

Energy consumption of low-energy consumption residential building retaining structure based on DeST analysis

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Abstract. By DeST simulation software to build a residential construction in Inner Mongolia autonomous region, on the basis of without thermal insulation layer, one by one, change the retaining structure of exterior wall, roof, Windows and window wall ratio, build heat load value when simulating the factors changed, points out that the palisade structure factors impact on building energy consumption in size.

Introduction

In this paper, analyzing influence factors of retaining structure energy consumption by the cold area of Inner Mongolia a residential building, using DeST software mainly for building exterior wall, roof, Windows, window wall ratio factors such as in-depth analysis.

Construction profiles and building a model

Taking a residential building in the Inner Mongolia Autonomous Region as a simulation object. The residential building is 6 story brick structure, the height is 3M, the north-south direction, the direction of the window wall ratio are 0.4 and 0.3, building area is 2103.32m². Enclosure structure are shown in Table 1. Building plane diagram shown in Figure 1.

Table 1 Building envelope construction table

Category	Construction	Heat Transfer Coefficient W/(m ² ·K)
Roof	6mm Asphalt felt +20mm Cement mortar +120mm Reinforced concrete	3.47
Floor	20mm Cement mortar +120mm Reinforced concrete +20mm Cement mortar	2.86
Outer Wall	20mm Cement mortar +240mm Reinforced concrete +20mm cement mortar	1.74
Interior Wall	20mm Cement mortar +180mm Ceramsite concrete wall +20mm Cement mortar	2.02
Door	Single wooden door	2.50
Interior Wall	Ordinary single-layer glass Windows	5.70

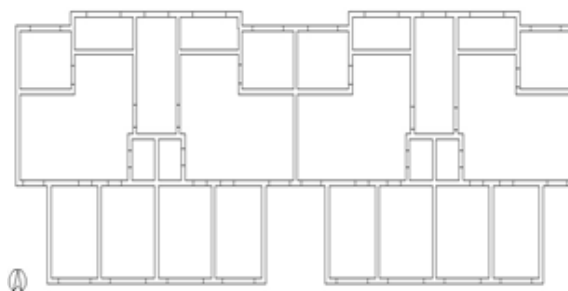


Figure 1 Benchmark floor plan

Parameter setting and simulation

Meteorological parameters setting. The bulb temperature statistics Inner Mongolia area every day shown in Figure 2. Calculated by the average temperature relates to the heating period is 18°C . Select the Inner Mongolia Ji LanTai for typical meteorological year.

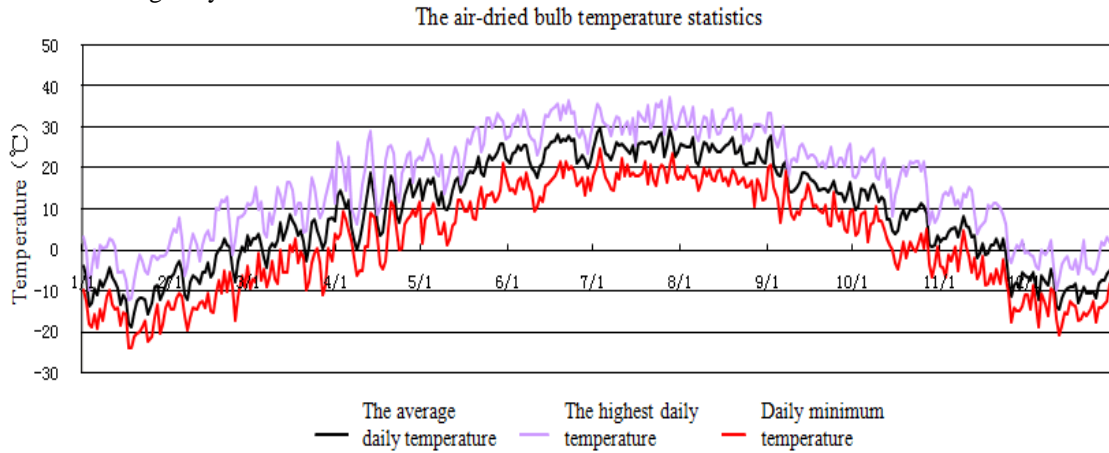


Figure 2 The air-dried bulb temperature statistics of Inner Mongolia region

Inside the room heat disturbance parameters setting. Every household room contains the main bedroom, second bedroom, guest room, living room, kitchen and bathroom. The per capita quantity of heat is 53 W/m^2 . Bedroom and living room lighting the maximum heating capacity of 5 W/m^2 . The living room equipment maximum heating capacity of 9.3 W/m^2 . The largest heat kitchen equipment for 48.2 W/m^2 .

System setting. In this simulation, The living room air conditioning starting specified in Table 2.

Table 2 Each room different time air conditioner start-stop

Room Type	Time		Weekdays		Weekend	
Bedroom Air Conditioner Start-stop	1:00—7:00		100%		1:00—7:00	100%
					8:00—11:00	0%
	8:00—20:00		0%		12:00—14:00	100%
					14:00—20:00	0%
Living Room Air Conditioner Start-stop	21:00—24:00		100%		21:00—24:00	100%
	1:00—6:00		0%			
	7:00—8:00		100%		1:00—7:00	0%
	9:00—16:00		0%		8:00—21:00	100%
	17:00—21:00		100%			
	22:00—24:00		0%		22:00—24:00	0%

Energy consumption calculation. The heating period is from October 15th to April 15th the next year. The annual total heat load of $205062.61 \text{ kW} \cdot \text{h}$. The annual total heat load index of $124.23 \text{ kW} \cdot \text{h/m}^2$. The whole year hourly load Figure 3.

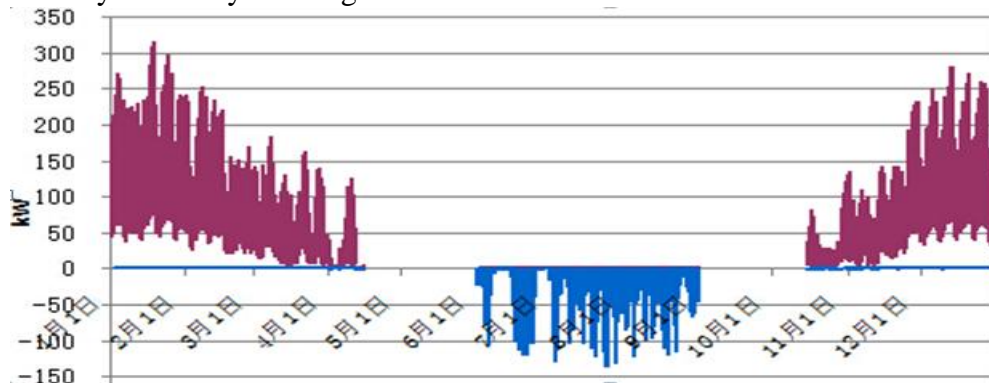


Figure 3 All-year hourly dynamic load

Analysis on the influence factors of each individual optimization of retaining structure

Separate different external wall thermal insulation layer. The currently building insulation materials used are EPS foam board, XPS board, rock wool board, polyurethane thermal insulation board and so on. Four kinds of common insulation materials are added in the exterior walls of the building on the base. Exterior insulation scheme is shown in Table 3.

Table3 Five kinds of exterior insulation scheme

Scheme	Construction	Heat transfer coefficient W/(m ² •K)
Scheme A	20mm Cement mortar +240mm Multi hole clay brick +20mm Cement mortar	1.74
Scheme D	20mm Cement mortar +30mm Rock wool board +240mm Multi hole clay brick +20 Cement mortar	0.89
Scheme B	20mm Cement mortar +30mmEPS +240mm Multi hole clay brick +20 Cement mortar	0.81
Scheme C	20mm Cement mortar +30mmXPS +240mm Multi hole clay brick +20 Cement mortar	0.67
Scheme E	20mm Cement mortar +30m Polyurethane sandwich panel +240mm Multi hole clay brick +20mm Cement mortar	0.64

In addition to wall materials changed, the rest of the parameters are constant. Software simulation of the building heat load is shown in Figure 4.

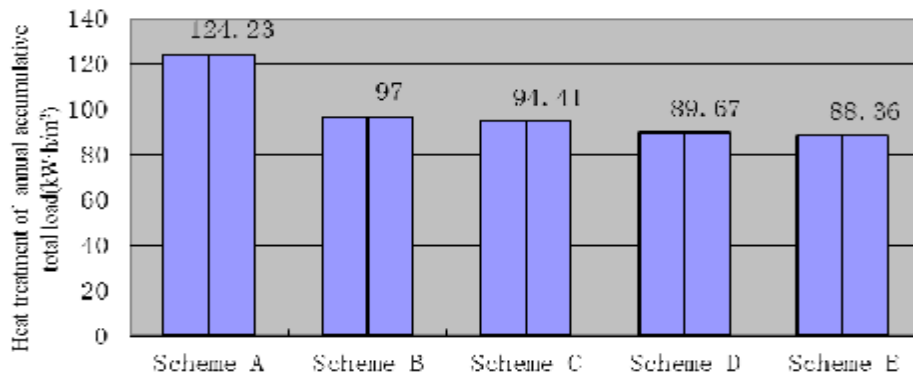


Figure 4 Five plan total heating of the heat load

Observe in Figure 5, the heat transfer coefficient increases linearly with the heating load. The heat transfer coefficient is small, the heating load is small. But at the same time decreased with the load coefficient becomes small and moderate.

By selecting the same insulation materials, changing the thickness of insulation board, the simulation analysis of the relationship between the energy consumption and the thickness of insulation board. In the architectural model is still the benchmark model, the selection of insulation material EPS foam board, all the other parameters are unchanged, the simulation of exterior wall thermal insulation layer is 40mm, 50mm, 60mm, 70mm, 80mm thick annual building heat load. Simulation results are shown in Table 4.

Table 4 Seven kinds of the heat load and relative treatment of annual accumulative total energy saving rate exterior wall thermal insulation layer thickness

Thermal Insulation Layer Thickness(mm)	The Annual Cumulative Load Index (kW•h/m ²)	The Relative Energy Saving Rate (%)
0	124.23	0
30	94.41	24
40	90.30	27.31
50	87.23	29.78
60	84.86	31.69
70	82.98	33.20
80	81.45	34.44

Observation of Table 4, with the increase of the thickness of the insulation layer of the wall, the relative energy saving rate continues to increase, but the relative energy saving ratio tends to relax, and not the thickness increases, the relative energy saving ratio is bigger. Application of economic analysis to the insulation layer thickness of a reasonable method to calculate .

Separate different roof insulation layer. Adding four kinds of roof insulation materials based on the benchmark model. Roof insulation scheme is shown in Table 5.

Table5 Five kinds of roof external thermal insulation

Scheme	Construction	Heat transfer coefficient W/(m ² •K)
Scheme A	6mm Asphalt Felt+20mm Cement mortar +120mm Reinforced concrete roof board	3.468
Scheme B	6mm Asphalt Felt +20mm Cement mortar +30mm Hydrophobic expanded perlite board +120mm Reinforced concrete roof board	1.766
Scheme C	6mm Asphalt Felt +20mm Cement mortar +30mmEPS+120mm Reinforced concrete roof board	1.199
Scheme D	6mm Asphalt Felt +20mm Cement mortar +30mmXPS+120mm Reinforced concrete roof board	0.835
Scheme E	6mm Asphalt Felt +20mm Cement mortar +30mm Polyurethane foam plastic+120mm Reinforced concrete roof board	0.776

In addition to the roof material, the other parameters are constant. Software simulation of the building heat load is shown in Figure 5.

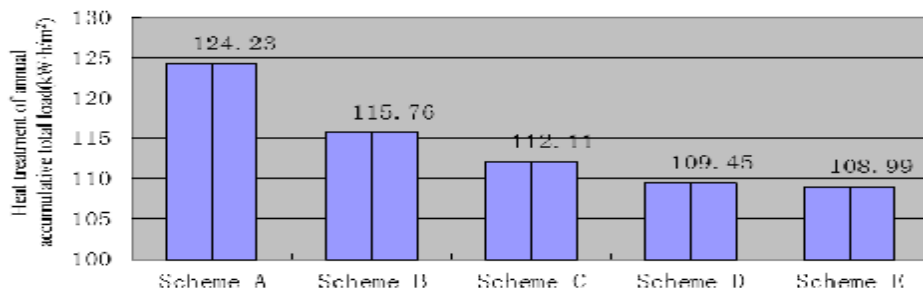


Figure 5 Five plan total heating of the heat load

Observation of Figure 5, adding the roof insulation layer makes the building heat load relative energy saving ratio are increased by 6.82%, 9.76%, 11.90%, 12.27%, rising curve. This shows that the roof with insulation layer, enhance indoor thermal stability and thermal insulation performance and reduce energy consumption.

Change the window glass. To change the original single glass, for some of the commonly used energy saving glass. Glass solutions is shown in Table 6.

Table 6 Six kinds of glass

Scheme	The Category of The Glass	The Glass Layer	Heat transfer coefficient $W/(m^2 \cdot K)$
Scheme A	Ordinary single-layer glass Windows (6mm)	1	5.7
Scheme B	Ordinary single-layer glass Windows	2	3.1
Scheme C	Inert gas filled+Coated glass and LOW-E glass	2	2
Scheme D	In a film insulating glass (mono film)	2	1.7
Scheme E	Vacuum coating composite insulating glass	3	1.4
Scheme F	In a film insulating glass (double film)	2	1

In addition to the glass changed, the rest of the parameters are constant. Software simulation of the building heat load is shown in Figure 6.

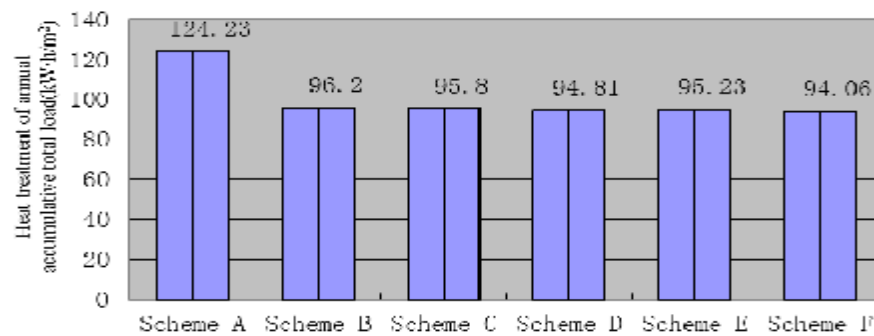


Figure 6 Six schemes cumulative heating heat load diagram

Observe in Figure 6, the heat load of the overall downward trend, but the load index and the window heat transfer coefficient is not a linear relationship. The reason for this is that the heat transfer coefficient is caused by temperature difference of heat flow through the window, it is the conduction, convection and surface radiation heat transfer of the three combination. So energy consumption is related with the shading coefficient of window, visible light transmittance, air permeability.

Change the window wall ratio. When the south window wall ratio is constant, the North window wall ratio increased from 0.3 to 0.6, the heat load of the heating season has increased by 5.23%, the North outside the window area should be controlled within a proper range to meet the lighting, ventilation and internal requirements.

Conclusion

On the construction of exterior wall, roof model, window glass, window wall ratio of these four factors separately through the analysis of energy consumption of building energy simulation software DeST, the result is the external wall thermal insulation material and the south window wall ratio on the building heat load impact, windows and roof insulation material second, North window wall ratio is inversely proportional to relationship with the heat load. Therefore, the first energy-saving residential building to strengthen heat preservation effect of exterior wall thermal insulation layer; secondly, the abundant solar energy area, increase the South window wall ratio, as far as possible the use of solar heat radiation, while reducing the North window wall ratio, reduce indoor heat loss; The last is the development and utilization on roof insulation and energy-saving glass.

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