

LETTER TO THE EDITOR

Evaluation Model of Spatial Environmental Spillover Suitability of Middle School Buildings

Zheng Tan*, Yiming He, Hao Liu

College of Architecture and Urban Planning, Nanyang Institute of Technology, Nanyang 473000, China

Email: tanzheng2256@163.com

The niche fitness model can not only quantitatively study the niche fitness of urban human settlements environment quality in different regions, but also concisely and intuitively reveal the dominant factors and spatial differentiation rules that cause the regional differences of niche fitness of human settlements environment quality. The light environment in the space environment of middle school buildings is the focus of this paper. Through the environment analysis software Autodesk Ecotect and Radiance to assist in modeling, analysis and comparison, focusing on the light environment simulation of the middle school building working environment; and through the example simulation to illustrate the impact of maintenance and shading components on the light environment; finally, some follow-up research and suggestions on the lighting strategy of the middle school building are made. This provides a theoretical basis for decision-making and management departments to formulate urban planning plans.

Environment Analysis Software; Middle School Building Space; Light Environment; Shading Components

I INTRODUCTION

Niche is one of the most important concepts in modern ecology. Previous researchers have done a lot of analysis and research on the definition and connotation of niche. Hutchinson uses the mathematical point set theory to view niche as a total aggregate of living conditions for a biological unit (individual, population or species). He points out that if each measurable environmental feature is given as a coordinate in n-dimensional space, the niche of species can be defined as an area in the n-dimensional space (He 2013). Within the n-dimensional space of the niche of the representative species, the suitability of organisms varies from point to point, and the suitability decreases significantly at the adjacent boundary points in the area. From the point of view of the utilization of n-dimensional resources by species, quantitative research on the change law of the suitable degree of n-dimensional spatial region representing niche has important theoretical and practical value. In order to strengthen the artificial control measures and optimize the utilization of resources and environment, Wang Gang and Li Zizhen put forward the theory of niche suitability in the 1990s, and gave the mathematical model of niche suitability. That is, on the basis of niche theory established by Grinnell, Elton, Hutchinson and other scholars, the method of using Hutchinson theory to abstract niche concepts mathematically and determine the ecological boundary by suitability is presented (Fan and Zhang 2013). The suitability of real and optimum habitat conditions, that is, the closeness between real and optimum resource positions, is established. It is a new fitness measure on Hutchinson's "n-dimensional hyper-volume". It specifically describes the suitability between the demand of crop growth, yield formation

process and the environmental supply. According to this idea, the temperature niche, humidity niche, nutritional niche, spatial niche and temporal niche involved in crops can be comprehensively quantified and compared. Niche suitability has become an important theory in biology. Many scholars have analyzed this problem and obtained some research results.

Rui Wang published an article entitled “Livability Design of Residential Building Environment Space” in the Journal of Ekoloji on Issue 107 in 2009 (Wang 2019). This article mentioned that with the improvement of people’s quality of life, living environment requirements and spiritual pursuit level, the concept of life changed from simple “survival needs” to “environmental needs”. The living environment of human beings requires the return of ecology, and their demand for environmental ecology and culture requires the creation of livable residential areas. The current design method of residential building environment space has low precision in choosing the optimal path, low precision in building area planning and low satisfaction with the design environment space. The design method of livability of residential building environment space is put forward. The road network and floor connections on each floor are considered as separate structures. According to the floor distribution of the berth point, the structural network model is used to analyze the path of the floor, and the optimal path through all the berth points in the multi-storey building space is obtained (Childers et al. 2016). On the basis of establishing hierarchical structure, basic areas are calculated and planned, and shared areas and individual building areas are shared. Through the space shape, light and color, the interior design of residential buildings is carried out. The outdoor environmental space of residential buildings is planned and designed by architectural style, road space and green space. Combining interior design with outdoor design, the livability design of residential building environment space has been completed. This paper draws on the research directions and conducts in-depth research.

From the point of view of ecology, urban human settlements environment is a composite artificial ecosystem composed of three interacting and interdependent sub-systems: society, economy and ecology. The coordination of the whole system affects the suitability of urban residents’ life. At present, China is in the period of rapid development of industrialization and urbanization. The sustainable development of urban human settlements environment has been seriously challenged, and the problem of human settlements environment is very prominent. In recent years, the research on the quality evaluation of human settlements environment has been carried out mainly from two aspects: one is to make a simple and qualitative evaluation of the human settlements environment of a region from the perspective of ecological environment and landscape science, so as to judge whether the region is suitable for human habitation (Jones et al. 2017). At present, this kind of evaluation has not yet formed a systematic and quantifiable evaluation index system; the other is to proceed from the point of view of facilitating the lives of the residents, and to evaluate the human settlements environment of a region. A region’s infrastructure, public services, location conditions, living conditions, social stability, etc. are evaluated to determine whether it can meet the needs of residents’ lives. This kind of evaluation has formed some indicators system. However, most of these indicators only focus on the small environment of “convenience” of life, while neglecting the natural and ecological environment that affects the city as a whole.

II IDEA DESCRIPTION

In recent years, the speed of green building development in China has been accelerating, and some provinces and municipalities have created a good effect of rushing to establish green construction demonstration zones. The Eighteenth National Congress of the Communist Party of China put forward the idea of respecting and protecting the nature of ecological civilization, putting the construction of ecological civilization in a prominent position and integrating it into all aspects of economic construction, political construction, cultural construction and social

construction. This means that during the Twelfth Five-Year Plan period, there will be a new climax in the sustainable construction and transformation of domestic buildings.

In recent years, many aspects of nature, society and economy have been involved in the popular green building action, including the rationality of architectural design, the use of renewable energy and so on. In the design stage, how to optimize the envelope structure is also one of the factors that cannot be ignored. According to the survey, windows are the most energy-consuming building in China except for the top floor. Because of the new pursuit of aesthetics in modern design, designers and even users are enjoying the beautiful lighting and landscape of large open window buildings. While facades are fashionable, they sometimes inevitably give way to the influence of facades on the interior environment and comfort of buildings in the future. This is especially reflected in the construction of some school buildings in recent years, in the requirements of a good-looking skin, users often feel uncomfortable with the interior school light and thermal environment in the later stage. Based on this background, this paper will focus on how the outer envelope structure of middle school buildings affects the internal environment, and through an example to simulate and compare the impact of shading components on the comfort of light environment. In school space, light environment is one of the most important factors of work comfort, which will directly affect the school efficiency and even psychology of users.

In the simulation process, there are two commonly used environment analysis software, Autodesk Ecotect and Radiance. Autodesk Ecotect is more familiar with it. It can be imported or modeled to carry out sustainable design and analysis, including light environment, thermal environment and other analysis functions. However, in light environment analysis, Ecotect cannot fully accurately and vividly display a space, especially the two-degree illumination of indoor space, while Radiance, a professional photometric software, can make up for the shortcoming of Ecotect, which can be used in conjunction with each other and complement each other.

Suppose there is a school with 4 m in length and 3 m in height in a pure glass curtain wall. There are two sets of desks and chairs near the window and computers on the desk. In the setting of Ecotect, the windows are set to double low-E glass, and the weather is loaded to Shanghai meteorological data. In the simulation process, we hope to test the influence of shading components on indoor light environment. Therefore, first of all, a pure glass curtain wall school space without shading components is created (Fig. 1 (a)). Radiance light environment analysis software is used to calculate the day lighting coefficient. The results are shown in Figure 1 (b). In this simulated school space, the average daylight coefficient of the indoor floor height plane is 11.4%. Figure 1 (c) shows that in this school, the illumination on the table exceeds 1000 lx, and the illumination on the wall beside the glass curtain wall exceeds 1000 lx. China's building lighting design standards stipulate that in middle school building sites, design rooms and drawing rooms need the brightest lighting environment. The recommended lighting coefficients of design rooms and drawing rooms are 4.0% and 600 lx respectively. The recommended lighting coefficients of schools and conference rooms are 3.0% and 450 lx respectively. The recommended lighting coefficients of copy rooms and archives are 450 lx. The standard value of coefficient is 2.0%, and the standard value of indoor natural illumination is only 300 lx. This shows that in the model without shading components, the lighting coefficient is too high, and the illumination on the desktop is too high, which will cause users a very uncomfortable feeling of light environment.

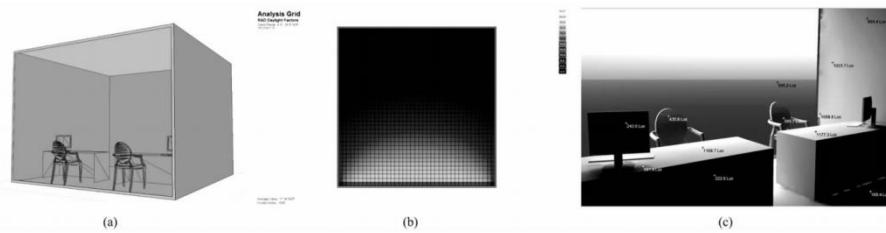


Figure 1 Modeling

There are many famous schools or multi-functional high-rise buildings in China. Some of them use glass curtain wall reasonably. Jinmao Building is one of them. Designer SOM uses stainless steel, rigid skin and glass to build a tall, traditional skyscraper with modern sense (Figure 2 (a)). In the simulation stage, it is hoped that the previous model can be improved by using the design method of the partial skin shading component of Jinmao Building for reference (Fig. 2 (b)). In the previous model, the scale, furniture and material of the school space remained unchanged, and only two kinds of sunshade components were added on the basis of the external facade of the first test, namely, the horizontal sunshade component located at the top level and the vertical sunshade component close to the outside of the curtain wall. Among them, the horizontal sunshade plate is 75 cm wide and the middle space is 15 cm wide; the vertical sunshade aluminum plate is covered with straight holes in the middle. The aperture is 7 cm in diameter and the aluminium plate itself is located in the central position of the curtain wall, and the width is 2 m. The landscape entrance is left on both sides for convenient viewing.

In the second simulation process, the indoor light environment was obviously improved due to two sets of sunshade components (Fig. 2 (c)). The illumination of the school desktop was basically controlled from 400 lx to 600 lx. If the function of the school was a design room, drawing room or school, the illumination was within a reasonable range; moreover, thanks to the help of the light filtering system, the indoor illumination was more important. The light becomes more uniform, and the illumination of walls, floors and computer surfaces has been significantly improved rationally. This shows that, in the absence of artificial auxiliary lighting, outdoor light can be completely adjusted by adjusting the light filtering system. Previous examples of Jinmao Tower also provide a method for environmental analysis and exploration, that is, by imitating and learning high-valued buildings in sustainable design at the initial stage of design, and then making corresponding improvements, ultimately achieving the desired comfort effect.

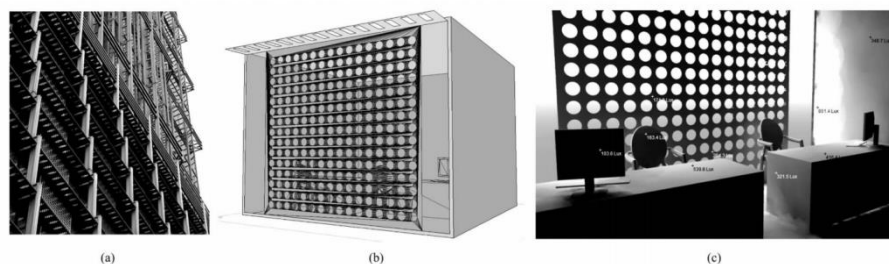


Figure 2 Model Improvement

III RESULTS

However, illumination is actually only one of the factors affecting the comfort of light environment, and there are many factors affecting the efficiency of users. For example, because the above tests are in cloudy and overcast Sky Condition, if one day the outdoor light is strong and the visibility is high, it is likely to have a greater glare effect on the indoor light environment. In the outdoor sunny weather, because of the strong contrast between indoor and

outdoor illumination, users in indoor space are easily troubled by glare, so indoor shade curtains are also indispensable.

In the test (Fig. 3 (a)), the illumination on the surface of the analog computer display exceeds 600 lx in some areas, because the display itself has brightness, which is generally between 50 and 300 cd/m². Therefore, if the illumination of natural light is too high, it will affect the resolution and contrast of the content displayed on the display, thus further affecting the user's comfort. In view of this situation, the curtain wall interior space in foreign countries is often used to improve the wall and ground material to make light diffuse reflection as far as possible, or to set up Venetian blinds in the windows, so that after artificial secondary filtering, the light will be more gentle to illuminate the interior, and can be arbitrarily adjusted under different weather conditions in sunny and cloudy days.

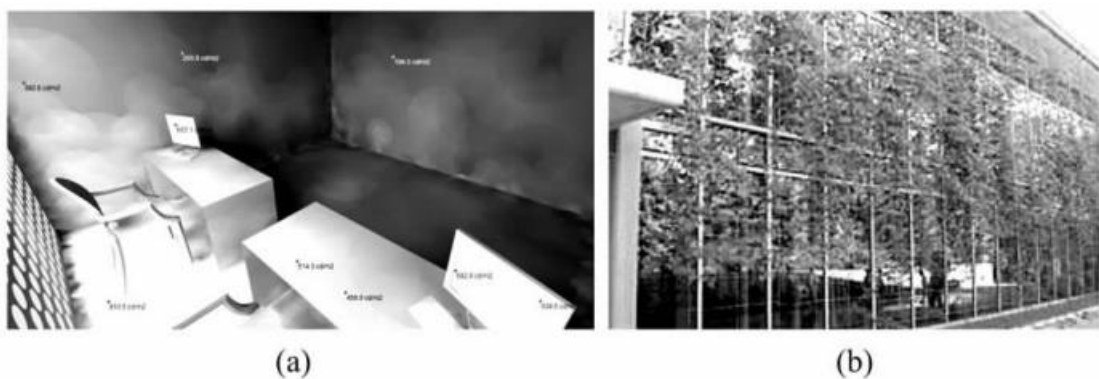


Figure 3 Test

Middle school buildings and other forms of glass curtain wall buildings adopt different kinds of light control strategies in China and abroad, most of which are mainly sunshade and shutters. Pritzker Family Children's Zoo at Lincoln Zoo uses green plants as light filters. In order not to pollute the roots of plants to the surface of the curtain wall, stainless steel nets are set outside the curtain wall several centimeters away, so that plants can climb along the steel nets and form an organic, environmentally friendly and beautiful sunshade. Structure and the endothermic effect of plants even improve the thermal environment outside the building. The only thing to note is that the best variety of plants is deciduous plants, and shading buildings can also get sunshine in winter. In addition, with the development of science and technology, glass material itself has also promoted the evolution of glass curtain wall system. Commonly used low-E glasses can reflect most of the infrared thermal radiation in the solar spectrum, but only a few of the visible light is blocked. Later, the development of heat-absorbing glass, or with bronze, grey colored glass, can reduce at the same time in China and abroad, middle school buildings and other forms of glass curtain wall building using different light control strategies, mostly sunshade, shutters. Pritzker Family Children's Zoo at Lincoln Zoo uses green plants as a light filter. In order not to pollute the roots of plants to the curtain wall skin, stainless steel nets are set on the outside of the curtain wall several centimeters away, so that plants can climb along the steel net and form an organic, environmental and beautiful shade. Sun structure, and the heat absorption of plants even improve the thermal environment outside the building, the only thing to note is that the plant species is best for deciduous plants, shading buildings can also get sunshine in winter. In addition, with the development of science and technology, glass material itself has also promoted the evolution of glass curtain wall system. Commonly used low-E glasses can reflect most of the infrared thermal radiation in the solar spectrum, but only a few of the visible light is blocked. Later developed heat-absorbing glass, or with bronze, grey colored glass, can reduce both solar radiation and visible light, so that the visible light penetrating the room also decreases. Among

many glass curtain wall design examples, the GSW headquarters building in Berlin, Germany is undoubtedly a high-level double-deck glass curtain wall design model, which combines aesthetics, energy saving and practicality perfectly. The color sunshade with transparent holes can make the rotary bearings on both sides of the top and bottom rotate freely by computer control, and do not interfere with the opening and closing of the double curtain wall, thus ensuring the benign co-operation of lighting, ventilation and heat insulation in all aspects. Some of the floors in GSW are large open workspaces. The illumination of indoor working planes can be maintained at 400-500 lx through the adjustment of sunshade all the year round.

IV CONCLUSION

This paper provides a method through software simulation, that is, in the early stage of design, computer-aided simulation of shading components can effectively help us to judge the image of unknown space, so as to do the subsequent perfect processing. In light environment analysis, the above two software can really help many designers to carry out assistant design. We believe that this method will have a positive impact on the interior light environment design of buildings in the future.

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