dfrac{m}{p}\sigma_s^2\\ 0\end{cases} \tag{16}$$

Among them, α, β, γ, and ρ are the order of a, b, c, and d of the insulation thermal performance test sequence of the enclosure wall. To sum up, the thermal insulation performance test of the enclosure wall is realized.

Optimize the temperature control parameters of high rise building envelope

In the process of optimizing the temperature control parameters of the high rise building envelope, it is necessary to first analyze the energy consumption of the thermal insulation points of the high rise building envelope [16, 17]. If there is a thermal energy connection between the thermal insulation points of the high rise building envelope and the adjacent thermal insulation points, the heat energy sharing phenomenon will occur in the following time, T. Therefore, the value range of the thermal insulation point of the high rise building envelope is within the interval, so as to obtain the probability distribution function of the thermal insulation point of the high rise building envelope:

$$f=\left\{\begin{matrix}0 & m<0\\ \dfrac{m}{T} & 0<m<T\\ 1 & m>T\end{matrix}\right\} \tag{17}$$

where m is the threshold value of the probability distribution of thermal insulation points on the high rise building envelope. When $m < 0$, it indicates that the distribution of thermal insulation points is in a normal state. At this time, the probability of heat sharing between two adjacent thermal insulation points is $1 - p$, so the relationship formula of heat consumption at thermal insulation points on the high rise building envelope:

$$F(t) = \frac{P(T < m) - P(T < 0)}{P(T < 0)} \tag{18}$$

where T is the interval period of heat consumption at the heat preservation point of the high rise building envelope.

The optimization of the temperature control parameters of the high rise building envelope [18, 19] is based on the thermal insulation performance data of the high rise building envelope and the process of obtaining the value of the decision-making variable of the energy consumption of the thermal insulation material of the high rise building envelope through the Compton backscattering detection technology. In order to determine the optimal value area, a constraint condition of the thermal insulation performance limit [20] of the high rise building envelope should be established:

$$\left| T_d > T_v; T_c > T_\varphi \right| \tag{19}$$

where T_d is the thermal energy of the high rise building envelope through the thermal insulation material, T_v – the thermal energy of the inner wall of the high rise building, T_c – the thermal conductivity coefficient of the high rise building envelope thermal insulation material, and T_φ – the average decreasing degree of the surface heat of the high rise building envelope thermal insulation material.

Based on eq. (19), the transformation relationship between the heat conduction coefficient of the high rise building envelope and the average constraint is established:

$$Z = \begin{Bmatrix} |Q|, \text{ When the i}^{\text{th}} \text{ inequality is not satisfied} \\ 0, \text{ When the i}^{\text{th}} \text{ inequality is satisfied} \end{Bmatrix} \tag{20}$$

Make the heat insulation performance model of high-rise building envelope meet the above constraints, and convert the heat transfer temperature limit of high-rise building envelope into the form of objective function, so as to establish the optimization function of temperature control parameters of high-rise building envelope, which can be expressed as:

$$H = \alpha_i + \sum_{i=1}^{n} C + c \tag{21}$$

where α_i is the heat transfer coefficient between the high rise building envelope and the insulation material, C – the penalty coefficient in the optimization process of the temperature control parameters of the high rise building envelope, and c – the actual ratio of the heat load on the surface of the high rise building envelope.

Using high rise building retaining wall insulation point probability distribution function of retaining wall get high rise building the relation formula of point in heat preservation heat consumption based on high rise building retaining wall insulation limit constraints, building high rise building retaining wall insulation limit constraints, optimization of high rise building retaining wall temperature control parameters combining with function, optimized the temperature control parameters of the high rise building envelope.

Optimize the thermal insulation performance of high rise building envelope wall

In the retaining wall for high rise building insulation performance optimization, according to the result of the investigation, to get the characteristics of the high rise building retaining wall, adopts the Compton backscattering detection technology optimization analysis of high rise building the heat transfer coefficient of retaining wall, build high rise building retaining wall retaining wall thermal resistance change and the high rise building, the relationship between the temperature variation of per unit area. The optimization recommended value of the thermal insulation coefficient of the high rise building envelope wall is given. By adjusting the optimization recommended value, the thermal insulation performance of the high rise building envelope wall is optimized.

According to the aforementioned description of the optimization process of the thermal insulation performance of the retaining wall of high rise buildings, analyze the economic index of the optimized retaining wall of high rise buildings and the energy consumption of high rise buildings, determine the relationship between the optimal parameters of the surface heat transfer coefficient of the retaining wall of high rise buildings, and calculate the thermal load of the retaining wall of high rise buildings according to the characteristics p(x) of the retaining wall of high rise buildings, Build the heat dissipation model of high rise building envelope:

$$p(x)\frac{1}{\zeta j}=\frac{\alpha_x}{\lambda(x)}\left[\frac{\lambda(x)}{j}\right] \tag{22}$$

where α_x is the heat loss on the surface of the high rise building envelope, $\lambda(x)$ – the heat transfer coefficient of the high rise building envelope structure, which is proportional to each other, and j – the thermal resistance coefficient.

The Compton backscattering detection technology optimization analysis of high rise building the heat transfer coefficient of retaining wall, retaining wall surface heat transfer of high rise building with heat dissipating impact factor is $(q_k - q_s)$ high rise building indoor and outdoor temperature difference and heat preservation material absorbed radiation efficiency h_k, through calculating the sun radiation the high rise building retaining wall thermal insulation material, the influence relationship of solar radiation on the internal environment of the high rise building envelope is obtained, which is expressed:

$$h_k\left(q_k-q_s\right)+\sum\lambda(x)=Q_R\sigma\psi_B \tag{23}$$

where Q_R is the change value of energy consumption of the high rise building envelope insulation material in unit area, σ – the radiation amount of sunlight to the high rise building envelope insulation material, and ψ_B – the thermal resistance value.

Since the change of thermal resistance ψ_B is affected by the heat transfer coefficient $\lambda(x)$ and the area of insulation material S, the relationship between the change value of energy consumption Q_R and thermal resistance ψ_B is established:

$$h_k\left(q_k-q_s\right)+\sum\frac{\delta}{\psi_B}\left[\frac{\omega_u}{S}\right]=\sum_{s\notin S}Q_R\left(q_k-q_s\right) \tag{24}$$

According to the relation of the previous formula, the energy saving, δ, of the thermal insulation material of the high rise building envelope in unit area has no relationship with the heat transfer coefficient, $\lambda(x)$, and the lighting inclination angle, ω_u, of the envelope, and only the thermal resistance value will affect the value of δ.

In order to analyze the influence of the change of thermal resistance value of the thermal resistance material of the high rise building envelope insulation material $\Delta\psi B$ on the energy consumption saving amount $\Delta\psi B$, the ratio between the two needs to be calculated to describe the energy consumption saving relationship caused by the change of thermal resistance value of the thermal resistance material of the high rise building envelope insulation material:

$$V\frac{\partial}{\zeta\partial(x)}=[\Delta\delta\lambda(x)]F_j+\Delta\psi_B Q_R \tag{25}$$

Among them, the area of the retaining wall inside, V, for high rise building, high rise building, F_j, said retaining wall thermal insulation material of energy consumption caused by thermal resistance changes, through the aforementioned analysis, high rise building retaining wall thermal insulation material can be determined the best heat transfer rules, to calculate the retaining wall in high rise building the best recommended value of the optimization of the heat transfer coefficient, the calculation formula:

$$J=F_j+\sum_i C_i+F_jV \tag{26}$$

where C_i is the maximum amount of heat given off by environmental factors.

Experimental desing and result analysis based on finite element model

Establishment of finite element model

In this paper, the model of shear-wall retaining structure with slit is separated model, Solid 65 for concrete, Link 8 for steel bar, Solid 45 for loading beam, MISO model for multi-linear isotropic reinforcement for constitutive relation, and William-Warnke criterion for failure criterion. The enclosure model is shown in fig. 1, and the model parameters are listed in tab. 1. In the table, SHW-120a and SHW-120b denote one sheeting wall, P-SHW-120a and P-SHW-120b denote one traditional sheeting wall, and SHW-120c and P-SHW-120c denote two floors of slab-bound shear walls. The parameters of the model are shown in tab. 1.

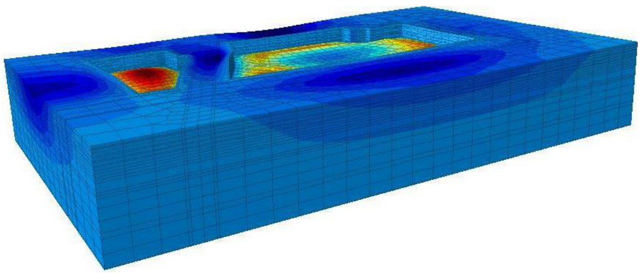

Figure 1. Wall model

Table 1. Model parameters

Specimen number	Length [mm]	Highly [mm]	Thickness [mm]	Shear span ratio	Axial compression ratio
SHW-120a	1300	1100	100	0.85	0.13
P-SHW-120a	1300	1100	100	0.85	0.13
SHW-120b	1300	1100	100	0.85	0.05
P-SHW-120b	1300	1100	100	0.85	0.05
SHW-120c	1300	2200	100	0.85	0.13
P-SHW-120c	1300	2200	100	0.85	0.13

The heat preservation rate and energy consumption index of different methods were compared and tested

The insulation rate and energy consumption of the three methods were tested, and the test results were shown in figs. 2 and 3.

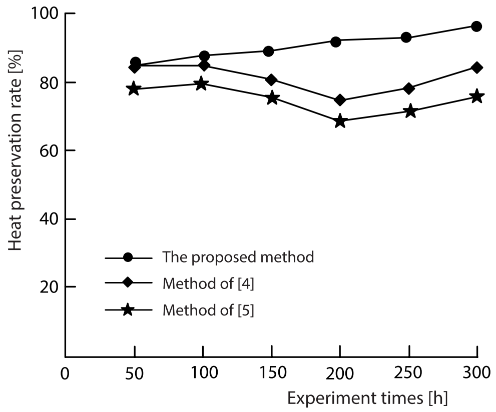

Figure 2. Comparison of insulation rate of high rise building envelope

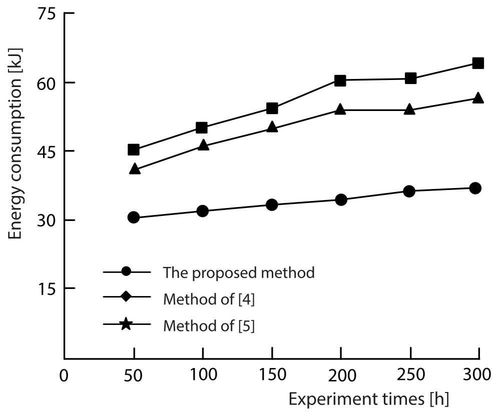

Figure 3. Energy consumption test results

It can be seen from the results of fig. 2, the use of [5] of hot summer and cold winter areas of insulation layer thickness of the wall retaining wall heat preservation performance optimization method to optimize high rise building, high rise building retaining wall heat preservation effect reached 84%, and in the process of the 100th to 200th experiments, high rise building retaining wall heat preservation effect appeared obvious drop. There was an upward trend after the 200th trial, but the amplitude was small. When the thermal insulation performance optimization method of building envelope proposed in [4] is used to optimize the thermal insulation performance of high rise building envelope, the thermal insulation effect of high rise building envelope is only 76%. With the increase of the number of experimental tests, the experimental results fluctuate greatly. However based on Compton backscattering detection technology of high rise building retaining wall heat preservation performance optimization method to optimize high rise building retaining wall thermal insulation performance, high rise building heat preservation effect of retaining wall is as high as 93%, and the other two high rise buildings than retaining wall heat preservation performance optimization method, high rise building retaining wall heat preservation effect increased by 8% and 16%, respectively, it has certain advantages.

As can be seen from the experimental results in fig. 3, when the optimization method of wall insulation layer thickness in hot summer and cold winter area proposed in [5] is adopted to optimize the thermal insulation performance of the high rise building envelope, the energy consumption is 51 kJ, and between the 100th and 200th experiments, the energy consumption shows a sudden increase. When the thermal insulation performance optimization method of the high rise building envelope wall proposed in [4] is adopted to optimize the thermal insulation performance of the high rise building envelope wall, the energy consumption is 59 kJ, and the energy consumption also increases with the increase of the number of experimental tests. However, the energy consumption is only 36 kJ when the thermal insulation performance optimization method of the high rise building envelope based on Compton backscattered detection technology is used to optimize the thermal insulation performance of the high rise building envelope, and the energy consumption does not change much with the increase of the number of experiments. On the whole, the proposed method has better performance.

Analysis of heat preservation property of high rise building envelope

This paper analyzes the scientific of the research method on the thermal insulation of high rise buildings under the condition of maintaining illumination intensity. An initial preset indoor temperature is set in the simulation software. The insulation performance data of different methods are shown in tab. 2.

Table 2. Comparison of research on thermal insulation of high rise buildings

The preset temperature	Optimization method of wall insulation layer thickness in hot summer and cold winter area	The proposed method
10 °C	9 °C	10 °C
11 °C	10 °C	11 °C
12 °C	10 °C	12 °C
13 °C	11 °C	13 °C
14 °C	12 °C	14 °C
15 °C	13 °C	15 °C
16 °C	14 °C	16 °C
17 °C	15 °C	16 °C
18 °C	15 °C	18 °C
19 °C	16 °C	19 °C
20 °C	17 °C	20 °C
21 °C	18 °C	20 °C
22 °C	18 °C	21 °C
23 °C	19 °C	23 °C
24 °C	20 °C	25 °C
25 °C	21 °C	25 °C
26 °C	22 °C	27 °C
27 °C	23 °C	27 °C
28 °C	24 °C	28 °C
29 °C	25 °C	28 °C
30 °C	26 °C	30 °C

As shown in tab. 2, the initial preset indoor temperature is gradually increased between 16 °C and 30 °C, and at the same time, the indoor temperature calculated by the traditional method and the proposed method is also gradually increased. However, due to the different calculation formulas, there are certain differences in the results. According to the data in tab. 2, the calculation result of the traditional method is 1 °C less than the preset temperature at the initial 10 °C, and 4 °C less than the preset temperature at 30 °C. This calculation method has a large error. Although the calculation method under the photo-thermal effect has some errors, and the calculation results are small in some cases, it also ensures a higher accuracy rate, and is more scientific than the traditional calculation method.

Conclusions

In order to optimize the thermal insulation performance of high rise building envelope and improve the defects of traditional methods, a finite element analysis method is proposed. The objective function of thermal insulation performance is established, and the thermal performance parameters of retaining wall are calculated and fused. The thermal performance of the retaining wall is controlled by its thermal performance parameters, and the temperature control parameters of the retaining wall are optimized.

In the experimental part, the finite element model of shear wall retaining structure is established and the model parameters are set. Simulation experiments are designed using finite element model to test the application performance of the proposed method. The experimental results show that the thermal insulation rate and energy consumption index of the proposed method are better than those of the traditional method. The indoor temperature of high rise building is preset, and the thermal insulation performance of the enclosure is tested. The results show that the proposed method can keep the preset temperature with high fitting degree.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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