Research on Building Greening and Shading in Hot Summer and Warm Winter Region

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Abstract. With the increasing emphasis on green buildings, people pay more and more attention to building greening and shade. Especially in hot summer and warm winter areas, vegetation and green shade are adopted to achieve the effect of building energy conservation, so as to obtain better energy-saving effects. This paper analyzes the common greening technology and methods of buildings in the hot summer and warm winter regions, systematically summarizes the energy saving effects of different types of green shade, and further improves the greening shading system and provides new application ideas in green buildings.

1. Introduction

Summer heat, high temperature and high wet weight, and no summer in the long summer are the typical climatic characteristics of hot summer and warm winter regions. Solar radiation affects the energy consumption of air conditioning in summer in southern China. The key ways to save energy are external sunshading and external surface ventilation. Therefore, in the southern regions, especially in hot summer and warm winter regions, the key to energy saving in the summer is the application of passive technology. Making full use of the transpiration and shielding features of greening is of great significance for improving the indoor thermal environment and low air-conditioning energy consumption.

2. Climate Characteristics of Summer and Warm Winter Region and the Principle of Greening and Shading

2.1. Hot summer and warm winter climate

The hot summer and warm winter regions mainly refer to the south of China, south of the north latitude 27° and east longitude 97° east, including the entire Hainan, most of Guangdong, most of Guangxi, southern Fujian, small parts of Yunnan, and Hong Kong and Macau. Taiwan [1]. The area is a subtropical humid monsoon climate characterized by long and humid summers, short and mild winters, high temperatures for many years, relatively low temperatures and poor daily temperatures, low temperature differences between day and night, and strong solar radiation. The rainfall is abundant, the air humidity is high, and so on. The hot summer and warm winter regions are divided into the southern and northern districts. The northern district adopts heat insulation measures in the summer
and the winter takes into consideration the heating. The southern district does not consider the winter heating, and only considers the summer heat insulation.

2.2. Green shade principle

(1) Energy Saving Technology of Greening and Shading

The essence of the sunshade is to transfer, absorb, consume or block the solar radiation of the building's external protective structure, reduce the overall heat gain of the building, and reduce the heat transfer speed, so as to achieve an ideal heat insulation effect. The greening shading is to cover the surface of the enclosure structure with plants, form a climate buffer layer, utilize the shade and heat insulation characteristics of the plants, and use its own photosynthesis and evaporation to consume or transfer solar radiation, and at the same time absorb the ambient environment energy, thereby reducing the ambient temperature, improving the local microclimate, and converting it into a benign recycling of energy.

(2) Energy Saving Effect of Greening and Shading

In the hot summer and warm winter regions, the energy-saving effects of greening and shade are mainly reflected in: 1) Through the transpiration of plant leaves, the heat energy is converted, thereby reducing the amount of solar radiation of the building envelope, and reducing the outer surface of the envelope. Temperature; 2) Green shade can bring obvious cooling effect, reduce heat exchange between outdoor air and enclosure structure, reduce air conditioning load, create a comfortable thermal environment, and ultimately achieve the desired building energy efficiency; 3) Reduce the heat island effect. The three-dimensional afforestation of the building can relieve the temperature rise of the air in the city through the transpiration and absorption of green plants and improve the heat island effect of the city.

As shown in Figure 1, compared with other shading facilities, the scope of greening shading is wider and larger, and it can better adjust the contradiction between the shading demand of residential buildings in summer and the natural heating demand in winter; at the same time, it can be changed through greening configuration. The direction of the air flow induces air into the room, thereby improving thermal comfort [2].

![Figure 1. Regulation of the microclimate of buildings in the summer and winter.](image)

3. Analysis on design strategy of greening and Shading in hot summer and warm winter region

3.1. Green shade

The green shade mainly improves summer thermal comfort through two aspects: 1) lowering the ambient temperature in the residential area; 2) blocking the direct sun and reducing the intensity of solar radiation. To sum up, there are three methods of greening and shade that are commonly used in buildings in hot summer and warm winter regions: 1 Greening and shade of the environment; 2 Vertical greening and shading; 3 Green roof and shade.
(1) Environmental greening and shading

Environmental greening shading refers to the planning of vegetation, including lawns, flower beds, trees, etc., through the calculations, simulations and tests of the environment in which the buildings are located and surrounding sites. The greening of the environment is mainly based on shrubs on a large area of lawns. Trees on both sides of the road and on the periphery of the square are mainly arbors, forming an environmental greening and shade system for outdoor venues to reduce the amount of direct solar heat radiation to the ground and the structure of the envelope. Get hot, thus lowering the ambient temperature.

In summary, according to the two major factors of local climate and geography, through optimization and comparison of different types of green land types and different greening plants, the long-wave radiation heat transfer amount of the ground and the environment as the second heat source can be reduced, and the indoor environment can be improved. It is an effective and active way of heat insulation and energy saving.

(2) Vertical Greening and Shading

Vertical greening and shade refers to the sunshade treatment that is carried out by means of a covering method in which the plants grow and spread on the facades of buildings and structures [3]. Compared with the environmental greening and shading, vertical greening and shade have a more obvious effect on building energy conservation. In summer, most of the buildings in hot summer and warm winter areas have the phenomenon of "West Sun" sultry, so the vertical green shade is mainly used in the construction of Western and Southern walls.

The vertical greening of the gables is also referred to as the “breathable wall”. This is because after the building is covered with vertical plants on the west gable, an air layer is formed between the plants and the wall, which makes it possible for plants to transpire through the leaves. Photosynthesis, absorption and conversion of solar radiant heat, thereby reducing the absorption of solar radiation by building envelopes, the ground, and other objects in the surrounding environment; On the other hand, due to the presence of air interspaces, the direct sunlight passing through the plants is delayed. The wall undergoes radiative heat transfer. As shown in Figure 2, vertical greening reduces the external surface temperature of the building and the site's local climate temperature through a combination of two functions. It can eliminate the adverse effects of “West Sun” on the indoor thermal environment and improve the indoor thermal environment.

![Figure 2. Vertical green visor.](image)

(3) Green roof and shade

The roof is one of the components of the external protective structure that mainly receives solar radiation. The sun receives the strongest direct radiation and the longest operating time, and its
outdoor comprehensive temperature is also the highest [4]. In summer, the amount of heat that enters the room from the roof often accounts for more than 70% of the total heat of the total building envelope. Therefore, in the hot summer and warm winter areas, the use of roof greening and shading to strengthen and improve the roof insulation capacity is of great significance for improving the indoor thermal environment of the top floor room [5]. On the one hand, green roofs use the photosynthesis of plants to convert thermal energy into biological energy, use the transpiration of the leaves of plants to increase the amount of evaporative heat dissipation and reduce the outdoor temperature of the roof; On the other hand, the thermal resistance and thermal inertia of the plant cultivation materials are used to reduce the inside of the roof. Surface temperature, while blocking the sun through the plant. Due to the difference between the roof and the ground, sunshine, temperature, humidity and other factors will change with the increase in floor height. Choosing the right form of roof greening and shade can achieve the desired effect.

Figure 3. Vertical greening combined with roof greening.

As shown in Figure 3, when the vertical greening shading and roof greening and shading are used together, the cooling and heat insulation effects of the building will be greatly enhanced. Compared with the ground and surrounding protective structures, the solar radiation received on the roof has a wide range, strong intensity, and long time. It can strengthen the photosynthesis of plants and objectively promote the enhancement of greening and shading effects. At the same time, plants and turf are also conducive to evaporative cooling of the entire roof. Due to the large temperature difference between day and night and rapid wind speed, the roof of the building accelerates the evaporative cooling of the entire roof, and the cooling effect is more obvious.

Table 1. Three kinds of green shade

| Visor performance | Green visor | Vertical green shade | Roof green shade |
|-------------------|-------------|----------------------|-----------------|
| Green planting site | Residential building surroundings | Residential West and South Gables | Residential roof |
| Green shade principle | Photosynthesis and transpiration; enhanced ventilation | Blocking direct sunlight; climate buffer; photosynthesis and transpiration | Reflect or absorb direct sunlight; convert heat energy |
| Main shading effect | Adjusting the temperature and humidity environment and improving the microclimate in residential and surrounding areas | Eliminate the adverse effects of “West Sun” on the internal thermal environment of residential buildings | Strengthen the ability of roof insulation |

Compared with other shading facilities, the scope of greening shading is wider and the effect of energy conservation is greater, and it can better improve the problem of the shading demand of
residential buildings in summer and the natural heating demand in winter; at the same time, through the greening configuration, air can be promoted. Convection improves the thermal comfort of the environment.

3.2. Green shade structure technology and post-maintenance

(1) Environmental greening needs to formulate a complete construction plan. Seedling preparation → balance pruning → chemical treatment → excavation transportation → tree point excavation → soil treatment → planting → pouring bottom water → lashing and fixing → conservation, in the latter stage of conservation requires reasonable pruning of arbors, reinforcement of tree stumps or branches, annual Conduct 1-2 loose soils to ensure adequate moisture, maintenance facilities are neat, complete, and strengthen management.

(2) The roof greening structure is reasonable. Satisfy building waterproof and energy-saving standards, while the roof load should be light to facilitate the maintenance of leakage in the later period. Green roof should choose non-absorbent insulation material, the insulation layer is placed under the waterproof layer and set the slip layer, priority to use waterproof blanket structure, in order to help ensure insulation and energy saving effect and post-maintenance.

(3) Vertical greening technology has a good thermal insulation effect on buildings, and has a certain degree of protective effect on the opposite wall, which can prevent moisture, corrosion, and waterproof. The application of vertical greening must vary from place to place. As usual, scaffolding scaffolds are erected at the gates; instead, fences are planted with hedgerows, hedgerows, or perths. Walls can be covered with climbing plants. Balcony and window sill can be bonsai or planting climbing plants to increase the greening effect. Ground can be laid turf.

For the planting and maintenance of plants, the plant climbing or hanging vertical greening and straight-wall container vertical greening are relatively simple, and the technical requirements are low, while the modular vertical greening and non-woven nutrition liquid greening methods are relatively complex and technical requirements. High, because the deployment and control of fluids is a science that requires professionals. Therefore, such plant wall installation will generally provide basic maintenance and maintenance training, and customize the corresponding vertical building greening manual based on the environmental characteristics, including the detailed description of its management procedures and nutrient solution irrigation methods.

4. Status and Prospects of greening and Shading applications

Green buildings are in line with the concept of sustainable development and therefore have great potential for development. In the future, when building green buildings, we should rationally use green shade to closely coordinate the relationship between buildings and the surrounding environment. At the same time, it needs to be rapidly strengthened in the research and application of new technologies. Therefore, suggestions and prospects for future greening and shade development in hot summer and warm winter regions are proposed:

(1) Consider from the technical level, that is, strengthen the use of non-renewable resources, improve the insulation and thermal insulation performance of the enclosure structure, optimize the efficiency and effectiveness of the heating or cooling system, and rationally utilize the green shading facilities so as to effectively reduce the external walls of the building. Temperature and greening environment.

(2) Continuously carry out technological innovation and build a building greening and shade technology organization. Finally, we must optimize the collaboration mechanism, improve the professional segmentation design tradition, fully grasp the policy changes, understand the investor's decision-making trends, and build an integrated design team.

(3) Policy support and improvement of laws and regulations. The government and related departments should strengthen the leadership of greening and shade in the region, further guide the planning and design of greening and shade, and formulate relevant regulations to promote their faster and better development.
(4) In the process of continuous promotion of greening and shade, the industry should pay attention to self-discipline construction, actively fulfill its obligations and assume responsibility, while the government also needs to actively introduce the experiences, advanced technologies and innovations in the building greening and shade in developed countries such as Europe, America and Japan. Methods, forms, etc., to promote the green shade market development and seek a breakthrough.

5. Conclusion
It is a new idea and direction for the sustainable development of buildings to study how green shade can play a greater role in building energy efficiency. This article combines the climate characteristics of the hot summer and warm winter regions and systematically summarizes three common green shade forms: environmental greening, sunshading, vertical greening, sunshading, and roof greening and sunshading, as shown in Table 1. Through summarization and analysis, on the one hand, this article has beneficially supplemented the building greening and shading system, and hopes to improve the green building development and improve the thermal comfort of the ecological environment through scientific and rational greening and shade design.

References
[1] Specification for thermal design of civil buildings (GB 50176-93). Beijing: China Plan Press, 1993.
[2] Chaoyang Huang, Xiaotu Liu. The Effect of Greening on Thermal Protection. Huazhong Architecture, 2004, 101-103.
[3] Yang Zhang, Liuyuan Wu. Research on the related problems of three-dimensional building greening. Journal of Xi'an University of Architecture & Technology: Natural Science Edition, 2003, 166-168.
[4] Hongwei Ke, Dongtao Wang. The ecological measures to improve the thermal environment of residential buildings. Journal of Henan University: Natural Science Edition, 2004, 103-105.
[5] Xudong Gao, Song Jin, Yadong Qu. Study on the Influence of Roof Greening on Thermal Comfort of Indoor Body. Journal of Chongqing University, 2007, 44-48.