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Research on energy efficiency for residential buildings in variation characteristics of regional climate

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Abstract. The energy-saving and emission-reducing routes of buildings under the temporal and spatial changes of climate in hot summer and warm winter regions are formulated. Based on the results of climate model, building model and dynamic energy consumption analysis model, the energy consumption trend of typical buildings in the future climate environment is predicted, and the key influencing factors of building energy consumption under the East Asian monsoon region in Guangdong Province are analyzed. The simulation calculation and optimization analysis are carried out for the core problems, and the energy saving and emission reduction route is put forward.

1. Introduction

Buildings are created by climate, which has a decisive impact on building energy consumption. Since the 1980s, global climate has been warming significantly, and building energy consumption has also changed. In developed countries, building energy consumption, transportation (automobile) energy consumption and industrial energy consumption account for about 30% of their total energy consumption. In building energy consumption, air conditioning energy consumption (heating and cooling) is directly related to climate change. Therefore, in order to study the impact of climate change on building energy consumption, it is necessary to study the characteristics of building energy consumption.

2. Building model

Reference standard "Energy-saving Design Standard for Residential Buildings in Hot Summer and Warm Winter Area" (JGJ 75-2012), the parameters of typical residential building envelope structure are as follows: building shape: one ladder, two households, six storeys high, 80m² per household, rectangular building (total area 960m²); building exterior wall: equivalent to 180mm brick wall, heat transfer coefficient is 2.17, solar radiation absorption coefficient is 0.7; floor: 100mm steel; Reinforced concrete structure; Inner partition wall: 120mm brick wall; Roof: 100mm reinforced concrete floor + 10mm polystyrene plastic insulation, solar radiation absorption coefficient 0.7; Window-to-wall ratio: South 43%, North 30%, East 15%, West 15%; Shading: South balcony door 1.5m shading, North balcony 1.2m shading, window opening depth 100mm; Outer window: Aluminum alloy window, heat transfer coefficient 5.61, shading coefficient 0.9, no skylight. Indoor environment: summer and winter temperatures are 26.0°C and 16.0°C respectively, and the number of ventilation is 1.5 times per hour. The facade of the building is shown in Figure 1.



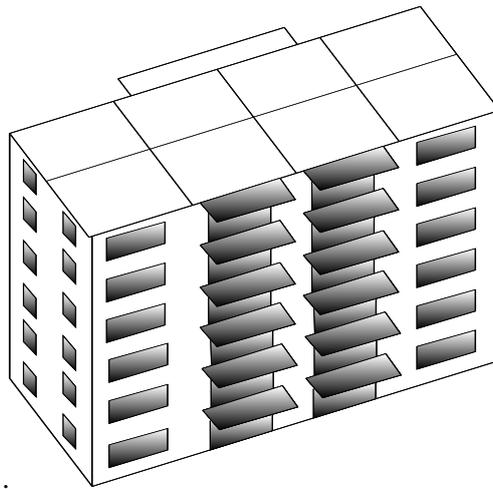


Figure 1

The plane dimensions of typical residential building models are shown in Figure 2.

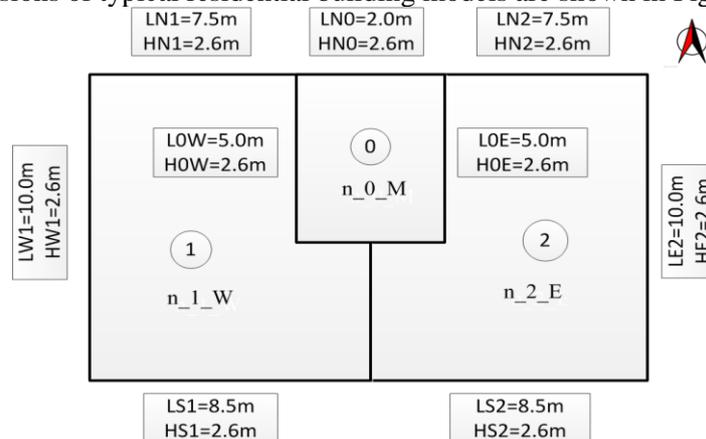


Figure 2

3. Discussion

For buildings at the beginning of the 21st century, the energy-saving level is about 3.5 stars. 5.5 stars and 6.5 stars represent the current energy-saving level of buildings. This level can meet the current energy standards and possible energy performance requirements in the future. Heat pump system is used for space heating and cooling. The COP is set to 2.5, which meets the Energy-saving Design Standard for Residential Buildings in Hot Summer and Warm Winter Areas. JGJ 75-2012 Minimum Energy Efficiency Ratio Requirements. Considering that lighting, hot water and other household appliances are insensitive to global warming, the impact of climate change on building energy consumption and carbon emissions comes from energy use for space heating and cooling.

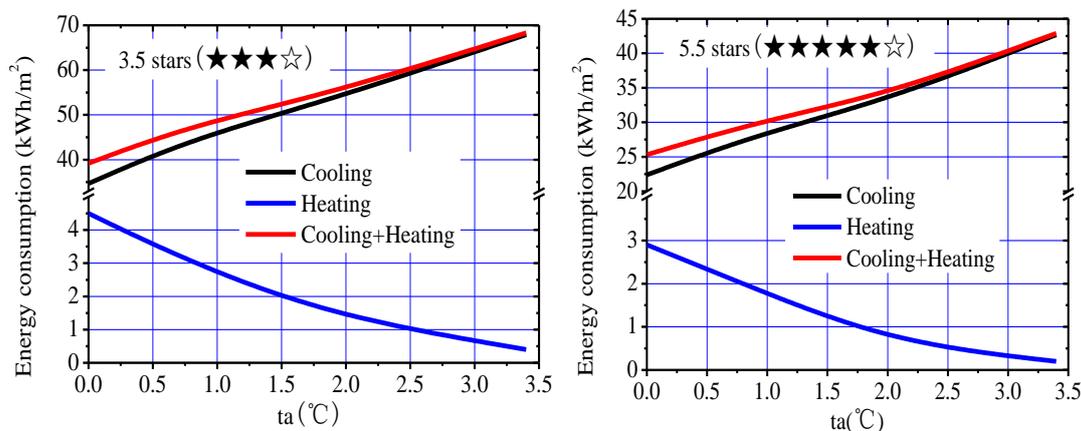


Figure 3

The energy consumption calculation model of MIRCO-M (Japan Climate System Research Center, National Environmental Research Institute and Global Change Frontier Research Center) based on AOCM is established. The energy consumption of 3.5-star and 5.5-star buildings varies with global climate change. The trend is shown in Figure 3. The results show that, due to the significant increase of cooling energy consumption in Guangzhou, there is a complementary offset zone between heating and cooling in the increased total energy consumption.

With global temperature rising by 1°C, energy consumption for 3.5-star buildings is expected to increase by 25%, while energy consumption for 5.5-star buildings is expected to increase by 20%.

For the future energy consumption of buildings in Guangzhou, the energy consumption of 5.5-star buildings can cope with the energy saving demand of temperature rising by 3 degrees Celsius. That is to say, when the temperature is 3 degrees Celsius higher than the current climate, the energy consumption level of 5.5-star buildings is equivalent to that of 3.5-star buildings at present; and when the average temperature of the environment rises by 1 degrees Celsius, the energy consumption of 6.5-star buildings in the future will exceed the current climate. The energy consumption level of 5.5 stars in the environment, 6.5 stars buildings can not meet the building energy-saving needs when the temperature rises by 1°C. The calculation results are shown in Fig. 4.

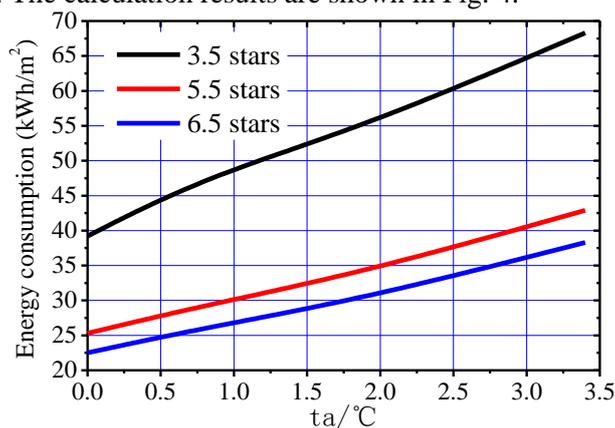


Fig. 4.

4. CONCLUSION

The energy consumption calculation model of MIRCO-M (Japan Climate System Research Center, National Environmental Research Institute and Global Change Frontier Research Center) based on AOCM is established. The energy consumption trend maps of 3.5 star and 5.5 star buildings vary with global climate change. The results show that the energy consumption of 3.5-star buildings is expected to increase by 25% as global temperature rises by 1 °C, while the energy consumption of 5.5-star buildings is expected to increase by 20%. The research results can effectively strengthen the building

energy-saving adaptability in response to global warming: the renovation of existing buildings, from 3.5 star to 5.5 star; the standard of new buildings, from 5.5 star to 6.5 star, can achieve the purpose of energy saving and emission reduction by improving the material performance of envelope structure.

Acknowledgments

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