Current Status and Energy Savings Potential of Solar Shading in Ningbo

Jian Yao

***Abstract*—**To investigate the energy performance of solar shading devices, this paper carried out a survey on the current status of solar shading utilization in buildings in Ningbo and performed building simulations to evaluate the energy savings potential by adopting different solar shading devices. Results show that solar shading utilization in this area is not popular and effective, and should be considered firstly in the design stage since the potential for energy savings is up to 6.8% for residential buildings and 9.4% for commercial buildings.

***Keywords*—**Solar shading, Energy savings, Building design.

I. Introduction

BUILDINGS are responsible for approximately 40% of energy consumption and 36% of EU CO_2 emissions. And in China, they consume more energy, accounting for about 46.7% of the total energy consumption [1]. Therefore, several building energy standards have been implemented in China to achieve a 50% energy reduction compared with building built in 1980s [2,3]. In these standards, improving the energy performance of building envelope, such as the adoption of wall [4] and roof insulating materials [5], energy efficient windows [6], was considered as a major energy-efficient measure and the U-value for each building element should be lower than a maximum allowable value. Many studies have been conducted on the energy savings potential of improving the performance of building envelope [7-8]. However, they focused on wall insulation, lowering the U-value of windows and building orientation. Solar shading for buildings, a significant energy-saving measure [9-10], has rarely been investigated in Ningbo city. Thus, this paper carried out a survey on current status of solar shading in Ningbo, evaluated the energy savings potential of applying solar shading in buildings based on numerous building simulations, and gave suggestions on improving building energy efficiency.

II. Survey

To investigate the current status of solar shading utilization in buildings, a survey was conducted in the three major districts (Jiang bei, Hai shu and Jiang dong) of Ningbo city as shown in Fig. 2, which is geographically representative of the city. The survey is also representative of building type and building age, including 300 residential buildings and 58 commercial buildings. Most kinds of solar shading are considered in this survey, such as external shading devices, glazing shading and green shading.

Fig. 1. The three districts.

A. Solar shading in residential buildings

According to Fig. 2, external shading devices in residential buildings in Ningbo are not popular and only conventional shading such as overhangs and awnings are widespread used. Overhangs on south facade reach about 60%, while awning utilization is 64.2% in east, 60.1% in west and 47.6% in north. Other devices take a small part in application, especially for external movable shading. Internal shading on south facade is the most popular with a percentage of 71.9%, followed by west and east facades with their percentages of less than 20%. But in some buildings there is even no shading on any facade. These data mean that solar shading in residential buildings is not popular and not very effective in reducing solar gain due to lack of advanced devices.

B. Solar shading in commercial buildings

Fig. 3 gives different solar shading utilization in commercial buildings in Ningbo. It is clear that commercial buildings use similar kinds of solar shading devices as residential ones. Overhangs, fins and internal shading are three major shading measures adopted in commercial buildings. Self-shading by Low-e glazing is another important measure. Like residential buildings, external movable shading devices is rarely used. Moreover, the number of commercial buildings without solar shading is much higher than that of residential buildings. This means that commercial buildings are also lack of solar shading.

Jian Yao is with the Faculty of Architectural, Civil Engineering and Environment, Ningbo University, Ningbo, China, e-mail: yaojian@ nbu.edu.cn.

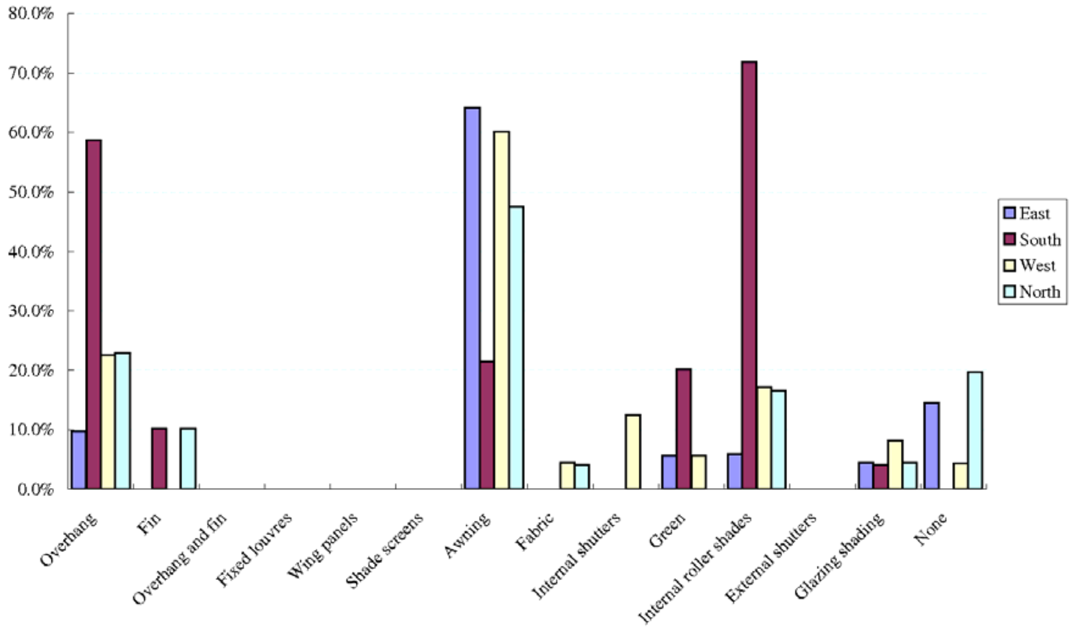

Fig. 2. Different solar shading utilization in residential buildings in Ningbo.

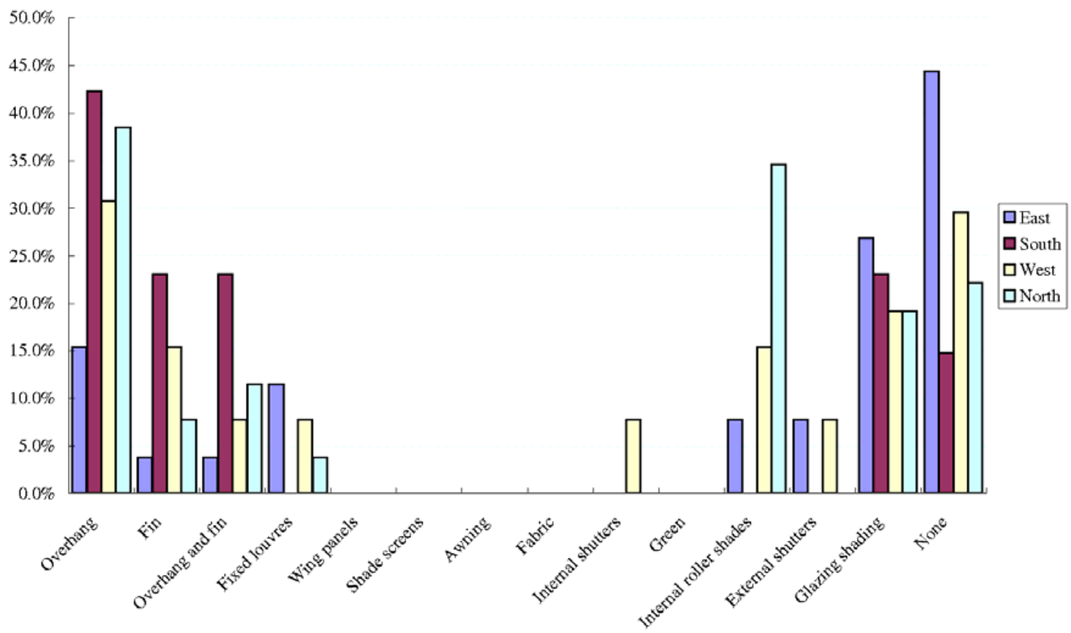

Fig. 3. Different solar shading utilization in commercial buildings in Ningbo.

III. Energy savings potential

To evaluate the energy savings potential of applying solar shading devices in buildings, a representative residential building and a representative commercial building was considered [9]. They both comply with the building energy design standards in China [2,3]. Building simulations were carried out with DOE-2 to predict the energy savings potential by adopting different shading devices with shading coefficient (SC) changing from 0.1-1.

Figs. 4 and 5 give the total energy savings potential (cooling and heating) of the residential and commercial buildings, respectively. They have the same energy savings trends as SC decrease for different facades and the commercial building has has a little bigger potential than the residential one. Among different facades, windows on west facade have the biggest

World Academy of Science, Engineering and Technology
Vol:5 2011-05-28

energy savings potential that is 2 times higher than others, followed by windows on east and north facades, and windows on south facades has least energy savings potential. These potential changes linearly with SC variation and the highest value for the residential building is 6.8% and 9.4% for the commercial building. Therefore, solar shading devices are important in reducing building energy consumption, and movable shading devices have great advantages in both reducing cooling energy and heating energy and should be adopted firstly.

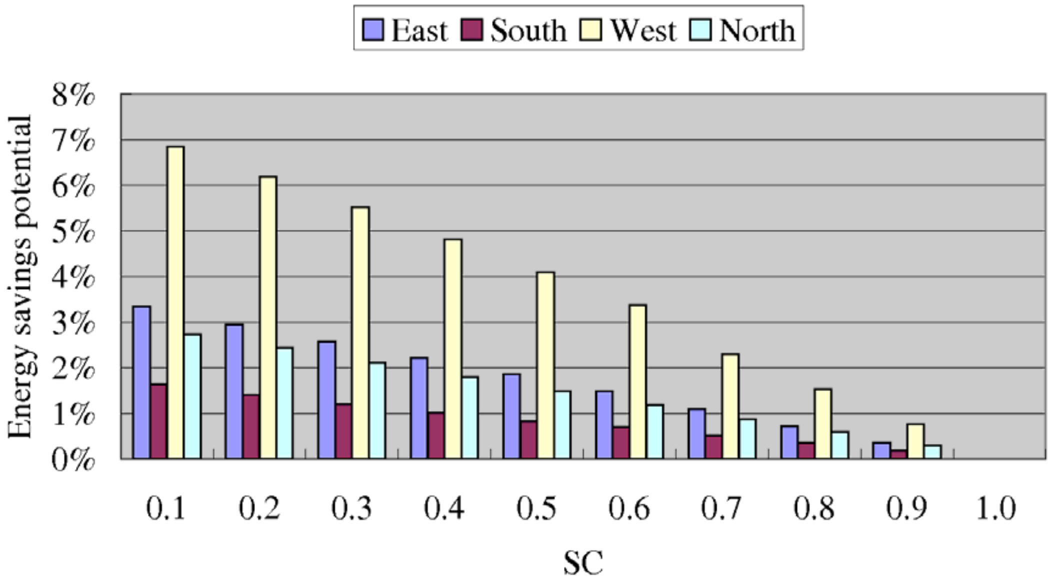

Fig. 4. Energy savings potential of the residential building.

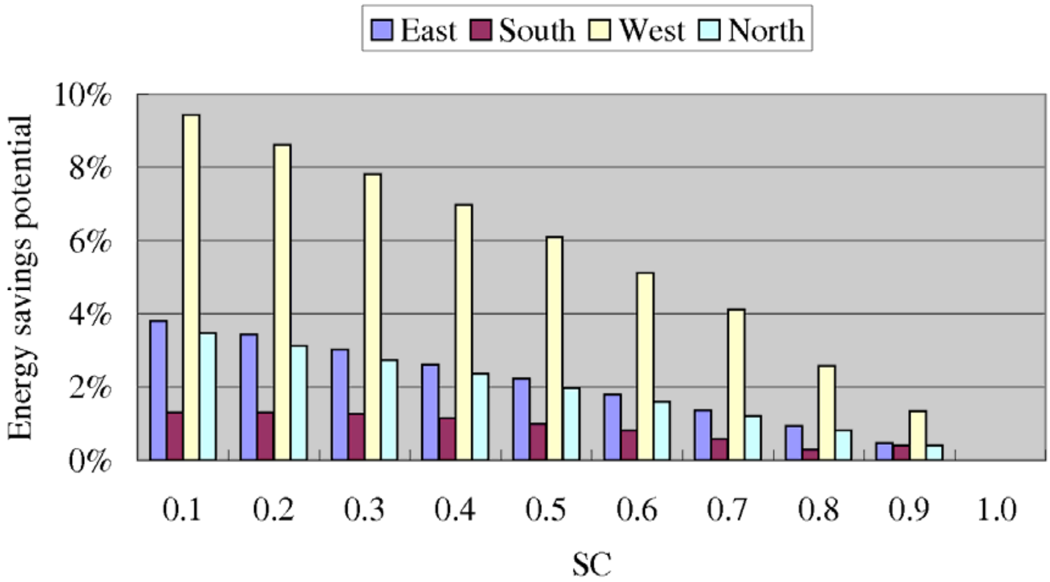

Fig. 5. Energy savings potential of the commercial building.

IV. Conclusions

This paper carried out a survey on the current status of solar shading utilization in buildings in Ningbo and performed building simulations to investigate the energy savings potential by adopting solar shading devices. Results show that solar shading utilization in this area is not popular and should be considered firstly in design stage since the total energy savings potential reaches 6.8% for residential buildings and 9.4% for commercial buildings.

REFERENCES

[1] Y. Wu, “China Building Energy Efficiency: Current Status, Issues, and Policy Recommendations,” *China Ministry of Construction*, 2003.

[2] China Architecture and Building Press, *The People’s Republic of China National Standard JGJ 134-2001, Design standard for energy efficiecy of residential buildings in hot summer and warm winter zone*, Beijing, 2001.

[3] China Architecture and Building Press, *The People’s Republic of China National Standard GB 50189-2005, Design standard for energy efficiecy of public buildings*, Beijing, 2005.

[4] Zhou Yan, Ding Yong and Yao Jian, “Preferable Rebuilding Energy Efficiency Measures of Existing Residential Building in Ningbo,” *Journal of Ningbo University (Natural science & engineering edition)*, vol. 22, pp. 285-287, 2009.

[5] A. Niachou, K. Papakonstantinou, M. Santamouris, A. Tsangrassoulis, and G. Mihalakakou, “Analysis of the green roof thermal properties and investigation of its energy performance,” *Energy and Buildings*, vol. 33, pp. 719-729, 2001.

[6] Lee ES, Tavil A., “Energy and visual comfort performance of electrochromic windows with overhangs,” *Building and Environment*, vol. 42, pp. 2439-2449, 2007.

[7] Yao Jian and Yuan Zheng, “Study on Residential Buildings with Energy Saving by 65% in Ningbo,” *Journal of Ningbo University (Natural science & engineering edition)*, vol. 23, pp. 84-87, 2010.

[8] D.G. Fridley, N. Zheng, N. Zhou, “Estimating Total Energy Consumption and Emissions of China’s Commercial and Office Buildings,” *LBNL-248E, Lawrence Berkeley National Laboratory*, 2008.

[9] Yao, J. and J. Xu, “Effects of different shading devices on building energy saving in hot summer and cold winter zone,” *2010 International Conference on Mechanic Automation and Control Engineering*, Wuhan, China 2010, pp. 5017-5020.

[10] F. Hammad, and B. Abu-Hijleh, “The energy savings potential of using dynamic external louvers in an office building,” *Energy and Buildings*, vol. 42, pp. 1888-1895, 2010.