Form Design and Control Optimization Method of Science and Technology Urban Blocks based on Multi-factors of Micro-climate Environment with Block Box as the Medium

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Abstract. The microclimate environment of urban blocks is directly related to its spatial form, which in turn affects the quality of urban public space, especially in science and technology urban blocks with high requirements for outdoor public space quality. In response to the lack of comprehensive attention to the multi-factors of microclimate environment in the current block form design and control, we adopt multiple physical environment indicators including sunlight duration, wind speed and temperature as a basis for establishing the optimization method of block form design with the support of the sunlight, wind and heat simulation tools. From the optimized block box form, the refined height zoning, the location and shape of streets and open spaces are obtained and reflected in the control plan to guide the actual development and construction. Take a science and technology urban block in the core area of Suzhou Science and Technology City as an example, this method has been applied and tested, and its operability and ability to improve microclimate in various aspects have been preliminarily confirmed. With the optimization method of block form design and control, the climate performance of science and technology urban blocks is improved and the goal of energy conservation and emission reduction is achieved.

Keywords: multi-factors of micro-climate environment; science and technology block; form optimization; design and control; block box

1 INTRODUCTION

1.1 Background

The Importance of Urban Micro-climate in the Design of Science and Technology Blocks.

The micro-climate environment of urban blocks has always been one of the hot spots in the study of human settlements. Urban micro-climate includes meteorological factors such as air temperature, wind speed, relative humidity and solar radiation,

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which affect the quality of urban public space. Especially for science and technology urban blocks, where more public communication space is needed, it is extremely important to improve the comfort of public space by enhancing its microclimate conditions. With the rapid urbanization process, the extensive development and construction of urban blocks result in problems such as sunlight obstruction, poor summer ventilation, and enlarged urban high-temperature areas. In order to resist the discomfort of the external environment, the increase in the use of building air conditioning equipment has further increased the man-made heat in the city, thereby raising the urban energy consumption and forming a vicious circle.

The Attention of Physical Environmental Factors in the Block form Design.
Sunlight, wind and heat are the key elements of the physical environment of the urban block. Scientific and refined building height layout helps achieve good daylighting conditions of urban blocks. To meet the wind environment requirements, the design of urban block form should be based on ensuring its ventilation efficiency of the block, namely its ability to introduce the summer monsoon and hinder the winter monsoon. Reasonable open space design and architectural form guidance should be adopted to form a block shape that is conducive to heat acquisition and dissipation, in order to improve the heat environment of the block. The existing research and technology generally focuses on the influence of a single physical environmental element on the block form, lacking consideration for the superposition of multiples environmental elements. In addition, in the existing design and control process, the physical environment simulation is often placed in the individual building scheme stage at the end of the block construction. While, consensus has been formed that the introduction of physical environment analysis and simulation in the early stage of block form design helps to enhance the initiative of block form in micro-climate shaping and regulation.

The Application of Block Box in the Block form Control.
With the same planning control index, there may be a variety of block forms with different levels of adaptation to the climate, of which the residents' experience also varies. The block box is a control medium of urban block form as a supplement to general planning indicators. It is mainly applied to control the height division, building concession, interface line rate to achieve the goals of shaping overall urban form, landscape and visual corridor, street landscape, street space experience and so on. The existing physical environment simulation technologies have put forward the optimization directions for the design and optimization of block form. Their combination with the block box helps to translate optimization strategies into a refined index in the planning control metaphors.

1.2 Previous Research

The Relationship between Block form and Microclimate.
In the past few decades, people have conducted in-depth discussions on environ-

mental indicators such as urban morphology, climate and heat comfort at different scales. A large number of studies have shown that the different morphological elements of the block space affect the sunlight and wind-heat environment.

In the study of sunlight, the concept of " solar envelope " proposed by Ralph L. Knoewles calculates the maximum volume range of buildings that can be built in the target block by two-dimensional method. Ahmad Okeil takes into account the different needs of sunlight in winter and summer, and proposes a sunshine-oriented residential block organization RSB (Residential Solar Block) model[1]. Xiaodong Song and Chengyu Sun use the envelope method to meet the sunlight of adjacent residential buildings and ensure the maximum floor area ratio in the plot, which proves that the “Solar envelope” model is suitable for small and medium-sized urban plots[2].

In the discussion of wind environment, Xing Hu et al.[3] found that sky-view factor (SVF), plan area density, frontal area density, porosity, relative rugosity, sinuosity and other indicators are generally used as urban form indicators in wind environment evaluation. Among them, frontal area density and porosity can be used as important control indicators to guide the wind environment in urban block design. For example, Adolphe uses porous media to characterize the characteristics of urban morphology with topology[4]. In the local research, the average height of the building and the degree of building enclosure are also taken as the influence of the block shape on the wind environment at the pedestrian scale[5].

In the early stage, the heat environment of urban block form was mainly studied and discussed for urban heat island effect. Among them, more attention was paid to the space of street canyon, and the discussion of street aspect ratio, orientation and sky-view factor was derived. The sky-view factor was considered to be one of the most important factors affecting the intensity of urban heat island effect[6]. In the study Yamashita[7] and Givoni[8] found that the sky-view factor was positively correlated with the heat island and heat transfer effect of the block. Givoni[9], Bruse[10] and other scholars found that changing the aspect ratio, orientation and layout of the block is helpful to adjust the wind and heat environment of the block. In addition, Jiyu 's research reality, sky-view factor was also related to solar radiation and block heat dissipation[11].

Micro-climate Considerations in Block form Control.

Sunlight, wind and heat are related to the living environment of human beings. The environmental problems brought about by urbanization have led to the emergence of block control methods for different living environments in the field of urban planning. Since the 19th century, the British Urban Planning Department has promulgated a series of sunlight laws, which stipulate that the width of urban streets and the layout of buildings need to meet the sunlight and air circulation. German scholars represented by Gropius has deeply explored the relationship between sunlight, building height and building interval[12]. Based on the elements of sunlight, ventilation and landscape, some urban planning departments in United States proposes the “Sky Exposure Plane” to control the building setback distance, building critical width and building retreat height of commercial office areas to meet the requirements of construction[13]. In Japan 's “Building Datum Law”, the “Sun Shadow Regulation” limits the shape, height and plan layout of new buildings for residential buildings to protect and control the sunlight duration of adjacent land. The attention of China 's block management and control in the microclimate environment is mainly reflected in the building and the plot level. For example, there are different minimum building distance for sunlight and setback distance requirements in each city. At the plot level, for high-rise residential buildings, some cities meet the corresponding sunlight quality requirements by stipulating the sunlight time within a certain limit within the blocked plot (generally 1-2 hours on the winter solstice). Guangzhou wind environment management, control guidelines and evaluation technical guidelines established a three-level spatial transmission system from urban district-superblock-block, and stipulate the control requirements of street aspect ratio, street wall length and interface at the block level[14]. San Francisco Master Plan requires that the wind speed in the public leisure area and pedestrian area should not exceed 5m/s.

In addition, the intensity of block control is also related to the correlation of physical environment factors, which some of the block control improves the microclimate environment of the block through guiding suggestions. For example, the Incentive Zoning in the United States stipulates that developers can obtain the construction volume reward by building a prescribed square in a high-density commercial area, which helps to optimize the wind and heat environment of urban space. Urban Climate Map and Wind Environment Assessment Criteria-Feasibility Study in Hong King proposes an explanation method for urban ventilation performance, stipulating that it is recommended to control building density in local urban areas and to provide more open space in non-construction land areas to increase the ventilation of the block.

Gaps.

There are many connections between the study of meteorology and urban morphology. In the realm of meteorology, the research on block form is generally conducted around single climatic factor such as sunshine, wind or thermal environment, and rarely touches the comprehensive influence of multiple climate factors. However, in the practical projects, the climate adaptability design of urban blocks often requires comprehensive consideration of microclimate factors including light, wind and heat. It is often difficult to achieve consistency and coordination in the overall climate regulation of the block when the form design is solely based on a single factor.

At present, most of the form control regulations aiming at microclimate environmental protection are based on considerations of building sunlight conditions, which often serve as mandatory control requirements for block form design. While, the requirements of wind environment and heat environment are generally used as guiding principles in urban form control. This is because the variables and indicators involved in wind and thermal environments are complex and difficult to be directly converted into quantitative and specific morphological control indicators. In addition, as the scale span involved in wind and thermal environment is comparatively large, less attention is paid to them at the micro scale of urban blocks.

1.3 Research Objectives

The core objective of this study was to establish a form design and control optimization method for science and technology blocks in terms of multiple elements of micro-climate environment with the block box as a medium. This objective can be broken down into the following three sub-goals:

(1) To establish a comprehensive method for optimizing the shape of blocks with multiple micro-environmental element.

(2) To build up ideas and methods for actively adapting to climate in the urban block design, which greatly improve the design efficiency.

(3) To establish a work path to translate the optimization results of the block box form into the refined control plans.

2 CASE STUDY AND RESEARCH TOOLS

2.1 Case Study

The science and technology block in the core area of Suzhou Science and Technology City is selected as a case study. Suzhou is located in the northern subtropical monsoon marine climate zone, which is generally warm and humid with a pronounced monsoon. According to the meteorological data, the region has the characteristics of high temperature and high humidity in summer and low temperature and high humidity in winter. The dominant wind is from the southwest with an average wind speed of 3.5m/s in summer, from the northeast with an average wind speed of 3.5m/s in winter, and from the southeast with an average wind speed of 3m/s in transition seasons (Fig.1).

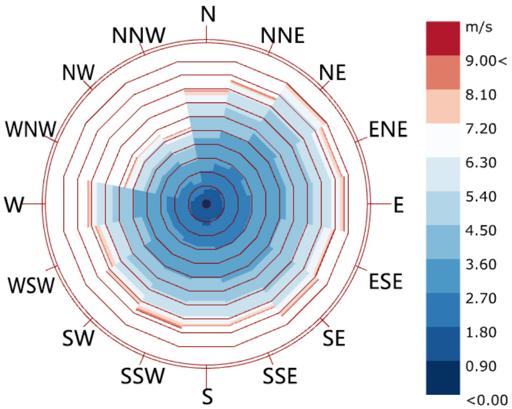

Fig. 1. Typical directional wind distribution in the summer.

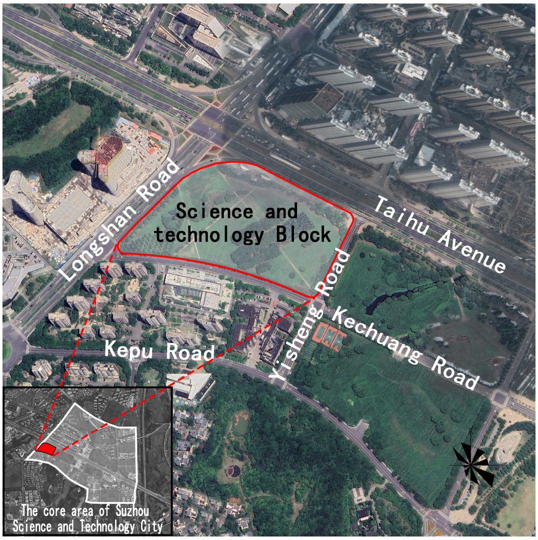

Fig. 2. Aerial photograph of the current status of the science and technology block.

The science and technology block is located in the southwest corner of the core area of the Suzhou Science and Technology city, covering an area of about 6.6 hectares. The north of the block is Taihu Avenue, the main road of the city (Fig.2). The analysis of the summer wind environment of the site shows that there is a good wind condition inside the site, and the local wind speed can reach 2.5 m/s (Fig.3). According to the block planning indicators provided by the government planning department, there are two types of land in the block (Commercial and business land use, Green space). Among them, commercial and business land use (B1B2) is also used as science and technology building. As shown in the detailed regulatory planning (Fig.4, Tab.1), around the science and technology block, the north and south are residential land use, and the east and west are commercial and business land use.

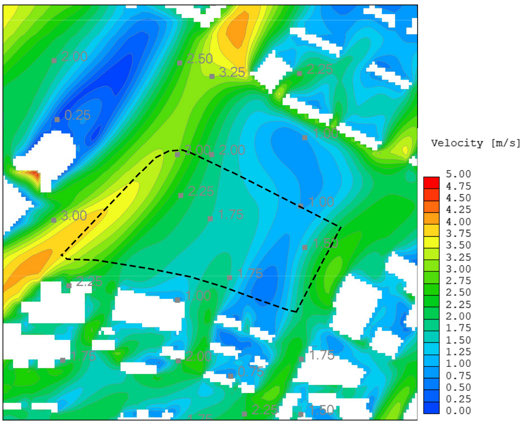

Fig. 3. Wind-environment simulation and site analysis in summer.

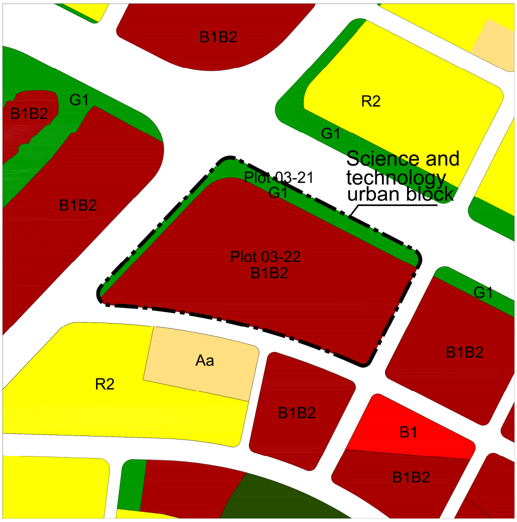

Fig. 4. Detail regulatory planning of the science and technology urban blocks.

Table 1. The plot control index of the science and technology urban blocks.

Plot Code	Land Code	Land use	Site Area (ha)	Building height control (m)
03-21	G1	Green space	0.86	---
03-22	B1B2	Commercial and business	5.79	150

2.2 Research tools

The sunlight analysis in the study uses the ladybug and honeybee plug-in developed by Mosta method based on the grasshopper platform as a simulation tool to conveniently carry out multi-period sunlight simulation and the generation of solar envelope. The sunlight data source is cited from the Energy Plus climate website, and the local sunlight parameters of Suzhou are selected. For the simulation calculation of wind environment, the structured grid fluid analysis and calculation are carried out by the CFD software scSTREAM platform. The wind direction and wind speed data are also read by the Energy Plus climate website. The reference height is fixed as the Chinese wind speed test height of 10m, the wind speed value is taken as 10 m/s, and the boundary condition for incoming flow is set as external incoming flow. The analysis area includes the science and technology block and the surrounding area to ensure the accuracy of the simulation. The heat environment research of the science and technology block is based on the ENVI-met platform, and the local meteorological data is used in the process of the calculation. The heat analysis scope includes science and technology blocks and surrounding blocks, including materials such as buildings, roads, vegetation and water, and simulates the heat environment during 5:00-18:00 on typical days in summer and winter.

3 OPTIMIZATION METHOD OF THE FORM DESIGN AND CONTROL OF SCIENCE AND TECHNOLOGY URBAN BLOCKS

Taking the block box as the form control medium, it can be operated and controlled on the block box through the relevant form elements of the block[15]. The morphological characteristics of the block box can be simplified into information such as the block boundary line, the length of the side surface, and the height control, which is operable at the level of physical environment simulation and urban planning control. From the previous summary, based on the solar envelope, we can control the top surface height of the block box as the form optimization of sunlight conditions. Based on the porosity, more pore possibilities are created through volume changes within the block box (the ratio of effective open volume to total volume in the medium), that is, the length of the side surface is changed by the block box segmentation as the morphological optimization of the wind environment. Based on the sky-view factor, the change of the plane contour of the block box is used as the shape optimization of the heat environment.

In the order of optimization, as the sunlight optimization is a mandatory standard in the field of practice, it is given priority. The air temperature index of the heat environment involves the change of solar radiation and wind speed, so it is considered later. In the optimization of the form and control of the science and technology block, we adopt four main steps. First, the object model is established, including the surrounding urban environment and the research block box. Secondly, carry out the sunlight simulation with optimize the block box according to the solar envelope. According to the wind environment simulation, the ventilation corridor is set to cut the block box. Based on the heat environment simulation in summer, the plane contour of the block box is adjusted, and the open space is set up to improve the heat environment conditions. Finally, after flattening the block box model, it is translated into graphic information with urban planning control.

3.1 Basic Model Generation

Based on the existing buildings and the relevant planning indicators provided by the government planning department, the urban foundation model is established in Rhino. According to the land boundary line, building control line, building height control, the three-dimensional model of the science and technology block box is established. The block box is established in the model with the building control line of the plot as the plane contour to control, the height control as the highest height, and the geometric column formed by vertical pull-up. As shown in Figure 5, the model of the block box in the science and technology block is shown in Rhino, where the height of the block box is 150 m. The block box controls the horizontal and vertical form of the block, and represents the physical boundary range of the maximum construction of the block under the initial planning index.

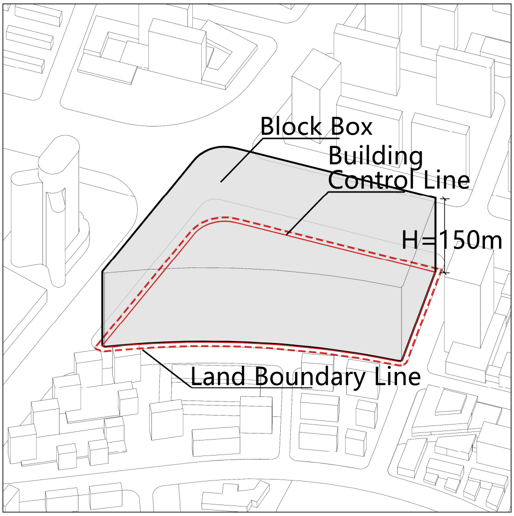

Fig. 5. Setting the three-dimensional model of the science and technology block box.

3.2 Form optimization based on sunlight environment improvement

The science and technology is used as office R & D building, in the relevant norms of Chinese architecture and planning, there is no mandatory control requirement for the sunlight duration of the building. Therefore, the science and technology block box can be discussed as a whole block form, and the control height of the upper surface of the block box can be optimized to reduce the sunlight impact on the surrounding block buildings after construction. Due to the residential area in the north of the science and technology block, it is necessary to judge whether the control height of the science and technology urban block affects the residential buildings. Sunlight simulation was carried out on the model of the block box and surrounding buildings in the science and technology block to understand the distribution of sunlight around the block.

Select the sunlight right boundary mode through the ladybug plug-in to ensure that the construction of the block box does not affect the sunlight rights of the surrounding buildings. Identify the bottom layer of the block box and the surrounding buildings, the sunlight time is selected to meet the 2 hours of sunlight on the winter solstice to meet the minimum requirements of the relevant specifications of the residential buildings on the north side. The generated solar envelope is selected as the highest control surface on the upper surface of the block box, which is also extracted and superimposed into the block box model. Therefore, the part of the solar envelope higher than the block box represents that the building height of the area does not affect the sunlight outside the block, which can increase the height form of the block in this area. On the contrary, the part of the solar envelope lower than the block box represents that the building in this area blocks the sunlight of the building outside the block, which the height of the block in this area needs to be reduced.

Based on the above, as shown in Figure 6, the optimization of the sunlight environment of the scientific research block box can be found. Under the sunlight right boundary mode, the highest control surface on the upper surface of the box in the block is gradually reduced from south to north due to the influence of the surrounding buildings, and the lowest control height on the north side is 70 m. For the reason that the west side of the scientific research block is far away from other buildings, the upper control surface of the block box in presents the morphological characteristics of high in the west and low in the east (Fig.6).

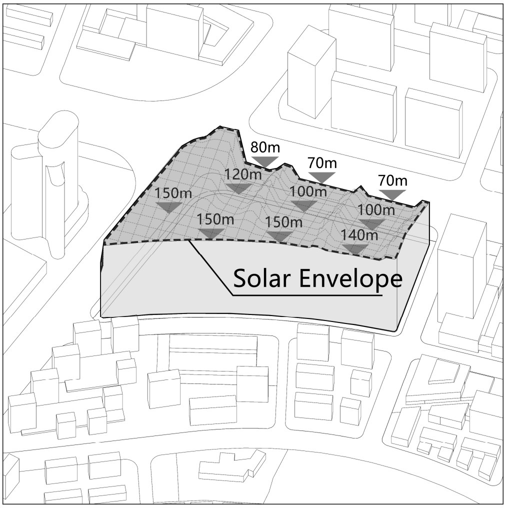

Fig. 6. The block box optimized by sunlight environment improvement.

3.3 Form optimization based on wind environment improvement

Based on the optimized block box, the possibility of ventilation in the science and technology block is discussed from the wind environment simulation. The science and technology block box and the surrounding block model are imported into Cradle 's scSTERAM platform to simulate the summer wind conditions of the science and technology block box. According to the wind speed and wind direction distribution map, we can get the wind conditions of the science and technology block in the case of the largest construction range with the city branch is not divided. By identifying the wind speed and direction at the pedestrian height of 1.5m, it can be seen that the southwest direction of the block is the main windward surface, and the angle between the wind direction at the windward surface and the normal direction of the plane where the windward surface is located is between 30 degrees and 90 degrees, which is basically consistent with the street orientation on both sides of the block box. It can be seen from the wind speed map that the average wind speed of Kechuang Road where the windward side is located is 2.5 m/s (Fig.7), which is higher than the calm wind condition of “Beaufort Scale”. It can be seen that the science and technology block has the potential conditions for ventilation and has a good wind environment for the internal buildings.

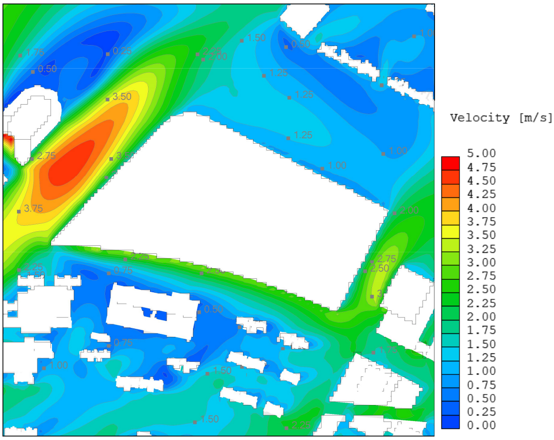

Fig. 7. The wind-environment simulation of the block box.

Since the plane size of the scientific research block is 380m in length and 180m in width, according to the study of the block form in the city centers in China[16], it can be seen that there is a possibility of re-segmentation of certain plots in the block. From the perspective of urban planning, the segmentation of large plots can not only better adapt to the layout of plot entrances and buildings, but also ensure that land use and building functions match. For the micro-climate, increasing the ventilation corridor running through the scientific research block is more helpful to improve the heat comfort inside the block. According to the basic scale commercial office plots and buildings, the setting range of ventilation corridors in blocks can be divided. The ventilation corridor is not less than 60 m from the two endpoints of the windward side of the science and technology block to meet the layout of commercial office buildings. The direction of the ventilation corridor is perpendicular to the windward side (Fig.8). The width of the ventilation corridor can be set according to the wind speed on the windward side of the corridor. According to the study of the ventilation efficiency in the street canyon space[17], when the wind speed is between 2m/s and 6m/s, the ventilation performance in the street is positively correlated with the air circulation capacity, and the ideal street aspect ratio could be controlled between 0.6 and 1.2.

In the design, according to the wind direction diagram, a certain width of the ventilation corridor is set at the midpoint of the science and technology block. Since the wind speed at the point O is 2.75m / s (Fig.8), combined with China 's road grade division, it can be seen that the width of the urban branch road is required (14 to 20m). The width of the ventilation corridor is set to 30m to meet the requirements of urban road and building setback distance. Finally, according to the above content, the block box model is segmented twice to obtain the block box model after the wind environment optimization (Fig.9).

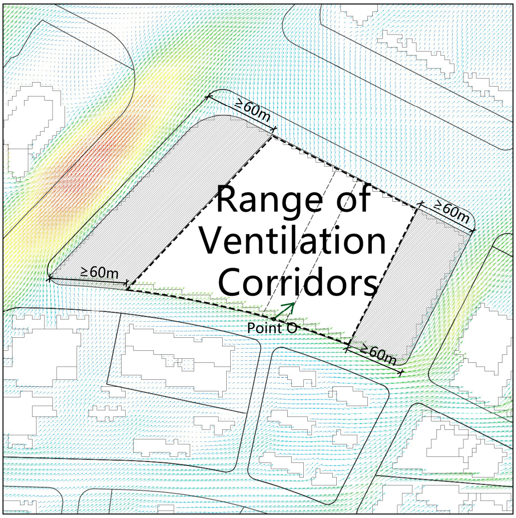

Fig. 8. The setting range of the ventilation corridor in the block according to the wind map.

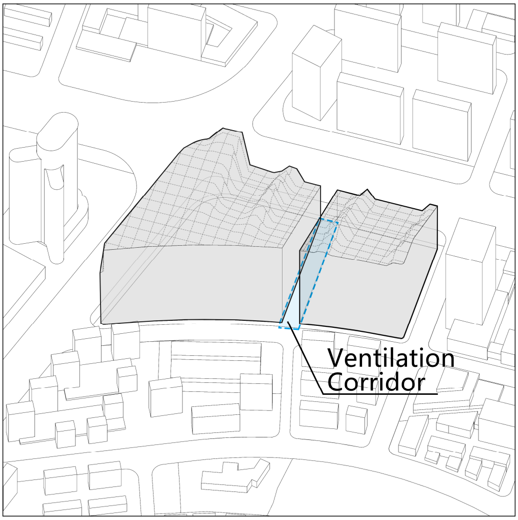

Fig. 9. Caption of the Figure 1. Below the figure.

3.4 Form optimization based on heat environment improvement

According to the physiological equivalent temperature（PET）map of the typical day of the block box in summer, the PET of the block box and the surrounding streets is identified. According to the evaluation of outdoor heat comfort [18], when PET is greater than 24 °C, the heat environment of the open space in the surface area is more uncomfortable. By setting up an open space to alleviate the air temperature in the area, it is helpful to improve the heat environment conditions inside the block [19].

Therefore, for the distribution of PET on typical summer days, from 5: 00 to 18: 00, the areas with PET greater than 24°C at each time period are concentrated between Kechuang Road, Ventilation Corridor and Yisheng Road (Fig.10). As the ventilation corridor helps the heat dissipation of the heat environment, the heat comfort of the street interface is improved [20]. In this design, we give priority to setting up an open space between the ventilation corridor and the Kechuang Road, taking 70mX50m as the size of the open space, and further dividing the block box to obtain the optimized block box (Fig.11).

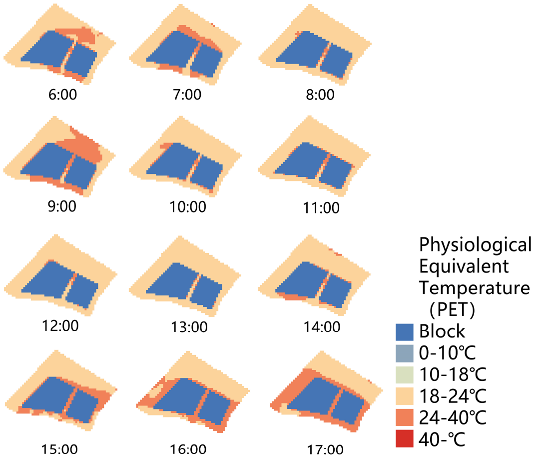

Fig. 10. The distribution of physiological equivalent temperature calculation of the block box.

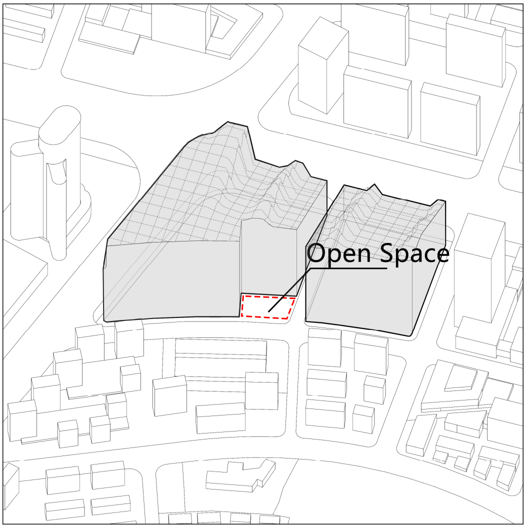

Fig. 11. The block box optimized by heat environment improvement.

3.5 From form design to control

According to the above, after the optimization of sunlight, wind and heat environment, it can be seen that the upper surface and side surface of the segmented block box are relatively broken. Through the form leveling and land division of the block box, it is convenient for us to read the form information of the block box, convert it into specific partition control content and feed back to the urban design plan (Fig.12).

With boxes of the divided science and technology blocks numbered, three boxes of science and technology blocks are divided according to the actual land demand. Compared with the original science and technology block box before optimization, the sunlight optimized science and technology urban block boxes have a control height partition (150m, 120m, 100m, 70m). Under the optimization of wind and heat environment, the additional ventilation corridor and open space are converted into urban branch road and green space. From the block plane information fed back to the detailed regulatory planning, it can be found that the original single science and technology urban plot is further divided into four plots, including three commercial and business plots and green space plot. Each plot allows local adjustment of the plot ratio due to changes in land area and height control. Finally, the planning indicators and specific control graphic content are obtained (Fig.13, Tab.2, Fig.14).

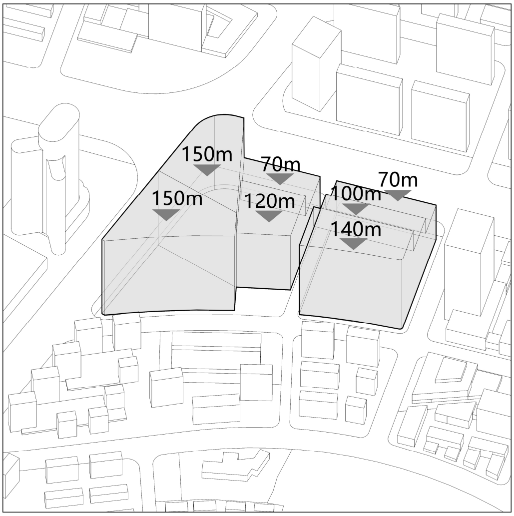

Fig. 12. The block box after flatting the upper surface height.

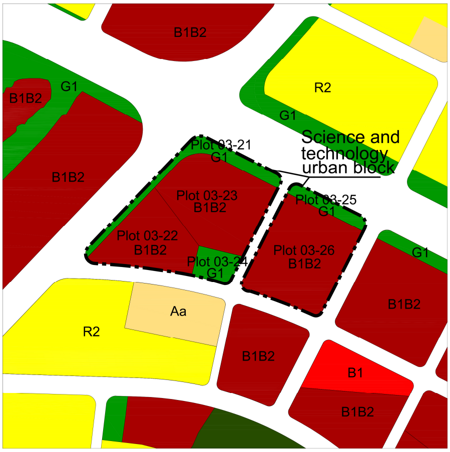

Fig. 13. Optimized detail regulatory planning of the science and technology urban blocks.

Table 2. The optimized plot control index of the science and technology urban blocks.

Plot Code	Land Code	Land use	Site Area（ha）	Building height control (m)
03-21	G1	Green space	0.56	---
03-22	B1B2	Commercial and business	1.27	150
03-23	B1B2	Commercial and business	1.87	120
03-24	G1	Green space	0.31	---
03-25	G1	Green space	0.26	---
03-26	B1B2	Commercial and business	2.04	100

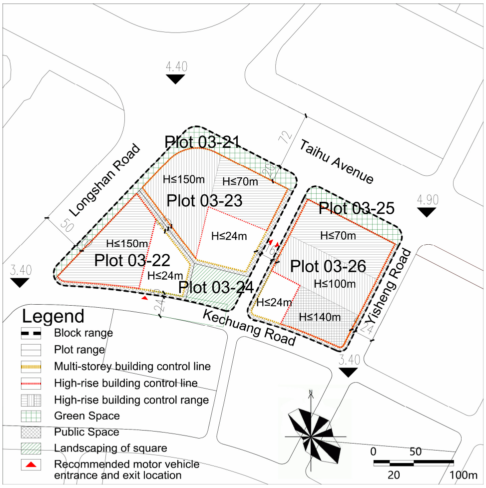

Fig. 14. Optimized urban design code of the science and technology urban blocks.

Finally, according to the content of the feedback of the block form control, the architectural texture layout is arranged within the box of the scientific research block as a concrete example of the block form design. As Suzhou is located in the hot summer and cold winter zone of China, the enclosed architectural texture is preferred, and the plate and point texture with enclosed form is selected (Fig.15). It can be found in the verification of the wind and heat environment after the specific form design that the overall wind and heat conditions of the scientific research block are better. The increased urban branch and square help to improve the wind environment inside the scientific research block. There are fewer calm wind areas inside the block, and the local average wind speed reaches 2.4 m/s (Fig.16). The open space of the block also makes the heat environment around the research block more comfortable, and the maximum temperature around the typical day in summer is not more than 33 °C (Fig.17).

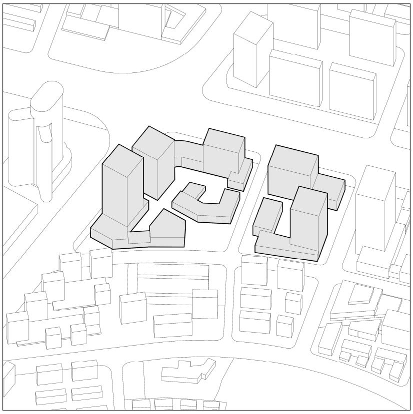

Fig. 15. An example of the science and technology urban blocks form design.

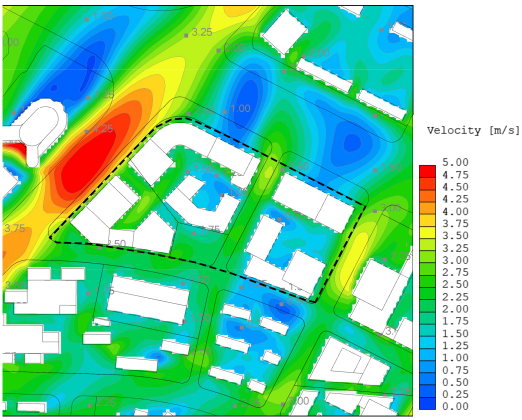

Fig. 16. Wind environment simulations of the science and technology urban block in summer.

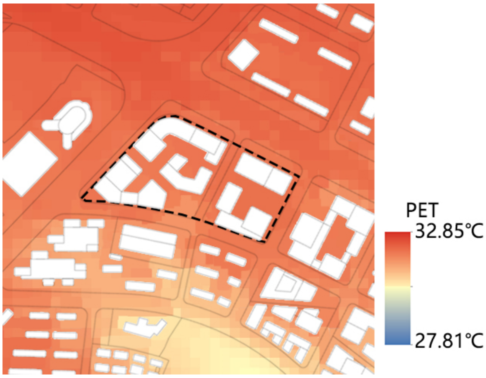

Fig. 17. Heat environment simulations of the science and technology urban block around the typical day in summer.

4 CONCLUSION AND DISCUSSION

Based on the case of the morphological optimization of the science and technology urban block in the core area of Suzhou Science and Technology City, we put forward three research objectives through the operation method of the block box, including the optimization of the microclimate environment of the block, the design process of the block form, and the control of the block form, so as to construct the fine control content and morphological optimization method of the block form to adapt to the microclimate.

Responding to objective 1, it is helpful to improve the climate adaptability of the urban space by optimizing the block form of the multi-factor comprehensive simulation of sunlight, wind and heat environment, which further optimizing the single index of the block shape according to the control intensity. The optimization of the sunlight environment is reflected in the change of the control height of the block to ensure the sunlight rights of the block and surrounding buildings. The possibility of secondary segmentation of the block through the setting of the ventilation corridor is to increase the windward capacity around the block, further create the possibility of building ventilation, and realize the optimization of the wind environment. The optimization of heat environment can improve the ventilation and heat dissipation around the block through the setting of open space.

Moreover, two issues require further consideration. Firstly, we select the case as the scientific research block, the land use of the block is single and the surrounding urban environment is relatively simple. Therefore, we select the single index of each environmental factor (sunlight duration, wind direction and wind speed, air temperature) as the optimization content. However, for the complex urban spatial environment, there are some differences in the selection of the number of sunlight, wind and heat environment indicators, which related coupling remains to be further studied. Secondly, in the multi-factor optimization of microclimate environment, whether to gradually optimize according to the order of sunlight-wind-heat environment still needs further discussion. Based on the operability of the block box, the boundary and height control indicators of the block box are based on China 's planning and control efforts, corresponding to the relevant indicators of sunlight, wind and heat environment, which simplifies the correlation between the block box and the shape optimization to a certain extent. Whether there is an optimization order of other environmental factors is still worthy of further discussion.

Responding to objective 2, the advance of climate consideration to the front of the block form design, provides the ability to actively adapt to the climate for the block design, which will help to improve the deepening efficiency of the later form deepening design and ensure that the specific form plan will not have a large deviation in climate adaptation. Under this objective, there is an issue to be further considered: The block box is to express the possibility of the maximum form control of the block. It is a control language, which does not represent the form of the block after the final construction. There is a certain deviation from the actual situation in the simulation and calculation of the multi-elements of the micro-climate environment, but it can still have certain reference value. Therefore, we suggest that the sunlight, wind and heat environment should be checked again after the detailed design of the specific form.

Responding to objective 3, in the aspect of block control, through the optimized block box, according to the control index content represented by the block box, it is translated into the content of urban design planning code with control index and intention. These are helpful for planning managers to realize the fine management and control of blocks, and for builders to help interpret the relevant content of planning control more intuitively and clearly in the actual development and construction of blocks.

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