Dissertation Submitted to Politecnico di Milano for the Laurea Magistrale

Optimizing research of block-scale urban renewal project based on summer's microclimate and thermal comfort simulation -- case study of Shanghai

Candidate：	Yin Zheng
Student ID:	10669163
Supervisor：	Prof. Ma Wenjun/ Prof. Eugenio Morello
Academic Degree Applied for：	Laurea Magistrale
Speciality：	Architecture
Date of Defence：	Feb, 2020
Degree-Conferring-Institution：	Politecnico di Milano–Double Degree

Optimizing research of block-scale urban renewal project based on summer’s microclimate and thermal comfort simulation -- case study of Shanghai

ABSTRACT

Under the background of global climate change and rapid development of cities, urban climate problems are increasingly prominent, resulting in the deterioration of urban environment. Taking Shanghai as an example, with the rapid development in recent decades, the land in the central urban area is becoming increasingly saturated. In the future, on the one hand, the land will change from incremental development to stock development; on the other hand, due to the deterioration of urban environment, urban renewal will be an effective means to guide urban development. In recent years, the urban extreme climate occurs frequently, and the bad outdoor environment microclimate in summer seriously affects the outdoor thermal comfort and pedestrian activities. However, in the traditional urban renewal methods, the quantitative simulation method is rarely used to analyze the microclimate of the block. This paper focuses on the situation of urban microclimate and outdoor thermal comfort under the hot and humid weather in summer. Firstly, by analyzing the correlation between urban block factors and microclimate of scholars at home and abroad, as well as the block microclimate research of different cases, it summarizes the urban renewal strategy based on microclimate optimization, and then combines the characteristics of urban renewal projects in Shanghai, through urban renewal Envi-met quantitative simulation of the city microclimate software focuses on how to systematically guide the urban renewal and development of Shanghai through the strategy of microclimate and thermal comfort, and discusses the environmental factors of block construction, project management process and other aspects, and studies two different types of urban renewal projects, Caoyang village and Shanghai Music Valley, as examples of pre-evaluation projects, also taking the planning and design scheme of a waste land near the Bund as a case of post evaluation of urban renewal project. The purpose is to study the characteristics and problems of microclimate environment, this paper puts forward strategies and optimization methods for microclimate and thermal comfort of blocks. Finally, according to the different renewal methods of Shanghai urban renewal project, the optimizing strategies and methods of microclimate and thermal comfort in planning, design and management process in Shanghai are summarized.

KEY WORDS: Microclimate, Thermal comfort, Block-scale, Urban renewal, Envi-met

Contents

ABSTRACT ······ II
CHAPTER ONE: INTRODUCTION ······ 1
1.1 Background ······ 1
1.1.1 Urban climate ······ 1
1.1.2 Urban renewal and development of Shanghai ······ 1
1.1.3 Microclimate and thermal comfort ······ 2
1.1.4 Computer numerical simulation technology ······ 3
1.2 Research purpose and significance ······ 3
1.2.1 Research purpose ······ 3
1.2.2 Research significance ······ 4
1.3 Research progress at home and abroad ······ 4
1.3.1 Research progress of urban microclimate and thermal comfort ······ 4
1.3.2 Research progress on the combination of urban renewal with urban microclimate and thermal comfort ······ 7
1.3.3 Literature summary ······ 8
1.4 Research content, research method and related concept definition ······ 8
1.4.1 Research content ······ 8
1.4.2 Research method ······ 10
1.4.3 Related concept definition ······ 11
CHAPTER TWO: MICROCLIMATE AND THERMAL COMFORT OPTIMIZATION STRATEGY OF URBAN RENEWAL IN SHANGHAI ······ 13
2.1 Optimization strategy guided by controllable factors of urban blocks ······ 13
2.1.1 Building density and height ······ 13
2.1.2 SVF ······ 14
2.1.3 Building layout ······ 15
2.1.4 Green space rate, green layout and water body ······ 16
2.1.5 Flooring materials ······ 17
2.2 Design strategy oriented optimization strategy ······ 17
2.2.1 Create shadow areas ······ 18
2.2.2 Create air duct ······ 18
2.2.3 Optimize the surface materials of the block ······ 21
2.2.4 Increase and optimize plants and water bodies ······ 22
2.3 Summary of this chapter ······ 23

CHAPTER THREE: NUMERICAL SIMULATION METHOD OF MICROCLIMATE AND THERMAL COMFORT OF URBAN BLOCK ···························24
3.1 Urban Microclimate Simulation Software Envi-met ···························24
3.1.1 Introduction of Envi-met ···························24
3.1.2 Simulation process of Envi-met ···························25
3.1.3 Effectiveness of simulation results and software advantages of Envi-met ·27
3.2 Software simulation accuracy verification of Envi-met ···························28
3.2.1 Measuring tools and methods ···························28
3.2.2 Verification of actual measurement and simulation results ···························29
3.3 Simulation boundary conditions and evaluation methods of Envi-met ···························30
3.3.1 Boundary condition setting ···························30
3.3.2 Relevant parameters and evaluation methods ···························31
3.4 Preliminary simulation analysis of optimization strategy ···························32
3.4.1 Simulation results of basic model ···························33
3.4.2 Simulation results of control group ···························34
3.5 Summary of this chapter ···························37
CHAPTER FOUR: IMPLEMENTATION PROCESS OF SHANGHAI URBAN RENEWAL PROJECT AND SIMULATION OF MICROCLIMATE AND THERMAL COMFORT OF REPRESENTATIVE PROJECTS ···························39
4.1 Current situation and background of Shanghai Urban Renewal Project ···························39
4.1.1 Background and development history ···························39
4.1.2 Pilot project of urban renewal ···························40
4.2 Microclimate and thermal comfort simulation analysis of four representative urban renewal block projects ···························41
4.2.1 Current situation and layout analysis ···························42
4.2.2 Microclimate and thermal comfort analysis of the block ···························43
4.2.3 Microclimate and thermal comfort improvement methods ···························47
4.3 Research on the implementation process of Shanghai Urban Renewal Project ·48
4.3.1 Policy and planning management process ···························48
4.3.2 Pre-evaluation and post-evaluation ···························49
4.4 Summary of this chapter ···························51
CHAPTER FIVE: SIMULATION AND OPTIMIZATION OF MICROCLIMATE AND THERMAL COMFORT IN PRE-EVALUATION OF URBAN RENEWAL PROJECT ···························53
5.1 Background of case block ···························53
5.2 Simulation and evaluation of Caoyang village ···························54

5.2.1 Block modeling ··· 55
5.2.2 Analysis of distribution and feature selection of thermal comfort in blocks 56
5.2.3 Microclimate characteristics and analysis of block ··· 60
5.2.4 Correlation analysis of Microclimate Characteristics and thermal comfort · 62
5.3 Simulation and evaluation of Shanghai Music Valley ··· 64
5.3.1 Block modeling ··· 64
5.3.2 Analysis of distribution and feature selection of thermal comfort in blocks 66
5.3.3 Microclimate characteristics and analysis of block ··· 70
5.3.4 Correlation analysis of Microclimate Characteristics and thermal comfort · 71
5.4 Summary and optimization method of microclimate and thermal comfort of case block ··· 73
5.4.1 Summary of microclimate and thermal comfort of block ··· 73
5.4.2 Optimization method and evaluation of Caoyang first village block ··· 74
5.4.3 Optimization method and evaluation of Shanghai Music Valley block ··· 78
5.4.4 Comparison of case block optimization methods ··· 82
5.5 Summary of this chapter ··· 83
CHAPTER SIX: SIMULATION AND OPTIMIZATION OF MICROCLIMATE AND THERMAL COMFORT IN POST-EVALUATION OF URBAN RENEWAL PROJECT ··· 85
6.1 Background and introduction of design scheme ··· 85
6.1.1 Project background ··· 85
6.1.2 Introduction of design scheme ··· 86
6.2 Simulation of design scheme ··· 87
6.2.1 Block modeling of design scheme ··· 87
6.2.2 Thermal comfort simulation of design scheme ··· 87
6.2.3 Microclimate Simulation of design scheme ··· 89
6.3 Post evaluation and optimization of design scheme ··· 90
6.3.1 Advantage analysis of microclimate and thermal comfort of design scheme ··· 90
6.3.2 Analysis of design scheme microclimate and thermal comfort ··· 91
6.3.3 Optimization method of design scheme ··· 94
6.4 Summary of this chapter ··· 94
CHAPTER SEVEN: CONCLUSION AND PROSPECT ··· 95
7.1 Strategies and optimization methods for microclimate and thermal comfort of Shanghai Urban Renewal Project ··· 95
7.1.1 Microclimate and thermal comfort strategy of Shanghai urban renewal

project in planning and design ········· 95
7.1.2 Microclimate and thermal comfort strategies in the management process of Shanghai Urban Renewal Project ········· 98
7.2 Conclusion and innovation ········· 99
7.3 Future research ········· 101
REFERENCE ········· 103

Catalogue

FIG 2-1 TOP LEFT: DETERMINANT; TOP RIGHT: POINT GROUP; BOTTOM LEFT: ENCLOSING; BOTTOM RIGHT: SVF DIAGRAM 15
FIG 2-2 LEFT: ARCHITECTURAL SHADOW; MIDDLE: LANDSCAPE SHADOW; RIGHT: INSTALLATION SHADOW 18
FIG 2-3 ANALYSIS OF THE INFLUENCE OF THE PERMEABILITY OF THE MAIN SECTION ON THE VENTILATION OF THE BLOCK 20
FIG 2-4 REFERENCE MAP OF URBAN LINEAR PARK 20
FIG 2-5 GROUND FLOOR OVERHEAD REFERENCE DRAWING 21
FIG 2-6 MULTI LEVEL GREENING REFERENCE MAP 22
FIG 2-7 WATER REFERENCE MAP OF URBAN BLOCK 23
FIG 3-1 STRUCTURE DIAGRAM OF ENVI-MET MODEL [31] 25
FIG 3-2 INTERFACE DIAGRAM OF ENVI MET OPERATION MODULE 26
FIG 3-3 INTERFACE DIAGRAM OF SPACES MODELING MODULE IN ENVI MET 26
FIG 3-4 BIO MET OPERATION INTERFACE AND SETTING DIAGRAM 27
FIG 3-5 REFERENCE DIAGRAM OF PHOENIX SIMULATION RESULTS 28
FIG 3-6 LEFT: TR-76UI; RIGHT: STUDENT DORMITORY AREA OF MINHANG CAMPUS OF SHANGHAI JIAOTONG UNIVERSITY 29
FIG 3-7 COMPARISON OF MEASURED AND SIMULATED AIR TEMPERATURE IN THE DORMITORY AREA OF BUILDING 23, MINHANG CAMPUS, SHANGHAI JIAOTONG UNIVERSITY 30
FIG 3-8 COMPARISON OF MEASURED AND SIMULATED RELATIVE HUMIDITY IN THE DORMITORY AREA OF BUILDING 23, MINHANG CAMPUS, SHANGHAI JIAOTONG UNIVERSITY 30
FIG 3-9 AERIAL VIEW OF EACH GROUP OF MODELS 33
FIG 3-10 SIMULATION RESULTS OF BASIC MODEL 33
FIG 3-11 PMV DIAGRAM OF GROUP A SIMULATION RESULTS 34
FIG 3-12 B AND C SIMULATION RESULTS AND PMV DIFFERENCE DIAGRAM OF BASIC MODEL 35
FIG 3-13 D AND E SIMULATION RESULTS AND PMV DIFFERENCE DIAGRAM OF BASIC MODEL 36
FIG 4-1 FOUR MAJOR RENEWAL ACTION PLANS OF SHANGHAI IN 2016 [67] 40
FIG 4-2 PHASE I PLAN OF BRIDGE 8 41
FIG 4-3 PMV DRAWING OF NO.8 BRIDGE, 800XIU, JINGUYUAN AND SHANGGONG NEW VILLAGE 43
FIG 4-4 AVERAGE RADIATION TEMPERATURE MAP OF NO.8 BRIDGE, 800XIU, JINGUYUAN AND SHANGGONGXIN VILLAGE 44
FIG 4-5 AIR TEMPERATURE MAP OF NO.8 BRIDGE, 800 SHOW, JINGUYUAN AND SHANGGONG NEW VILLAGE 45
FIG 4-6 WIND SPEED MAP OF NO.8 BRIDGE, 800XIU, JINGUYUAN AND SHANGGONG NEW VILLAGE 46
FIG 4-7 LEFT: FOUNTAIN, BRIDGE 8; RIGHT: OUTDOOR SUNSHADE SEAT, 800 SHOW 47
FIG 4-8 LEFT: JINGUYUAN; RIGHT: SHANGGONG NEW VILLAGE 48
FIG 4-9 SCHEMATIC DIAGRAM OF SHANGHAI'S CURRENT URBAN RENEWAL ORGANIZATION [68] 48
FIG 4-10 FLOW CHART OF CURRENT URBAN RENEWAL PLANNING IN SHANGHAI [68] 49
FIG 4-11 DISTRIBUTION OF PILOT PROJECTS OF "WALKING IN SHANGHAI - COMMUNITY SPACE MICRO RENEWAL PLAN" IN 2016 AND 2017 [70] 50
FIG 4-12 FLOW CHART OF URBAN MICROCLIMATE ASSESSMENT SCHEME [71] 51
FIG 5-1 BIRD'S-EYE VIEW AND CURRENT SITUATION REFERENCE MAP OF CAOYANG VILLAGE [73] 54
FIG 5-2 AERIAL VIEW AND PANORAMIC REFERENCE OF SHANGHAI MUSIC VALLEY 54

FIG 5-3 TOP VIEW AND AERIAL VIEW OF ENVI MET MODEL OF CAOYANG VILLAGE 55
FIG 5-4 PMV OF CAOYANG VILLAGE 56
FIG 5-5 DISTRIBUTION AND PROPORTION OF PMV IN CAOYANG VILLAGE 57
FIG 5-6 CHARACTERISTIC POINT SELECTION MAP OF CAOYANG VILLAGE 57
FIG 5-7 WIND SPEED DIAGRAM, AIR TEMPERATURE DIAGRAM AND RELATIVE HUMIDITY DIAGRAM OF CAOYANG FIRST VILLAGE 60
FIG 5-8 AVERAGE RADIATION TEMPERATURE AND SKY ANGLE COEFFICIENT OF CAOYANG VILLAGE 60
FIG 5-9 ENVI MET MODEL OF SHANGHAI MUSIC VALLEY 65
FIG 5-10 PMV MAP OF SHANGHAI MUSIC VALLEY 66
FIG 5-11 DISTRIBUTION AND PROPORTION OF PMV IN SHANGHAI MUSIC VALLEY 67
FIG 5-12 FEATURE POINT MAP OF SHANGHAI MUSIC VALLEY 67
FIG 5-13 WIND SPEED DIAGRAM, AIR TEMPERATURE DIAGRAM AND RELATIVE HUMIDITY DIAGRAM OF SHANGHAI MUSIC VALLEY 70
FIG 5-14 AVERAGE RADIATION TEMPERATURE AND SKY ANGLE COEFFICIENT OF SHANGHAI MUSIC VALLEY 70
FIG 5-15 THERMAL COMFORT DISADVANTAGEOUS SPACE IN CAOYANG FIRST VILLAGE 75
FIG 5-16 THE STRATEGY TO GET THROUGH THE ADVERSE POINTS OF WIND SPEED IN CAOYANG VILLAGE (LOCAL) 75
FIG 5-17 STRATEGY OF REDUCING OPEN SPACE IN CAOYANG VILLAGE (LOCAL) 76
FIG 5-18 PMV DIAGRAM OF CAOYANG FIRST VILLAGE OPTIMIZATION PLAN 76
FIG 5-19 MICROCLIMATE PARAMETER DIAGRAM OF THE OPTIMIZATION SCHEME OF CAOYANG VILLAGE 77
FIG 5-20 PMV COMPARISON OF OPTIMIZATION SCHEME OF CAOYANG FIRST VILLAGE 78
FIG 5-21 SHANGHAI MUSIC VALLEY BLOCK SPACE THERMAL COMFORT DISADVANTAGEOUS SPACE 79
FIG 5-22 STRATEGY OF INCREASING VEGETATION IN MUSIC VALLEY LANE OF SHANGHAI 80
FIG 5-23 THE STRATEGY OF INCREASING VEGETATION IN SHANGHAI MUSIC VALLEY BLOCK SPACE (PARTIAL) 80
FIG 5-24 PMV CHART OF SHANGHAI MUSIC VALLEY OPTIMIZATION PLAN 80
FIG 5-25 MICROCLIMATE PARAMETERS OF SHANGHAI MUSIC VALLEY OPTIMIZATION SCHEME 81
FIG 5-26 PMV COMPARISON OF SHANGHAI MUSIC VALLEY OPTIMIZATION SCHEME 82
FIG 5-27 LEFT: PMV DIFFERENCE DIAGRAM OF OPTIMIZATION SCHEME OF CAOYANG FIRST VILLAGE; RIGHT: PMV DIFFERENCE DIAGRAM OF OPTIMIZATION SCHEME OF SHANGHAI MUSIC VALLEY 82
FIG 6-1 LEFT: SATELLITE MAP OF THE PROJECT BLOCK; RIGHT: CURRENT SITUATION MAP OF THE PROJECT 85
FIG 6-2 AERIAL VIEW OF THE DESIGN, CARLOS IGNACIO CARRENO YEPES, 2019 86
FIG 6-3 DESIGN SCHEME OUTDOOR SPACE RENDERINGS, CARLOS IGNACIO CARRENO YEPES, 2019 86
FIG 6-4 DESIGN PLAN ENVI MET MODEL TOP VIEW AND AERIAL VIEW 87
FIG 6-5 PMV DIAGRAM AT 1.5M LEVEL OF DESIGN SCHEME 88
FIG 6-6 PMV DIAGRAM AT 6.5M LEVEL OF DESIGN SCHEME 88
FIG 6-7 MICROCLIMATE PARAMETER DIAGRAM AT THE LEVEL OF 1.5M IN THE DESIGN SCHEME 89
FIG 6-8 MICROCLIMATE PARAMETER DIAGRAM AT THE LEVEL OF 6.5M IN THE DESIGN SCHEME 90
FIG 6-9 DESIGN SCHEME COURTYARD SPACE RENDERINGS, CARLOS IGNACIO CARRENO YEPES, 2019 91
FIG 6-10 VENTILATION ANALYSIS DIAGRAM OF DESIGN SCHEME BLOCK 91
FIG 6-11 ANALYSIS DIAGRAM OF THERMAL COMFORT UNFAVORABLE SPACE IN OUTDOOR SPACE OF DESIGN SCHEME 92
FIG 6-12 ANALYSIS DIAGRAM OF ADVERSE SPACE OF MICROCLIMATE ON THE ROAD ADJACENT TO THE DESIGN SCHEME 93
FIG 6-13 ANALYSIS DIAGRAM OF MICROCLIMATE ADVERSE SPACE OF ROOF PLATFORM (+ 6.5M) IN DESIGN SCHEME 93

Table

TABLE 3-1 PARAMETER SETTING OF ENVI MET SIMULATION BOUNDARY CONDITION 31
TABLE 3-2 RELATIONSHIP BETWEEN PMV VALUE AND THERMAL COMFORT 32
TABLE 3-3 MODEL COMPARISON SIMULATION INFORMATION TABLE 32
TABLE 3-4 PMV VALUE OF CONTROL GROUP MODEL AND COMPARISON WITH BASIC MODEL 36
TABLE 4-1 BOTTOM ANALYSIS AND ENVI MET MODEL TABLE 42
TABLE 5-1 PMV VALUE AND ENVIRONMENTAL CHARACTERISTICS OF CHARACTERISTIC POINTS IN CAOYANG VILLAGE.. 58
TABLE 5-2 NUMERICAL TABLE OF MICROCLIMATE PARAMETERS OF CHARACTERISTIC POINTS IN CAOYANG VILLAGE..... 62
TABLE 5-3 CORRELATION ANALYSIS OF PMV AND MICROCLIMATE PARAMETERS AT CHARACTERISTIC POINTS IN CAOYANG VILLAGE 63
TABLE 5-4 PMV VALUE AND ENVIRONMENTAL CHARACTERISTICS OF CHARACTERISTIC POINTS IN SHANGHAI MUSIC VALLEY 68
TABLE 5-5 NUMERICAL TABLE OF MICROCLIMATE PARAMETERS AT CHARACTERISTIC POINTS OF SHANGHAI MUSIC VALLEY 71
TABLE 5-6 CORRELATION ANALYSIS OF PMV VALUE AND MICROCLIMATE PARAMETERS OF SHANGHAI MUSIC VALLEY... 72
TABLE 7-1 SUGGESTIONS ON MICROCLIMATE STRATEGY OF SHANGHAI URBAN RENEWAL PROJECT 95

Chapter one: Introduction

1.1 Background

1.1.1 Urban climate

At present, China is in the period of rapid development of cities. In the process of high-speed and high-intensity development, the problems of urban climate and physical environment are becoming increasingly serious, which further affects the ecological and sustainable development of cities. The impact of large-scale construction on urban environment changes land use and urban underlying surface properties in urban development, resulting in the urban heat island effect. At the same time, due to the large amount of heat produced by industrial production, daily life, automobile exhaust, etc., the temperature of urban environment has increased, further aggravating the bad urban climate.

Urban climate has become a global concern. The urban climate environment makes the economic and social development face major challenges. Taking Shanghai as an example, due to the aggravation of urban climate problems, the climate conditions in summer continue to deteriorate. According to statistics, the frequency of extreme high temperature weather days in Shanghai has increased significantly in recent years [1]。The deterioration of city climate leads to the frequent occurrence of extreme weather day. It not only has a serious impact on Residents' daily life, but also directly causes incidence rate of respiratory diseases, cardiovascular diseases and other related diseases.

With the increasing urgency of urban climate issues, many scholars began to combine urban planning and design with climate related issues. For example, from the perspective of global climate change, the research progress of adaptive planning to deal with climate change in many countries was studied [2].The methods to deal with urban climate problems are usually divided into mitigation strategies and adaptation strategies. Mitigation strategies are mainly realized by reducing human emissions, while adaptation strategies are mainly realized by improving urban spatial morphology and optimizing urban ecology [3].

1.1.2 Urban renewal and development of Shanghai

Since the 1980s, Shanghai has experienced a period of large-scale development and rapid expansion of the city. In the process of rapid development of the city, there are many urban problems. Compared with the newly built urban blocks in the process of large-scale urban construction, the construction quality, supporting services and facilities of the old urban blocks are obviously backward, and the old urban blocks are gradually declining. Nowadays, Shanghai has gradually entered a new stage of high-quality development by rethinking and exploring the urban development and strengthening the control of large-scale urban construction. At present, the land supply in Shanghai is very tight. The city's plan proposes to control the zero increment of construction land in 2020, and the scale of land use will be controlled within 3226 square kilometers. The speed of large-scale urban construction has slowed down due to land, policy and other factors. As a result, the current situation of the dilapidated old blocks in Shanghai and the slow down urban construction speed have brought new opportunities to the urban renewal of Shanghai. At present, Shanghai has clearly pointed out that the city will transform from incremental development to stock development. There are many types of urban renewal projects in Shanghai, including old industrial land, old town, old residential area, old shantytown, old commercial office area, waterfront space, etc. the overall urban renewal volume is very large. In 2014, Shanghai municipal government issued the guiding opinions on the preparation of a new round of urban master plan in Shanghai and several opinions on further improving the level of land conservation and intensive use in this city, which clearly put forward the requirements of "total locking, incremental decline, stock optimization, flow efficiency increase, quality improvement"[4].

1.1.3 Microclimate and thermal comfort

Urban microclimate is a study between urban climatology and architectural climatology, involving many disciplines such as climatology, physical geography, urban planning and so on. According to the related literature, the microclimate of urban block is mainly affected by four aspects, namely, regional climate conditions, urban morphology characteristics, urban ecological characteristics and human heat emissions [5].Different characteristics of urban blocks will produce different physical environment conditions under the influence of the same regional climate conditions. The microclimate will be affected by the air temperature, relative humidity and other aspects of the block.

The thermal comfort of urban outdoor space is closely related to people's daily work and life. The quality of outdoor thermal comfort directly affects people's feeling and physical and mental health in outdoor space. Many factors, such as air temperature, relative humidity, wind speed and average radiation temperature, will affect people's thermal comfort in outdoor space. At present, PMV (predicted mean vote) model, PMV-PPD (predicted percentage of dissatisfied) modified model, physiological equivalent temperature pet (physical equivalent temperature), universal thermal climate (UTCI) are widely used in thermal comfort evaluation indexes Index), standard effective temperature, etc [5]. In recent years, many scholars have carried out relevant research on microclimate and thermal comfort. Through the simulation of many factors, such as the form of built environment, vegetation, water body, surface materials, etc., to study the impact on the outdoor microclimate and pedestrian thermal comfort in summer [6]. The simulation research on outdoor thermal comfort has also been carried out in other regions of the world, and the relevant evaluation methods have been reviewed and summarized, and the future research direction has been put forward [7].

In the long run, the sustainable development of the city is inseparable from the high-quality urban environment. Microclimate and thermal comfort have a close impact on the quality of urban outdoor environment, as well as people's satisfaction with outdoor environment in life, work and other aspects.

1.1.4 Computer numerical simulation technology

With the rapid development of computer technology, the research on urban environment is not limited to field measurement, questionnaire survey, experience summary and other ways. More and more computer numerical simulation technology is used. Through quantitative simulation and analysis of various physical environment factors, more scientific basis is provided for urban planning and design. With its powerful simulation and data processing capabilities, as well as its flexible and efficient features, the computer numerical simulation technology has the advantages that field measurement, research and other methods do not have, and will become the main means to study the urban microclimate in the future. Moreover, the application scope of computer numerical simulation technology has now covered the macro and medium aspects from urban planning and design to single building design Multiple scales such as view and micro scale[8].

1.2 Research purpose and significance

1.2.1 Research purpose

Urban renewal is the only way for a city to develop to a certain stage. At present, Shanghai is in an important stage of urban renewal, and the total volume of renewal is very large. The success of each urban renewal project will have an important impact on the development of its neighborhood and even the whole city. With the deterioration of urban climate in summer, the microclimate and thermal comfort of the block scale directly affect people's daily life. By combining microclimate and thermal comfort with urban renewal project in Shanghai, the optimization methods of urban renewal project in planning, design and management process are put forward. The purpose of this paper is to provide microclimate and thermal comfort simulation methods and relevant strategies and suggestions for planners, designers, urban managers and other groups.

1.2.2 Research significance

The purpose of block planning and design of high quality urban environment should be to achieve the comprehensive environmental comfort of blocks. Whether the city is livable is directly related to the quality of urban outdoor space. Creating a good outdoor urban environment is an important content in the process of urban renewal [9]. The research on urban microclimate and thermal comfort started late in China. Although China gradually began to pay attention to the requirements of urban environmental quality in the process of urban development, put forward the development concept such as ecological city, and required the coordinated development of urban construction and environment, the current relevant standards and analysis methods are not comprehensive, and the planning and design strategies generally stay in the qualitative analysis stage.

Based on the summer microclimate and thermal comfort, this paper systematically puts forward the optimization strategy of microclimate and thermal comfort through the study of urban renewal project in Shanghai, and puts forward strategies and suggestions on the planning, design, management process and other aspects of urban renewal project, which is of great significance to guide the scientific development of urban renewal in Shanghai.

1.3 Research progress at home and abroad

1.3.1 Research progress of urban microclimate and thermal comfort

For urban planning designers, controllable factors are the key points to improve urban microclimate and thermal comfort through planning and design methods, mainly including urban block construction factors and urban block ecological characteristics. Urban block building factors mainly include building layout type, building density, building height, sky angle coefficient and other factors to represent the geometric characteristics of urban block space, as well as factors such as paving material, building facade material and building roof material to represent the surface material type of urban block. The ecological characteristics of urban blocks mainly include green space rate, green layout, water layout and other factors [5]. In the research of urban microclimate and thermal comfort at home and abroad, the single or comprehensive factors of controllable factors are mostly studied.

（1）Spatial geometry, microclimate and thermal comfort

The difference of microclimate factors caused by the different spatial geometric characteristics of urban blocks results in different wind and heat environments. Mohammad taleghani (2015) studied the spatial form, microclimate and thermal comfort of various urban blocks in the Netherlands [10]. Zhao Dong (2016) studied the influence of spatial form of residential quarters on Microclimate [11]. Yuan Chao (2010) took Hong Kong as an example to study how to deal with the urban heat island effect under the premise of maintaining the land utilization rate by adjusting the building density and building height in the high-density urban environment [12]. Li Han (2016) studied how architectural layout patterns affect microclimate [13]. Tania Sharmin (2017) focused on the effects of aspect ratio and sky angle coefficient on microclimate and thermal comfort [14].

（2）Surface material type, microclimate and thermal comfort

Different ground, building facade and roof materials of urban blocks will affect the heat storage capacity and the ability of reflecting radiant heat of the blocks, resulting in different microclimate conditions of the blocks. Salman shooshtarian (2018) and Mohammad (2018) proposed to use permeable, light colored and appropriate reflectivity ground materials to optimize the microclimate of the block. For the building facade and roof, although the material will produce more radiant heat due to reflection, the light color and high reflectivity building facade and roof material can reduce the surface temperature and the air temperature of the nearby space, so most studies still recommend the use of green facade, green roof and other ways are more conducive to the building of microclimate in the block[15,16].

（3）Ecological characteristics, microclimate and thermal comfort

In terms of the ecological characteristics of urban blocks, a number of studies have confirmed the role of green space and trees in improving microclimate and thermal comfort of blocks. Chen Cheng (2015) found that with the increase of greening rate, the air temperature of the block will approach a certain value, and the microclimate impact of roof greening on pedestrian height will decrease with the increase of building height [17]. Yue Xiaozhi (2018) proposed to optimize the microclimate environment by increasing roof greening and other ways without changing the green space rate [18]. Zhang Wei (2015) and Ma Xiaoyang (2014) studied the influence of different green space layout and types on microclimate through quantitative analysis [19,20]. Chen Yu (2006) studied the impact of urban parks on the thermal environment through testing and simulation, and believed that urban parks not only have an optimization effect on their own microclimate, but also have a favorable impact on the surrounding built-up environment microclimate [21]. Teresa zolch (2016) found that trees have better influence on microclimate than roof and wall greening due to the shadow effect, but it can still improve the urban thermal environment through roof and wall greening if necessary [22]. Song Xiaocheng (2011) studied the impact of rivers on urban microclimate, and found that the regulation of rivers on the surrounding environment microclimate is related to river width, wind direction and other factors, and is subject to the difference in the distance between buildings and rivers and the layout of buildings [23].

（4）Comprehensive factors, microclimate and thermal comfort

Guo Linlin (2017) reviewed the progress and limitations of microclimate research at the block scale in China, and believed that the quantitative control of factors affecting microclimate can improve the effect of design strategies, and the microclimate research on the built environment needs to be increased [24]. Li Yue (2018) found the importance of floor area ratio, building density and building height on the microclimate of typical blocks in Shanghai. However, for the built blocks, the adjustment of details can still be used to optimize the microclimate [25]. Mohamad Fahmy (2009) studied how to improve the thermal comfort environment of a city block in Cairo [26]. Xu Mengjie (2017) studied how to create green travel in urban blocks through microclimate improvement with the example of Lingang ecological demonstration area [27]. Rao Junquan (2015) established the evaluation index system of thermal environment and thermal comfort based on the study of thermal environment evaluation of block scale in Guangzhou, and found that building density and floor number are the most sensitive factors to thermal environment evaluation index [28]. Yupeng Wang (2015) put forward corresponding strategies to slow down the heat island by simulating and analyzing three plots with different characteristics in Canada [29]. Liao Shijia (2012) focused on how to reduce the heat island effect of block scale through planning strategies [30]. Zheng Zihao (2016) combined urban 3D modeling with urban microclimate simulation, and pointed out the advantages of this analysis and simulation method [31]. Ariane middel (2013) demonstrated that block design based on microclimate improvement strategy can effectively improve the quality of microclimate and thermal comfort of block [32]. Lin Man(2013) studied the relationship between multiple factors and microclimate and thermal comfort in a typical residential area in Guangzhou [33]. Qin Wencui (2015) studied the influence of building layout, green layout and other factors on microclimate by simulation [34]. Li Lingshu et al. (2016) studied the impact of vegetation, street trend, street height to width ratio and other factors on the microclimate and thermal comfort environment of streets in summer [35].. Kristian Fabbri (2017) studied the microclimate distribution of three different vegetation in an archaeological area in Russia, Italy, in winter and summer [36]. Hamed Farhadi (2019) studied the improvement strategies of various factors through the simulation analysis of vegetation, building orientation, materials and other factors, so as to reduce the heat island effect [37]. Ferdinando Salata (2017) studied measures to alleviate outdoor microclimate by simulating factors such as vegetation and ground material properties [38].

1.3.2 Research progress on the combination of urban renewal with urban microclimate and thermal comfort

In the current research, the application of urban microclimate and thermal comfort is mostly simulated and analyzed by practical cases, and the improvement strategies of planning and design are put forward. Wang pin (2013) summarized the impact of current multiple factors on urban microclimate and the combination of urban climate and urban planning [39]. Lenghong (2014) referred to the experience of many countries in the world, and proposed that urban planning and design should be combined with microclimate environment optimization [40]. Lu Xingsheng (2018) obtained outdoor thermal comfort index by simulating a certain area of Shijingshan in Beijing, and proposed the method of landscape planning in urban renewal according to the distribution of thermal comfort index [41]. Li Xiaojun (2014) focused on the study of wind environment and analyzed the methods of urban renewal in a certain region of Shenzhen [42]. Peng Yi (2015) proposed strategies for urban renewal in terms of building layout, air duct design, green configuration, etc. through the simulation of wind and heat environment in the old urban area of Dazhimen, Wuhan [43]. Zheng Jian (2017) studied the current situation of the wind and heat environment in the traditional streets of Zhaoqing Fucheng through the method of multi factor scoring, and proposed the optimization and renewal scheme according to the wind and heat environment simulation [44]. Shiyuan (2012) proposed the optimization strategy of urban design in this area by simulating the outdoor environment of Xidan commercial street in winter and summer in Beijing [45]. Deng Shichao (2014) proposed the green renewal strategy of urban blocks from the aspects of physical environment, energy consumption, operation management, etc [46]. Wang Zhen (2008) proposed the overall layout strategy of urban blocks by simulating and analyzing the floor gap of blocks in hot summer and cold winter areas, and thought that the design strategy should focus on the dominant wind direction in summer when it can not be considered in summer and winter [47]. Tathiane A.L. Martins (2016) studied the influence of vegetation, water, building form, materials and other factors on outdoor microclimate and pedestrian thermal comfort, and proposed corresponding urban cold island design strategies [48]. Evyatar erell (2008) comprehensively studied many factors of coping with urban climate in the process of urban design, and related optimization methods and applications [49].

1.3.3 Literature summary

At present, the urban microclimate and thermal comfort conditions are the worst in summer, and have a great impact on the daily work and life of urban residents. Therefore, most of the research focuses on the urban summer. In general, some progress has been made in the study of urban microclimate and thermal comfort, and the combination of urban renewal with urban microclimate and thermal comfort. The research of various factors of urban environment and their application in planning and design have also been paid attention to. The analysis method and advantages through numerical simulation software have been gradually recognized Universal. However, most of the above literatures focus on one factor or several factors that affect the urban microclimate environment, or reveal the problem of an example, and study the optimization strategy for the example. There are three deficiencies: first, there are many factors that affect the microclimate and thermal comfort of urban blocks, including temperature, humidity, wind speed, radiation, etc Multi parameter, not limited to some factors, should be analyzed for various parameters; secondly, lack of systematic microclimate strategy research for a city or a region, and lack of universal applicable value in the city or the region only for a case study; thirdly, some of the microclimate and thermal comfort optimization strategies proposed in the case study, fail to take into account the reality For example, the characteristics of the project lack a certain degree of applicability.

1.4 Research content, research method and related concept definition

1.4.1 Research content

The research topic of this paper comes from the consideration of the current urban climate environment and the environmental problems in urban development. In recent years, the impact of climate change on urban development and urban life is more and more great. Taking Shanghai as an example, the highest temperature in history has been refreshed repeatedly in summer, and extreme weather days appear frequently. People's daily life and physical and mental health outside in summer are greatly affected. In addition, in the process of urban development, Shanghai has gradually transitioned from the extension expansion to the quantitative space development, which will bring huge urban renewal space for Shanghai.

Considering the above two aspects, this paper focuses on how to systematically guide the urban renewal and development of Shanghai through the strategies of microclimate and thermal comfort, discusses the environmental factors of block construction, project management process and other aspects, and summarizes the microclimate and thermal comfort strategies in planning, design and management process in the urban renewal project of Shanghai, In order to cope with the impact of summer extreme climate conditions on the urban environment. The main research contents are as follows:

First, through the analysis of the research progress, three main problems of the existing research are found. Then, taking Shanghai urban renewal project as the research object, the optimization strategy is systematically discussed in many aspects, and several parameters related to microclimate and thermal comfort are considered in the case simulation.

Secondly, from the two perspectives of the controllable factors of urban blocks and the design strategies, the optimization strategies of microclimate and thermal comfort of urban renewal projects in Shanghai are discussed respectively, and the application methods of relevant strategies are systematically elaborated. The controllable factors of urban blocks include building density, building height, sky angle coefficient, building layout, green space rate and green layout The design strategies include creating shadow areas, creating air ducts, optimizing the surface materials of blocks, increasing and optimizing plants and water bodies.

Thirdly, envi met is selected as the simulation software of this paper. The modeling process of envi met and the effectiveness of the software in urban microclimate simulation are discussed, and verified by the actual measurement. The influence of several main factors on the microclimate and thermal comfort of the block was quantitatively simulated by comparative analysis.

Fourthly, the paper studies the implementation process and representative projects of Shanghai urban renewal project, and proposes to add pre assessment and post assessment into the implementation process of urban renewal project. The representative projects are No. 8 bridge, 800xiu, Jinguyuan of Huayang street and shanggongxin village of Daning street. The microclimate and thermal comfort of the current layout of each project are analyzed by software simulation.

Fifthly, through the pre evaluation method, taking two typical urban renewal projects in Shanghai, Caoyang village 1 and Shanghai Music Valley as examples, the microclimate and thermal comfort status simulation, problem analysis and optimization research are carried out. Using envi met to simulate the thermal comfort PMV distribution map of the block, the characteristic points in different blocks are selected, and the open degree and shade of each characteristic point and each section are compared Then the microclimate factors in the block, such as air temperature, relative humidity, wind speed, average radiation temperature and sky angle coefficient, are simulated to analyze the influence of different block characteristics on microclimate and thermal comfort. Then through the research on the relationship between the characteristic point PMV value and each microclimate factor, and combining the characteristics of the two projects, the paper puts forward the targeted strategies, and compares the microclimate and thermal comfort of the optimized scheme with the current situation, so as to realize the optimization of the scheme.

Sixthly, through the method of post evaluation, the urban renewal design scheme of a vacant land near the Bund is simulated, the microclimate and thermal comfort of the street area in the scheme are studied, and the advantages and existing problems of the scheme are analyzed according to the simulation results, and further optimization methods are proposed.

Seventh, it classifies different types of urban renewal projects, puts forward the methods of optimizing microclimate and thermal comfort in Shanghai urban renewal projects, discusses from two aspects of planning, design and management process, and puts forward systematic strategies and process suggestions for urban renewal projects with different renewal methods.

1.4.2 Research method

（1）Literature induction

The research on microclimate and thermal comfort of block involves many subjects such as urban climatology, urban planning, ecology, etc. From the topic selection to the completion of the thesis, this paper refers to and draws lessons from a large number of domestic and foreign materials and relevant case practice, through the analysis of a large number of literature and the analysis of research methods and research focus, and cross studies the relationship between urban microclimate and thermal comfort and various factors of urban blocks, to understand the current situation of existing research, and to clarify the research focus.

（2）Numerical simulation method

The simulation and evaluation methods of urban microclimate and thermal comfort are generally divided into field measurement and numerical simulation. The numerical simulation method is widely used because it is fast and time-saving, and it can simulate the numerical distribution of all parameters in all spaces of the block. In this paper, envi met software is used to simulate the distribution of microclimate and thermal comfort of the block, which has the characteristics of fast experiment speed and rich simulation information, and the optimization strategy can be put forward according to the simulation results.

（3）Combination of numerical simulation and field measurement

In this paper, when the simulation accuracy of envi met is verified, No. 23 dormitory area in the east of Minhang campus of Shanghai Jiaotong University is selected, and the validity of envi met in Shanghai block Microclimate Simulation is verified by comparing the numerical simulation with the measured value.

（4）Combination of qualitative and quantitative methods

In this paper, through envi met simulation, we get the PMV correlation diagram and specific values of air temperature, relative humidity, wind speed, average radiation temperature and thermal comfort of urban blocks. By using the qualitative analysis of visualization diagram and quantitative analysis of numerical value, we study the microclimate and thermal comfort of urban blocks, and through the difference between the PMV values of simulation results, we quantitatively analyze the optimization strategies effectiveness.

1.4.3 Related concept definition

（1）Microclimate

Urban microclimate refers to the climate conditions in a certain area of the city, which affects people's daily life, work, health and other aspects. It is affected by natural factors such as temperature, humidity, wind, solar radiation and other factors, as well as the nature of underlying surface, human heat emission and other factors. The urban microclimate describes the urban scale in a small scale. Generally speaking, it describes the climate conditions with a horizontal scale of 1km and a vertical scale of 120m [5].

（2）Thermal comfort

Thermal comfort is the evaluation of people's satisfaction with the surrounding environment, which is usually related to the external physical environment, people's physiological feelings and people's psychological feelings. In the process of rapid urban development, the focus of the research is to improve the quality of daily living environment by improving the comfort of outdoor environment.

（3）Block scale

Block is an important factor in urban planning and a basic unit of urban structure. In this paper, the street scale refers to the spatial scale corresponding to the urban area composed of one or several adjacent blocks.

（4）Urban renewal

Urban renewal refers to the planned reconstruction activities through functional adjustment, environmental improvement, facility renewal, etc. to prevent urban recession. Urban renewal can be generally divided into three types: redevelopment, renovation and protection.

Chapter two: Microclimate and thermal comfort optimization strategy of urban renewal in Shanghai

In recent years, the number and frequency of extremely high temperature days in Shanghai have increased significantly [50]. The thermal comfort of outdoor work and stay in hot and humid environment is very poor, which affects the work efficiency and work safety of corresponding types of work, and reduces the use of outdoor public space by the public. Especially in the built-up area of the city center, due to the high building density, serious surface hardening, more rivers and lakes filled with water surface and other reasons, it has a great impact on people's life.

The interaction mechanism between urban block, microclimate and thermal comfort is very complex, and the evaluation angle and standard are different. In the planning and design of urban renewal, the optimization of microclimate and thermal comfort can be realized from the following three aspects: first, the optimization of space geometry to increase the heat dissipation capacity of the space; second, the optimization of building surface and ground materials to reduce the heat storage capacity of the space; third, the optimization of urban street ecological characteristics to increase the cold source factor [51]. In terms of environmental problems, behavior and other factors, effective design strategies can be adopted to optimize microclimate and thermal comfort. Through the summary of environmental, behavioral and psychological factors, it can be found that people's outdoor activities in summer and winter are different in different environmental characteristics, and the thermal adaptation strategy of urban outdoor space can be used to optimize the environment [15]. This chapter focuses on the microclimate and thermal comfort characteristics of the urban renewal project under the climate conditions of Shanghai, evaluates the advantages and disadvantages of the microclimate of the block under the humid and hot environment in summer and the optimization strategy of the urban renewal, which is divided into the optimization strategy guided by the controllable factors of the urban block and the optimization strategy guided by the design strategy.

2.1 Optimization strategy guided by controllable factors of urban blocks

2.1.1 Building density and height

With the increase of the building density, the direct sunlight on the ground will generally reduce, and the shadow area of the building will increase accordingly. The microclimate of the block and the thermal comfort of pedestrians can be significantly improved [52]. Similarly, when the building height increases, the shadow area of the building is larger, and the air temperature and thermal comfort are relatively better [25]. In urban block environment, the change of thermal comfort index is most sensitive to building density and building height [28]. However, building density and building height are not the only factors that affect the microclimate of the block. When the building density is too high, the distance between buildings will be correspondingly reduced. If the building layout and orientation of the block are not good at this time, the air will not flow smoothly in the block, which will affect the ventilation and heat dissipation effect of the block, and worsen the microclimate [53]. In order to achieve better microclimate and thermal comfort, it is necessary to obtain the appropriate building density and height through the corresponding quantitative simulation combined with the actual situation. In the special urban environment, in order to create a good microclimate, the focus is also different. For example, in the high-density urban environment, under the same intensity of land use, it is necessary to balance the relationship between building density and building height, find the appropriate critical point, and achieve the best optimization effect [12].

2.1.2 SVF[1]

The sky angle coefficient is a parameter that describes the scale of the space seen at a certain point in the space. It can be used to describe the degree of space closure, as shown in Figure 2-1. When the SVF value of urban block is smaller, the area of block facing the sky is smaller, and the layout of block features such as block buildings and trees is more compact. In sunny summer, with the increase of SVF, the heat island effect of the block will decrease [11,54]. However, the thermal comfort of urban blocks is not only determined by the temperature, but also related to solar radiation and other factors. Under the extreme climate conditions in summer, the increase of solar radiation range brought by the increase of SVF is more unfavorable to the change of thermal comfort than the change of air temperature. Therefore, in general, urban space should be arranged as compact as possible, and large area of open space should be avoided. At this time, urban blocks can provide more shadow areas, and improve the thermal comfort of outdoor space under extreme climate conditions in summer.

---

[1] sky view factor

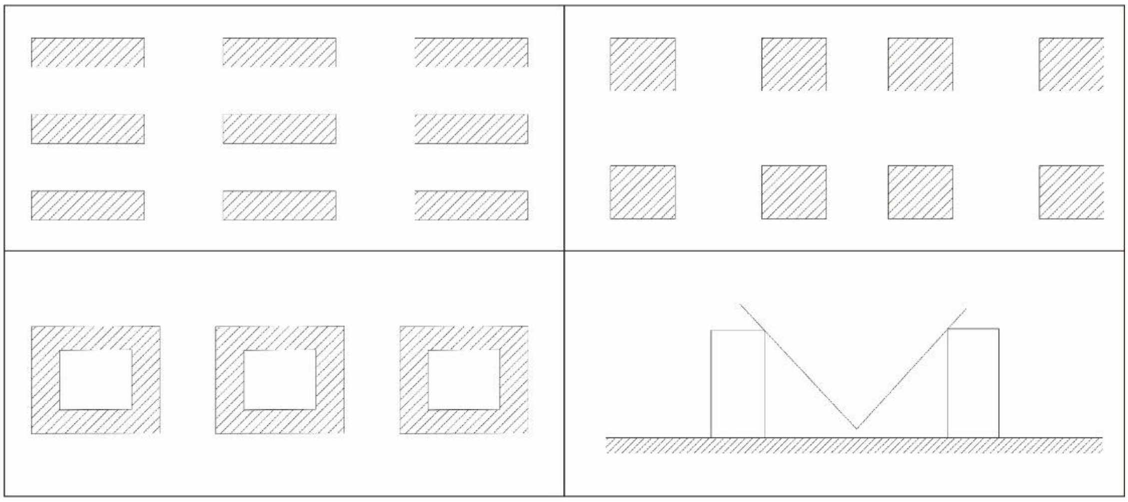


Fig 2-1 Top left: determinant; top right: point group; bottom left: enclosing; bottom right: SVF diagram

2.1.3 Building layout

The influence of building layout on the microclimate and thermal comfort of urban blocks is most closely related to the wind. Smooth ventilation can improve the thermal comfort of urban blocks. The relative humidity in the upwind direction of the block is generally high. If the wind can flow well in the block, it can improve the distribution of relative humidity in the block [25]. Several typical block building layout modes are shown in Figure 2-1. When the layout of street buildings conforms to the dominant wind direction, the microclimate condition of the layout of the row building is better, because the layout of the row building makes the wind easier to penetrate and pass through the block, and is generally better than the plate type, point group type and enclosure type [25]. When the building layout does not conform to the dominant wind direction, the impact on the microclimate is related to both the type of building layout and the angle between the building layout and the dominant wind direction. At this time, when the dominant wind direction of the city is poured along the main corridor of the block or at an angle of 45 degrees with the dominant wind direction, the blocking effect of the street on the wind is small, and under the conditions of equal volume ratio and equal greening rate, the point group Street The distance between buildings in the area is relatively large, and the wind is relatively easier to circulate. The layout of row and plate type buildings can block the wind when it does not conform to the dominant wind direction, and the wind cannot flow smoothly inside the block. Therefore, compared with the row and enclosure type, the point group layout is better [11,13].

The size of building spacing in building layout will also have an impact on the microclimate of the block. For example, when the building spacing increases, the air will more easily penetrate into the block interior under the condition of natural convection, so as to improve the microclimate of the block. From this point of view, the point layout is better than the determinant and enclosure layout [55]. However, when the building space is too large or the block space is too empty, the thermal comfort of the block becomes worse because of more direct sunlight. In some special building layout, for example, when the building width is too large due to the building types such as shops along the street, the ventilation effect of the block interior will be affected, and the microclimate is relatively worse [25].

2.1.4 Green space rate, green layout and water body

In terms of ecological conditions, the higher the green space rate, the lower the air temperature, the higher the relative humidity, and the better the microclimate [56]. However, only by increasing the green space rate, when the green space area reaches a certain value, the cooling and humidifying range of microclimate in the block tends to slow down, and the cooling effect of decentralized green space is better than that of centralized green space in the same green area [19].

The green space rate has an important impact on the microclimate of the block, but in addition to the green space rate, the influence of the green layout on the microclimate is also obvious. While improving the green space rate of the block, the impact of the wind direction of the block should be considered, and the green space layout should be adjusted accordingly [51]. When the arbors gather excessively, the wind field in the block will be blocked to some extent. The layout of greening should cater to the ventilation corridor, so as to improve the microclimate of the block better [25]. In terms of green allocation, trees have a better effect on microclimate improvement than grasslands, because trees can provide shadow areas, reduce solar radiation, and improve microclimate and thermal comfort more effectively than grasslands [25]. In summer, more trees should be planted in urban blocks to achieve a large area of thermal comfort zone. In terms of cooling and dedusting effect, trees and shrubs are far more effective than lawns [18].

In terms of the combination of block greening, the combination of arbor, shrub and grassland is the best, followed by arbor, grassland, shrub and grassland, and only grassland has the worst microclimate [20]. When the ecological conditions of the street area are not easy to change or the space of the block is limited, roof greening and vertical greening can also be used to increase the greening rate of the block, and roof greening has a more effective cooling and humidifying effect [34]. There are many ways of greening layout. The effect of decentralized greening plus green roof is the best, followed by decentralized greening, and centralized greening is the worst. On the premise of not changing the green rate, the effect of improving the microclimate of the block by improving the green coverage rate through green roof and other ways is more obvious [18]. For cities with scarce land, in fact, the space for greening of new blocks is limited, while the vertical greening occupies less land, which is an effective measure to improve the greening rate and microclimate of blocks [53].

In the aspect of block water factors, rivers and other natural water bodies can improve the air temperature and relative humidity around the block, and then improve the microclimate, but it needs to be considered in combination with wind direction and surrounding building layout. The cooling effect of the river on the air generally stays above the water surface, but has little impact on the temperature of the surrounding area of the river, and the distance between the river and the adjacent buildings and the layout of the buildings near the river have obvious impact on the microclimate distribution of the block [23]. When there is no natural water body in the block, the microclimate of the block can be improved by artificial water bodies such as fountains, waterways and artificial lakes [15].

2.1.5 Flooring materials

Because of the different heat capacity and reflection ability of the materials, the influence degree of the surface materials on the microclimate is different. Hard, low reflectivity, poor permeability of the paving materials, generally absorb more solar radiation, the air temperature of the block is relatively high [25]. A large area of artificial pavement will aggravate the heat island effect of the block and worsen the microclimate of the block [23]. However, some researches have pointed out that although most of the existing researches on the analysis and Simulation of the paving materials affirm the application effect of the high reflectivity materials, others hold a negative attitude, because although the high reflectivity materials can improve the air temperature, the radiation to the surrounding environment increases significantly [37]. High reflectivity materials reflect more radiant heat in summer, which worsens the thermal comfort of the block [57]. For urban renewal projects, it is necessary to study the complex influence of material types on microclimate through quantitative simulation in combination with the actual situation of the block, and finally select appropriate materials.

2.2 Design strategy oriented optimization strategy

2.2.1 Create shadow areas

（1）Architectural shadow

In summer, the thermal comfort of the shadow area is much better than that of the non shadow area because of the shielding of the solar radiation. In the urban renewal project, it is necessary to consider the characteristics and distribution of block buildings. For areas with less shadow and more open space, the capacity of block buildings can be appropriately increased and more shadow areas of buildings can be provided by means of new construction if conditions permit. When the building capacity of the street area cannot be increased, the transition space can be created and the shadow area of the building can be increased by means of building corridors and roof overhanging.

（2）Landscape shadow

The shadow area formed by trees or other landscapes in summer can better block the direct sunlight and greatly reduce the average radiation temperature in the area. When the urban renewal project is limited by policies, economic factors and other factors, and the building cannot be changed, the way of landscape can be adopted to plant trees or other landscapes in the open area of the block and other places with poor microclimate and thermal comfort, so as to create landscape shadow to improve microclimate. The arrangement of trees and other landscapes shall be considered in combination with the location of the shadow area at noon in summer.

（3）Device shadow

If it is not suitable to use new buildings or create landscape shadows in urban renewal projects, shadow areas can be created by setting up devices in areas with poor thermal comfort in the block to improve the thermal comfort of the area to a certain extent, such as cornices, sunshades, outdoor sunshade seats, etc.

Fig 2-2 Left: Architectural shadow; middle: landscape shadow; right: installation shadow

Source: Internet

2.2.2 Create air duct

（1）Optimize building orientation

In urban renewal projects, the direction of road network in blocks is generally difficult to adjust, but when there are some buildings blocking the dominant wind direction in the street area in summer, it will greatly affect the ventilation effect of blocks. If conditions permit, we can adjust the building orientation in the block, so that the wind can better penetrate and cross the block, and optimize the microclimate of the block.

（2）Adjust the orientation and height width ratio of urban street Valley[2]

The direction of urban street Valley has obvious response to the change of wind speed, and the wind speed increases significantly due to the narrow tube effect[3] when the wind direction complies with the dominant wind direction. However, when the direction of urban street Valley blocks the dominant wind direction significantly, the air flow in the street Valley is not smooth, and the air temperature will increase significantly [56]. The influence mode of the ratio of height to width of urban street Valley on microclimate is more complex. When the ratio of height to width of street Valley increases, the direct radiation from the sun decreases, but at the same time, the heat dissipation process and the long wave radiation from the street Valley to the outside of the Street valley also slows down because of blocking. Therefore, the influence of the ratio of height to width of street Valley on microclimate is comprehensive, which needs to be simulated and divided according to the specific climate and surrounding environment Analysis of [58].

（3）Improve the permeability of the main section of the block to the wind

The higher the permeability of the main section of the block in the dominant wind direction is, the easier the wind is to enter the block. The main section of the block should avoid too long or too many building blocks, and strengthen the circulation of wind in the block. In the urban renewal project, when the permeability of the main section to the wind in the street area is low, the permeability of the main section to the wind can be improved through building openings, building overhead and other ways to optimize the microclimate in the street area [28].

[2] It refers to the urban area similar to the natural canyon composed of buildings on both sides of the urban road.

[3] When the wind direction is consistent with the street trend, the street canyon becomes a narrow channel, and the wind is squeezed in different directions, resulting in the phenomenon that the wind speed increases through the street.

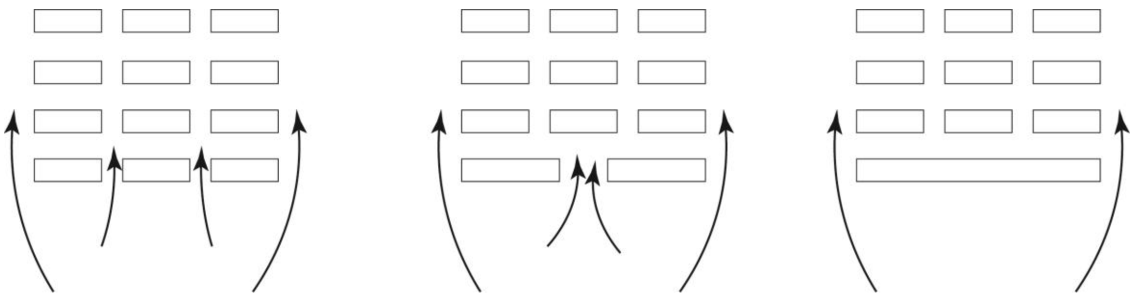


Fig 2-3 Analysis of the influence of the permeability of the main section on the ventilation of the block

（4）Create a special channel

In some special urban renewal projects, special air ducts can be created in blocks. For example, when the building is low, the high-rise wind can easily pour into the block, and the continuous low-rise buildings can be used to create air ducts in accordance with the prevailing wind direction. The way of landscape can be used to create air passage in urban block, such as planning and designing linear park or belt green space in accordance with the dominant wind direction, so as to optimize the ventilation effect of the block.

Fig 2-4 Reference map of Urban Linear Park
Source: Internet

（5）Opening of adverse point of wind speed

When there is an area with poor wind speed in the block, we can optimize the wind environment and microclimate by opening the building at the unfavorable point of wind speed or overhead the ground floor. For example, the wind speed of enclosed buildings or buildings along the street with too large width is generally very low in the interior or leeward, and opening at a proper position can effectively improve the microclimate of the block.

Fig 2-5 Ground floor overhead reference drawing
Source: Internet

2.2.3 Optimize the surface materials of the block

（1）Reflectivity of paving material

The microclimate of urban blocks can be adjusted by improving the reflectance of paving materials. The materials with high reflectance should be used to effectively reduce the heat absorbed by each surface of blocks. The high reflectance of grassland can be effectively used to reduce the heat absorbed by the ground. However, at the same time, the high reflectivity materials will reflect more solar radiation heat at the same time, which will increase the average radiation temperature of the block environment. The appropriate materials should be selected according to the different environment in the block [37].

（2）Permeability

The better the permeability of the paving material in the block, it can effectively reduce the radiation heat absorbed in the daytime, and reduce the heat storage capacity of the block space, thus improving the microclimate and thermal comfort of the block [58].

（3）Material and color of building facade and roof

Improving the material reflectance of building facade and building roof can reduce the heat absorbed by buildings in the block and the heat storage capacity of the block, but the high reflectance material will reflect more solar radiation heat to the surrounding environment at the same time, and the heat reflected by the building facade will increase the average radiation temperature at the pedestrian height of the block and affect the thermal comfort of pedestrians, so it should be targeted at the block The selection of materials should be considered comprehensively. Light color materials should be used for building facade and building roof materials, which can effectively reduce the radiation heat absorbed by the surface. Dark color surfaces will increase the heat absorbed by the materials, which should be reduced.

2.2.4 Increase and optimize plants and water bodies

（1）Greening rate and number of trees

Improving the greening rate of the block can effectively improve the air temperature of the block. Increasing the number of trees in the block can not only improve the air temperature of the block, but also significantly reduce the average radiation temperature of the block in summer, and create suitable microclimate and thermal comfort conditions of the block.

（2）Multi level greening

When the greening rate of the block is fixed, a variety of greening matching methods can be used to optimize the microclimate of the block, such as street trees, grassland, scattered green space, etc., and when no additional space is added, green roofs, green walls and other methods can be used to enrich the way of block greening, so as to optimize the microclimate of the block.

Fig 2-6 Multi level greening reference map
Source: Internet

（3）Water body

In summer, natural water bodies such as rivers can optimize the microclimate conditions of the block by improving the ambient air temperature and relative humidity. When the distribution of natural water bodies is less or the application is limited, a variety of artificial water bodies can also be used, such as fountains, landscape water surfaces, water sprinklers, etc., to optimize the microclimate by using the evaporation of water bodies.

Fig 2-7 Water reference map of urban block
Source: Internet

2.3 Summary of this chapter

Based on the climate characteristics of Shanghai, this chapter summarizes two ways of urban renewal project to create better microclimate and thermal comfort: one is to take the controllable factors of urban blocks as the guide, that is, to control the factors of single urban built environment to achieve the optimized effect, including building density and height, sky angle coefficient, building layout, green There are five types of land rate and green layout, water body and paving material; the second is guided by design strategy, that is, through targeted strategies, to control the planning and design of urban renewal projects, including creating shadow areas, creating air ducts, optimizing the surface materials of blocks, increasing and optimizing plants and water body.

Chapter three: Numerical simulation method of microclimate and thermal comfort of urban block

3.1 Urban Microclimate Simulation Software Envi-met

3.1.1 Introduction of Envi-met

Envi met, a city Microclimate Simulation software, was developed in 1998 by Professor Michael Bruce and his team from the University of Bohong, Germany. Envi met, based on the knowledge of air hydrodynamics, urban climatology and other related fields, mainly studies the interaction of buildings, vegetation, underlying surface and atmosphere in the city, and studies the microclimate environment in a certain range of the city through the simulation of meteorological conditions, buildings, vegetation, underlying surface and other factors [59]. In recent years, more and more attention has been paid to urban climate, and the research related to envi met is increasing, for example, using envi met software to simulate microclimate in cities in Central Europe to study the impact of global warming [60,61].

Envi met software comes with a database of building materials database, plant database and other modules. Through the application and research of envi met, the self-contained system modules of its software system, such as enclosure structure, underlying surface, green plants, have the advantages of Urban Microclimate Simulation, and are considered to be the most comprehensive and effective numerical simulation software in the field of Microclimate Simulation [60,62]. The simulation structure of envi met is shown in Figure 3-1.

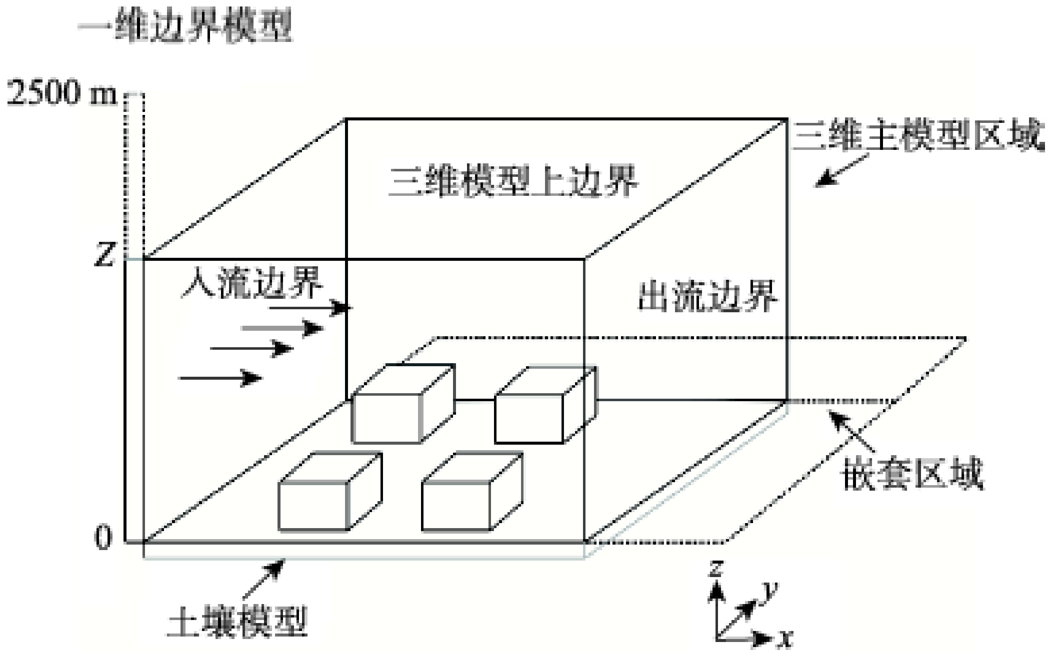


Fig 3-1 Structure diagram of Envi-met model [31]

3.1.2 Simulation process of Envi-met

The Microclimate Simulation Process of envi met can be divided into four parts, namely software modeling, boundary condition setting, software simulation operation, result output and presentation, and the functions of each part of envi met have its own modules, as shown in Figure 3-2. The software modeling is realized by building the urban area to be simulated in a certain number of 3D grid frames with the spaces module, as shown in Figure 3-3, and the spaces module can give the geographic location of the simulation area and other information, and output it to the. INX format file after the modeling is completed. After the spatial modeling of urban blocks is completed, it is necessary to configure simulation files for the. INX files that have been modeled, input meteorological boundary conditions such as temperature, humidity, wind speed, wind direction, etc., and then export them to. Simx format files, and simulate them through the operation module of envi met. After the operation, the simulation results can be visualized in the Leonardo module by means of graphs and tables. In addition, the bio met module of envi met software can calculate the thermal comfort index value of the required simulation area by calculating the atmosphere folder in the output simulation results.

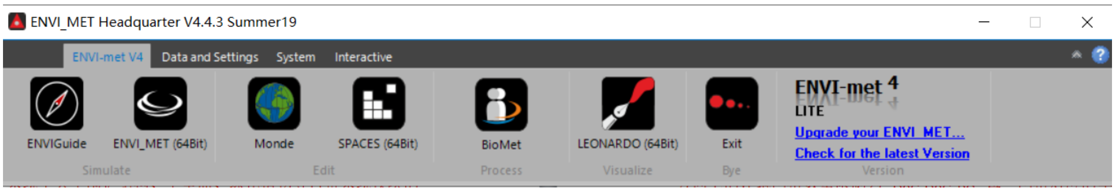


图 3-2 Interface diagram of envi met operation module

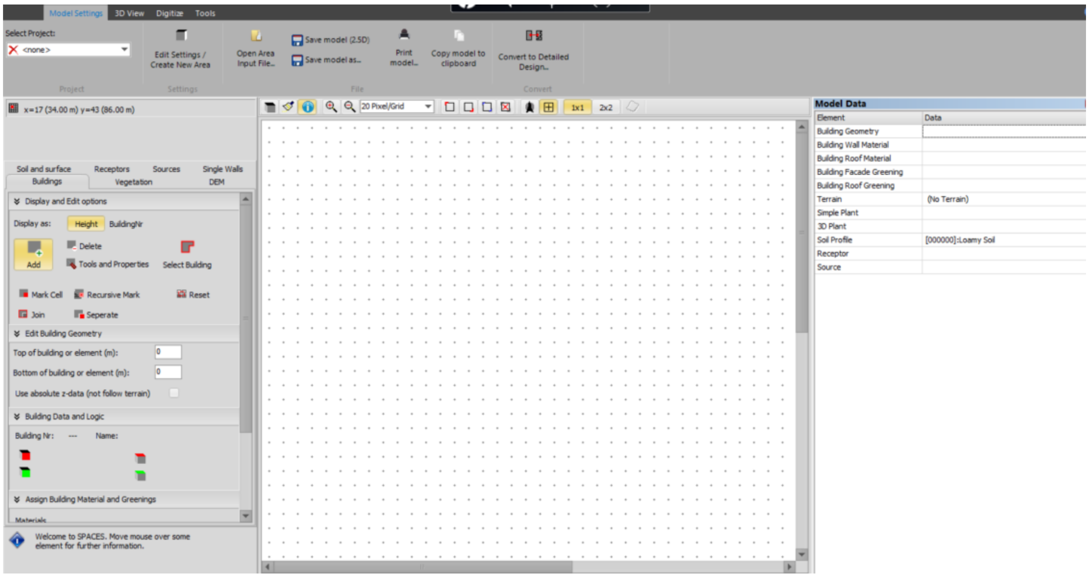


Fig 3-3 Interface diagram of spaces modeling module in envi met

The method adopted in this paper is to export the base map of the target simulation area through the 91 satellite map assistant, convert the base map to the BMP format picture, and import the envi met module spaces for modeling combined with the field survey information. Input the simulation results into envi met's Biomet module, simulate and calculate the thermal comfort index PMV value of the target area, where the setting of Biomet is shown in Figure 3-4. Through Leonardo, the simulation results will output the parameters of the target block, such as air temperature, relative humidity, wind speed, average radiation temperature, and thermal comfort parameter PMV value.

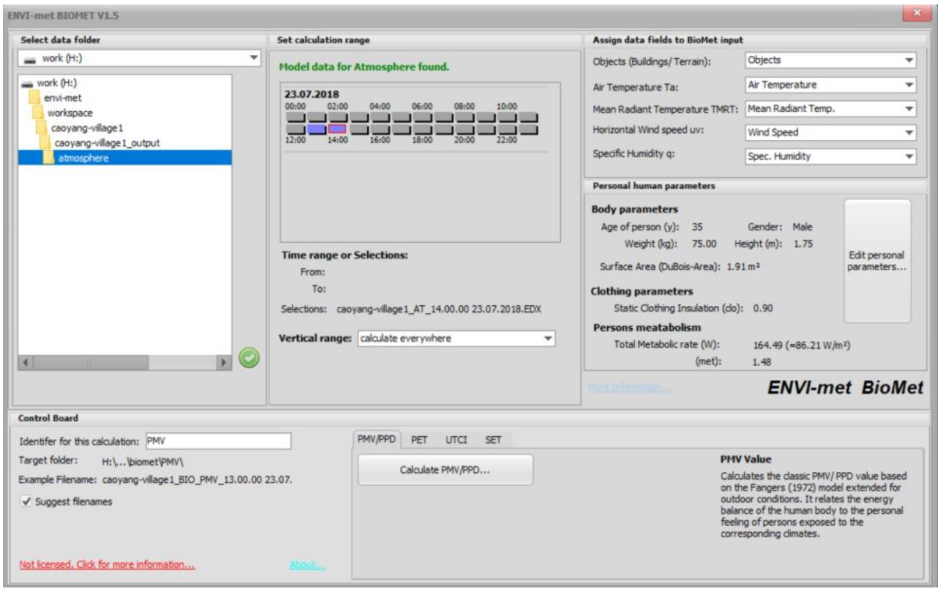


Fig 3-4 Bio met operation interface and setting diagram

3.1.3 Effectiveness of simulation results and software advantages of Envi-met

At present, many studies have been carried out by envi met to verify the simulation and actual measurement of an example, and used in the analysis of urban microclimate. Many studies have proved that the simulation results of envi met are in good agreement with the actual measurement, and verified the effectiveness of using envi met to simulate urban microclimate [18, 33, 34, 63, 64]. There are some differences between the simulation results of envi met and the actual measurement results, mainly due to the simplification of the ground, vegetation, building and other factors of urban blocks in the modeling process, but from the results, the agreement between the simulation results of envi met and the actual situation is still good [37]. Envi met can simulate urban microclimate on a small scale [41].

Other commonly used CFD (Computational Fluid Dynamics) numerical simulation software for urban environment simulation includes Phoenix, fluent, etc. various CFD software have corresponding software advantages, such as Phoenix can simulate the air flow and heat transfer around, on and inside the building, so it is widely used by professionals such as building HVAC engineering, as shown in Figure 3-5. Compared with other commonly used CFD simulation software, envi met focuses on the simulation of small and medium-sized urban blocks, considering the impact of vegetation, water and other elements in the block environment on the block, and can simulate the air flow in a certain area and the heat exchange between vegetation, building surface, ground and other elements and air. Therefore, the microclimate of urban blocks is simulated The simulation results are more comprehensive. In addition, the two most critical factors affecting the urban microclimate are wind and sun. Envi met software well associates the radiation model and turbulence model, and the simulation effect on the block scale is more accurate [65].

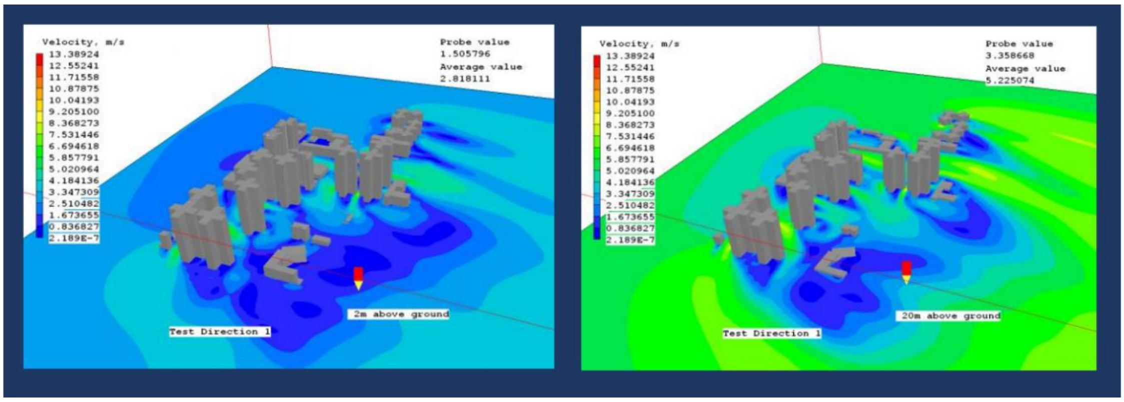


Fig 3-5 Reference diagram of Phoenix simulation results
Source: http://www.cham.co.uk/

3.2 Software simulation accuracy verification of Envi-met

3.2.1 Measuring tools and methods

In order to verify the effectiveness of envi met software simulation in Shanghai, this section validates the student dormitory area of building 23 in the east of Minhang campus of Shanghai Jiaotong University through the combination of envi met software simulation and actual measurement. In the experiment, six measuring points are arranged in the dormitory area. The principle of arrangement is to consider the uniformity of the distribution of points. The location of points is to consider the different ground types and the degree of sheltering by buildings and trees. The ground types include pedestrian tile pavement, concrete pavement and grassland, so that the verification results have universal applicability. The instrument used in the experiment is the CO2 recorder of T & D Corporation, with the model of tr-76ui. The instrument can be used to record air temperature, relative humidity and other parameters in real time. The accuracy of air temperature is 0.1 ℃, and the accuracy of relative humidity is 1%, as shown in Figure 3-6.

The test time of actual measurement and simulation is from 9:00 a.m. to 17:00 p.m. on September 26, 2019. Due to the relatively slow change of air temperature and relative humidity, the method of reading each measuring point at each whole point is adopted. After the measured parameters are stable, record the air temperature and relative humidity of all measuring points at each whole point. The measured weather is sunny in most days and cloudy in a few days, meeting the requirements of simulation environment.

Fig 3-6 Left: tr-76ui; right: student dormitory area of Minhang campus of Shanghai Jiaotong University

3.2.2 Verification of actual measurement and simulation results

The boundary conditions simulated by envi met software refer to the meteorological parameters of Minhang Meteorological Bureau on that day. The air temperature and relative humidity values of the six measuring points obtained from the actual measurement and simulation are shown in Fig. 3-7 and Fig. 3-8.

From the comparison of all the measured data and the simulated data, it can be found that the air temperature of the measured data is higher than the simulated data, while the relative humidity is lower than the simulated data, which is related to the initial boundary conditions of envi met. The meteorological data of Minhang District can not represent the actual situation of all the places in the region, and there are some differences. There are fluctuations in the measured data, which have a certain impact on the actual reasons such as the situation of pedestrians and vehicles in the student dormitory area, while the changes in the simulated situation are relatively gentle due to only considering the factors such as building, greening, material type, etc. The temperature drop from 4 p.m. to 5 p.m. is relatively large, which is related to the cloudy cover of the sun in that period of the day. In general, from the comparison of the measured and simulated data of each of the six measuring points, it can be seen that the envi met simulation results can still better reflect the change trend of the air temperature and relative humidity in the block, and both the measuring points and the simulated data reach the highest temperature at 14:00 p.m. Through the verification, it can be shown that envi met is effective in the simulation of microclimate environment of the block.

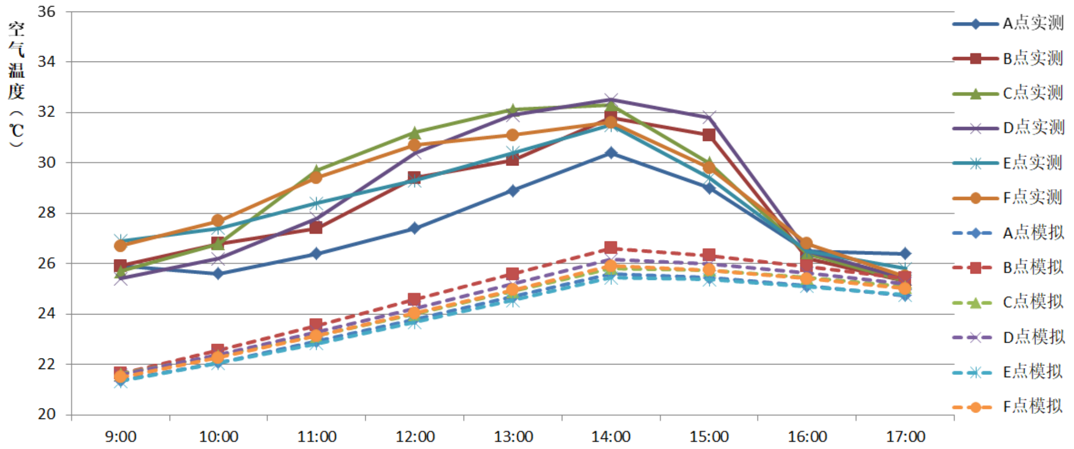


Fig 3-7 Comparison of measured and simulated air temperature in the dormitory area of building 23, Minhang campus, Shanghai Jiaotong University

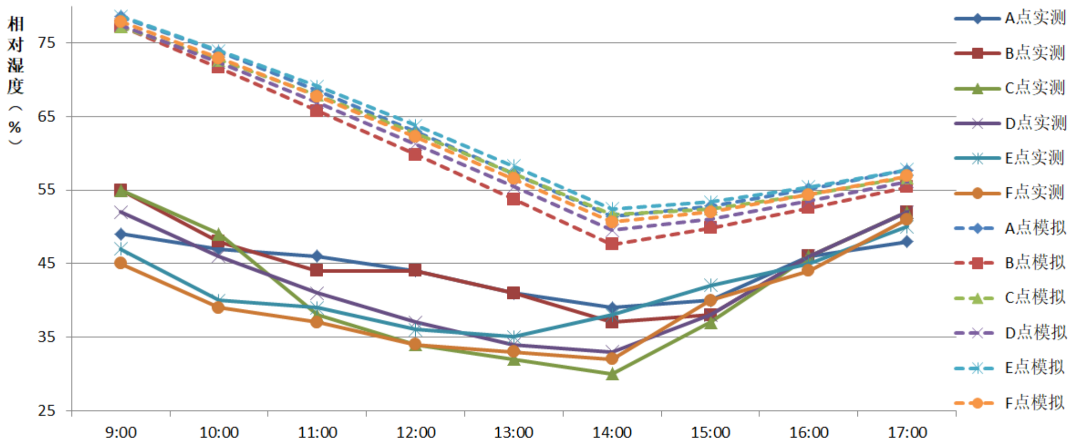


Fig 3-8 Comparison of measured and simulated relative humidity in the dormitory area of building 23, Minhang campus, Shanghai Jiaotong University

3.3 Simulation boundary conditions and evaluation methods of Envi-met

3.3.1 Boundary condition setting

In this paper, envi met version 4.4.1 is used. Envi met defines the number of grids of a certain size in three-dimensional direction as the simulation area. The unit length of each grid is defined as DX, Dy, DZ, and the unit length is meters. The smaller the unit grid number scale is, the higher the relative accuracy of simulation is. The research area of this paper is Shanghai. The research focus is on the outdoor microclimate and thermal comfort from noon to afternoon in summer, i.e. under the extreme climate conditions. Therefore, the simulation time is the hottest summer day in the whole year, i.e. 14:00 p.m. on July 23, 2018. The output condition of the simulation results is 1.5m, i.e. the microclimate and thermal comfort distribution of human height. The simulated boundary conditions are shown in table 3-1.

Table 3–1 Parameter setting of envi met simulation boundary condition

	Parameter	value
Boundary condition setting	time	23 / 07 / 2019 14:00
	Air temperature/（℃）	33
	Relative humidity/（%）	60
	Roughness length	0.01
	Wind direction 10m high /（° ）	135（south-east）
	10m high wind speed /（m/s）	3.1

3.3.2 Relevant parameters and evaluation methods

The predicted mean vote PMV is proposed by the Danish scholar Fanger based on the thermal comfort equation through people's different comfort feelings of cold and heat. It can be used to reflect the cold and hot feelings of most people in the same environment. In this paper, the microclimate and thermal comfort of the city are used as the evaluation criteria of the outdoor environment of the city block, the thermal comfort of the pedestrian height is taken as the key evaluation index, and the PMV value is used to evaluate the thermal comfort [66]. PMV takes into account the air temperature, relative humidity, wind speed and average radiation temperature in outdoor environmental parameters, as well as two human parameters. The value from small to large represents the human body's thermal comfort sensation from cold to heat. When the value is 0, it represents moderate thermal comfort, as shown in table 3-2. At the same time, with the multi parameter analysis method of the microclimate parameters air temperature, relative humidity, wind speed, average radiation temperature and sky angle coefficient in the urban environment as the auxiliary analysis, the paper quantitatively studies the microclimate and thermal comfort of the urban block, and puts forward the optimization strategy based on the above parameter indexes for the relevant cases.

Table 3-2 Relationship between PMV value and thermal comfort

PMV value	<-4	-4	-3	-2	-1	0	1	2	3	4	>4
Thermal comfort	Extremely cold	Very cold	Relative cold	cool	Relative cool	middle	Relative hot	hot	Relative hot	Very hot	Extremely hot

3.4 Preliminary simulation analysis of optimization strategy

In this section, taking the typical block of Shanghai as the basic model, five variables, such as building density, building height, building orientation, trees and grassland, and ground material, are selected to study the change of microclimate and thermal comfort in the block through envi met simulation. The simulation area of the basic model in envi met is 180m long, 180m wide and 90m high. The accuracy in X, y and Z directions is DX = dy = 4m and DZ = 3M respectively. The basic model is a 6-Row 3-column row building layout. Each building is 24 meters high, 36 meters wide and 12 meters deep. The building faces 25 degrees south by East. There are no grassland trees in the block. The default loam ground material of envi met software is used. The model information of the basic model and the corresponding parameter changes of the five groups of variables are shown in table 3-3.

Table 3-3 Model comparison simulation information table

model parameter	Model number	parameter
Basic model	000	6 rows and 3 rows; 36 * 12 * 24m in length, width and height; 25 ° south by east; no grass trees; loam
Building density	A01	5 rows and 3 columns (decrease one row)
	A02	4 rows and 3 columns (decrease two row)
Building height	B01	12m (height reduced by 12m)
	B02	36m (height increased by 12m)
Building orientation	C01	South (25 degrees clockwise)
	C02	25 ° south by West (50 ° clockwise)
Tree and grass	D01	Add grass
	D02	Add tree
Surface material	E01	Dark concrete (reflectivity increased by 0.2)
	E02	Light colored concrete (reflectivity increased by 0.8)

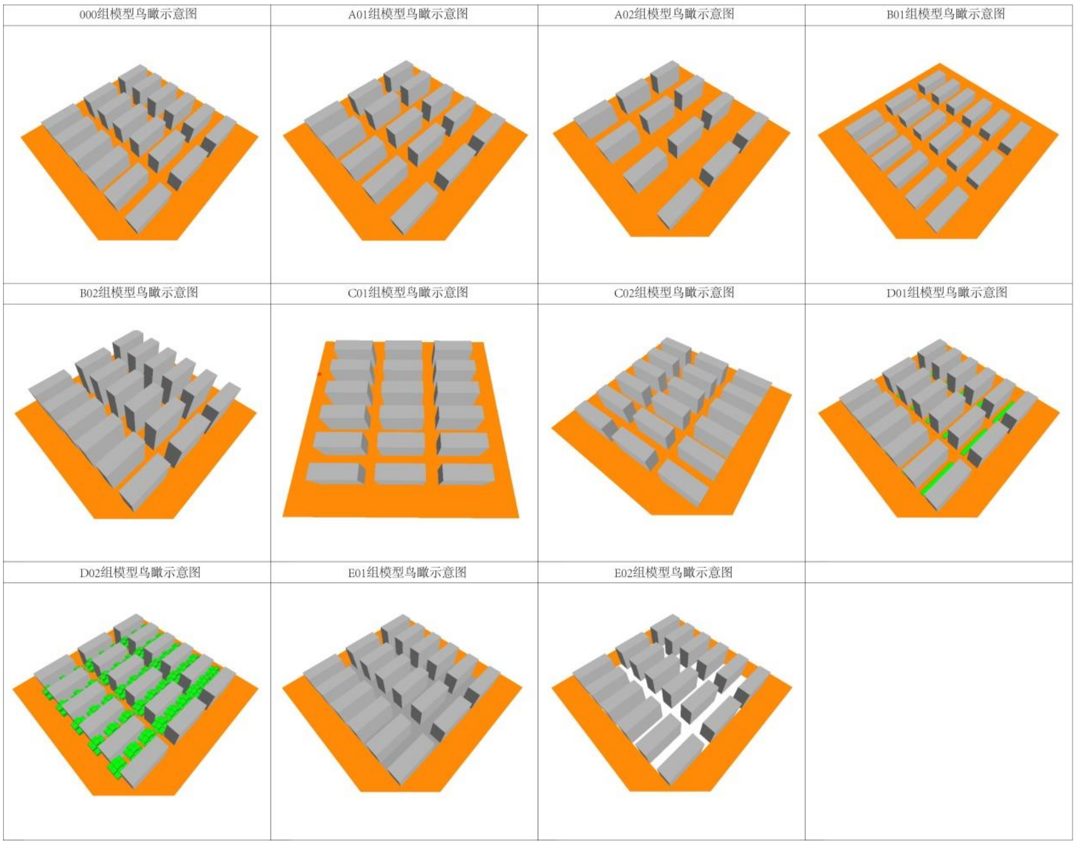


Fig 3-9 Aerial view of each group of models

3.4.1 Simulation results of basic model

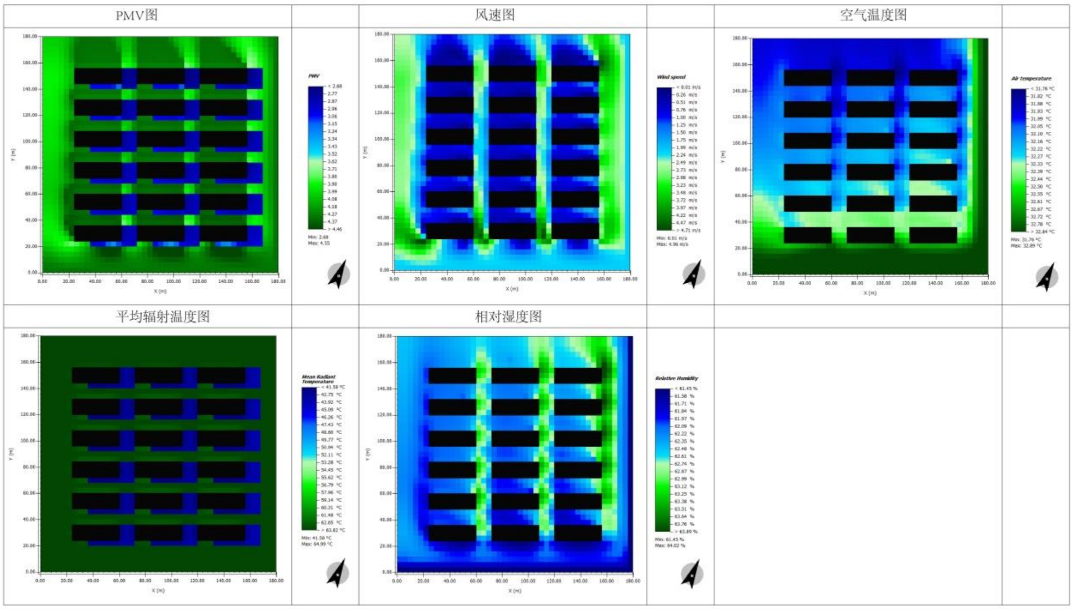


Fig 3-10 Simulation results of basic model

Through envi met simulation, output PMV diagram, wind speed diagram, air temperature diagram, average radiation temperature diagram and relative humidity diagram of the basic model, as shown in Figure 3-10. The average value of PMV in the basic model block is 3.9375, and the regional distribution of thermal comfort in the block is quite different. Only the PMV of the space in the shadow of the building is about 2.7, and the PMV of the other spaces is above 3.5, even up to 4.5. The PMV of the space on the South and north sides of each building is the largest, and the thermal comfort is the worst. The distribution of average radiation temperature in the block is consistent with that of PMV, which indicates that solar radiation has a great influence on thermal comfort in summer. It can be seen from the comparison between the wind speed chart and the PMV chart that although the wind speed in the block formed by the space between the building and the building is small due to the building orientation blocking the wind, the PMV value of the space is still reduced and the thermal comfort is improved to a certain extent. The size of the wind speed in the block also affects the distribution of the relative humidity in the block. The relative humidity in the air duct is higher than that in the space between buildings. Due to the similarity of the environment of each point in the basic model, the air temperature distribution in the block is relatively small.

3.4.2 Simulation results of control group

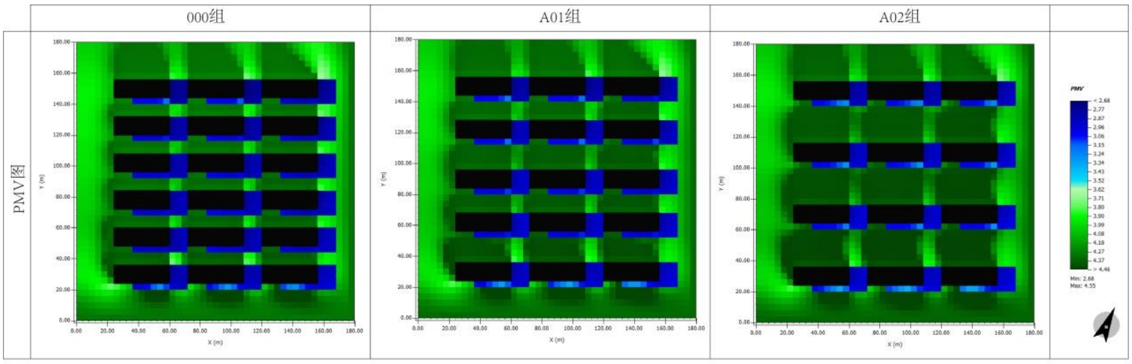


Fig 3-11 PMV diagram of group a simulation results

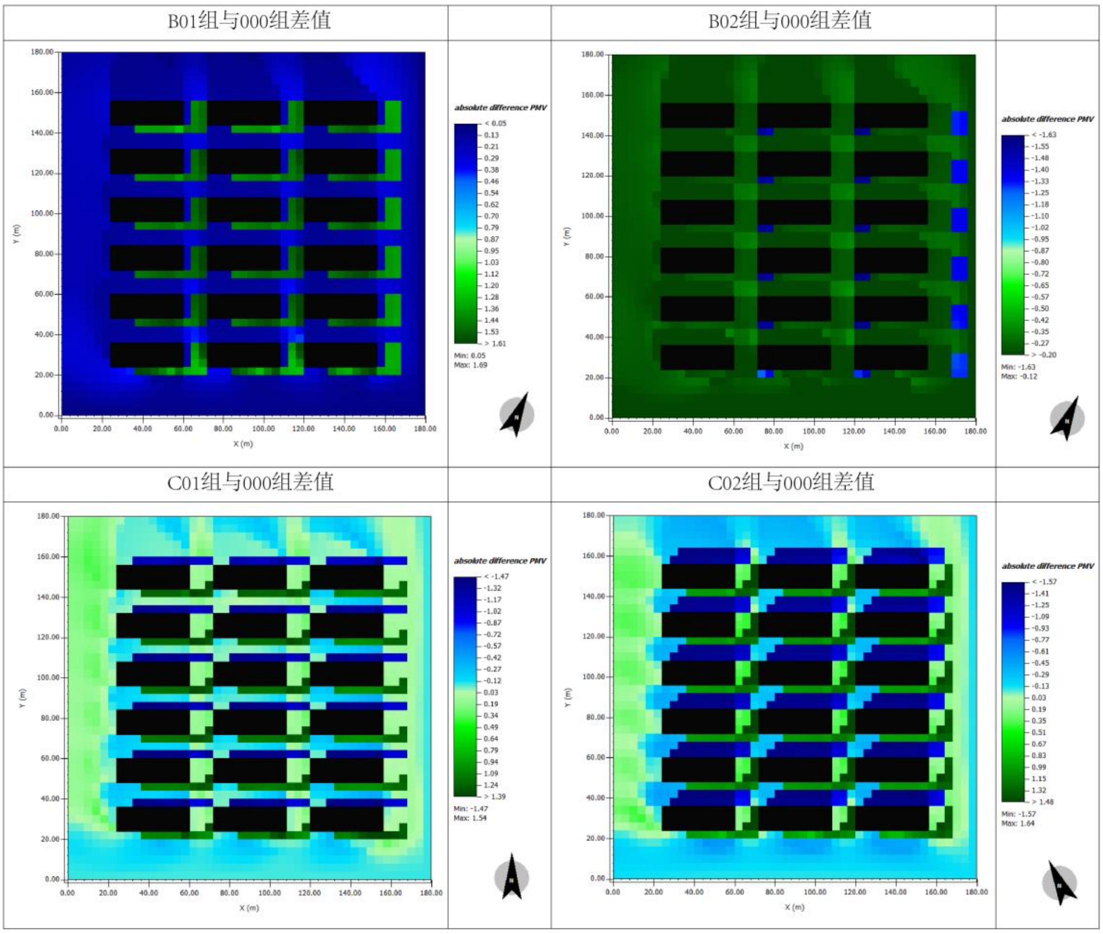


Fig 3-12 B and C simulation results and PMV difference diagram of basic model

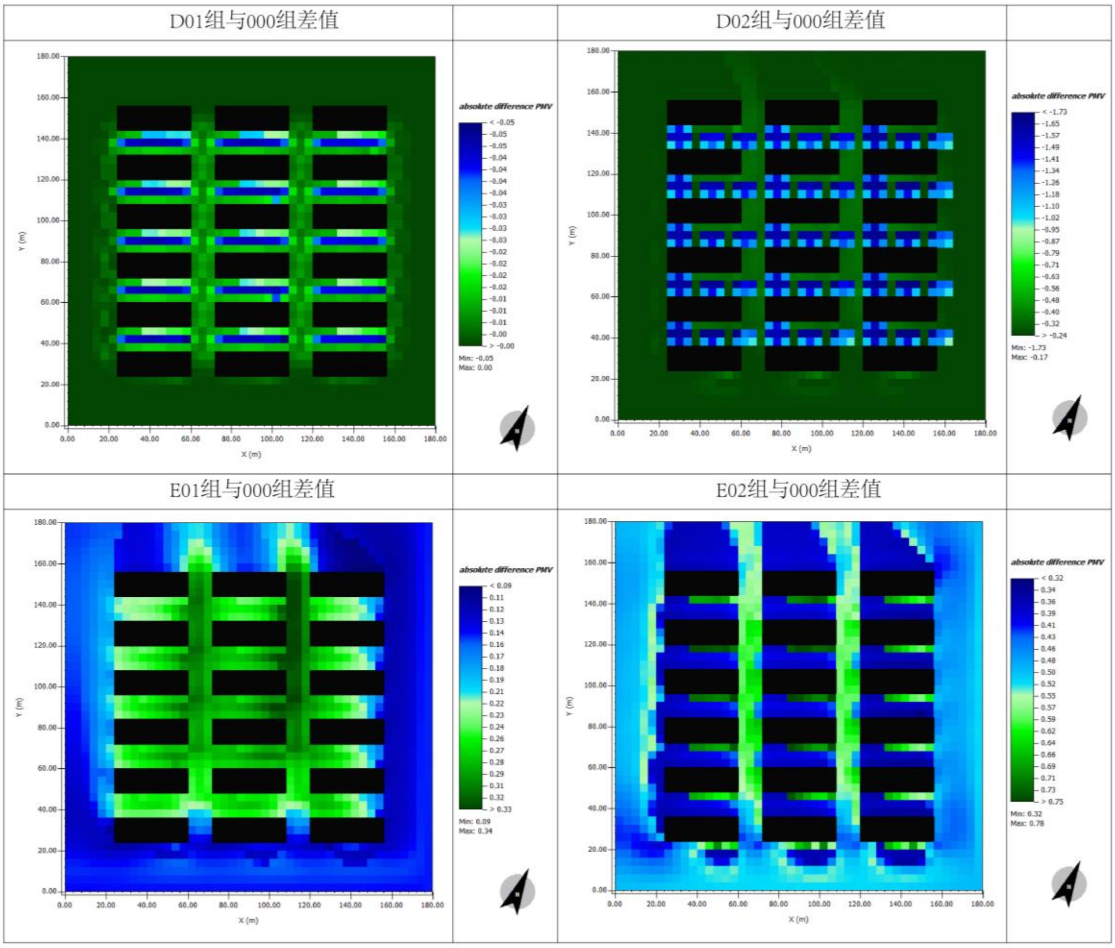


Fig 3-13 D and E simulation results and PMV difference diagram of basic model

Table 3-4 PMV value of control group model and comparison with basic model

	000	A01	A02	B01	B02	
Changes relative to the underlying model	-	Reduce one row of buildings	Reduce two row of buildings	Building height reduced by 12 meters	Building height increased by 12 meters	
PMV value	3.9375	4.0385	4.1308	4.2425	3.7454	
Difference with basic model PMV	-	0.1010	0.1933	0.3050	-0.1921	
	C01	C02	D01	D02	E01	E02
Changes relative to the underlying model	25 degrees clockwise	Turn 50 degrees clockwise	Add grass	Add tree	Reflectivity increased by 0.2	Reflectivity increased by 0.8
PMV value	3.9394	3.8195	3.9309	3.5718	4.0842	4.3002

Difference with basic model PMV	-0.0019	-0.1180	-0.0066	-0.3657	0.1467	0.3627

Through envi met simulation for each control group, PMV distribution of block a is shown in Figure 3-11, and PMV difference of group B-E is shown in Figure 3-12 and figure 3-13 by making difference with PMV distribution of basic model. Block change factors, average PMV value and PMV difference with basic model of each control group are shown in table 3-4. According to the results of the chart, with the decrease of the building density of the block, the shadow area inside the block becomes less, and the thermal comfort of the block tends to be worse; with the increase of the building height, more shadow areas are generated in the block, and the thermal comfort of the block tends to be better; when the building direction is consistent with the dominant wind direction, the wind is more likely to pour into the space between the buildings, and in the street The circulation in the area can be better, and the thermal comfort of the block presents the trend of becoming better; both grassland and arbor can make the thermal comfort of the block better, but the thermal comfort improvement effect brought by arbor is much more significant, and the thermal comfort improvement of grassland for the block is very limited; compared with the natural road, the thermal comfort of the block is poor, and the pavement with higher reflectivity reflects the solar radiation Radiant heat, the thermal comfort of the block is worse, which shows that the impact of reflected radiant heat on the thermal comfort of the block is more significant than other factors.

Comparing the results of PMV simulation between the five groups of control group and the basic model, it shows that different block factors will affect the microclimate and thermal comfort of the block. The differences of block thermal comfort caused by the differences of building density, building height, building orientation, arbor and grassland, and paving materials in the simulation of the control group also verify the microclimate and thermal comfort described in Chapter 2 The influence of comfort optimization strategy on Shanghai city block.

3.5 Summary of this chapter

This chapter discusses the background, operation process and effectiveness of envi met, and defines the simulation boundary conditions, relevant parameters and evaluation methods used in this paper. The effectiveness of envi met simulation is verified by the combination of measurement and simulation. Through the simulation of typical blocks in Shanghai and the comparison of thermal comfort of the control group, the applicability of the optimization strategy guided by controllable factors and the optimization strategy guided by design strategy described in Chapter 2 is further verified.

Chapter four: Implementation process of Shanghai urban renewal project and simulation of microclimate and thermal comfort of representative projects

4.1 Current situation and background of Shanghai Urban Renewal Project

4.1.1 Background and development history

In the early stage of rapid development, Shanghai mainly expanded its urban development by extension, built a large number of new buildings, and expanded its urban scale rapidly. The old areas in the city are not valued, lack of vitality and face decline. Nowadays, due to the deterioration of urban environment and the frequent occurrence of urban problems, in order to meet the needs of today's times, Shanghai began to change from "incremental planning" to "stock planning", and put forward relevant concepts such as stock optimization and quality improvement.

At present, the urban renewal projects in Shanghai can be divided into industrial land, old residential area, historical and cultural area, and business district. Taking industrial land as an example, the number and scale of its renewal is the most considerable. In the 13th five year plan for the utilization and protection of land resources in Shanghai issued in 2017, it was mentioned that the scale of industrial land in the city should be controlled at about 550 square kilometers, which will produce a huge urban renewal space compared with the current scale of industrial land. In terms of old residential areas, there are still about 12.16 million square meters of old style lanes and simple houses in the central city of Shanghai. In addition to other types of urban villages, old towns, etc., the potential of urban renewal scale is huge.

The renewal methods of old areas in Shanghai mostly adopt the method of urban renewal to give new vitality to the area. For example, by transforming old industrial plants into creative spaces and commercial blocks, Shanghai has become a popular and dynamic area in the city. But at the same time, there are a large number of old residential areas in Shanghai, which need to be renovated in the way of demolition and reconstruction due to the problems of long-term disrepair and potential safety risks. In the management measures for the implementation of Shanghai old housing demolition and reconstruction project issued by Shanghai Housing Administration in 2018, it is proposed that old houses with poor structure, long-term disrepair, potential safety hazards and no repair value identified by the management department can be reconstructed by demolition and reconstruction.

In the process of urban renewal in Shanghai, no matter how the project is demolished or reconstructed, good microclimate and thermal comfort environment can improve the quality and attract people, and meet the ecological requirements of urban construction in Shanghai, so as to build an environmentally friendly and sustainable urban block.

4.1.2 Pilot project of urban renewal

In 2015, Shanghai started to carry out the pilot work of urban renewal and launched 17 urban renewal projects. In 2016, Shanghai launched four renewal plans of "sharing community plan, innovation park plan, charm style plan and leisure network plan" again, as shown in Figure 4-1, and adopted "12 + X" flexible management mode [67]. The main body of urban renewal project is more refined, and the renewal method gradually turns to pay attention to the organic renewal of environmental quality. Shanghai begins to pay attention to the practice of the project in the urban renewal work.

	"12"示范项目名称	X示范项目名称
共享社区计划	曹杨新村 万里社区 塘桥社区	松江城中村改造 新江湾社区
创新园区计划	张江科技园 环上大影视园区 紫竹园区	漕河泾开发区 江湾社区 桃浦科技城 环同济
魅力风貌计划	外滩社区 197 等街坊 衡复风貌区 长白社区 228 街坊"两万户"	东斯文里 三林环外 外滩社区 160 街坊
休闲网络计划	黄浦江两岸慢行系统贯通 苏州河岸线贯通	世纪公园路步道

Fig 4-1 Four major renewal action plans of Shanghai in 2016 [67]

In Shanghai urban renewal project, there have been many successful cases, including industrial zone transformation, old residential area transformation and other urban renewal types, such as Hongfang, xingfuli, bridge 8, etc. Taking the first phase of No. 8 Bridge as an example, the original eight industrial buildings have been renovated and transformed into a modern creative park, realizing the success of economic benefits and social values. However, in the current urban renewal projects, the focus of improvement is still on the improvement of function and space quality, while the consideration of outdoor microclimate environment and thermal comfort is very little.

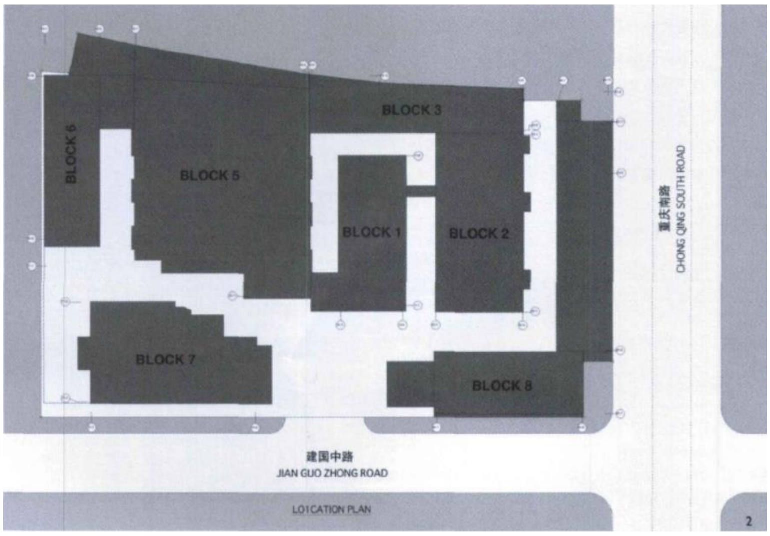


Fig 4-2 Phase I plan of bridge 8
Source: Internet

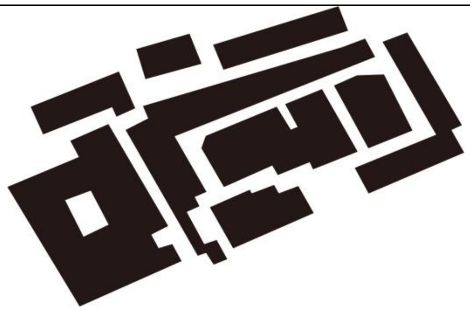
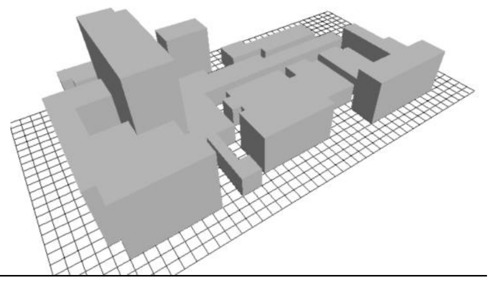
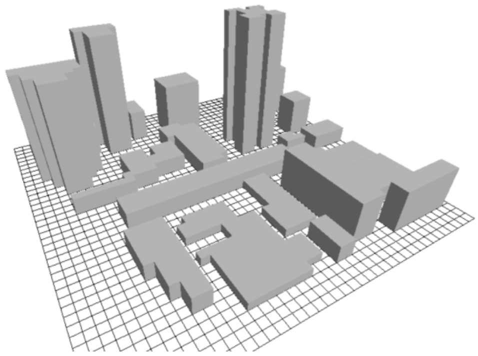
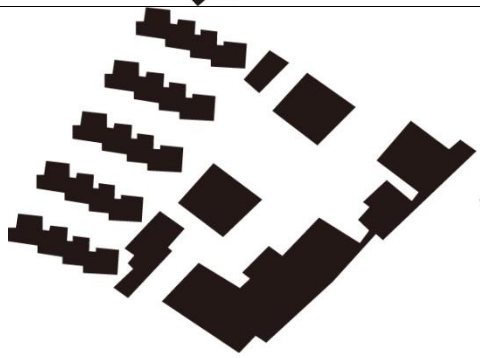
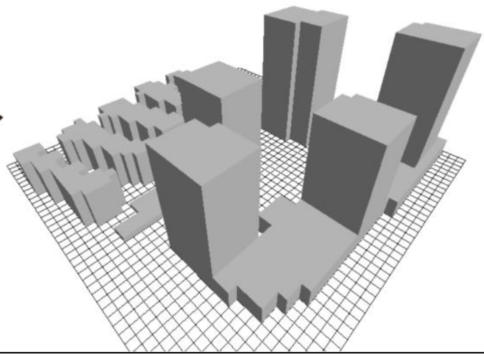
4.2 Microclimate and thermal comfort simulation analysis of four representative urban renewal block projects

The types of block combination of urban renewal projects in Shanghai are diversified. Taking residential area as an example, the combination mode of the block can be divided into determinant, point group, enclosing, mixed and so on. The arrangement of the determinant combination is regular, with better sunshine and ventilation conditions, but the space lacks the sense of enclosure. The layout of point group combination is flexible, the ventilation condition of the block is better, but the space lacks the sense of enclosure and order. Enclosed type can form a quiet closed or semi closed yard space, but the ventilation conditions are relatively unobstructed [72]. Different combination modes of blocks have their own advantages and disadvantages in space, and the microclimate and thermal comfort conditions of blocks are also different.

Industrial land and old residential areas are the two largest types of urban renewal land in Shanghai. Therefore, this section will select two representative block projects from the industrial land and old residential areas, namely, eight bridges, 800 shows, Jin Guyuan in Huayang street and new industrial village in Daning street.

4.2.1 Current situation and layout analysis

Table 4-1 Bottom analysis and envi met model table

name	Bottom analysis	Envi-met model
Bridge eight		
The 800 Show		
Jinguyuan, Huayang Street		

Eight bridge and 800 Show are typical cases of industrial building renovation in Shanghai. Jinguyuan and shanggongxin village in Huayang street and Daning Street are important pilot projects of "walking in Shanghai - micro renewal plan of community space". From the perspective of the current layout of urban blocks, the old industrial buildings in Shanghai, represented by No. 8 bridge and 800 Show, are characterized by compact space, narrow streets, low building height and irregular building layout. The block layout mode is mainly mixed. The old residential areas in Shanghai represented by Jinguyuan in Huayang street and shanggongxin village in Daning street have the characteristics of layout law, but there are differences in the layout patterns of the blocks. Jinguyuan is a typical point group layout pattern, and shanggongxin village is a typical determinant layout pattern.

There are obvious differences between the old industrial area and the old residential area in the block layout mode due to the different block types. For a specific type of block, the surrounding building layout type, road distribution, building height and other factors are also different due to the current situation. There is a high-rise building on the west side of the road to the south of No. 8 bridge, the road to the west of 800 Show, and three high-rise buildings distributed in dots on the north side. There is a large open space at the entrance of the two blocks. Jinguyuan block is arranged close to the street. The buildings along the street in the southeast are isolated from the influence of the road on the residential space to some extent. Five row houses are distributed in the northwest. Shanggongxin village block is adjacent to the Urban Branch Road. The spatial layout is between the residential area and the school. The block layout is regular and the degree of closure is weak.

4.2.2 Microclimate and thermal comfort analysis of the block

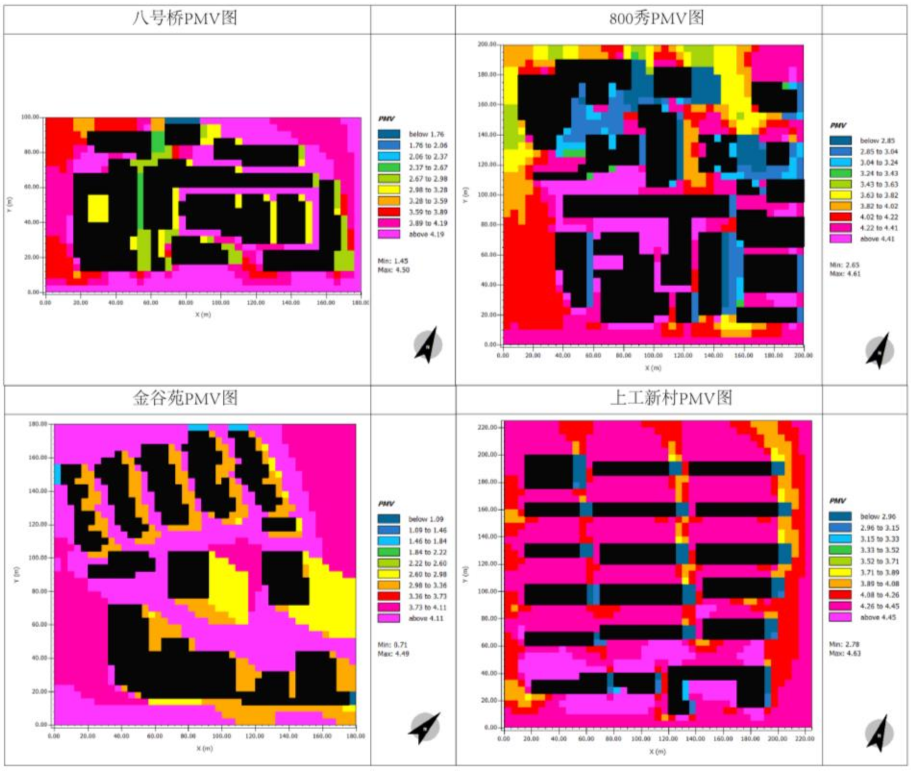


Fig 4-3 PMV drawing of No.8 bridge, 800xiu, Jinguyuan and Shanggong New Village

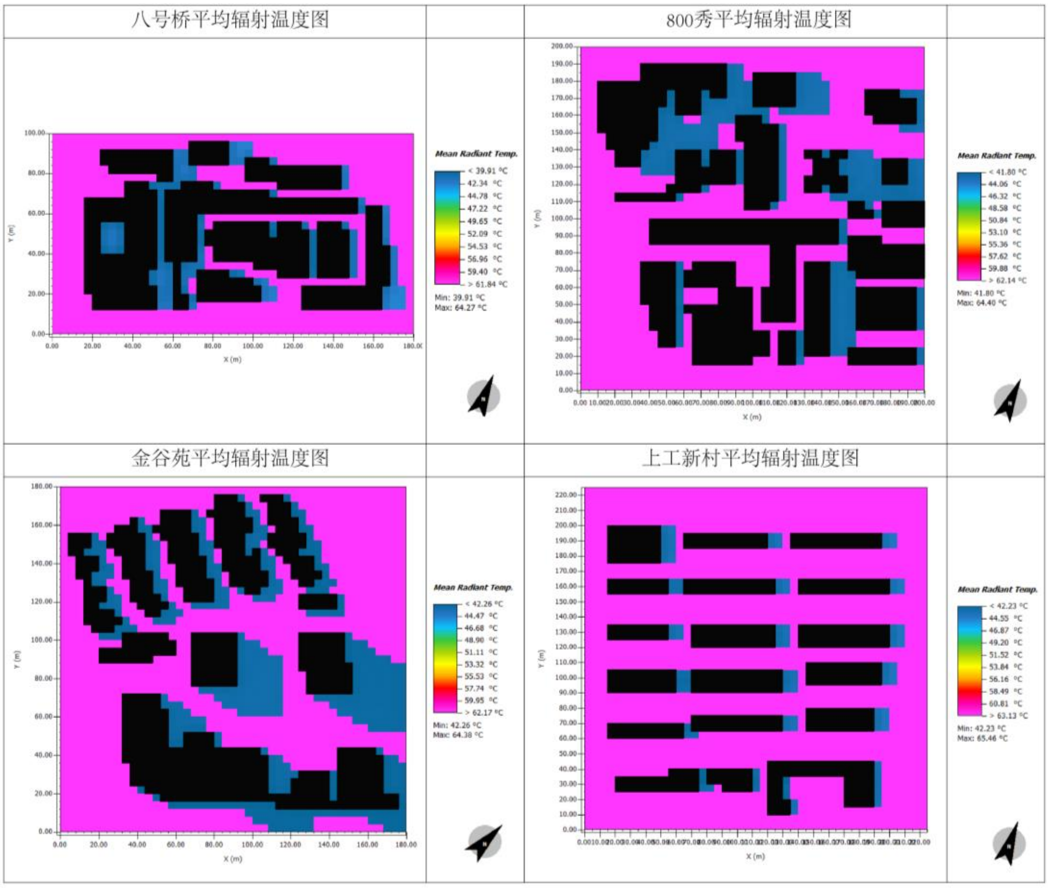


Fig 4-4 Average radiation temperature map of No.8 bridge, 800xiu, Jinguyuan and shanggongxin Village

Through envi met, the thermal comfort of the eight bridges, 800xiu, Jinguyuan and Shanggong new village was simulated. The PMV distribution and average radiation temperature of each block are shown in Figure 4-3 and Figure 4-4. From the simulation results, it is found that although the layout of No. 8 bridge and 800xiu block is relatively compact, the distribution of thermal comfort in the block is general. PMV value of thermal comfort in No. 8 bridge block is generally about 4.2, only part of the space is in the shadow of the building, PMV value is about 3.0, and the shadow area of high-rise building in the West does not cover the inside of No. 8 bridge block. The thermal comfort of 800 Show block is generally poor, PMV value is about 4.4. The thermal comfort distribution around the main show building is obvious compared with other areas. The PMV value of the shadow area of three high-rise buildings and multi-storey buildings in the East is about 3.0. The spatial distribution of Jinguyuan and Shanggong new village is relatively loose, but the distribution of thermal comfort is quite different. The point group high-rise buildings in Jinguyuan bring enough building shadow area to the block, its PMV value is about 2.8, and the thermal comfort of other spaces is relatively poor. In the thermal comfort distribution of Shanggong new village, the PMV value of a small number of buildings in the shadow area is about 2.9, the PMV value of some spaces in the block air ducts on both sides of the building is about 3.9, and the PMV value of other spaces is about 4.4.

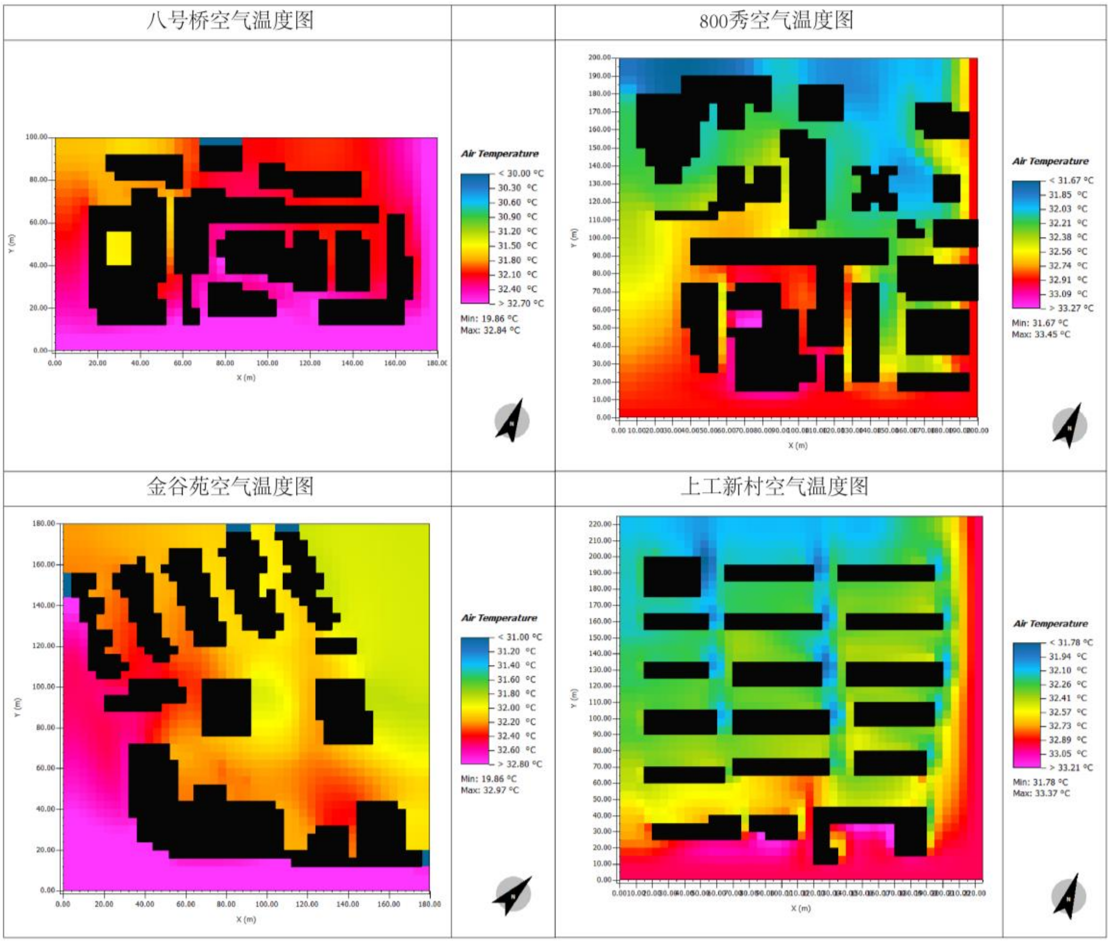


Fig 4-5 Air temperature map of No.8 bridge, 800 Show, Jinguyuan and Shanggong New Village

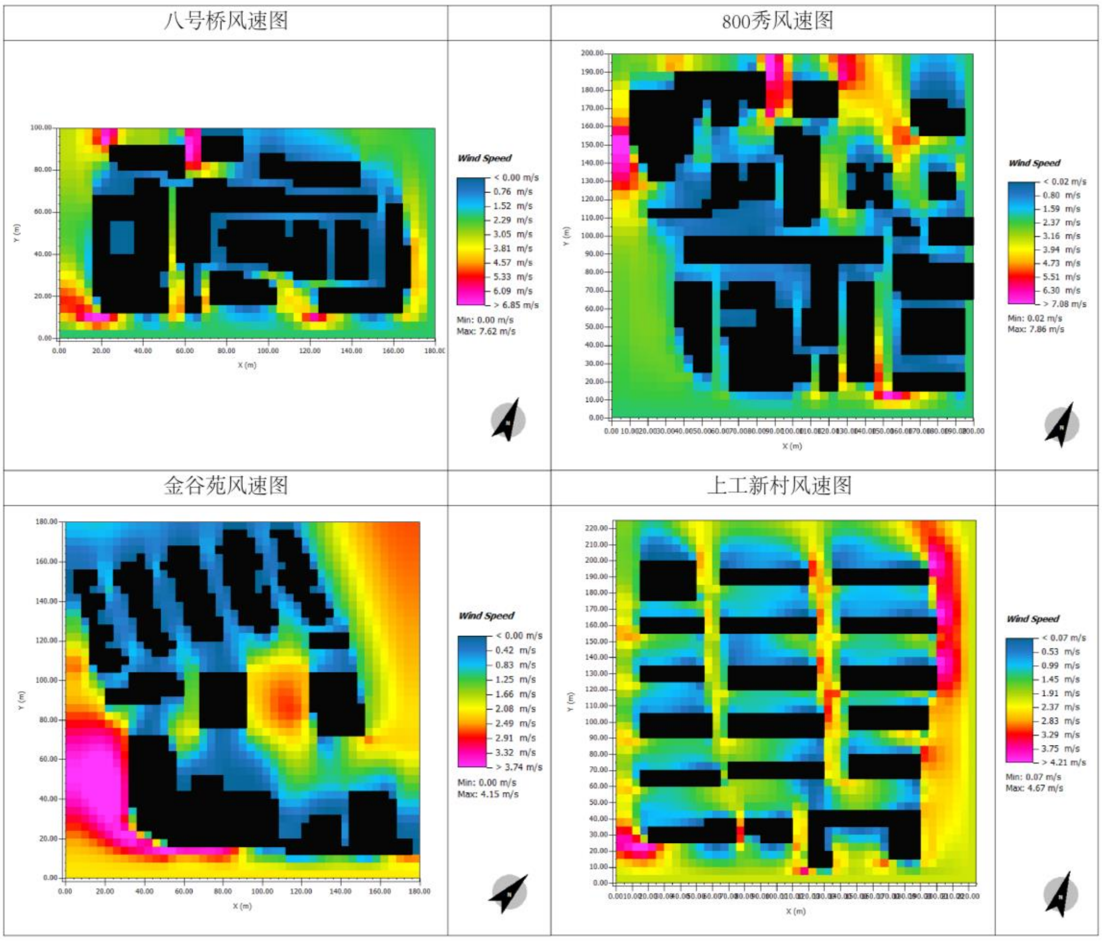


Fig 4-6 Wind speed map of No.8 bridge, 800xiu, Jinguyuan and Shanggong New Village

Figure 4-5 and figure 4-6 show the distribution of air temperature and wind speed of No. 8 bridge, 800xiu, Jinguyuan and Shanggong new village. From the perspective of the compactness of the block layout, the air temperature distribution in the eight bridge and 800 Show blocks is poor, and the air temperature in the compact space is generally high. Due to the limited space heat dissipation capacity, the layout of Jinguyuan and Shanggong new village is loose, and the air temperature distribution in the block is relatively good. The compact layout of the block has a great influence on the ventilation capacity, and the wind speed is obviously low. The internal wind speed of No. 8 bridge and 800 Show is generally lower than 1 m / s. The open space and the wind speed at the air duct of Jinguyuan and Shanggong new village are better.

Through the simulation of the above four cases, it can be seen that different types of urban renewal projects and current layout will produce different microclimate and thermal comfort distribution of the block. The layout of old industrial building blocks is compact, but due to the general low building height, it is unable to provide sufficient building shadow area outdoors under extreme climate conditions in summer, so the distribution of microclimate and thermal comfort is poor. There are obvious differences in the layout patterns of old residential blocks. Because of the large volume of single building and the high building height, the blocks with point group layout can produce sufficient building shadow area in the block. The microclimate and thermal comfort are in good condition. The space between buildings in the row layout block is large, and the building height is generally limited. When the building orientation is poor, the street The distribution of microclimate and thermal comfort is not ideal. From the perspective of building layout, when the block layout is compact, the air temperature and wind speed are unfavorable, but when the building can provide sufficient shadow area, the thermal comfort of the block is relatively better.

4.2.3 Microclimate and thermal comfort improvement methods

The above four cases of urban renewal projects in Shanghai are not ideal in terms of the distribution of microclimate and thermal comfort under the extreme climate conditions in summer. According to the different modes of demolition, reconstruction, improvement and protection, the urban renewal projects adopt different renewal methods. When the urban renewal projects are not suitable for the major renovation of block buildings, the thermal comfort of outdoor space can still be improved by means of vegetation, water, devices and other means. By setting fountains in the public space at the entrance of No. 8 bridge, the microclimate and thermal comfort of the surrounding space can be alleviated by water evaporation. By setting outdoor sunshade seats at the walkways on both sides of the main show building, part of the solar radiation can be resisted and the thermal comfort of the space can be improved, as shown in Figure 4-7. The old blocks represented by Jinguyuan and Shanggong new village generally improve the microclimate by planting trees, shrubs and other vegetation, and provide shadow areas for outdoor space, as shown in Figure 4-8.


Fig 4-7 Left: fountain, bridge 8; right: outdoor sunshade seat, 800 Show
Source: Internet

Fig 4-8 Left: Jinguyuan; right: Shanggong New Village
Source: Baidu Street View

4.3 Research on the implementation process of Shanghai Urban Renewal Project

4.3.1 Policy and planning management process

Although Shanghai urban renewal was carried out earlier, it was not until 2015 that formal documents were issued to guide the urban renewal work, namely, the implementation measures of Shanghai urban renewal and the implementation rules of Shanghai urban renewal planning land (for Trial Implementation), supplemented by relevant supplementary documents. The overall work content and organization of urban renewal are still in the preliminary stage [68].

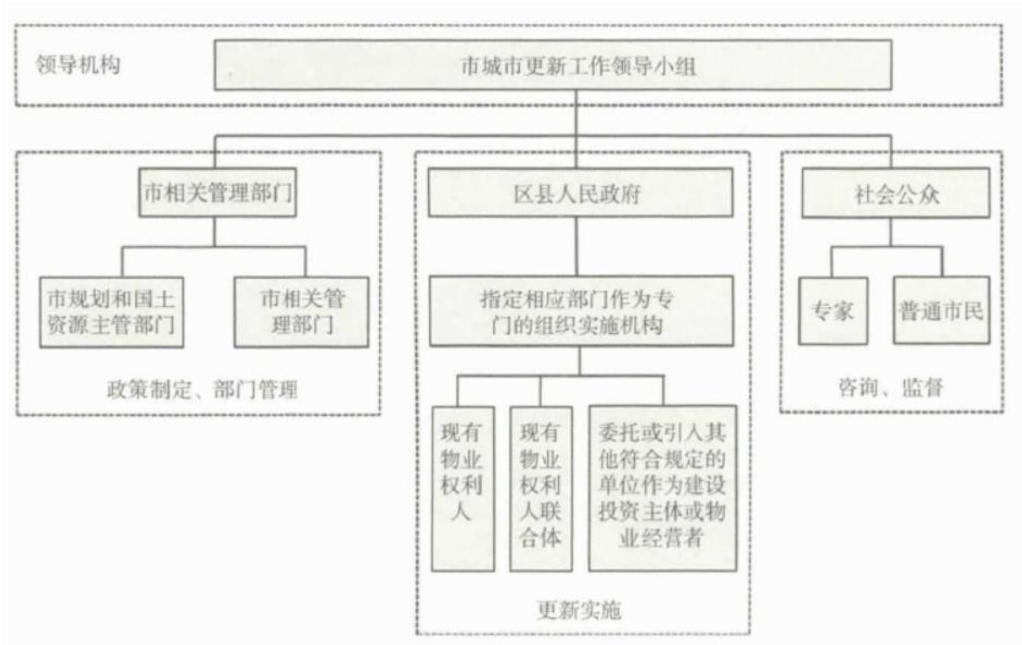


Fig 4-9 Schematic diagram of Shanghai's current urban renewal organization [68]

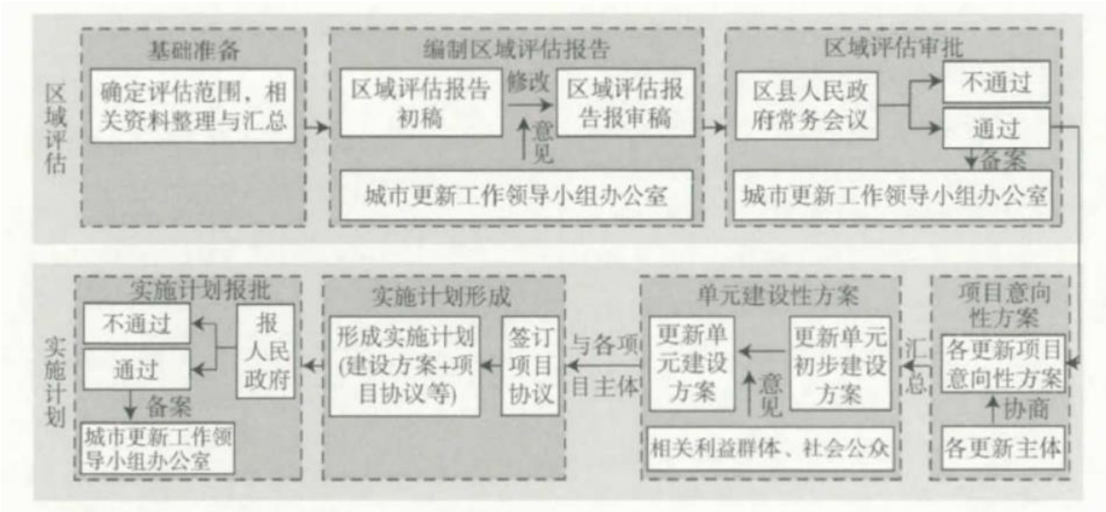


Fig 4-10 Flow chart of current urban renewal planning in Shanghai [68]

Shanghai has set up relevant organization departments of urban renewal and established relevant organization system to carry out urban renewal. Take Shanghai city renewal project Xintiandi, No. 8 bridge and Tianzifang as an example, the government carries out city renewal work [69] by developing cooperation with developers, giving the majority of the government power, government guidance and residents' autonomy. In the process of urban renewal, although the government has different degrees of involvement, as the key force of urban renewal project, the management role of each stage from evaluation to implementation is obvious. In the regional assessment stage, it is suggested to add the microclimate assessment report of the project area as the guidance of urban renewal project planning and design, which plays a key role in the development and implementation of the planning and design scheme and the realization of good microclimate and thermal comfort environment of the block.

4.3.2 Pre-evaluation and post-evaluation

Urban renewal generally makes urban space adapt to the requirements of urban development through protection, repair, demolition and reconstruction. Generally, the focus of urban renewal is function reorganization, quality improvement, comprehensive service improvement, etc., while the consideration of microclimate in traditional urban renewal is very lacking. In the "walking in Shanghai - community space micro update" plan carried out in Shanghai in 2016 and 2017, 22 pilot projects were carried out, which are characterized by re design and re organization of community space, focusing on the function of block scope and the quality of built environment [70]. However, little attention has been paid to the construction of microclimate in urban renewal projects.

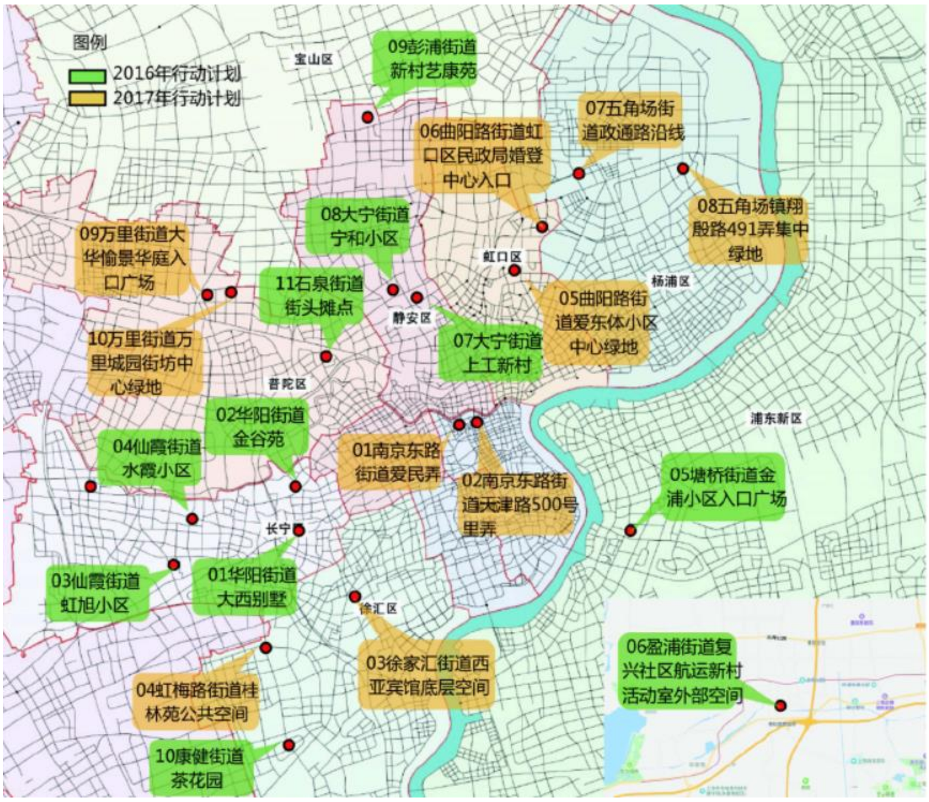


Fig 4-11 Distribution of pilot projects of "walking in Shanghai – community space micro renewal plan" in 2016 and 2017 [70]

Article 10 of Chapter II of the detailed rules for the implementation of land for urban renewal planning issued by Shanghai Municipal Bureau of planning and land resources in 2017 points out the contents of the evaluation report in urban renewal, which mainly includes: delimiting renewal units, carrying out public factor evaluation, and preparing intentional construction plans. Among them, the specific requirements of public elements include: ensuring accessibility, providing appropriate scale, dealing with adjacent relations, convenient use, paying attention to design and construction quality, etc., and put forward the ecological requirements for the implementation of urban renewal projects. Although Shanghai pays more and more attention to the quality of urban environment, the process of microclimate assessment in urban renewal project management is not specific. The process and assessment of urban microclimate in planning and project development are generally divided into urban local climate assessment and urban microclimate assessment. Local climate assessment focuses on the preparation of climate map at the level of urban macro planning and relevant climate planning. Urban microclimate assessment focuses on the improvement strategy research at the level of project, and carries out corresponding work based on the assessment results, such as a certain project in Shenzhen The microclimate assessment process of the region is shown in Figure 4-12.

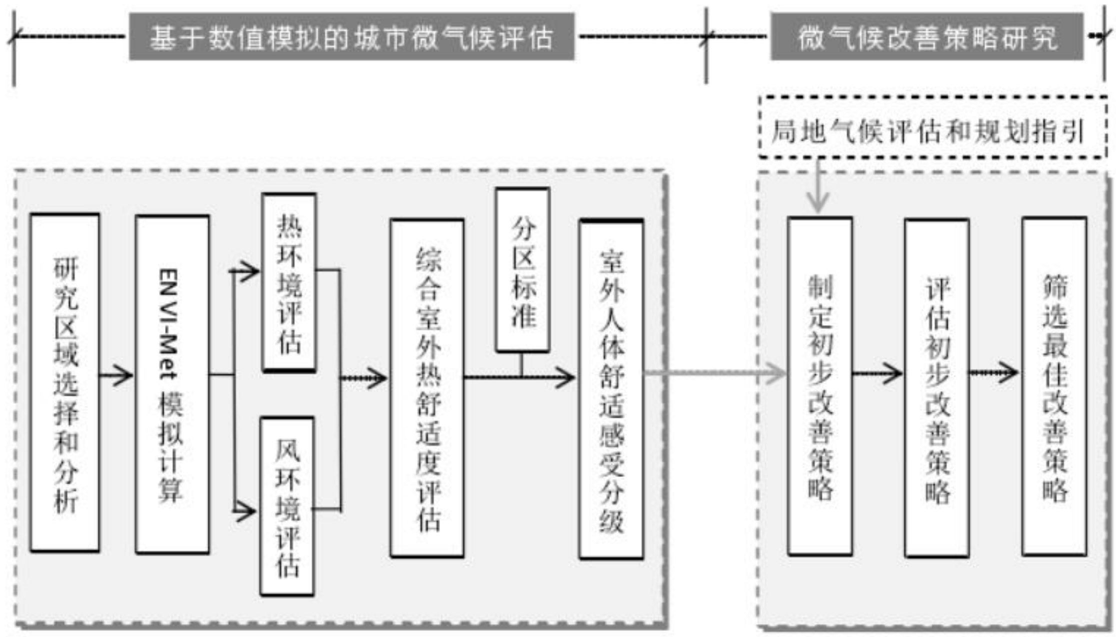


Fig 4-12 Flow chart of urban microclimate Assessment Scheme [71]

Microclimate Simulation can be used as the pre assessment content before the urban renewal project. Through the simulation of the current situation of each project in the early stage of urban renewal implementation, such as the industrial land, old residential areas, historical and cultural areas, or the old residential areas mainly based on the reconstruction, the preliminary judgment and pre assessment of the project's microclimate status can be made, and the microclimate model based on the project status can be used Based on the analysis results, it can better guide the follow-up planning and design work, adapt to the ecological requirements of urban renewal, and create a better microclimate environment. Microclimate Simulation can also be used as the post evaluation content of urban renewal projects whose planning and design schemes have been completed. On the one hand, it can test the implementation of the planning and design results of urban renewal projects on the microclimate construction of blocks. On the other hand, it can also strengthen the basis of the management department in the approval process, and test the existing or not meeting the expected microclimate problems, so as to change the subsequent projects The process of good and governance provides the basis.

4.4 Summary of this chapter

This chapter first combs the current situation and background of the urban renewal development in Shanghai, explains the huge potential of the renewal space scale of Shanghai in the field of urban renewal, which is in urgent need of research and support, and lists the completed urban renewal projects and related pilot work in recent years. Then through the simulation analysis of the current layout of four typical urban renewal projects in Shanghai, this paper explains the influence of block type and building layout on the microclimate and thermal comfort of the block, and finds that for different types of urban renewal projects, the distribution of microclimate and thermal comfort is obviously different, with certain regularity and development characteristics of Shanghai The particularity of. Finally, through the study of the relevant policies and management processes in the field of urban renewal in Shanghai, it points out that the consideration of microclimate and thermal comfort in the process is insufficient, and it is suggested to add the pre assessment and post assessment contents in the microclimate and thermal comfort in the early and later stages of the project development process, so as to guide and post assess the planning and design of urban renewal projects in Shanghai Period approval, governance process and other aspects of optimization.

Chapter five: Simulation and optimization of microclimate and thermal comfort in pre-evaluation of urban renewal project

Before planning and design of urban renewal project, the pre evaluation can be used to analyze the microclimate and thermal comfort of the project block, which has guiding significance for planning and design. The urban renewal projects in Shanghai show different characteristics due to the type, block layout, vegetation distribution, constraints and other factors. In this chapter, Cao Yang village and Shanghai Music Valley, two typical urban renewal projects in Shanghai, are selected. Based on the simulation analysis of the blocks and the characteristics of the project, microclimate and thermal comfort are proposed And the differences of microclimate and thermal comfort optimization methods of different types of urban renewal projects are compared.

5.1 Background of case block

In 2019, Putuo District has launched a comprehensive renovation plan, which will carry out the renovation of old blocks by combining urban renewal, improving the overall quality and other aspects, taking into account the characteristics of each block, and carry out the transformation according to local conditions. Caoyang village is located in Putuo District, Shanghai. It was built in 1952. It is the first group of new workers' village built in New China and the fourth group of historical protected buildings in Shanghai. It belongs to four categories of protection. Caoyang village covers an area of about 7800m2, with large spacing between blocks. Due to the disrepair for a long time, the block gradually exposed the problems of low material structure standard and backward supporting facilities, but the block still has certain cultural value.

Fig 5-1 Bird's-eye view and current situation reference map of Caoyang village [73]

Shanghai Music Valley, located in Hongkou District, Shanghai, is a key cultural and creative industry cluster area in Shanghai, belonging to the historical and cultural area. There are a large number of Shikumen Lilong buildings in the block, such as ruikangli and ruiqingli Shikumen communities. There are many historic buildings in the block. As early as 2011, Hongkou District officially used this area to build Shanghai Music valley. Now it has become a block integrating residential, commercial and creative functions [74]. This chapter selects the area north of Shajing port as the simulation object, including the national music industry base, ruikangli and ruiqingli Shikumen communities, peninsula Bay fashion culture and Creative Industry Park, etc.

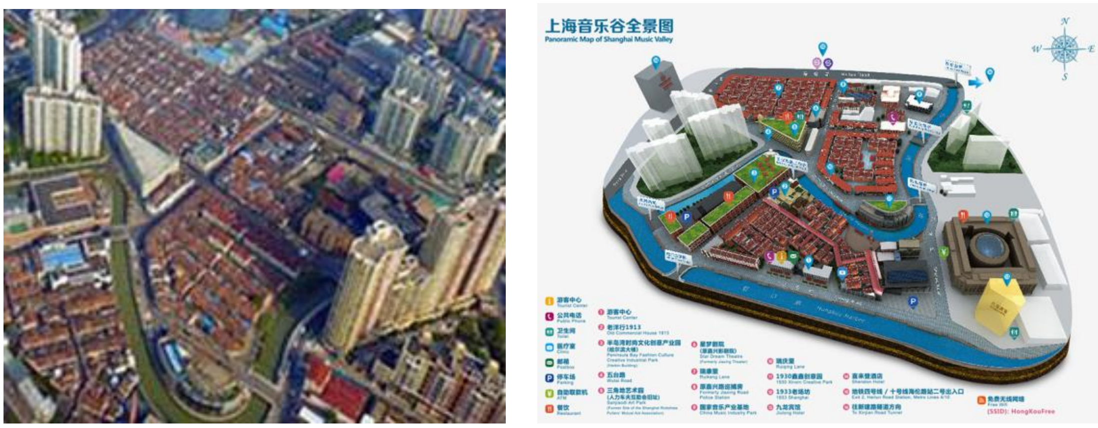


Fig 5-2 Aerial view and panoramic reference of Shanghai Music Valley
Source: Internet

5.2 Simulation and evaluation of Caoyang village

5.2.1 Block modeling

Using envi met software to model Caoyang village, including building, vegetation, water body, paving type and other block characteristics in the block, the modeling area size is 450m * 450m * 90m, the number of grid is 90 * 90 * 30, unit length DX = dy = 5m, DZ = 3M. The building height and layout of residential buildings in Caoyang first village block are relatively neat. The buildings are arranged in a row, with a building height of about 9 meters. There are cultural centers, banks, commercial stores, etc. in the southwest, with the building height ranging from 12m to 27m. The northwest side is a school building with a building height ranging from 9m to 21m and a low building density. The blocks are dotted with buildings 18 meters and 33 meters high.

Caoyang village has a good overall greening condition, with tall street trees planted on both sides of Huaxi Road, Tangpu road and Fengqiao road. Caoyang Park in the East has a high greening rate, many arbors are planted and widely distributed. There is a river beside Huaxi road to separate the blocks on the north and south sides. There are differences in the pavement materials of the block ground. Envi met sets each material as follows: the pavement material of the road is asphalt road, the pavement material of the residential area is mainly masonry Road, and the other parts of the ground are loamy soil.

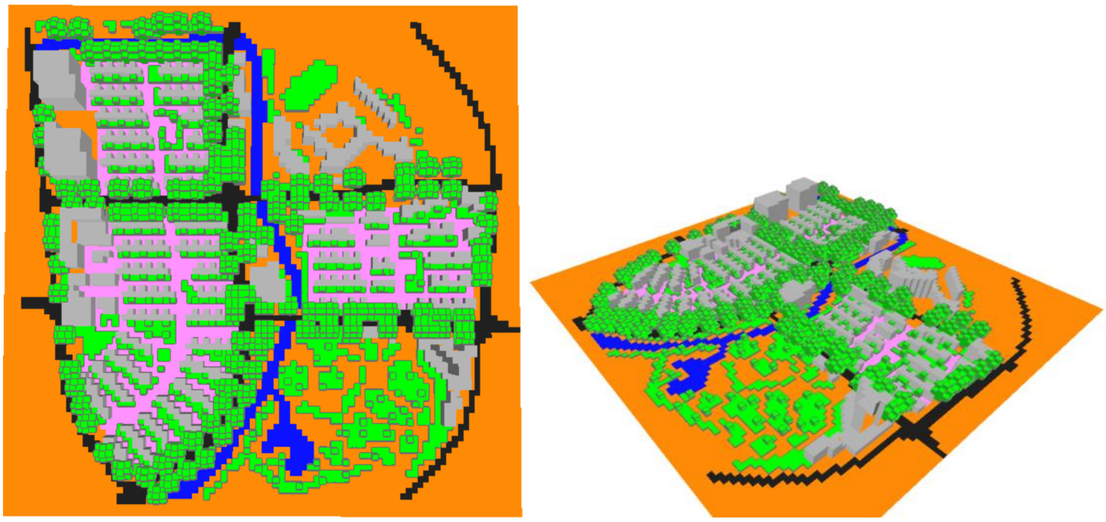


Fig 5-3 Top view and aerial view of envi met model of Caoyang village

5.2.2 Analysis of distribution and feature selection of thermal comfort in blocks

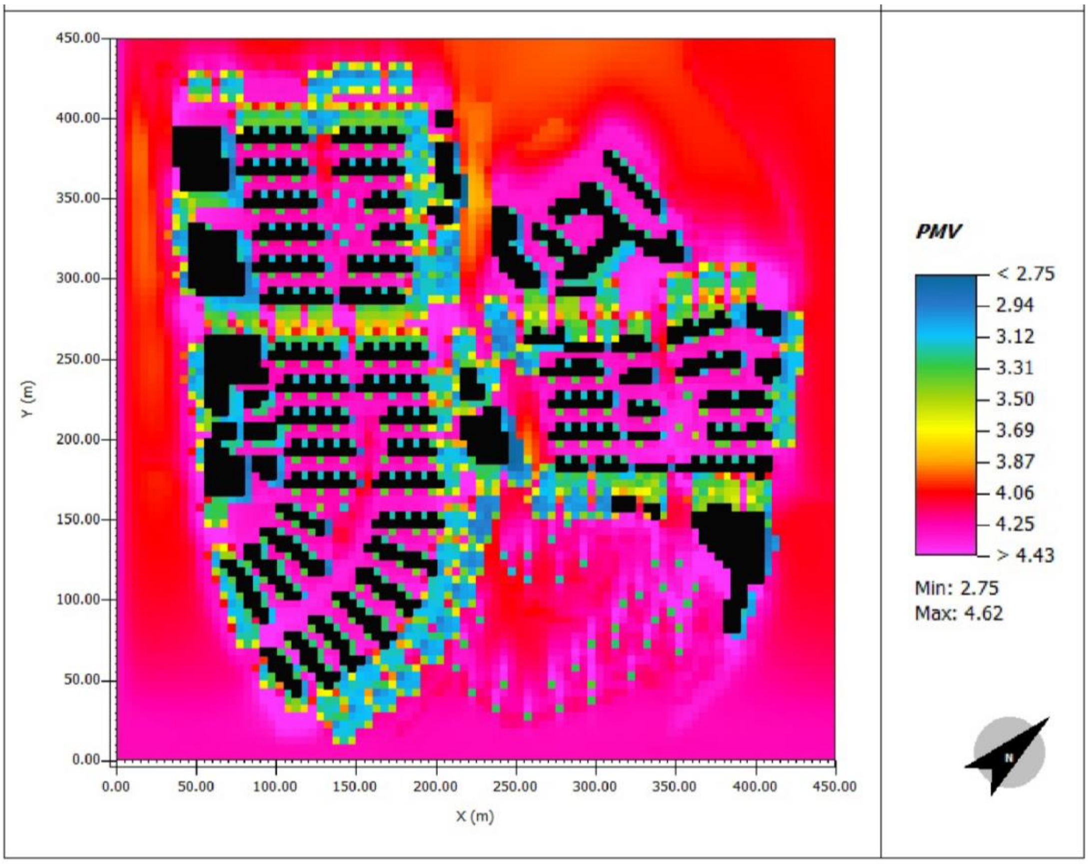


Fig 5-4 PMV of Caoyang village

According to the simulation results of the PMV value of Caoyang village, the overall thermal comfort distribution of Caoyang village shows a certain regularity except that there are a few areas with great difference from the surrounding environment. In some areas, for example, the PMV value of the East space of the southwest building is about 3.0, the PMV value of the street space of Huaxi road from southeast to northwest is about 3.1, the PMV value of the street space of Fengqiao road from northeast to southwest is about 3.4, the PMV value of the street space of Tangpu road from northeast to southwest is about 3.5, the PMV value of the non building and tree shadow area in Caoyang village is about 4 .2 or so.

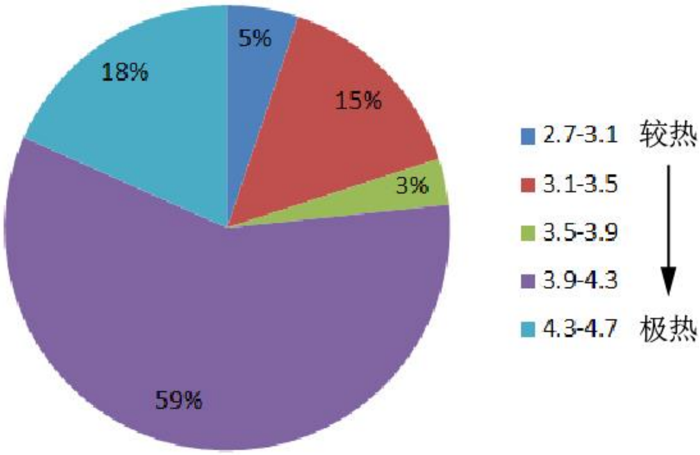


Fig 5-5 Distribution and proportion of PMV in Caoyang village

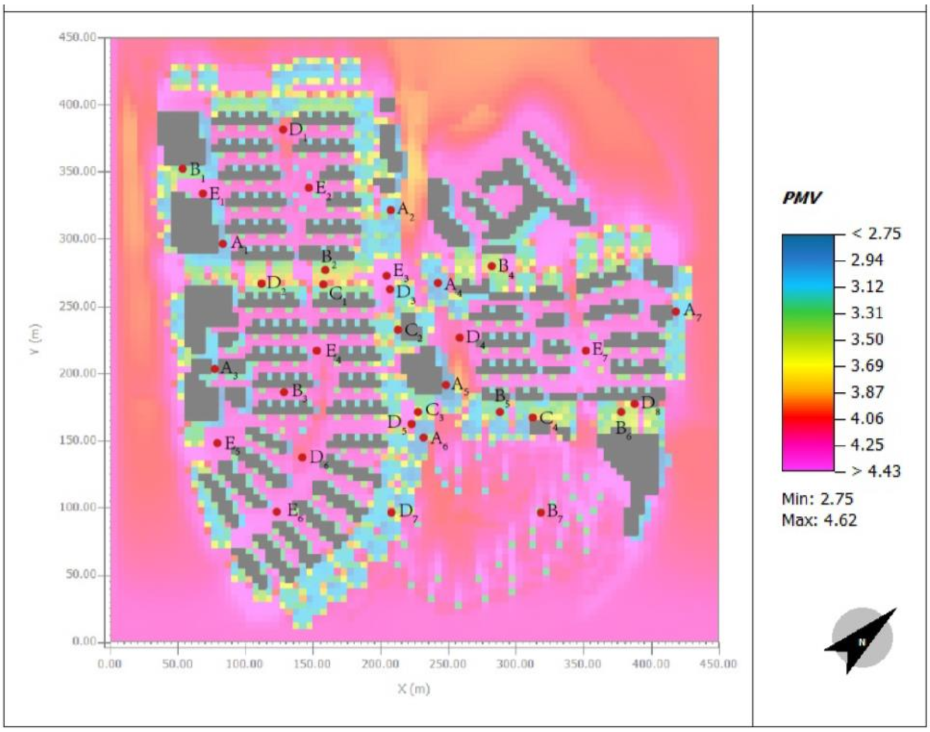


Fig 5-6 Characteristic point selection map of Caoyang village

The distribution of PMV value in the simulation area of Caoyang village 1 is counted, the model boundary and some invalid points are eliminated, and the proportion of the number of each interval point to the total number is made into pie chart, as shown in Figure 5-5. Although the overall PMV distribution of Caoyang village is poor, the space with PMV less than 3.9 accounts for about a quarter of the total, and the space with PMV less than 3.5 accounts for 20%, indicating that in extreme climate conditions, some space thermal comfort evaluation is relatively good. The space of PMV in 3.9-4.3 accounted for nearly 60%, while the space of PMV greater than 4.3 accounted for 18%.

Based on the distribution of PMV value of Caoyang first village block, the characteristic points of the block are selected through different sections of PMV value, and the relationship between the current condition of the block and thermal comfort is analyzed, as shown in Figure 5-6. According to the value of PMV, it can be divided into five sections: 2.7 < Xi < 3.1 (AI); 3.1 < Xi < 3.5 (BI); 3.5 < Xi < 3.9 (CI); 3.9 < Xi < 4.3 (DI); 4.3 < Xi (EI). The current characteristics of all characteristic points are summarized from three aspects: open degree, shadow area or not, and surface type, and the current characteristics of each interval are analyzed, as shown in Table 5-1. It can be found that whether the characteristic points of the block are in the shadow area has a high consistency with its thermal comfort, and the thermal comfort of the building shadow area is generally better than that of the tree shadow area. The environmental openness and thermal comfort of the characteristic points of the block also show good consistency, that is, when the layout of buildings, trees and other environments near the characteristic points is compact, the thermal comfort is significantly better than other spaces when the openness is dense. The PMV value of most of the feature points with loose open degree is in the range of D and E, because these feature points are most affected by solar radiation. The relationship between the surface type and thermal comfort is weak. Grassland can improve the spatial microclimate to a certain extent, but compared with the influence of shadow area and open degree on thermal comfort, it can not be the determinant of thermal comfort. Even for artificial pavement such as masonry or asphalt pavement, its space can form better microclimate and heat by adjusting the spatial layout and creating shadow area Comfort.

Table 5-1 PMV value and environmental characteristics of characteristic points in Caoyang village

PMV value interval	number	PMV value	Current characteristics of selected points (open degree; shadow area or not; surface type)	Status quo characteristics of the section
$2.7<x_i<3.1$	A_1	2.959	Dense；Architectural shadow；Masonry pavement	All of them are located in the shadow area of buildings or trees, and there are many shadow areas of
	A_2	3.041	Middle；tree shadow；Grass	
	A_3	3.046	Dense；Architectural shadow；Masonry pavement	
	A_4	3.015	Middle；tree shadow；Grass	

	A_5	2.797	Middle；Architectural shadow；Grass	buildings; the open degree of buildings and open spaces is relatively dense; grassland is the majority of the surface
	A_6	2.919	Loose；tree shadow；Grass	
	A_7	2.986	Middle；Architectural shadow；Grass	
$3.1<x_i<3.5$	B_1	3.316	Middle；Architectural shadow；Grass	All of them are in the shadow area of buildings or trees, and there are many shadow areas of trees; the open degree of buildings and open spaces is relatively dense; there are grassland and asphalt pavement on the surface
	B_2	3.466	Middle；tree shadow；asphalt pavement	
	B_3	3.347	Dense；Architectural shadow；Grass	
	B_4	3.474	Middle；tree shadow；asphalt pavement	
	B_5	3.212	Loose；tree shadow；asphalt pavement	
	B_6	3.317	Middle；tree shadow；asphalt pavement	
	B_7	3.287	Loose；tree shadow；Grass	
$3.5<x_i<3.9$	C_1	3.618	Middle；few tree shadow；Grass	It is basically located in the shadow area of trees, with large or small shadow range; the building and open space are mainly in the middle degree of open space; the surface has grass and asphalt pavement
	C_2	3.657	Middle；tree shadow；Grass	
	C_3	3.754	Loose；few tree shadow；asphalt pavement	
	C_4	3.707	Middle；tree shadow；asphalt pavement	
$3.9<x_i<4.3$	D_1	4.076	Middle；few Architectural shadow；Grass	There is basically no shadow or a small amount of shadow of buildings or trees, except for D8, which is located in the shadow area of buildings; the open degree of buildings
	D_2	4.026	Middle；no shadow；Grass	
	D_3	4.039	Loose；few tree shadow；Grass	
	D_4	4.116	Loose；no shadow；Grass	
	D_5	4.098	Loose；no shadow；asphalt pavement	
	D_6	4.127	Loose；no shadow；Grass	
	D_7	4.142	Loose；no shadow；Grass	

	D_8	4.110	Middle；Architectural shadow；Grass	and open spaces is relatively open; most of the surface is grassland
4.3<x_i	E_1	4.334	Middle；no shadow；Loamy	All of them are not in the shadow area; the open degree of buildings and open spaces is almost empty; the surface types are different and there is no special rule
	E_2	4.316	Loose；no shadow；Masonry pavement	
	E_3	4.406	Loose；no shadow；asphalt pavement	
	E_4	4.319	Loose；no shadow；Masonry pavement	
	E_5	4.340	Loose；no shadow；Grass	
	E_6	4.388	Middle；no shadow；Masonry pavement	
	E_7	4.395	Loose；no shadow；Masonry pavement	

5.2.3 Microclimate characteristics and analysis of block

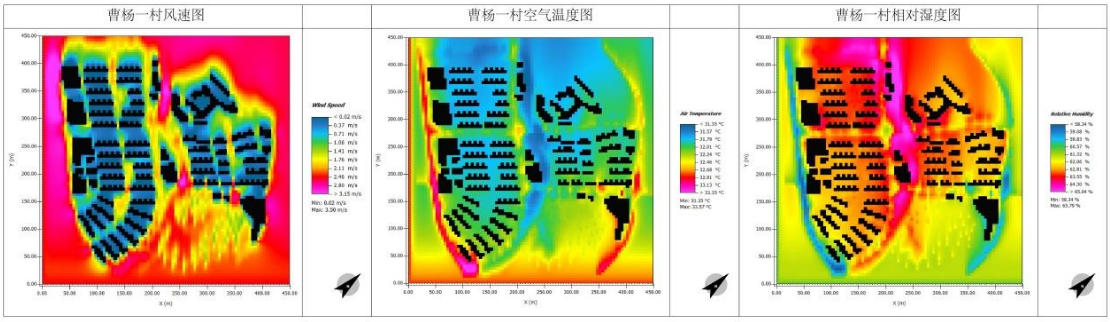


Fig 5-7 Wind speed diagram, air temperature diagram and relative humidity diagram of Caoyang first village

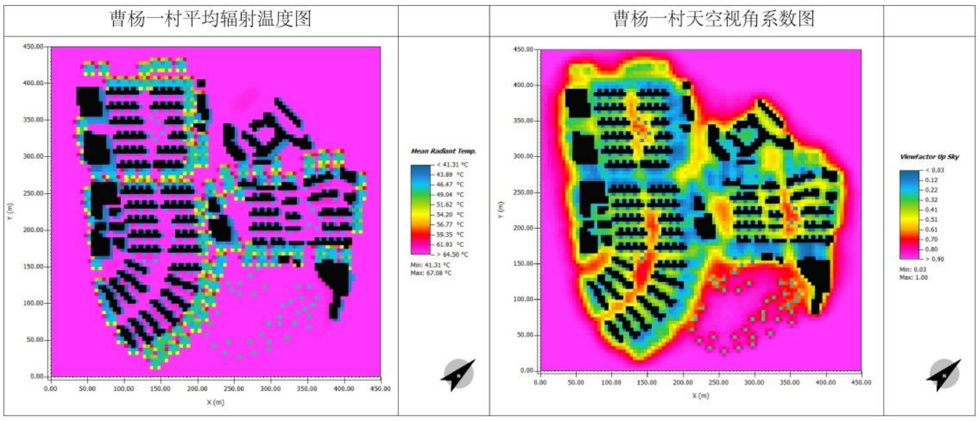


Fig 5-8 Average radiation temperature and sky angle coefficient of Caoyang village

The simulation results of wind speed, air temperature and relative humidity of Caoyang first village block are shown in Figure 5-7. From the wind speed map, we can see that the main road Huaxi road in the block is generally windy, with a speed of about 2m / s, because it complies with the dominant wind direction, and there is no obvious obstruction. The wind speed is generally large, and the narrow space of the road due to the layout of the building forms a good air channel due to the narrow pipe effect. The wind speed is further increased, and the wind speed between the buildings in the block is very small due to the obstruction of the building and the layout mode of the block. In addition to the large building density in the southwest and near the four large building areas, the building density in other areas of the block is moderate, and in the areas with large building density, due to the large interference on the air flow, the wind cannot penetrate well, and the wind speed is generally poor compared with the areas with moderate building density. The overall air temperature of Caoyang first village block is well distributed, fluctuating at about 31.6 ℃, which is related to the good distribution of ecological conditions such as trees, grasslands and water in the block, and the air temperature condition on the main air duct of the block is better. The air temperature in Asphalt Road area is higher than that in other areas of the block, and the larger the area is, the worse the air temperature distribution is. For example, at the road intersection, it indicates the influence of the ground type on the air temperature. The good ecological conditions of the block make the relative humidity distribution of the block better, and the good connection of the wind in the main street further optimizes the relative humidity distribution of the block.

As shown in Figure 5-8, the distribution of average radiation temperature in Caoyang first village block is obviously different. As a whole, it shows the characteristics of low average radiation temperature in street space and high average radiation temperature in residential area. The difference can reach more than 20 degrees. Because the tall street trees on both sides of the road in Caoyang village produce rich shadow areas in the street space, the overall road receives low solar radiation, and its average radiation temperature is low, while the distribution of trees in the block is generally close to the building, and there is no coherent qiaomukong, and the building height in the block is generally low, so the average radiation temperature distribution is poor. The distribution of the average radiation temperature map is consistent with the distribution of PMV in the block, and in the block space with low average radiation temperature, it corresponds to tree shadow area or building shadow area respectively, and its PMV value is generally low, which indicates that the shadow area has brought significant improvement to the distribution of thermal comfort in the block. The sky angle coefficient map reflects the airtight degree of the block space. The overall airtight degree of the internal space of the residential area is relatively low, which is consistent with the overall distribution of the average radiation temperature. There are several open public space areas in the block, with a large sky angle coefficient, which can be used as the space for the key improvement of microclimate and thermal comfort.

5.2.4 Correlation analysis of Microclimate Characteristics and thermal comfort

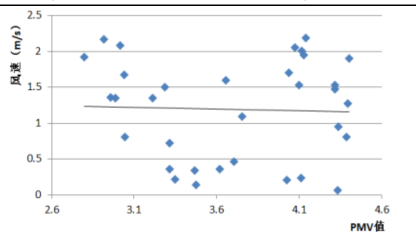
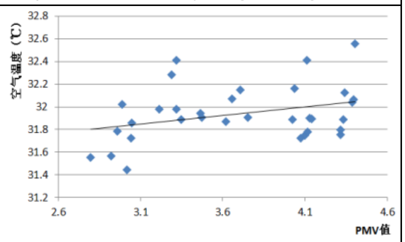
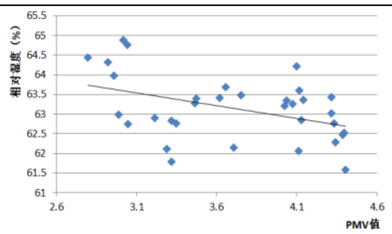
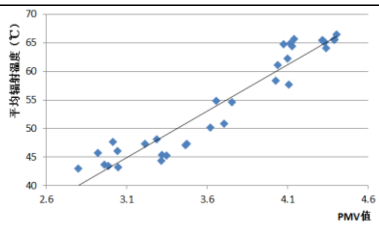
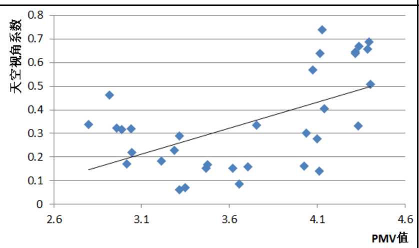
The thermal comfort condition of the block is affected by the microclimate characteristics. The microclimate characteristic parameters of the characteristic points selected based on the thermal comfort in Caoyang village are shown in table 5-2. Based on the data of the characteristic points, the correlation analysis is carried out between the thermal comfort index PMV value and the microclimate characteristic parameters, as shown in Figure 5-7.

Table 5-2 Numerical table of microclimate parameters of characteristic points in Caoyang village

number	PMV	Wind speed(m/s)	Air temperature(° C)	Relative humidity(%)	Average radiation temperature(° C)	Sky view factor
A1	2.9591	1.3584	31.784	63.986	43.667	0.32402
A2	3.0416	1.6772	31.722	64.773	46.045	0.3206
A3	3.0462	0.80536	31.858	62.738	43.18	0.21941
A4	3.0158	2.0785	31.444	64.889	47.696	0.17119
A5	2.7975	1.9224	31.554	64.442	42.942	0.33716
A6	2.9197	2.1701	31.567	64.322	45.722	0.4612
A7	2.9866	1.3457	32.023	62.986	43.426	0.31694
B1	3.3169	0.36491	31.979	62.828	44.345	0.29032
B2	3.4664	0.34104	31.943	63.276	47.06	0.15196
B3	3.3476	0.22377	31.886	62.765	45.231	0.071055
B4	3.4746	0.14014	31.903	63.399	47.352	0.16801
B5	3.2127	1.3546	31.976	62.905	47.33	0.18175
B6	3.3176	0.7215	32.409	61.788	45.385	0.059722
B7	3.2876	1.5055	32.282	62.121	48.117	0.2293
C1	3.6185	0.35844	31.871	63.414	50.188	0.1525
C2	3.6571	1.594	32.073	63.693	54.886	0.085913
C3	3.7544	1.0908	31.906	63.482	54.549	0.33384

C4	3.7078	0.46788	32.151	62.154	50.896	0.15742
D1	4.0765	2.0567	31.723	63.26	64.71	0.57039
D2	4.0269	0.20962	31.889	63.207	58.39	0.16149
D3	4.0391	1.7051	32.163	63.34	61.056	0.29986
D4	4.1162	2.0042	31.778	63.599	64.86	0.63794
D5	4.0989	1.5278	31.75	64.221	62.254	0.27551
D6	4.1275	1.9454	31.897	62.851	64.464	0.73903
D7	4.1424	2.1895	31.896	63.365	65.721	0.40419
D8	4.1109	0.23834	32.409	62.06	57.735	0.13984
E1	4.3343	0.067197	31.89	62.763	65.142	0.33029
E2	4.3162	1.4701	31.751	63.429	65.392	0.64444
E3	4.4065	1.9014	32.554	61.577	66.522	0.50891
E4	4.3194	1.5329	31.796	63.02	65.482	0.63761
E5	4.3406	0.94775	32.125	62.287	64.067	0.67064
E6	4.3886	0.80835	32.038	62.474	65.574	0.65623
E7	4.3953	1.2706	32.062	62.531	65.575	0.68788

Table 5-3 Correlation analysis of PMV and microclimate parameters at characteristic points in Caoyang village

<table>
<tr><td colspan="4">Relationship between PMV and parameters of characteristic points in Caoyang village</td></tr>
<tr><td>Wind speed</td><td>
</td><td>Air temperature</td><td>
</td></tr>
<tr><td>Relative humidity</td><td>
</td><td>Average radiation temperature</td><td>
</td></tr>
<tr><td>Sky view factor</td><td>
</td><td></td><td></td></tr>
</table>

From the corresponding relationship between the thermal comfort index (PMV) of the characteristic points of Caoyang first village block and the characteristic parameters of microclimate, it can be found that the best correlation is the average radiation temperature, which has a strong positive correlation with the thermal comfort PMV, indicating that the average radiation temperature is the most critical factor affecting the thermal comfort in summer, and that the shadow area has an important impact on the thermal comfort in summer 。 The greater the wind speed in summer, the better the thermal comfort. From the relationship between the wind speed and PMV value, it can be seen that when PMV is less than 3.8, that is, when the feature point is basically in the shadow area, the wind speed and PMV show a good negative correlation at this time. When PMV is more than 3.8, the regularity of the wind speed and thermal comfort at the feature point is weak, because the feature point is more affected by the solar radiation at this time, which also shows that the wind speed is more than the shade The influence of the shadow area on the thermal comfort of the block in summer is less. The relationship between the air temperature and PMV value of the characteristic points is consistent from the overall trend, and the relationship between the air temperature and relative humidity is relatively consistent with the negative correlation. From the perspective of the overall trend, the sky angle coefficient and PMV value show a positive correlation, but the characteristic points fluctuate. Because the sky angle coefficient describes the property of space closure degree, it does not have the particularity of describing space thermal comfort under extreme time. However, in the area with sky angle coefficient value greater than 0.5, because the surrounding block environment is relatively open, it is easy to be affected by the radiation of the sun The thermal comfort is generally poor, and the thermal comfort is relatively good in most areas with small sky angle coefficient.

5.3 Simulation and evaluation of Shanghai Music Valley

5.3.1 Block modeling

Envi met is used to model Shanghai Music Valley, including building, vegetation, water body, type of paving and other factors in the block. The size of the modeling area is 475m * 475m * 175m, the grid setting is 95 * 95 * 35, and the unit length DX = dy = DZ = 5m. Shikumen building complex in the block is arranged orderly, with compact layout, small building spacing and building height of about 6m or 9m. On the northeast side is the national music industry base, with relatively scattered building layout, and on the south side is Huaji apartment about 18 meters high. The southwest side of the block is the triangle Art Park, with a building height of about 15 meters. The height of the creative park at the corner of Shajing port is about 15 meters. In addition, there are two high-rise residential buildings with a height of about 45m and 69m in the southwest of music Valley block in Shanghai. The building height of Creative Park in the South ranges from 6m to 12m. There are high-rise residential buildings with a height of about 75m, 36m and 78m in the East. In order to achieve high simulation accuracy in the north of music Valley in Shanghai, the surrounding environment of this part is unified for modeling.

There are only a few grasslands and trees in the national music industry base and on both sides of the river along the Shajing port. Envi met sets the ground materials of Shanghai Music Valley as follows: asphalt pavement is used for the road, concrete pavement grey is used for the block interior, and loam is used for other parts.

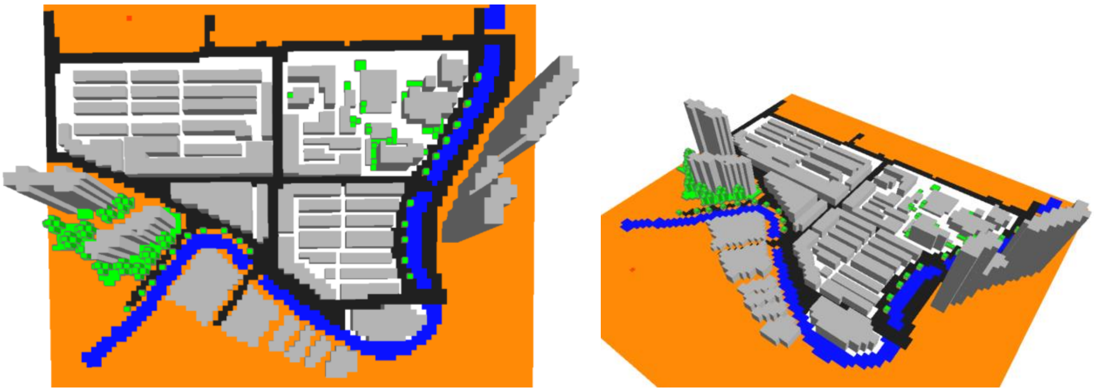


Fig 5-9 Envi met model of Shanghai Music Valley

5.3.2 Analysis of distribution and feature selection of thermal comfort in blocks

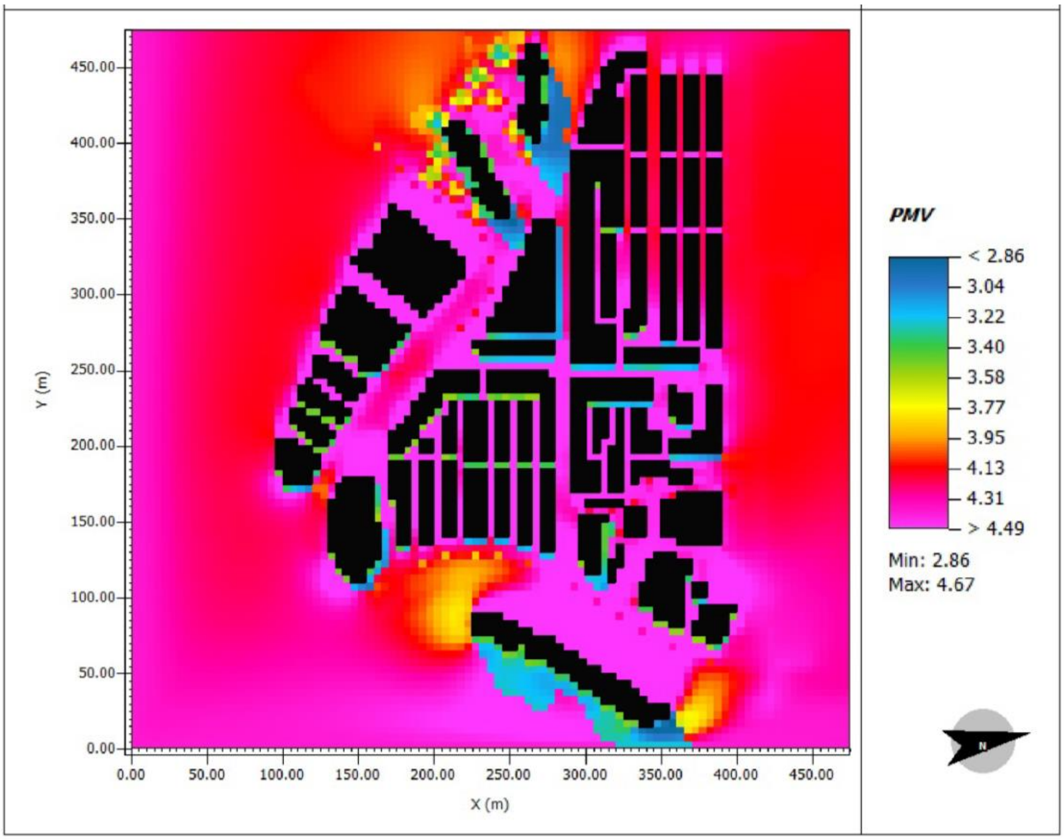


Fig 5-10 PMV map of Shanghai Music Valley

From the simulation results of PMV value of Shanghai Music Valley, the overall distribution of thermal comfort in the block is poor, as shown in figure 5-10. The thermal comfort of triangle Art Park and southwest high-rise residential shadow area is better, its PMV value is about 3.0, the thermal comfort of building shadow area of space in ruianli and ruiqingli Shikumen building complex in the block is general, its PMV value is about 3.5, and the thermal comfort of other areas in the block is generally poor, PMV value is greater than 4.0, the highest even reaches 4.5.

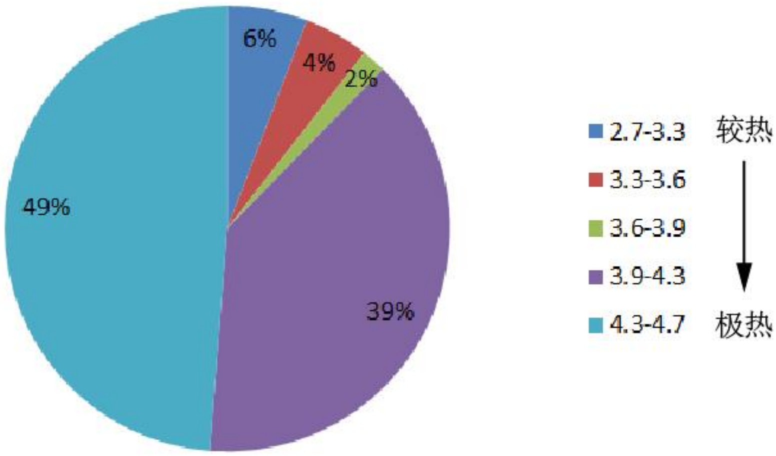


Fig 5-11 Distribution and proportion of PMV in Shanghai Music Valley

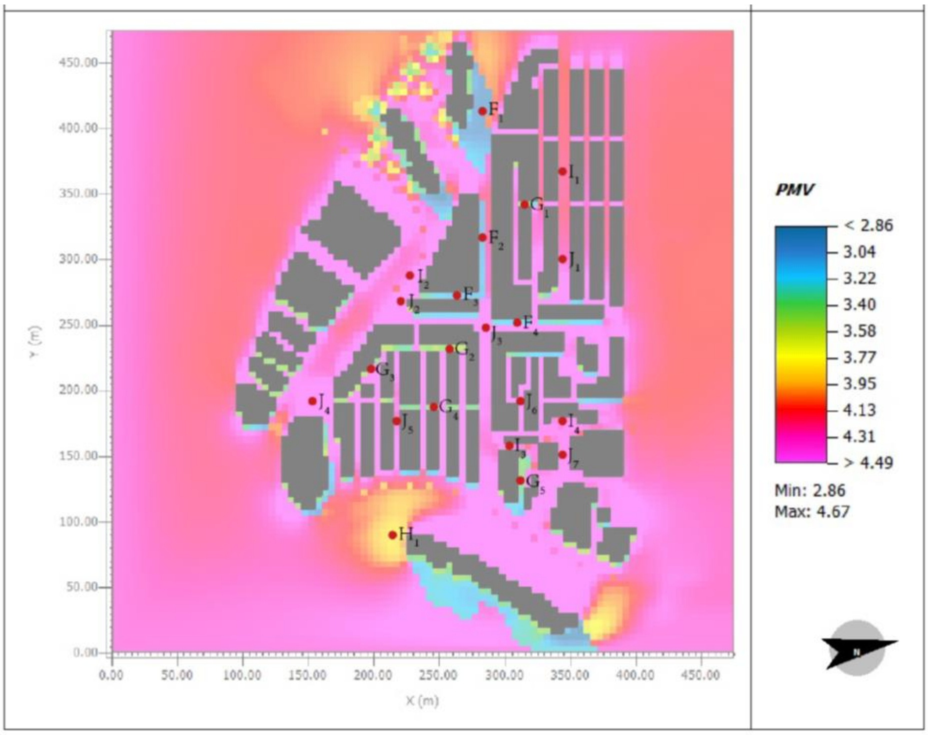


Fig 5-12 Feature point map of Shanghai Music Valley

The distribution of PMV value in the simulation area of Shanghai Music Valley is counted, the model boundary and some invalid points are eliminated, and the proportion of the number of each interval point to the total number is made into pie chart, as shown in Figure 5-11. The overall distribution of PMV in Shanghai Music Valley is poor, the space with PMV greater than 4.3 accounts for about half of the total, and the space with PMV less than 3.9 only accounts for about one eighth, indicating that the space with extremely poor thermal comfort in Shanghai Music Valley is still the majority, and the area with good thermal comfort evaluation in the block is few, and the overall thermal comfort in the street is poor.

Based on the distribution of PMV value in music Valley block of Shanghai, select characteristic points, as shown in Figure 5-12. According to the PMV value, it is divided into five sections, namely 2.7 < Xi < 3.3 (FI); 3.3 < Xi < 3.6 (GI); 3.6 < Xi < 3.9 (HI); 3.9 < Xi < 4.3 (II); 4.3 < Xi (Ji). The summary and analysis of the characteristic points of Shanghai Music Valley block are shown in table 5-4. It can be seen from the results that the few areas with better thermal comfort are all in the shadow area of buildings, indicating the importance of shadow area for the thermal comfort of blocks in summer. Although there are a few architectural shadows or arbor shadows in some characteristic points, their thermal comfort is still very poor, because the height of the internal buildings in Shanghai Music Valley block is generally low, so it is difficult to provide sufficient shadow areas. Because of the low building height and high building density in the block, the environmental open degree of the block characteristic points is not obviously related to the thermal comfort.

Table 5-4 PMV value and environmental characteristics of characteristic points in Shanghai Music Valley

PMV value interval	number	PMV value	Current characteristics of selected points (open degree; shadow area or not; surface type)	Status quo characteristics of the section
$2.7<x_i<3.3$	F_1	2.963	Middle ; Architectural shadow; Loamy	All of them are located in the shadow area of buildings; the open degree of buildings and open space is relatively dense; the surface types are different and the law is not obvious.
	F_2	3.109	Dense ; Architectural shadow; asphalt pavement	
	F_3	3.150	Dense ; Architectural shadow; concrete	
	F_4	3.210	Dense ; Architectural shadow; asphalt pavement	
$3.3<x_i<3.6$	G_1	3.508	Dense ; Architectural shadow; concrete	All of them are located in the shadow area of buildings; the open degree of buildings and open space is very dense; the surface type is concrete pavement.
	G_2	3.474	Dense ; Architectural shadow; concrete	
	G_3	3.550	Dense ; Architectural shadow; concrete	
	G_4	3.430	Dense ; Architectural	

			shadow；concrete	
	G_5	3.455	Dense ； Architectural shadow；concrete	
$3.6<x_i<3.9$	H_1	3.814	Loose；no shadow；Loamy	There is only one characteristic point in this section, no shadow; the degree of the open space between the building and the open space is loose; the surface type is loam
$3.9<x_i<4.3$	I_1	4.225	Dense ； Architectural shadow；concrete	It is basically located in the shadow area of buildings or trees, but the shadow area ranges from large to small; the open degree of buildings and open spaces is relatively dense; the surface types are different, and the law is not obvious.
	I_2	4.178	Middle ； tree shadow ； asphalt pavement	
	I_3	4.212	Dense ； few Architectural shadow；Grass	
	I_4	4.184	Dense ； few Architectural shadow；Grass	
$4.3<x_i$	J_1	4.339	Dense ； Architectural shadow；concrete	Basically, it is located in a small amount of building shadow area or no shadow area, and only one characteristic point is located in the building shadow area; most of the open degree of buildings and open spaces are dense, and a few are loose; the surface type of asphalt pavement and concrete pavement have both
	J_2	4.613	Loose；no shadow；asphalt pavement	
	J_3	4.477	Dense；no shadow；asphalt pavement	
	J_4	4.597	Loose；no shadow；asphalt pavement	
	J_5	4.389	Dense ； few Architectural shadow；concrete	
	J_6	4.515	Dense ； few Architectural shadow；concrete	
	J_7	4.453	Dense ； few Architectural shadow；concrete	

5.3.3 Microclimate characteristics and analysis of block

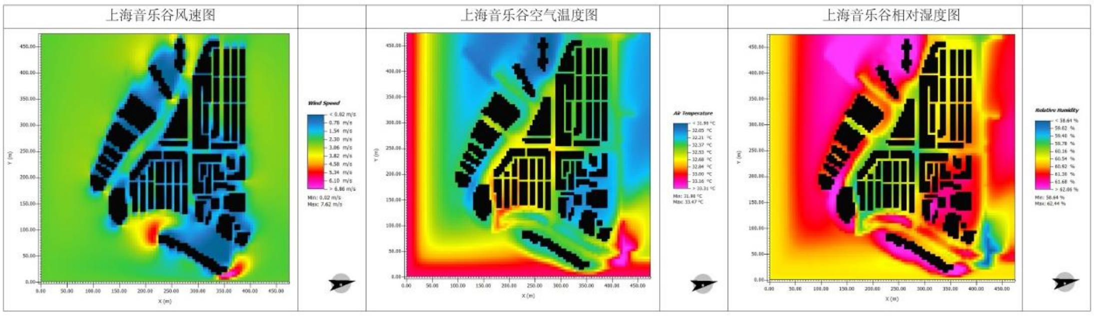


Fig 5-13 Wind speed diagram, air temperature diagram and relative humidity diagram of Shanghai Music Valley

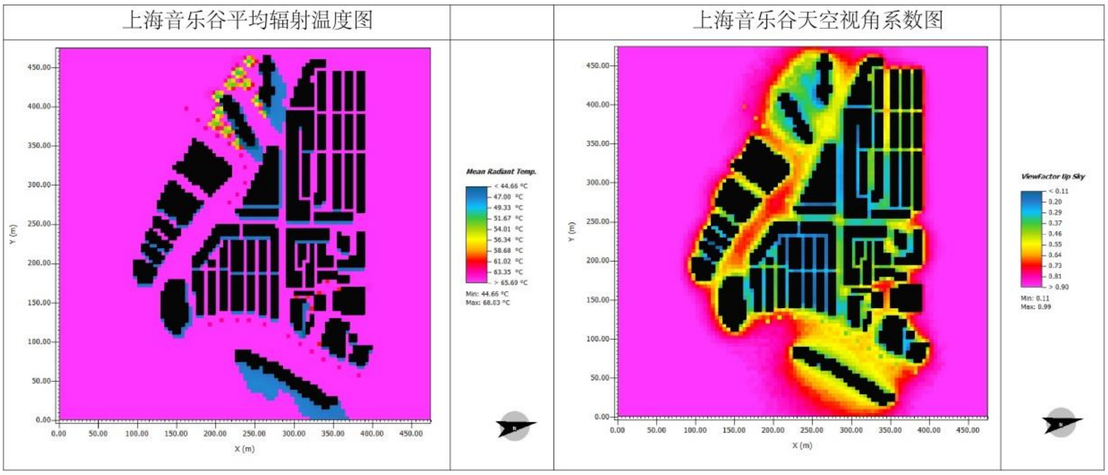


Fig 5-14 Average radiation temperature and sky angle coefficient of Shanghai Music Valley

The simulation results of wind speed, air temperature and relative humidity of Shanghai Music valley are shown in Figure 5-13. It can be found that the wind speed is very low because the overall building density of the block is large, and the building spacing is small, and the wind is difficult to circulate in the block, but because the dominant wind direction conforms to the river direction, and the building height in the block is low, the high-rise residential buildings near the block block block the interference of wind blocking and infiltration The low degree makes the wind penetrate into the block from the street space at the river channel and high altitude, which alleviates the low wind speed distribution in the block to a certain extent. The air temperature distribution in Shanghai Music Valley block varies with different plots. The air temperature fluctuates around 32.7 ℃ in Shikumen block of ruiqingli in the southeast plot, and around 32.3 ℃ in Shikumen block of ruikangli in the northwest plot. The water body improves the air temperature to a certain extent, which makes the air temperature in the River area of the block generally low, while the road The air temperature of asphalt pavement is generally high. The air temperature of a few areas with grassland vegetation in the block is lower than that of the road. The relative humidity of the river area is relatively high, and the relative humidity of the national music industry base in the northeast of the block is also high due to the distribution of grassland and trees.

As shown in Figure 5-14, due to the scarcity of trees and grasslands and the low height of buildings, the average radiation temperature in Shanghai Music Valley block is extremely different. Only a few areas have low average radiation temperature due to the shadow area of buildings, and other areas are higher than 60 degrees. The sky angle coefficient of view of block buildings is generally low, but the compact space layout does not bring good thermal comfort distribution effect because of the low building height.

5.3.4 Correlation analysis of Microclimate Characteristics and thermal comfort

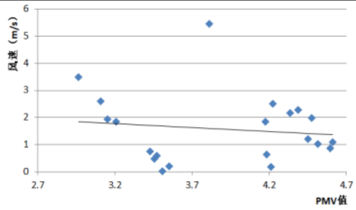
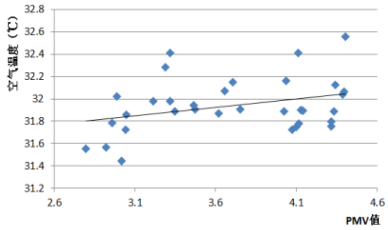
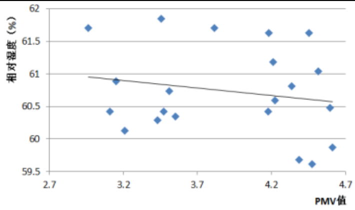
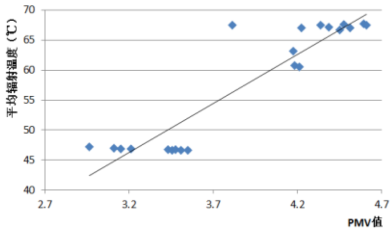
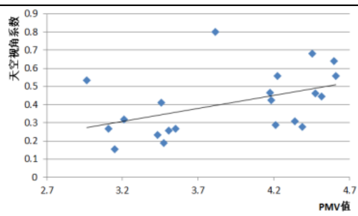
The parameters of the microclimate characteristic factors of the characteristic points selected by Shanghai Music Valley based on the thermal comfort are shown in table 5-5, and the correlation analysis between the thermal comfort index PMV value of Shanghai Music Valley at the characteristic points and the microclimate characteristic parameters is shown in table 5-6.

Table 5-5 Numerical table of microclimate parameters at characteristic points of Shanghai Music Valley

number	PMV	Wind speed(m/s)	Air temperature(° C)	Relative humidity(%)	Average radiation temperature(° C)	Sky view factor
F1	2.9634	3.5012	32.06	61.702	47.192	0.53533
F2	3.1096	2.5916	32.469	60.419	46.991	0.26854
F3	3.1507	1.9296	32.352	60.892	46.82	0.15319
F4	3.2105	1.8419	32.594	60.125	46.874	0.31906
G1	3.5086	0.017321	32.359	60.736	46.612	0.25665
G2	3.4747	0.58897	32.54	60.425	46.706	0.18849
G3	3.5509	0.19911	32.563	60.348	46.654	0.26546
G4	3.4307	0.75022	32.64	60.285	46.699	0.23264
G5	3.4556	0.47359	32.072	61.851	46.59	0.41163
H1	3.8144	5.4594	32.36	61.707	67.471	0.80177
I1	4.2257	2.5067	32.389	60.597	66.991	0.55912

I2	4.178	1.8454	32.501	60.424	63.119	0.46626
I3	4.2127	0.1878	32.31	61.18	60.531	0.28923
I4	4.1845	0.64744	32.132	61.629	60.775	0.42533
J1	4.3393	2.1613	32.351	60.812	67.47	0.30956
J2	4.6131	1.088	32.665	59.867	67.548	0.559
J3	4.4777	1.993	32.755	59.618	67.644	0.46291
J4	4.5977	0.85721	32.56	60.481	67.677	0.63855
J5	4.3895	2.2796	32.858	59.682	67.171	0.27651
J6	4.5157	1.0295	32.332	61.043	67.026	0.44539
J7	4.4535	1.2027	32.116	61.632	66.747	0.68086

Table 5-6 Correlation analysis of PMV value and microclimate parameters of Shanghai Music Valley

Relationship between PMV and parameters of Shanghai Music Valley			
Wind speed		Air temperature	
Relative humidity		Average radiation temperature	
Sky view factor			

It can be seen from the corresponding relationship between the PMV value of Shanghai Music Valley and each microclimate characteristic parameter that the best consistency is the average radiation temperature. The average radiation temperature of the characteristic points with PMV > 4.2 is more than 60 degrees. Only H1 point has relatively good thermal comfort due to the high wind speed of 5m / s, indicating the importance of shadow area to thermal comfort in summer. The wind speed of the characteristic points in the block is in the shadow area and not in the shadow area, that is PMV < 3.9 and PMV > 3.9, which has a strong negative correlation with the PMV value. The air temperature and relative humidity are characterized by large numerical fluctuation and poor regularity due to the poor ecological conditions and single ground type in the block, but there are grassland or arbor distribution near the points with low air temperature, such as F1, G5, I4 and J7, indicating that the air temperature is affected by the ground type. The thermal comfort of feature points with sky angle coefficient greater than 0.5 is generally poor, except that point F1 is located in the shadow area of high-rise residential buildings and point H1 is located in the high wind speed area, which is different from other feature points.

5.4 Summary and optimization method of microclimate and thermal comfort of case block

5.4.1 Summary of microclimate and thermal comfort of block

Through the simulation results of Caoyang village and Shanghai Music Valley, and the analysis of their respective characteristic points and areas, it can be found that the summer solar radiation has the most significant impact on the thermal comfort of the block, and the difference between the shadow area and the non shadow area is obvious. The building shadow area and the tree shadow area can bring obvious improvement effect to the block. The closed degree of the block, namely the sky angle coefficient, can reflect the reflection ability of the block to the solar radiation to a certain extent. The block should try to avoid too open area, which is not good for the microclimate and thermal comfort. The higher the building density is, the more shadow areas will be produced, the lower the average radiation temperature in the block, the better the thermal comfort of the block is generally, but at the same time, the building needs to have enough height to produce shadow areas. Good ecological conditions, such as trees, grassland and water body, can adjust the air temperature and relative humidity of the block, and form better microclimate conditions, especially trees can produce shadow areas, which can greatly improve the thermal comfort of the block space compared with grassland and water body. Compared with the shadow area, the increase of wind speed in summer has little effect on improving the thermal comfort of the block, but the building layout of the block should conform to the dominant wind direction. The ground type of the block is not the most important factor affecting the thermal comfort, but the surface type with high reflectivity and strong permeability, such as grassland, has better air temperature conditions than the hard ground such as asphalt pavement, which is beneficial to the improvement of microclimate.

Caoyang village belongs to the old district renewal in the urban renewal, Shanghai Music Valley belongs to the historical area renewal, the block type and layout are different. The streets of Caoyang village conform to the dominant wind direction, but the direction of the dominant wind direction is not good in the internal layout of the block. Most of the areas are low wind area or even no wind area, and the buildings in the block are relatively low with large spacing, and there is a large open space, which makes the internal thermal comfort distribution poor. The distribution of street trees on both sides of the street is good, which makes the distribution of microclimate and thermal comfort better. The overall better ecological conditions of the block improve the overall air temperature of the block, and to some extent improve the microclimate and thermal comfort, but the space in the block needs to be improved. The building density of music Valley block in Shanghai is high, but the low buildings are not enough to provide sufficient shadow area, which makes the distribution of thermal comfort in the block poor, and the compact block layout also affects the circulation of wind in the block. The river can improve the air temperature of the nearby area obviously, but it has limited effect on the microclimate of the block. The lack of vegetation elements such as trees and grassland in the block makes the distribution of microclimate conditions such as air temperature and relative humidity poor. The single ground type of the block also has a negative impact on the microclimate of the block.

5.4.2 Optimization method and evaluation of Caoyang first village block

Combined with the thermal comfort analysis and microclimate characteristic analysis of Caoyang first village block, the main unfavorable space and local unfavorable space of thermal comfort of Caoyang first village block are obtained, as shown in Figure 5-15. There are two kinds of disadvantageous spaces in the block. The main disadvantageous space is characterized by open space, which is greatly radiated by the sun. The local disadvantageous space is characterized by the disadvantageous points of wind speed, which has a strong blocking effect on the wind.

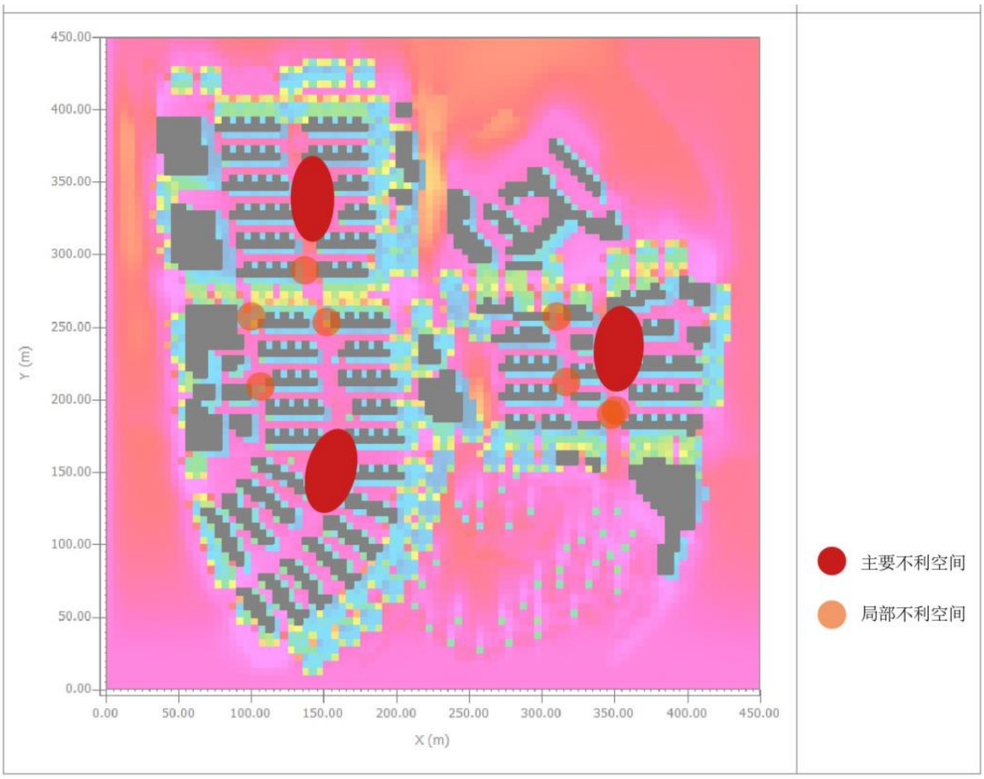


Fig 5-15 Thermal comfort disadvantageous space in Caoyang first village

Although most of Caoyang first village block are old houses, which are in disrepair for a long time, due to the existence of certain cultural value, the part of the building should not be changed too much, so only some adverse points of wind speed in the block are opened to improve the ventilation capacity of the block, as shown in Figure 5-16. In the improvement of the space in the block, the open space scale should be reduced, and the shadow area of the block should be increased by arranging trees and grasslands, so as to improve the open space in the current situation. In addition, the type of street paving shall be improved appropriately, as shown in Figure 5-17.

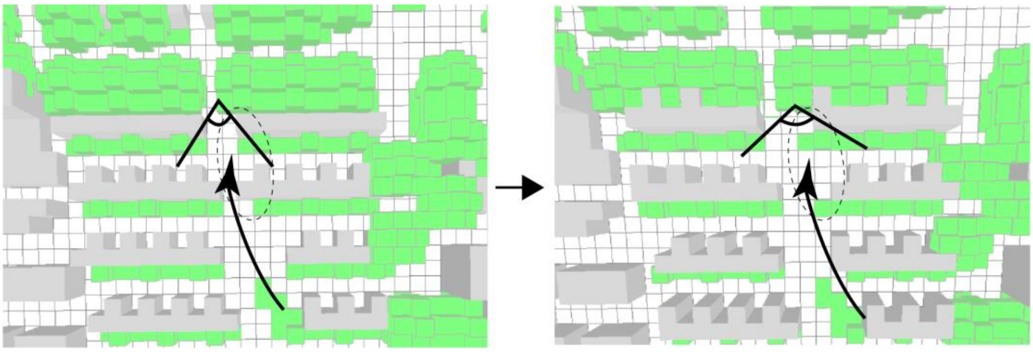


Fig 5-16 The strategy to get through the adverse points of wind speed in Caoyang village (local)

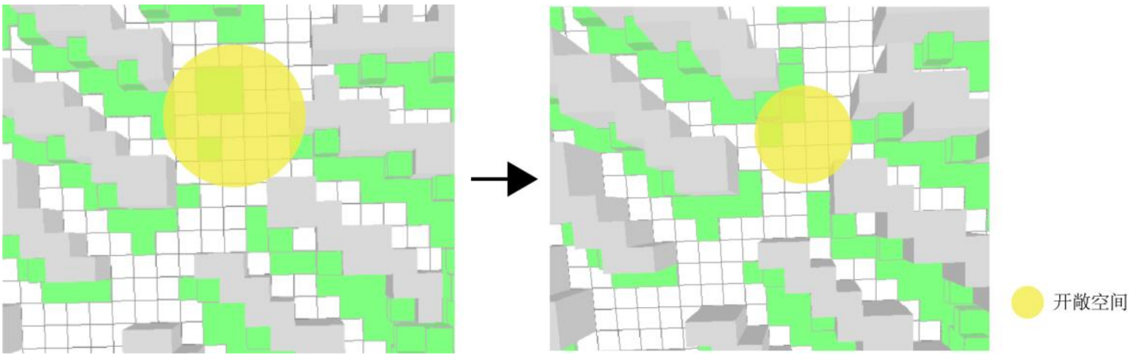


Fig 5-17 Strategy of reducing open space in Caoyang village (local)

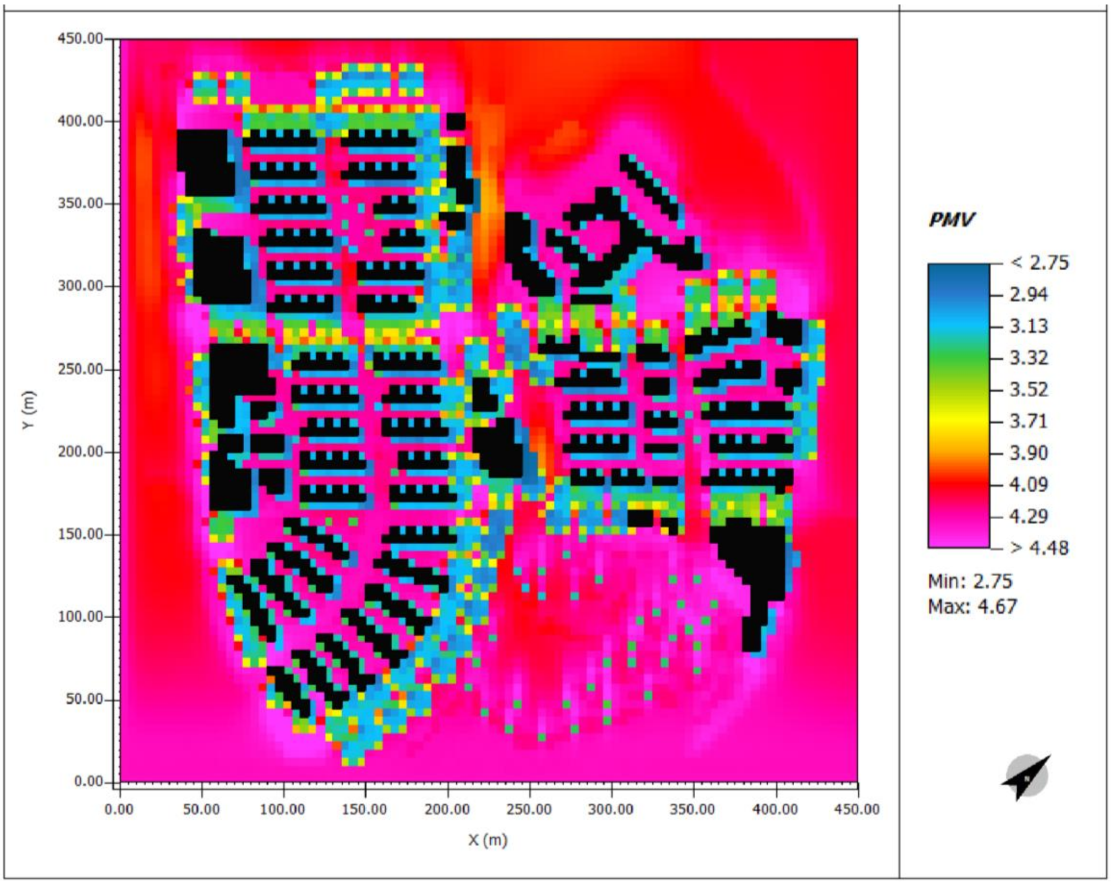


Fig 5-18 PMV diagram of Caoyang first village optimization plan

Integrate the optimization strategy of Caoyang village and import it into envi met for simulation to get the PMV diagram of the optimization scheme, as shown in Figure 5-18. By comparing the microclimate parameters of the optimization scheme with the current situation, the difference between the wind speed, air temperature, relative humidity, average radiation temperature and the current situation in the optimization scheme is plotted, as shown in Figure 5-19. It can be seen that the wind speed at several wind speed adverse points in the block has been significantly improved, and the ventilation capacity has been improved. Reduce the open space, and increase the distribution of trees and grassland in the block, so that the microclimate distribution of air temperature, relative humidity and average radiation temperature in the block is better. As shown in Figure 5-20, the thermal comfort of the whole block of Caoyang village is improved, the overall PMV of the block is reduced by about 0.1, and the PMV of the local space is reduced by 0.25.

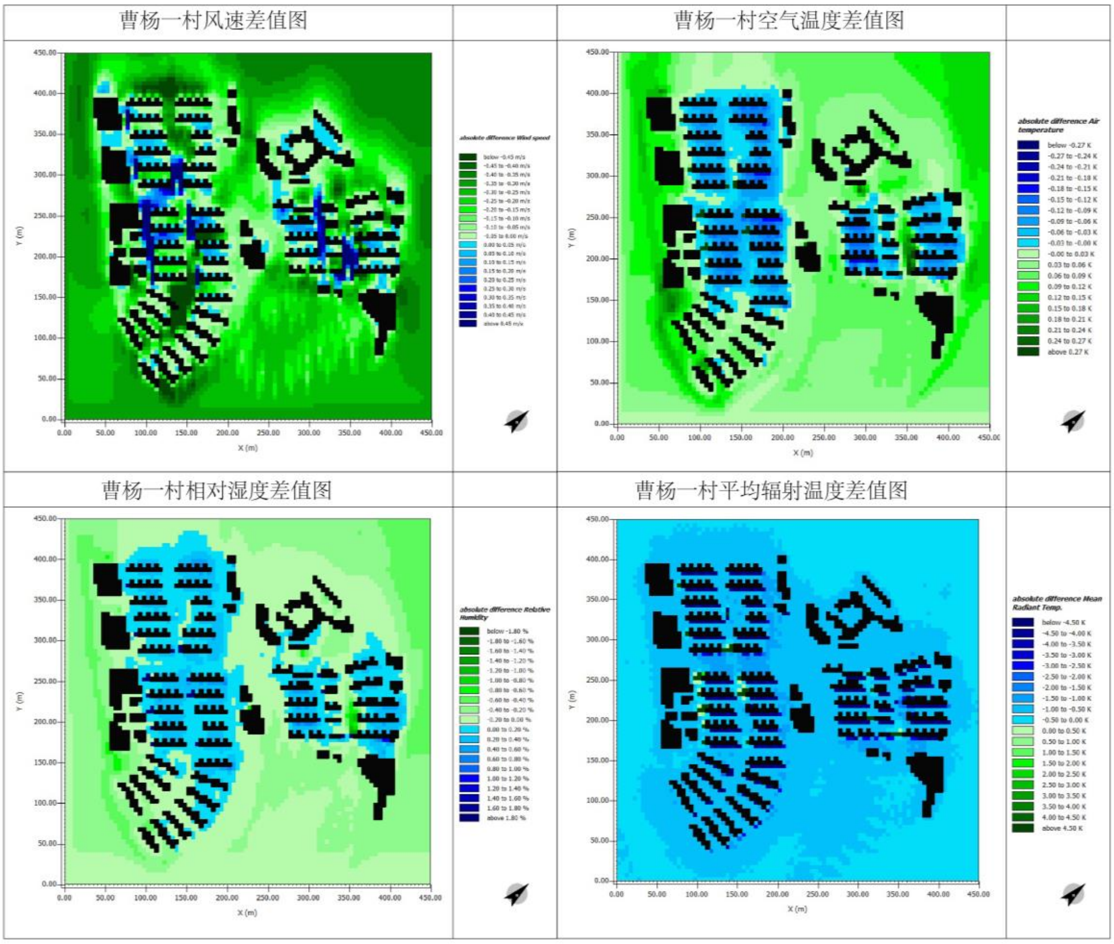


Fig 5-19 Microclimate parameter diagram of the optimization scheme of Caoyang village

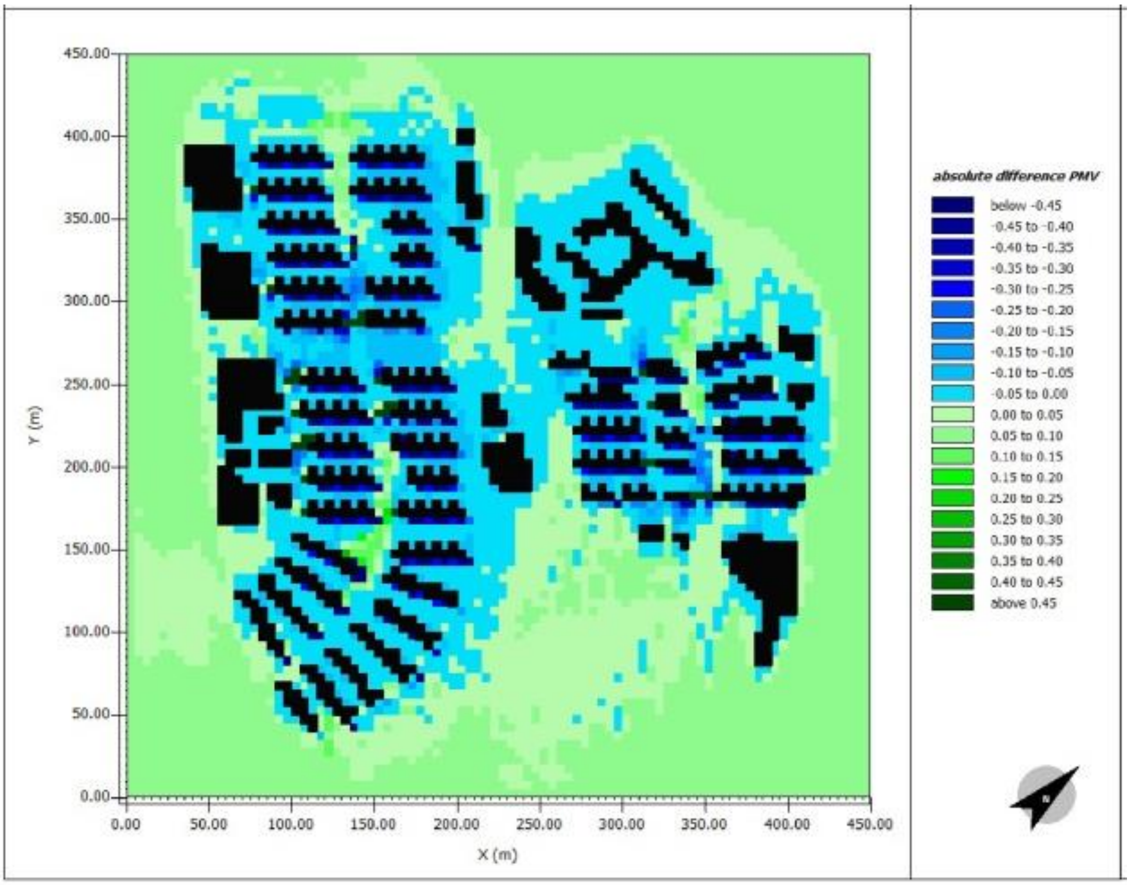


Fig 5-20 PMV comparison of optimization scheme of Caoyang first village

5.4.3 Optimization method and evaluation of Shanghai Music Valley block

Combined with the thermal comfort analysis and Microclimate Characteristics Analysis of Shanghai Music Valley block, the main unfavorable space and local unfavorable space of the thermal comfort of Shanghai Music Valley block are obtained, as shown in Figure 5-21. The overall layout of the block is very compact, and the main disadvantageous space is characterized by the strip lane space of ruikangli and ruiqingli Shikumen lane and the large area of open space along the river, while the local disadvantageous space is characterized by the lack of vegetation distribution.

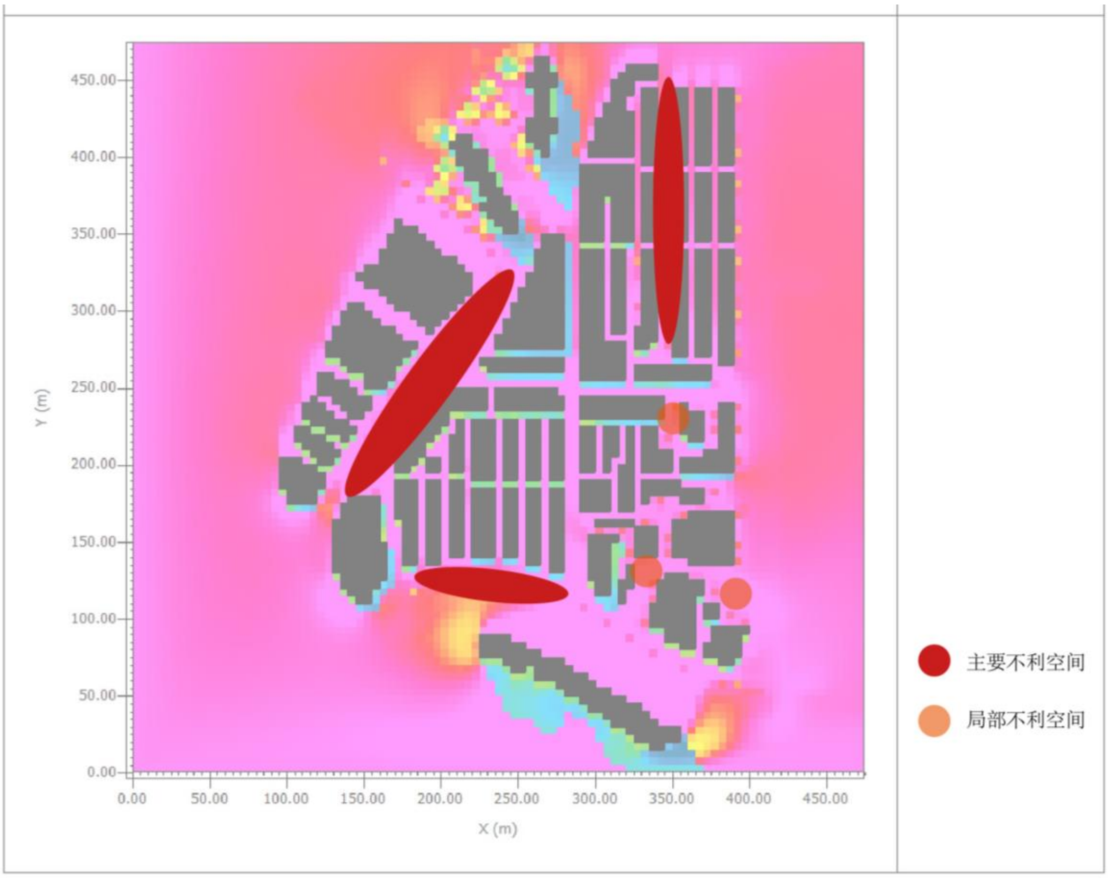


Fig 5-21 Shanghai Music Valley block space thermal comfort disadvantageous space

Shanghai Music Valley block has Shikumen community with cultural protection value, so the original building part should not be changed. The typical problem of microclimate in the block is the lack of ecological conditions such as trees and grasslands. By increasing the grassland and trees in the block, the greening rate of the block can be increased and the microclimate conditions of the block can be improved, which can alleviate the shadow of the block caused by the low building height to a certain extent The lack of area and the increase of grassland can also alleviate the microclimate problems such as the poor air temperature caused by the large area of artificial hard ground. Strategies for increasing vegetation in lane and block spaces are shown in Figure 5-22 and figure 5-23.

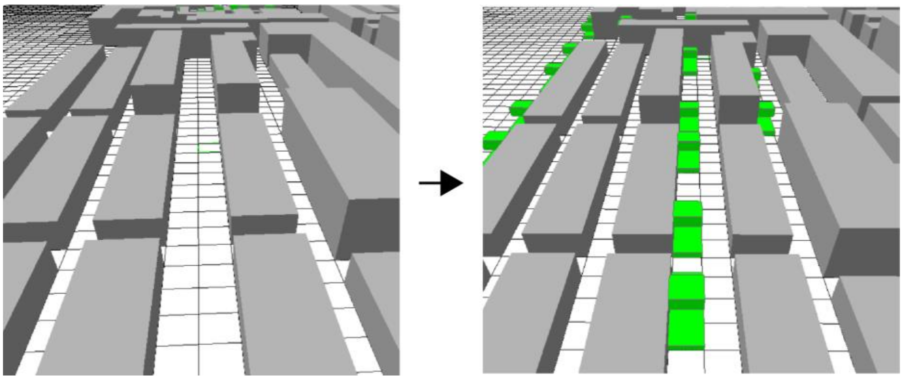


Fig 5-22 Strategy of increasing vegetation in music Valley lane of Shanghai

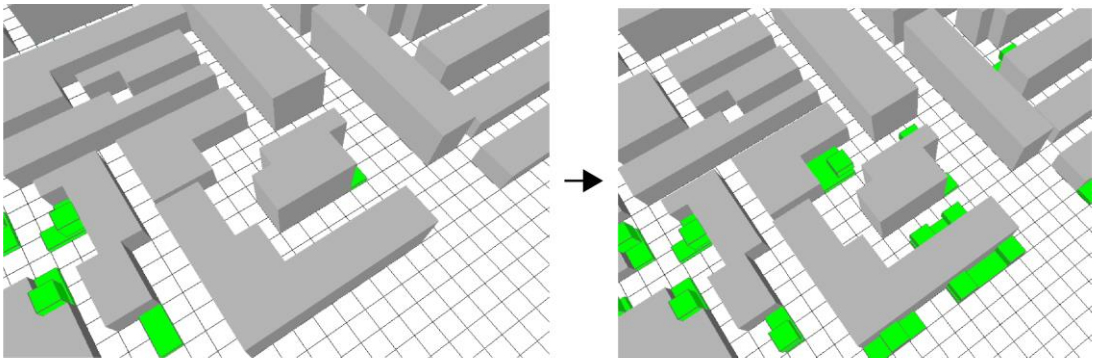


Fig 5-23 The strategy of increasing vegetation in Shanghai Music Valley block space (partial)

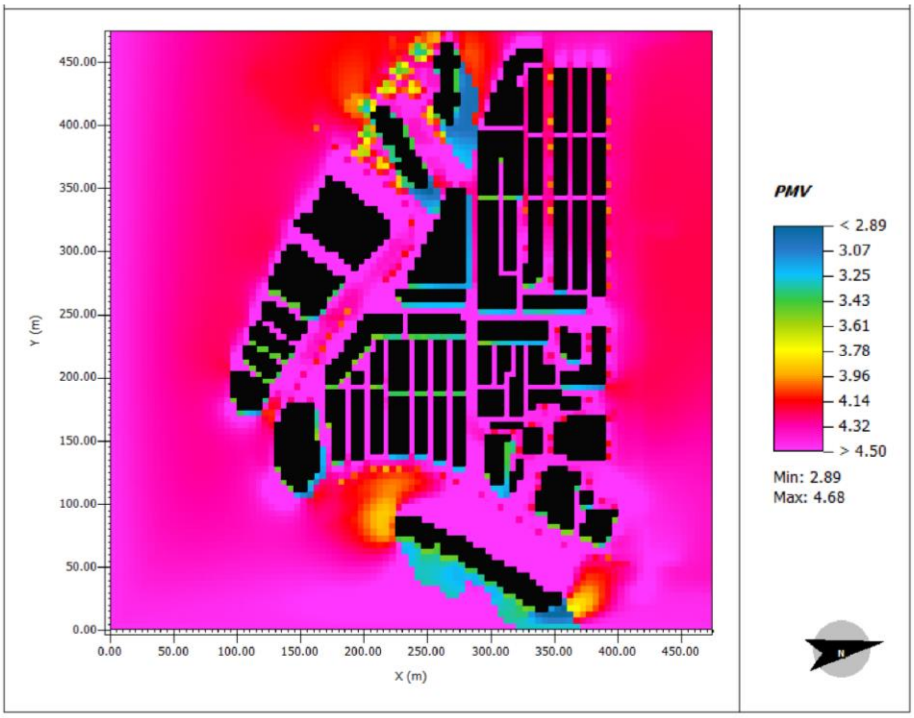


Fig 5-24 PMV chart of Shanghai Music Valley optimization plan

Integrate the optimization strategy of Shanghai Music Valley, and use envi met simulation to get the PMV diagram of the optimization scheme, as shown in Figure 5-24. By comparing the microclimate parameters of the optimization scheme with the current situation, the difference between the wind speed, air temperature, relative humidity, average radiation temperature and the current situation of the optimization scheme is plotted, as shown in Figure 5-25. It can be seen that the increase of vegetation in Lilong and block space improves the air temperature and relative humidity distribution in local space, and the appropriate increase of arbors provides part of the shadow area, which reduces the average radiation temperature of block space. Make a difference between the optimized PMV distribution of Shanghai Music Valley block and the current block, as shown in Figure 5-26. It can be seen that the thermal comfort in the local optimization space is improved, and PMV is reduced by about 0.15.

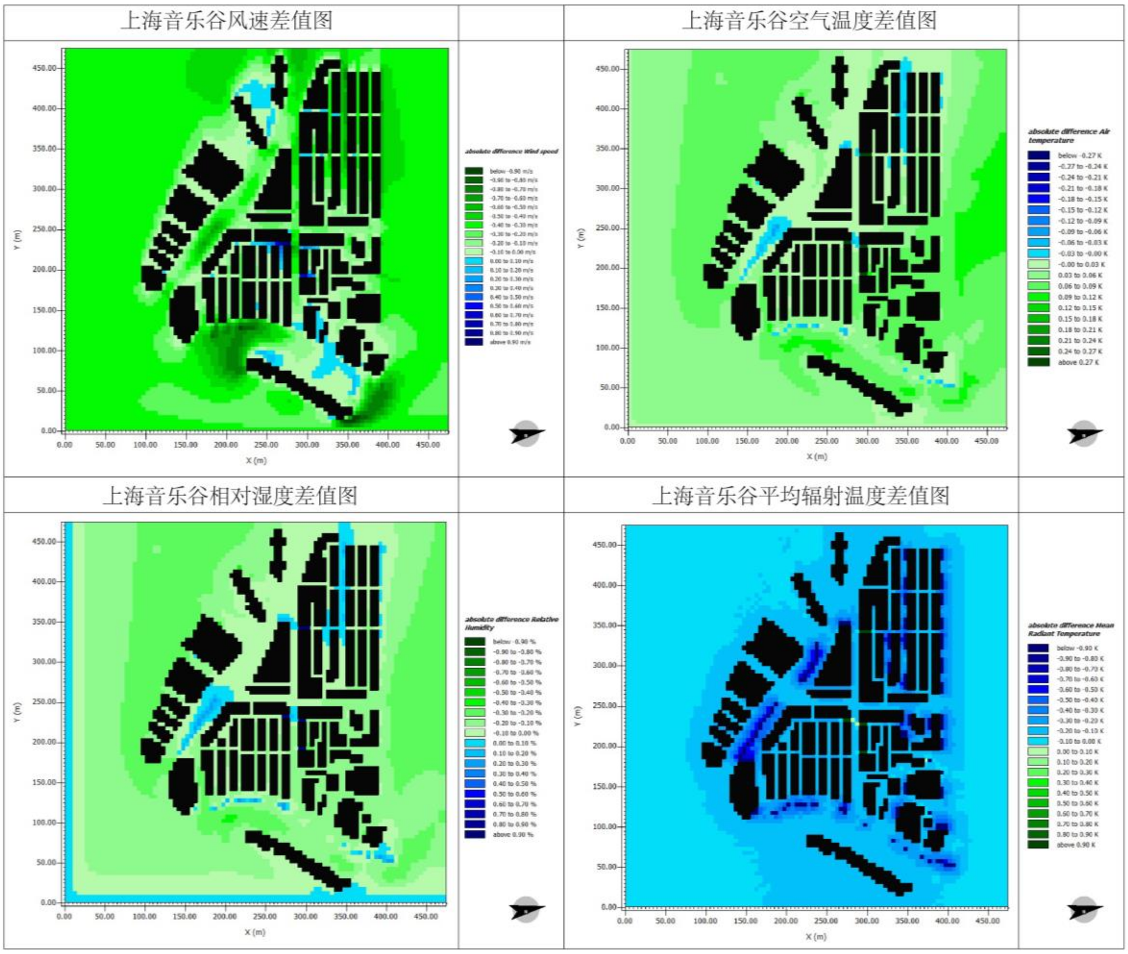


Fig 5-25 Microclimate parameters of Shanghai Music Valley optimization scheme

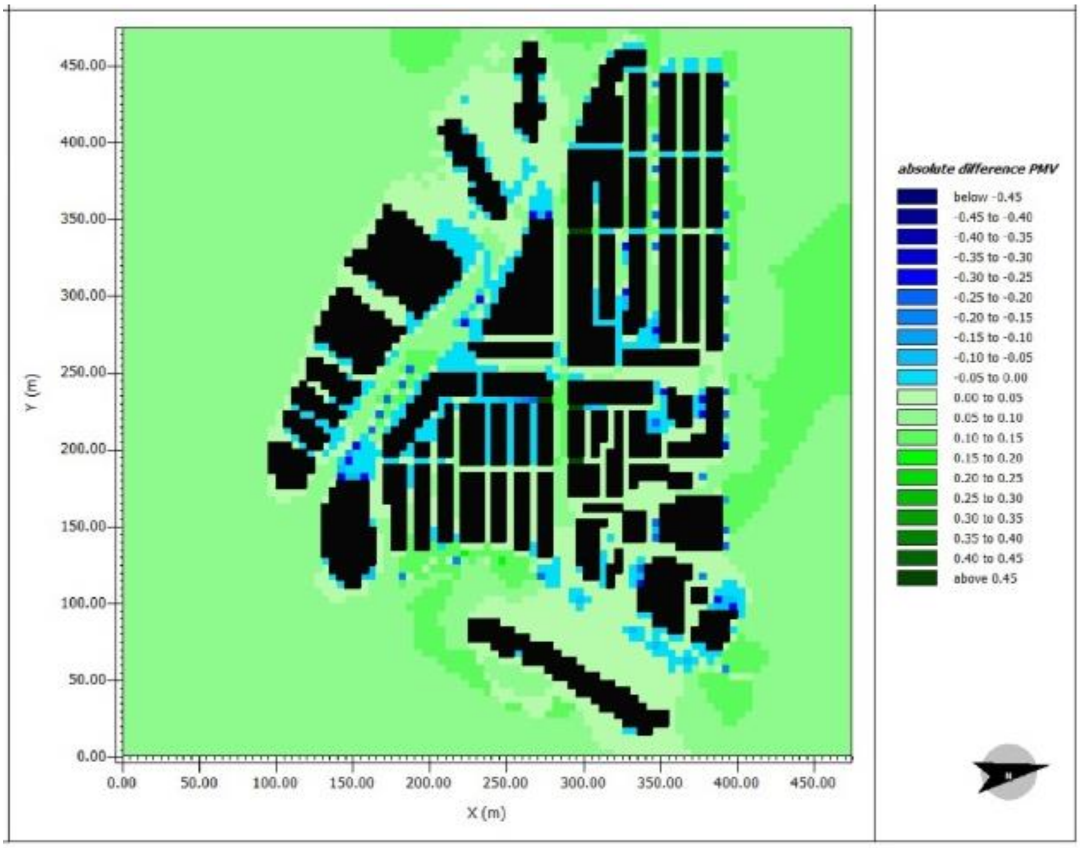


Fig 5-26 PMV comparison of Shanghai Music Valley optimization scheme

5.4.4 Comparison of case block optimization methods

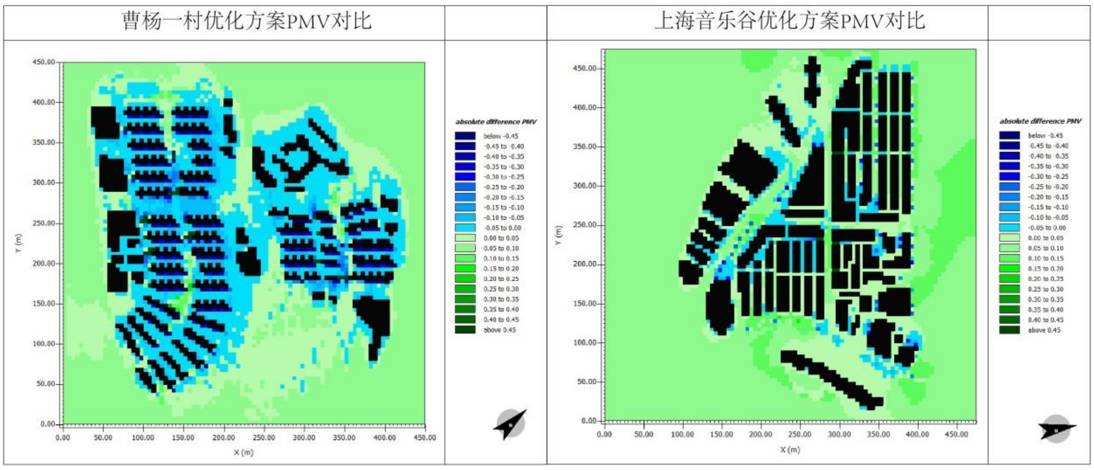


Fig 5-27 Left: PMV difference diagram of optimization scheme of Caoyang first village; right: PMV difference diagram of optimization scheme of Shanghai Music Valley

From the comparison between the optimization scheme of Caoyang village and the optimization scheme of Shanghai Music Valley and their current PMV, it can be seen that the overall thermal comfort of Caoyang village has been better improved, while the improvement of Shanghai Music Valley block stays in local space. In terms of renewal techniques, Shanghai Music Valley is a historic conservation area, which can not be changed in the block building part. In terms of block characteristics, the building layout of Caoyang village is relatively loose, while the layout of Shanghai Music Valley is very compact, and the ecological conditions of the two projects are obviously different. Based on the different characteristics of the two projects, Caoyang village has more available strategies for microclimate and thermal comfort, and the effect of optimization scheme is better. Shanghai Music Valley mainly adopts vegetation mode, but due to the lack of ecological conditions of the block itself, vegetation strategy can bring better microclimate and thermal comfort to the block. The improvement of microclimate and thermal comfort in Caoyang first village mainly lies in the improvement of ventilation capacity and the adjustment of open space, while the improvement of music Valley in Shanghai mainly lies in the improvement of ecological conditions and average radiation temperature. It can be seen that the improvement strategies adopted for different characteristics of urban renewal projects are different. However, through appropriate strategies, all of them can be street belts To improve microclimate and thermal comfort.

Among other feasible measures, Caoyang village can create a good outdoor microclimate and thermal comfort area by means of trees, outdoor corridors, etc., and can be optimized by artificial means such as shadow device and water spray device, so as to improve the ecological conditions and average radiation temperature of the block. In the actual planning and design process, it is necessary to consider the spatial function, spatial construction and other aspects, according to the actual situation, to achieve with a variety of plant types, such as "arbor + Bush", "arbor + Grassland" and other ways. Due to the compact layout of music Valley block in Shanghai, the sun shading device can be used in the walkway to further improve the ecological conditions and average radiation temperature of the block to improve the thermal comfort of the block. In addition, the use of space needs to consider practicality, not too limited, and the arrangement of plants and devices should not excessively interfere with the use of space. The optimization of some artificial devices cannot be simulated, so it is not presented in the scheme optimization diagram.

5.5 Summary of this chapter

In this chapter, based on the case study of Caoyang village and Shanghai Music

Valley, following the analysis logic of status analysis, thermal comfort analysis, microclimate characteristics analysis, correlation analysis of Microclimate Characteristics and thermal comfort, summary of microclimate problems, optimization scheme and optimization strategy, the problems existing in the microclimate and thermal comfort of the two case blocks are firstly analyzed Line analysis, and then analyze how the microclimate characteristics and thermal comfort of the case block are specifically related at the block level. Finally, through the combination of the above two parts of analysis, the feasible optimization methods for each case block are proposed. Each urban renewal project has its particularity. The simulation analysis process of microclimate and thermal comfort in this chapter can be used as the pre analysis, i.e. pre evaluation, to provide basis and strategic guidance for the planning and design of subsequent urban renewal projects.

Chapter six: Simulation and optimization of microclimate and thermal comfort in post-evaluation of urban renewal project

After the completion of the planning and design of the urban renewal project, the microclimate and thermal comfort of the block planning and design can be analyzed and evaluated through the post evaluation. In this chapter, the urban renewal design scheme completed by Carlos Ignacio Carreno Yepes is selected as the object. Through the simulation analysis of microclimate and thermal comfort of the scheme, the scheme post evaluation is carried out, and further optimization strategies are proposed.

6.1 Background and introduction of design scheme

6.1.1 Project background

The urban renewal project selected in this chapter is located in an empty plot near the Bund of Huangpu District, which is currently used as a temporary parking lot, as shown in Figure 6-1. The block is located in the Bund historical reserve. The surrounding Beijing East Road and Sichuan middle road are the never widening roads determined by Shanghai. The surrounding environment of the block has high building density and compact layout. Part of the west side of the plot is the existing multi-storey building, and the south side of the plot is the high-rise Shenhua financial building office building. The design purpose of this project is to realize the regeneration of vacant land in the high-density urban environment of the center of Shanghai by means of urban renewal.

Fig 6-1 Left: satellite map of the project block; right: current situation map of the project

6.1.2 Introduction of design scheme

The scale of the project block land is compact, less than 100m in the north-south direction and less than 60m in the east-west direction. In addition, the urban renewal plan not only needs to consider the relationship with the surrounding building volume, shape and other factors, but also has strict height limit requirements, and there are many limiting factors for the project. The buildings on the north side of the design plan are interconnected, and the buildings on the south side are of low height, 15m and 5m respectively. The buildings on the north side have open-air courtyard space, as shown in Figure 6-2. The north and south buildings are respectively connected by one floor building space and outdoor terrace space. The roof platform of the first floor building is accessible for pedestrians. There are many small trees and grasslands in the outdoor space, and the outdoor space adopts multi scene design, as shown in Figure 6-3.

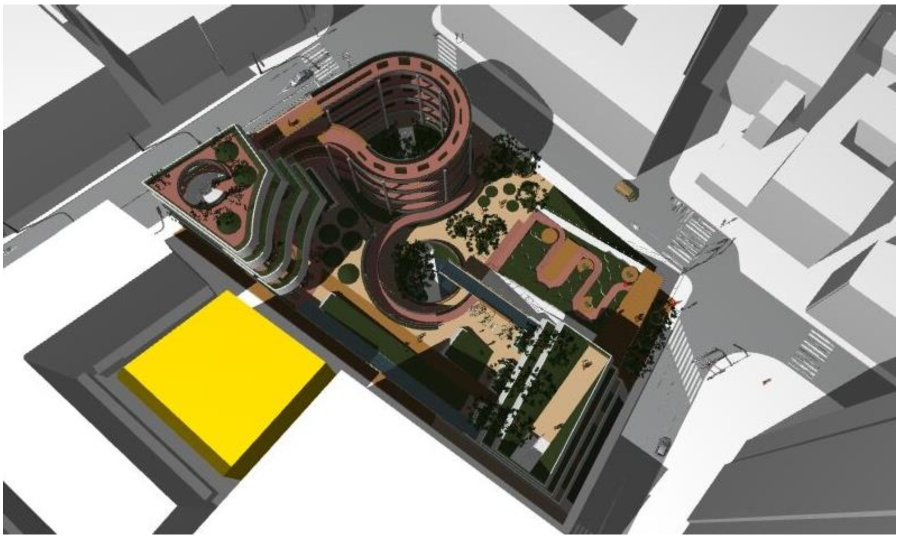


Fig 6-2 Aerial view of the design, Carlos Ignacio Carreno Yepes, 2019

Fig 6-3 Design scheme outdoor space renderings, Carlos Ignacio Carreno Yepes, 2019

6.2 Simulation of design scheme

6.2.1 Block modeling of design scheme

The modeling area size of the block in the design scheme is 135m * 135m * 190m, the number of grids is set as 45 * 45 * 38, unit length DX = dy = 3M, DZ = 5m. The modeling area includes the existing multi-storey buildings on the west side of the plot, as well as some buildings on the East and south side of the plot, as shown in Figure 6-4.

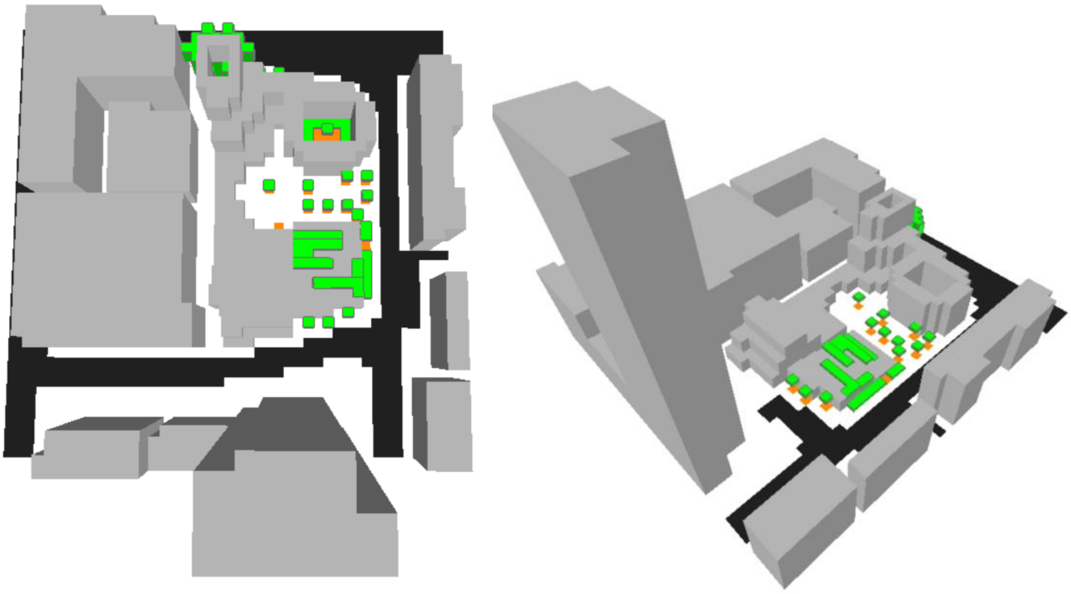


Fig 6-4 Design plan envi met model top view and aerial view

6.2.2 Thermal comfort simulation of design scheme

The thermal comfort of pedestrian height in the design scheme is divided into the ground and the roof platform of the first floor building, i.e. 1.5m and 6.5m horizontally. The thermal comfort of these two height blocks is simulated and analyzed, as shown in Fig. 6-5 and Fig. 6-6. It can be seen from the simulation results that the distribution of thermal comfort in the outdoor space at the ground is very poor, PMV values are greater than 4.5, and the distribution of thermal comfort in the shadow area of the North Building and the courtyard space is good, PMV values are about 3.4. The shadow area of the south building is less, and its PMV value is between 3.6 and 4.2. A few spaces on the roof platform of the first floor are located in the shadow area of the West building, with good thermal comfort distribution, PMV value of about 2.9, and PMV value of about 4.2 in other spaces. The PMV value of southeast roof platform is about 4.1.

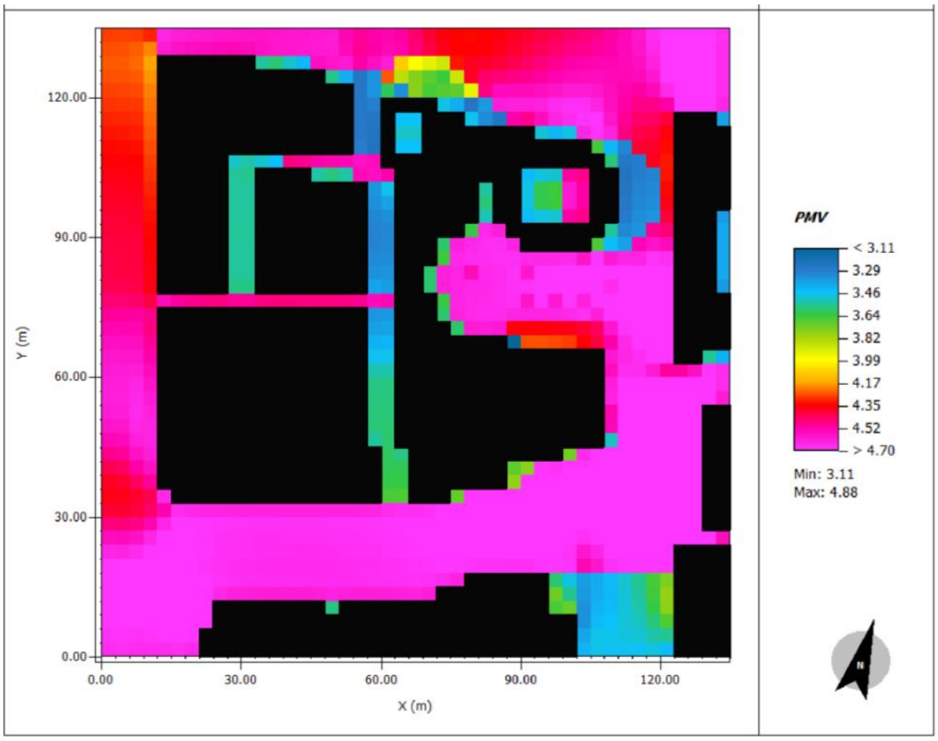


Fig 6-5 PMV diagram at 1.5m level of design scheme

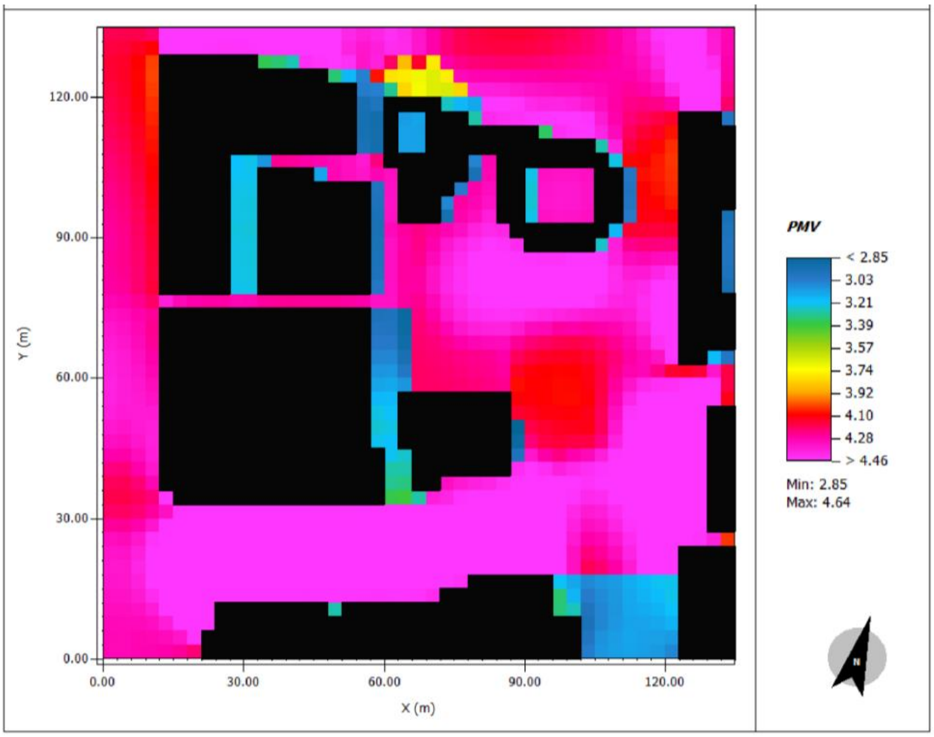


Fig 6-6 PMV diagram at 6.5m level of design scheme

6.2.3 Microclimate Simulation of design scheme

Microclimate Simulation of pedestrian height in the design scheme, i.e. at the level of 1.5m and 6.5m, as shown in Fig. 6-7 and Fig. 6-8. It can be seen from the simulation results that the wind speed in the outdoor space is generally very small, which is less than 1 m / s. The air temperature distribution of the road from the west to the east of the block is gradually increasing. The air temperature distribution of the road from the east to the south is very poor. The air temperature distribution in the courtyard is generally better than that in the outdoor space. The distribution of relative humidity in the block is decreasing from the west to the East. The average radiation temperature of the existing multi-storey buildings on the west side of the plot is well distributed. The average radiation temperature of the outdoor space of the project block is generally above 65 degrees, and the average radiation temperature of a few spaces is about 50 degrees. The wind speed distribution at the first floor platform is better than that at the ground, and the wind speed is generally higher than 1 m / s. The distribution trend of air temperature and relative humidity is the same as that at the ground, and the average radiation temperature is better than that at the ground.

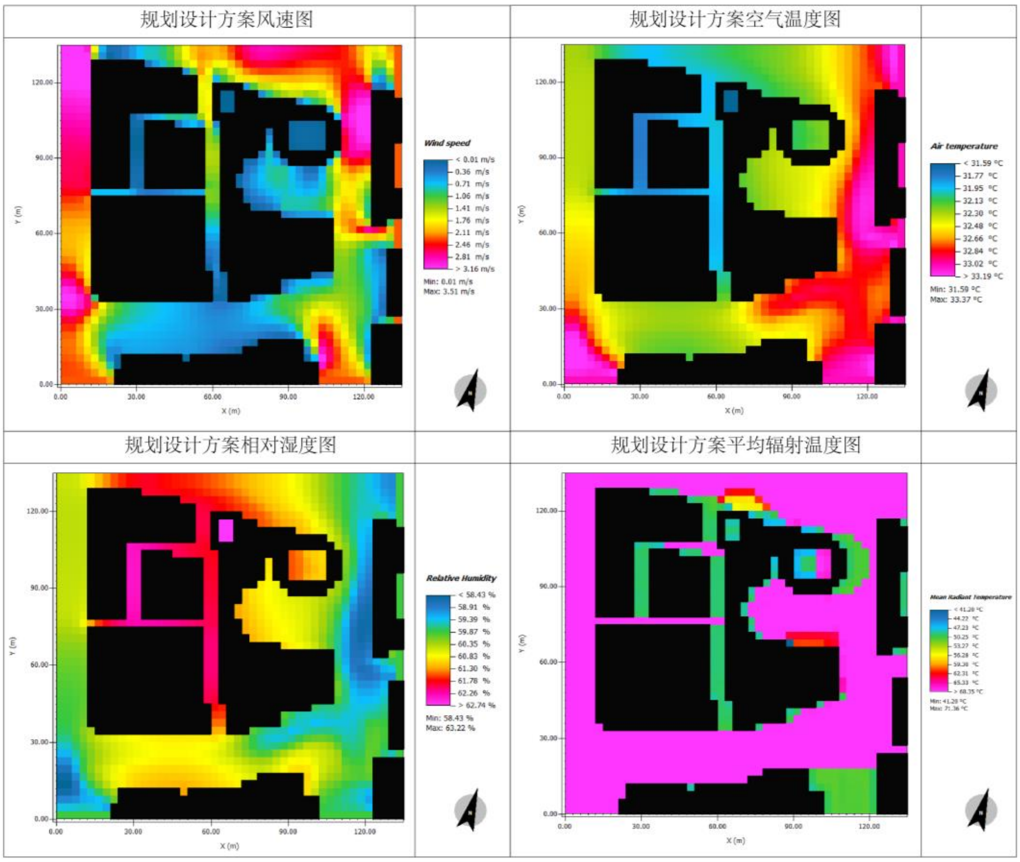


Fig 6-7 Microclimate parameter diagram at the level of 1.5m in the design scheme

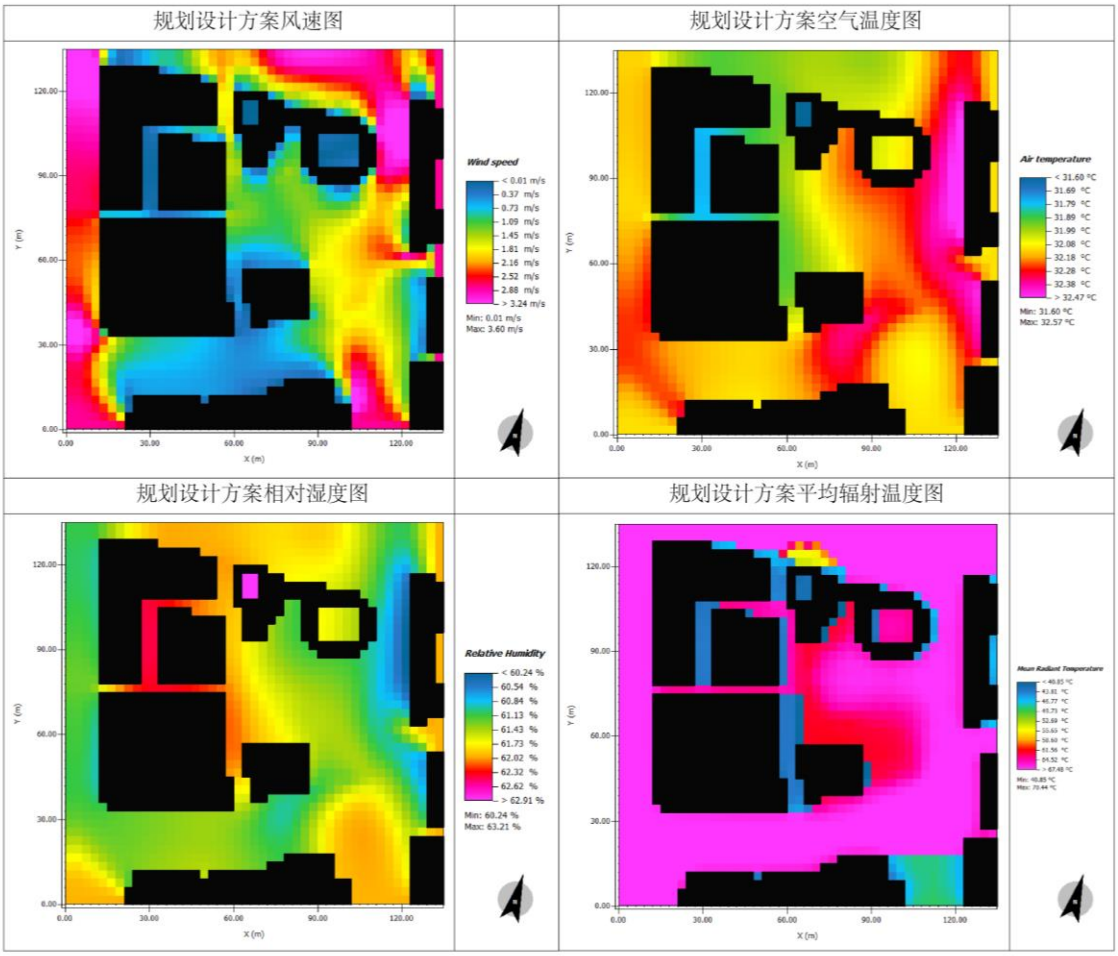


Fig 6-8 Microclimate parameter diagram at the level of 6.5m in the design scheme

6.3 Post evaluation and optimization of design scheme

6.3.1 Advantage analysis of microclimate and thermal comfort of design scheme

Combined with the simulation results of microclimate and thermal comfort, the advantages of the design scheme are as follows: first, the design method of internal courtyard is adopted in the north side, which brings sufficient shadow area to the courtyard space of the building, reduces the average radiation temperature of the courtyard, and the courtyard is set with grass and arbor, which further optimizes the air temperature of the courtyard, as shown in Figure 6-9; second, the southeast side of the scheme is built The building is only one floor high, which conforms to the dominant wind direction, and has little impact on the flow of the wind in the block. In addition, the building part on the north and south sides of the plan, except for the building space on the first floor, all the walls on the other floors are opened, which enhances the ventilation capacity in the block, as shown in Figure 6-10. Thirdly, the outdoor space is provided with a large area of grassland, which optimizes the microclimate distribution to a certain extent A small landscape waterfall is set up in the outdoor space from the roof platform of the first floor building to the ground, and the microclimate of the outdoor space is further optimized by using the water body.

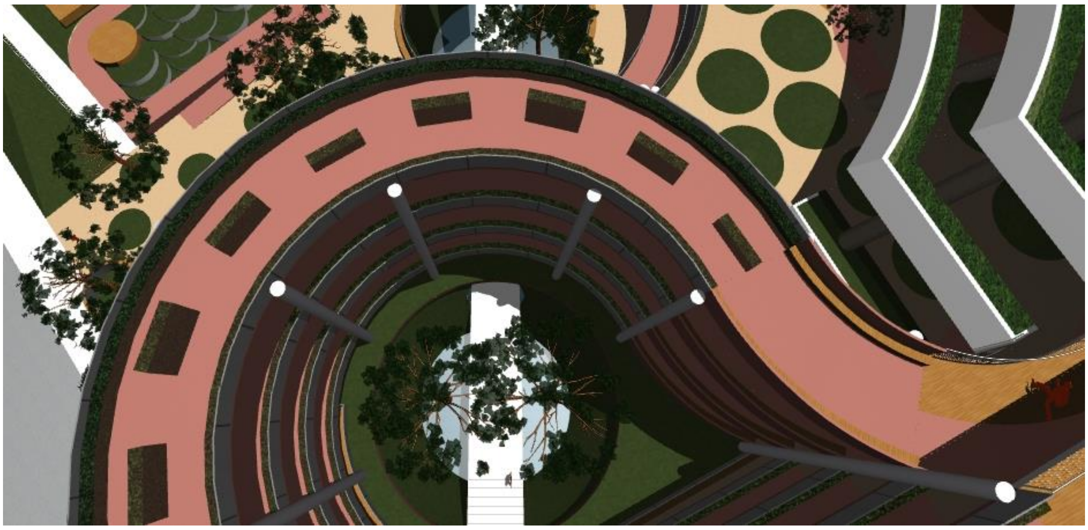


Fig 6-9 Design scheme courtyard space renderings, Carlos Ignacio Carreno Yepes, 2019

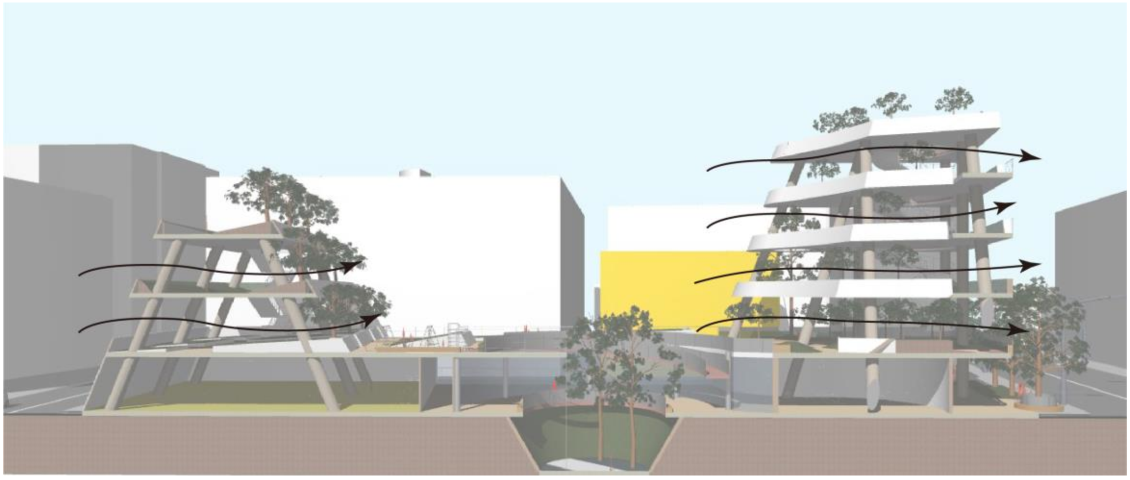


Fig 6-10 Ventilation analysis diagram of design scheme block

6.3.2 Analysis of design scheme microclimate and thermal comfort

The problems of the design scheme in microclimate and thermal comfort can be divided into three points: first, the outdoor space on the ground is relatively open, and the outdoor space with too large area is subject to strong direct solar radiation, so the thermal comfort is poor. Moreover, the landscape trees in the outdoor space are insufficient to provide enough shadow area, and the effect of improving the thermal comfort is not obvious, as shown in Fig. 6-11 2、 The air temperature of the road space adjacent to the block is very poor, as shown in Figure 6-12; thirdly, the average radiation temperature at the roof platform of the building on the southeast side is poor, and the thermal comfort of the space here is also poor, as shown in Figure 6-13.

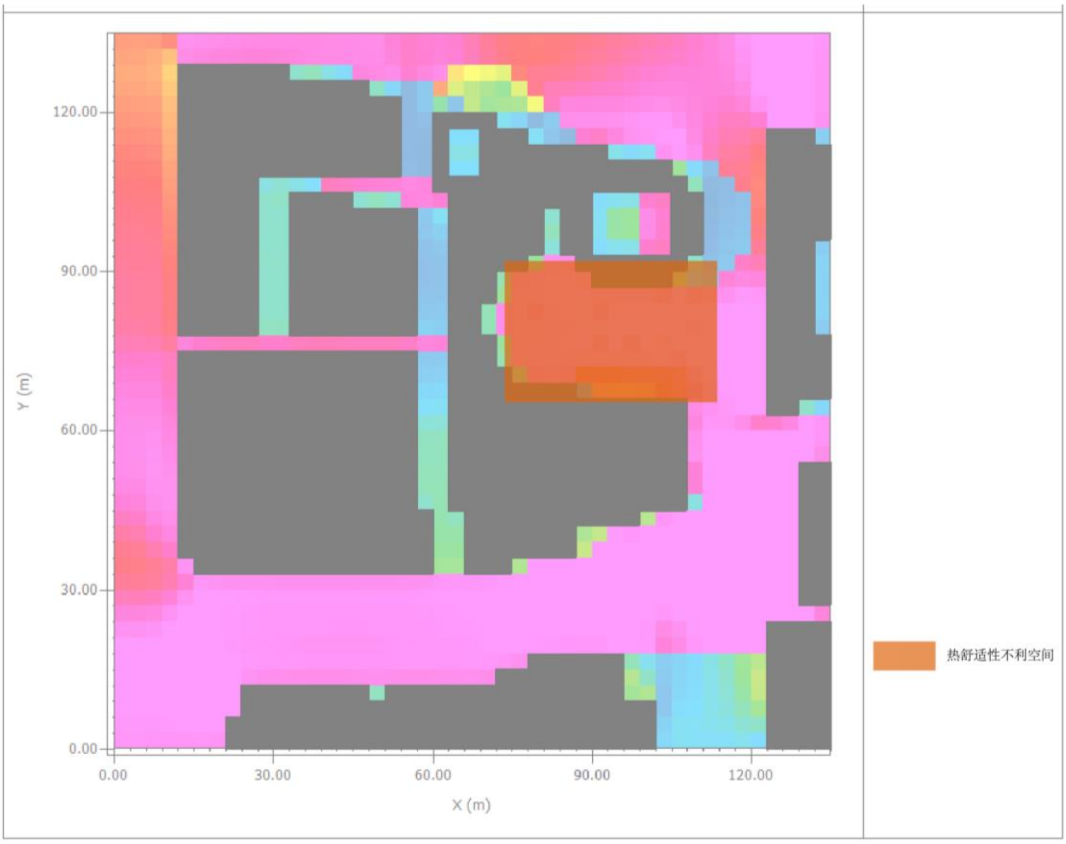


Fig 6-11 Analysis diagram of thermal comfort unfavorable space in outdoor space of design scheme

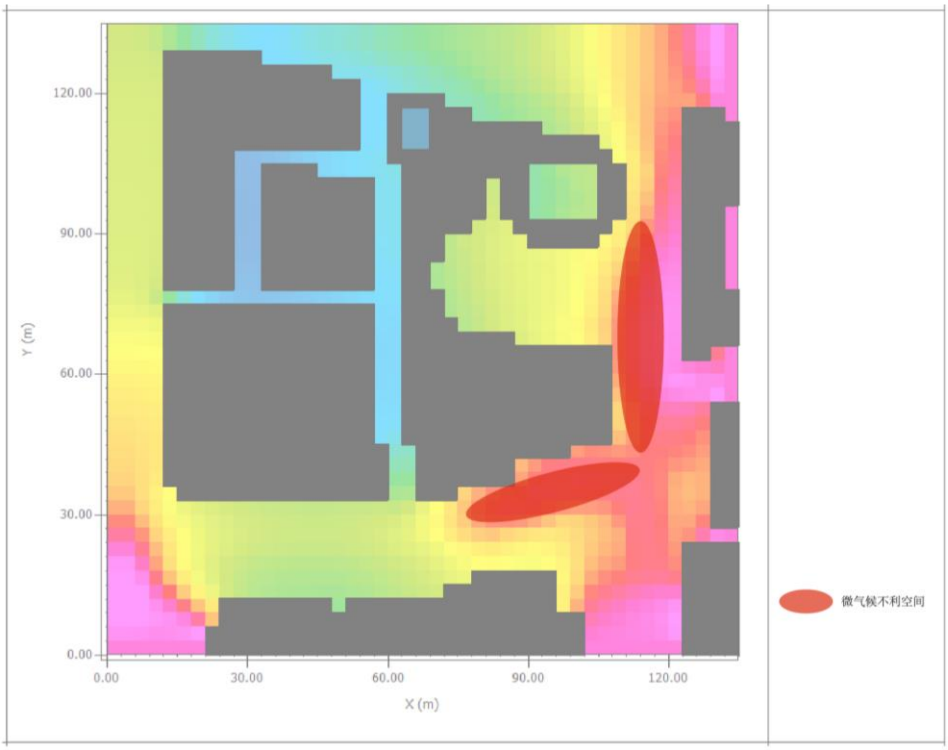


Fig 6-12 Analysis diagram of adverse space of microclimate on the road adjacent to the design scheme

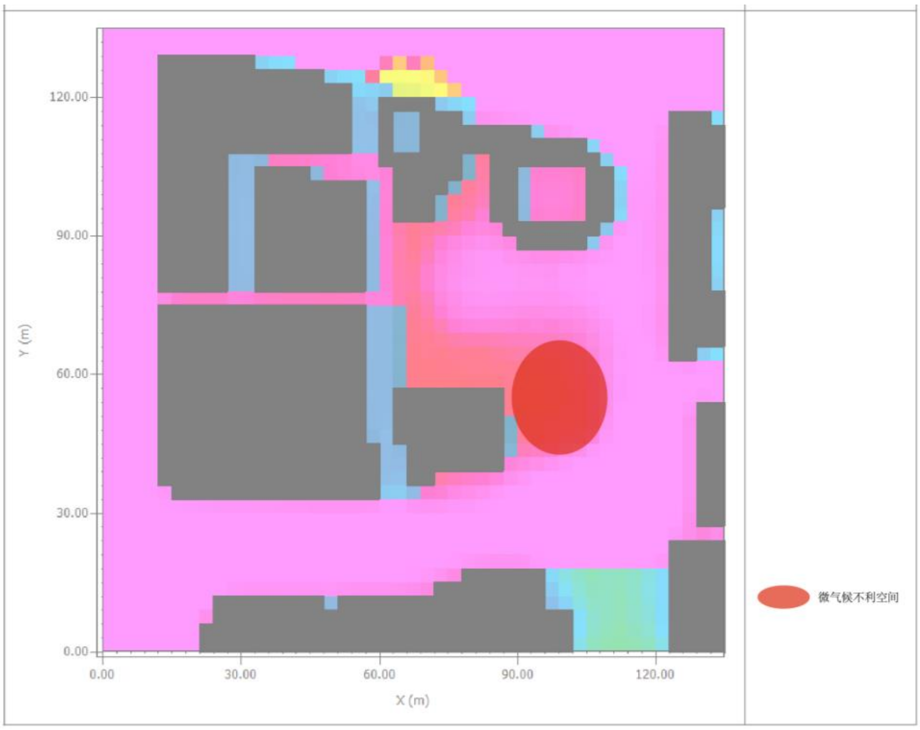


Fig 6-13 Analysis diagram of microclimate adverse space of roof platform (+ 6.5m) in design scheme

6.3.3 Optimization method of design scheme

To evaluate the advantages and problems of the microclimate and thermal comfort of the design scheme, the following five measures can be taken to optimize the scheme: first, the part connecting the north and south buildings can move to the East appropriately, reduce the area of the outdoor open space, and make full use of the microclimate and thermal comfort advantages of the existing multi-storey building shadow area in the West; second, the outdoor open space can pass through In addition, sunshade devices can be used to further reduce the solar radiation of the space. Thirdly, trees in the scheme can choose trees with larger crown and higher height, which can provide more outdoor shadow areas and lower the outdoor space under the condition of good ventilation near the ground The average radiation temperature between the buildings, so as to optimize the thermal comfort situation; fourth, the space adjacent to the road should be set with continuous street trees, and increase vegetation such as grass, shrubs, etc., to alleviate the problem of air temperature rise caused by the road pavement; fifth, the roof platform (+ 6.5m) of the southeast building should not be fully open, it is recommended to properly cover the roof, or level the three floors of the southwest building The platform is properly extended to serve as the roof of the outdoor space on the southeast side to alleviate the problem of rising average radiation temperature caused by solar radiation.

6.4 Summary of this chapter

In this chapter, the microclimate and thermal comfort of a vacant land near the Bund are simulated by post evaluation method. Through the combination with the analysis of microclimate and thermal comfort, the effect of microclimate and thermal comfort of the block is evaluated from two parts of scheme advantages and scheme problems, and the deepening direction and optimization method based on the scheme are proposed 。 It can be seen that through the post evaluation method of microclimate and thermal comfort, the planning and design scheme of urban renewal project can be further analyzed, the existing problems can be tested or the further optimization direction can be found, which provides an effective evaluation method for the audit work of relevant planning and design management departments.

Chapter seven: Conclusion and prospect

7.1 Strategies and optimization methods for microclimate and thermal comfort of Shanghai Urban Renewal Project

7.1.1 Microclimate and thermal comfort strategy of Shanghai urban renewal project in planning and design

In recent years, with the frequent occurrence of extreme high temperature days in summer in Shanghai and the deterioration of urban outdoor environment, the public demand for the quality of urban space is getting higher and higher, expecting the improvement of microclimate and thermal comfort, so it is urgent for planning and designers to pay attention to it, and use the relevant strategies of microclimate and thermal comfort in the corresponding project development. The current urban renewal in Shanghai is faced with many problems such as land resource constraints and insufficient space quality [4]. The constraints of urban renewal projects are different according to different types of projects. Based on this, we should take appropriate microclimate strategies to optimize the target blocks. Based on the relevant research content of this paper, this section improves the target city renewal project block through the summary of building block, block and building indication, material, block ecological characteristics and artificial devices. As shown in table 7-1, the analysis of block microclimate and thermal comfort should be taken as the basis before the urban renewal project, and on this basis, the microclimate and thermal comfort should be defined The objectives and principles of adaptability improvement provide strategic guidance for the follow-up design.

Table 7-1 Suggestions on microclimate strategy of Shanghai Urban Renewal Project

		Urban renewal category		
		Demolition and reconstruction of all project buildings	Local demolition and reconstruction of project buildings	Project buildings need protection and repair
Building block part	Architectural layout and orientation	The building layout should conform to the dominant wind direction in summer; The building layout should be consistent	The building layout should conform to the existing main air duct in the area; It is better to adopt more determinant	Remain unchanged

		with the main air duct; It is better to adopt determinant or point group layout rather than enclosed layout	layout than enclosed layout	
	Building density	The building density should be increased, but the building spacing should be controlled, not too small;	Increase the building density to a proper value	Remain unchanged
	Building height	The building height should be increased appropriately; The shadow area should cover more outdoor space at noon in summer	Increase the height of the building appropriately if conditions permit; Reconstruction of building height should cover more outdoor space at noon in summer	Remain unchanged
	Building overhead and opening	When the building blocks the air passage, it shall be properly opened; Appropriate use of overhead or open ground floor	The air duct of the building shall be properly opened; Where the wind speed is not good, the bottom building can be used for overhead or opening	Open properly at the place where the air duct is blocked if possible
Block and building surface and material	Paving material	The material with good permeability should be selected; Natural ground and high reflectivity materials should be selected and verified by simulation; Avoid large-scale dense materials	Reduce the use of dense materials; Natural ground should be used more when conditions permit; Appropriate use of high reflectivity materials in line with the overall characteristics of the area	The impermeable, dense and low reflectivity materials shall be properly adjusted to the natural ground or permeable and high reflectivity materials

	Building roof	Light color and high reflectivity roof materials should be used; More roof greening should be adopted	Light color and high emissivity roof materials should be used when conditions permit; Increase roof greening properly	Increase roof greening when conditions permit
	Building facade	Light color and high reflectivity facade material should be used; More facade greening should be adopted	The light color and high emissivity facade materials conforming to the characteristics of the plot shall be used when conditions permit; Proper increase of facade greening	Increase facade greening if conditions permit
Ecological characteristics of the block	Tree	More trees should be planted, with emphasis on sidewalks and main streets; Trees should be used in the open space with large sky angle coefficient; Trees should be used in non shaded areas at noon and afternoon	The main path of the block should be increased with trees; Trees should be used properly when the space conditions are open and the sky angle coefficient is large	Trees shall be increased appropriately when conditions permit, with emphasis on main activity space and main path
	Green space rate	It is advisable to increase the rate of green space and optimize the distribution of green space; Scattered green space layout should be adopted; Roof greening should be adopted	Increase the rate of green space appropriately, and adopt more scattered green space; Appropriate roof greening	Increase the rate of green space and increase the scattered green space appropriately when conditions permit; Roof greening when conditions permit
	Water body	Water of sufficient area	Use water when	Use water

		should be used	conditions permit	when conditions permit
Manual device part	Devices that produce shaded areas	For the functional space or main path without shadow area at noon, cornice, awning and other devices that can produce shadow area can be used	The functional space or main path of the shadow free area at noon shall be properly equipped with cornices, sunshades and other devices that can produce shadow area	If conditions permit, cornice, awning and other devices that can produce shadow area shall be properly used in the functional space or main path of the shadow free area at noon
	Artificial cold source device	Appropriate use of artificial cold source devices that generate wind and water, such as fans, fountains, etc	For space or main path with poor thermal comfort, artificial cold source device should be used	For space or main path with poor thermal comfort, artificial cold source device should be used

7.1.2 Microclimate and thermal comfort strategies in the management process of Shanghai Urban Renewal Project

There are a large number of urban renewal projects in Shanghai, and the types are complex. When using microclimate strategy to plan and design urban renewal projects of different types and different block characteristics, it is necessary to take corresponding planning and design strategies and management methods in combination with the actual situation of the project block. The numerical simulation software of urban block has been widely used in the research of urban environment and urban space. Through the calculation and processing of the model, the simulation results can be obtained efficiently and accurately. Taking the urban microclimate software ENVI met as an example, through the measurement and modeling of the target project block, the simulation results based on envi met output can be used to develop the microclimate and thermal comfort of the corresponding block According to the simulation results of PMV value of the block, analyze the overall thermal comfort unfavorable area of the project block, and provide quantitative microclimate optimization strategy guidance for the block through microclimate conditions such as wind speed map, air temperature map, relative humidity map, average radiation temperature map, sky angle coefficient map, etc. In the management process of urban renewal project, it is suggested that in the evaluation, approval and later governance research, numerical simulation software that can be used for quantitative simulation should be used to guide the management process more scientifically through the simulation results.

For urban renewal managers, in the early stage of the project, the analysis of microclimate and thermal comfort of the project will be put in front, which is conducive to the quantitative optimization of the urban environment. Therefore, Microclimate Simulation should be taken as the pre assessment step in the early stage of urban renewal project. Shanghai urban renewal carries out the whole life cycle path from regional assessment to implementation plan. Assessment is an important part in the process of urban renewal [75]. The pre evaluation before the planning and design of the project block, combined with the characteristics of the project and the relevant limiting factors, selects the appropriate microclimate strategy, which has an obvious effect on the optimization of the block. For the planning designer, the pre evaluation before the design is aimed at improving the microclimate environment of the block, which can effectively guide the design and control the later planning and design.

After the design scheme is completed and submitted for review, the urban renewal manager can carry out post evaluation for the microclimate and thermal comfort of the block in the management process, review and optimize the building monomer design, outdoor space design, functional streamline setting, landscape design and other aspects of the project block scheme, and play a controlling role in the real implementation of the scheme twice.

7.2 Conclusion and innovation

At present, the research on the combination of urban renewal, microclimate and thermal comfort generally stays at the level of single project case study. Taking Shanghai as an example, there is no systematic study on the planning and design strategy of block scale urban renewal project. Based on the climate characteristics of Shanghai in summer, this paper combines the microclimate and thermal comfort research of block scale with the urban renewal project of Shanghai, systematically summarizes the microclimate and thermal comfort optimization strategies of the urban renewal project of Shanghai, and puts forward the optimization and integration methods of microclimate and thermal comfort for the management process, planning and design strategies of urban renewal in Shanghai, The main conclusions are as follows:

(1) Based on the climate characteristics of Shanghai, the strategies of microclimate and thermal comfort of Shanghai urban renewal project can be divided into two parts: one is guided by the controllable factors of urban blocks, the other is guided by the design strategies. The optimization strategies guided by the controllable factors of urban blocks can be divided into five parts, namely, building density and height, sky angle coefficient, building layout, green space rate and greening Layout and water body, paving materials, the optimization strategy oriented by design strategy can be divided into four parts, namely, creating shadow area, creating air channel, optimizing the surface materials of blocks, increasing and optimizing plants and water bodies.

(2) The validity of envi met in Shanghai is verified by the combination of measurement and simulation. By the way of quantitative simulation, the PMV value of thermal comfort of the basic model and the related control block is simulated, and the thermal comfort of the block is obtained by building density, building height, building orientation, arbor and grassland, and the reflectance of ground material The influence degree of sexual distribution.

(3) Based on the research on the background and development process of urban renewal in Shanghai, the simulation of representative projects, and process management, this paper takes the case of representative urban renewal projects in the reconstruction of Shanghai Industrial Zone and old residential area as the analysis object, and finds that the block type, building layout and other factors have different effects on the microclimate and thermal comfort of the block, which should be paid attention to Take effective strategies to optimize. It is proposed to add pre assessment and post assessment based on microclimate and thermal comfort in the process of Shanghai urban renewal project.

(4) Taking Caoyang village and Shanghai Music Valley as pre evaluation cases, through systematic analysis, the paper studies the relationship between microclimate and thermal comfort, the summary of microclimate problems, the analysis process of optimization schemes and strategies, and the proposal of relevant strategies, and studies the relationship between microclimate and thermal comfort and urban renewal Based on the analysis method of the project, it is found that there are not only common

problems in the summer microclimate and thermal comfort of Shanghai urban renewal project, but also special problems according to the characteristics of each project.

(5) Taking the urban renewal design scheme of a vacant land near the Bund as a post evaluation simulation study, the microclimate and thermal comfort of the street area in the scheme are analyzed. According to the simulation results, the advantages and problems of the scheme in the perspective of microclimate and thermal comfort are found, and a further optimization method is proposed.

(6) Based on the classification of Shanghai urban renewal projects in terms of renewal techniques in terms of total demolition, partial demolition and protection, this paper discusses the four parts of building block, block and building surface, material, block ecological characteristics and artificial devices, and summarizes two strategies and methods in terms of microclimate and thermal comfort, that is, the optimization strategy and management process in planning and design Optimization strategy in.

7.3 Future research

There are many types of urban renewal projects in Shanghai, and the urban renewal process management is also in the initial stage. The urban renewal projects studied in this paper are not enough to cover the types and characteristics of all urban renewal projects. The research on the combination of microclimate and thermal comfort with the planning, design and management process of urban renewal in Shanghai also needs to be further deepened.

In this paper, envi met software is used for simulation analysis. However, due to the complexity of urban block environment and the limitation of modeling accuracy of the software itself, it is necessary to simplify the block model to a certain extent, and the simulation results have certain deviation. The simulation area involved in this paper is not close to the software modeling boundary as much as possible. Envi met can not simulate the characteristics of urban continuity well at the edge of the modeling model due to the lack of surrounding environment information, so the central area of its simulation range is more valuable [31]. Considering that the research focus is block scale, the accuracy of the modeling model of urban environment is missing, and the accuracy of envi met simulation should adapt to the research scope. In the future research, more factors that affect the microclimate of the block can be taken into account, such as building details, materials, vegetation types, etc., which can more accurately simulate the microclimate of the block And thermal comfort.

Although envi met is mainly used for the simulation of urban microclimate, it has different values for the city from macro scale, meso scale to micro block scale. From the perspective of multi-scale simulation, envi met can be coupled with other numerical simulation software suitable for large scale to study the urban environment. This paper focuses on summer, but according to different research topics and urban research types, we can also study the microclimate and thermal comfort throughout the year, or study different research project categories, such as the applicability of microclimate and thermal comfort strategies under different types of project conditions. In addition, cross research with other fields is also the direction of future urban research, such as planning and design based on microclimate and thermal comfort, and interdisciplinary research and application of atmospheric meteorology, building energy consumption, etc., which will provide a new vision for urban microclimate and thermal comfort research.

Reference

[1] 史军,穆海振.大城市应对气候变化的可持续发展研究——以上海为例[J].长江流域资源与环境,2016,25(01):1-8.

[2] 顾朝林,张晓明.基于气候变化的城市规划研究进展[J].城市问题,2010(10):2-11.

[3] 崔胜辉,徐礼来,黄云凤,黄葳.城市空间形态应对气候变化研究进展及展望[J].地理科学进展,2015,34(10):1209-1218.

[4] 苏甦. 上海城市更新的发展历程研究[A]. 中国城市规划学会、东莞市人民政府.持续发展 理性规划——2017 中国城市规划年会论文集（02 城市更新）[C].中国城市规划学会、东莞市人民政府:中国城市规划学会,2017:12.

[5] 金虹,王博.城市微气候及热舒适性评价研究综述[J].建筑科学,2017,33(08):1-8.

[6] Angeliki Chatzidimitriou, Simos Yannas. Microclimate design for open spaces: Ranking urban design effects on pedestrian thermal comfort in summer[J]. Sustainable Cities and Society,2016,26.

[7] Fong C S , Aghamohammadi N , Ramakreshnan L , et al. Holistic Recommendations for Future Outdoor Thermal Comfort Assessment in Tropical Southeast Asia: A Critical Appraisal[J]. Sustainable Cities and Society, 2019.

[8] 李晓君. 物理环境分析在多尺度城乡规划中的应用方法研究[A]. 中国城市规划学会、杭州市人民政府.共享与品质——2018 中国城市规划年会论文集（05 城市规划新技术应用）[C].中国城市规划学会、杭州市人民政府:中国城市规划学会,2018:10.

[9] 陈天,臧鑫宇,王峤.生态城绿色街区城市设计策略研究[J].城市规划,2015,39(07):63-69+76.

[10] Mohammad Taleghani, Laura Kleerekoper, Martin Tenpierik, Andy van den Dobbelsteen. Outdoor thermal comfort within five different urban forms in the Netherlands[J]. Building and Environment,2015,83.

[11] 赵冬. 华南城市典型居住小区空间形态对微气候的影响研究[D].广东工业大学,2016.

[12] 袁超.缓解高密度城市热岛效应规划方法的探讨——以香港城市为例[J].建筑学报,2010(S1):120-123.

[13] 李晗,吴家正,赵云峰,黄锦,李铮伟,阮应君.建筑布局对住宅住区室外微环境的影响研究[J].建筑节能,2016,44(03):57-63.

[14] Tania Sharmin, Koen Steemers, Andreas Matzarakis. Microclimatic modelling in assessing the impact of urban geometry on urban thermal environment[J]. Sustainable Cities and Society,2017,34.

[15] Salman Shooshtarian, Priyadarsini Rajagopalan, Amrit Sagoo. A comprehensive review of thermal adaptive strategies in outdoor spaces[J]. Sustainable Cities and Society,2018,41.

[16] Mohammad Taleghani. Outdoor thermal comfort by different heat mitigation strategies- A review[J]. Renewable and Sustainable Energy Reviews,2018,81.

[17] 陈铖. ENVI-met 软件对夏季室外热环境的模拟研究[A]. 中国城市科学研究会、中国绿色建筑与节能专业委员会、中国生态城市研究专业委员会.第十一届国际绿色建筑与建筑节能大会暨新技术与产品博览会论文集——S15 绿色校园[C].中国城市科学研究会、中国绿色建筑与节能专业委员会、中国生态城市研究专业委员会:中国城市科学研究会,2015:5.

[18] 岳小智,尹海伟,孔繁花,陈佳宇,刘梦茜.基于 ENVI-met 的绿地布局模式对微气候的影响研究——以南京市居住小区为例[J].江苏城市规划,2018(03):34-40.

[19] 张伟. 居住小区绿地布局对微气候影响的模拟研究[D].南京大学,2015.

[20] 马晓阳. 绿化对居住区室外热环境影响的数值模拟研究[D].哈尔滨工业大学,2014.

[21] Chen Yu, Wong Nyuk Hien. Thermal benefits of city parks[J]. Energy & Buildings,2005,38(2).

[22] Teresa Zölch, Johannes Maderspacher, Christine Wamsler, Stephan Pauleit. Using green infrastructure for urban climate-proofing: An evaluation of heat mitigation measures at the micro-scale[J]. Urban Forestry & Urban Greening,2016,20.

[23] 宋晓程. 城市河流对局地热湿气候影响的数值模拟和现场实测研究[D].哈尔滨工业大学,2011.

[24] 郭琳琳,李保峰,陈宏.我国在街区尺度的城市微气候研究进展[J].城市发展研究,2017,24(01):75-81.

[25] 李悦. 上海中心城典型街区空间形态与微气候环境模拟分析[D].华东师范大学,2018.

[26] Mohamad Fahmy, Stephen Sharples. On the development of an urban passive thermal comfort system in Cairo, Egypt[J]. Building and Environment,2009,44(9).
[27] 徐梦洁.基于微气候的城市街区绿色出行舒适度研究——以临港生态示范区为例[J].中外建筑,2017(12):80-82.
[28] 饶峻荃. 广州地区街区尺度热环境与热舒适度评价[D].哈尔滨工业大学,2015.
[29] Yupeng Wang, Umberto Berardi, Hashem Akbari. Comparing the effects of urban heat island mitigation strategies for Toronto, Canada[J]. Energy & Buildings,2016,114.
[30] 廖诗家. 街区尺度下热岛效应的规划缓解对策研究[D].中南大学,2012.
[31] 郑子豪,陈颖彪,千庆兰,李勇,谢锦鹏.基于三维模型的城市局地微气候模拟[J].地球信息科学学报,2016,18(09):1199-1208.
[32] Ariane Middel, Kathrin Häb, Anthony J. Brazel, Chris A. Martin, Subhrajit Guhathakurta. Impact of urban form and design on mid-afternoon microclimate in Phoenix Local Climate Zones[J]. Landscape and Urban Planning,2014,122.
[33] 林满,王宝民,刘辉志.广州典型小区微气候特征观测与数值模拟研究[J].中山大学学报(自然科学版),2015,54(01):124-129.
[34] 秦文翠. 街区尺度上的城市微气候数值模拟研究[D].西南大学,2015.
[35] 李凌舒. 街道夏季热环境多要素影响研究[A]. 中国风景园林学会.中国风景园林学会 2016 年会论文集[C].中国风景园林学会:中国风景园林学会,2016:6.
[36] Fabbri K , Canuti G , Ugolini A . A methodology to evaluate outdoor microclimate of the archaeological site and vegetation role: a case study of the Roman Villa in Russi (Italy)[J]. Sustainable Cities and Society, 2017:S2210670717306534.
[37] Hamed Farhadi, Mohsen Faizi, Hanyieh Sanaieian. Mitigating the urban heat island in a residential area in Tehran: Investigating the role of vegetation, materials, and orientation of buildings[J]. Sustainable Cities and Society,2019,46.
[38] Ferdinando Salata, Iacopo Golasi, Davide Petitti, Emanuele de Lieto Vollaro, Massimo Coppi, Andrea de Lieto Vollaro. Relating microclimate, human thermal comfort and health during heat waves: An analysis of heat island mitigation strategies through a case study in an urban outdoor environment[J]. Sustainable Cities and Society,2017,30.
[39] 王频,孟庆林.多尺度城市气候研究综述[J].建筑科学,2013,29(06):107-114.
[40] 冷红,袁青.城市微气候环境控制及优化的国际经验及启示[J].国际城市规

划,2014,29(06):114-119.
[41] 卢薪升,杨鑫.基于ENVI-met软件小气候模拟与热舒适度体验的城市更新研究——以北京石景山北辛安地区为例[J].城市发展研究,2018,25(04):147-152.
[42] 李晓君. 基于风环境模拟的城市更新规划方案优化研究——以深圳上步一单元为例[A]. 中国城市规划学会.城乡治理与规划改革——2014 中国城市规划年会论文集（04 城市规划新技术应用）[C].中国城市规划学会:中国城市规划学会,2014:14.
[43] 彭翀,邹祖钰,洪亮平,潘起胜.旧城区风热环境模拟及其局部性更新策略研究——以武汉大智门地区为例[J].城市规划,2016,40(08):16-24.
[44] 郑舰. 基于风热环境模拟评价的传统街区更新研究[D].华南理工大学,2017.
[45] 史源,任超,吴恩融.基于室外风环境与热舒适度的城市设计改进策略——以北京西单商业街为例[J].城市规划学刊,2012(05):92-98.
[46] 邓世超. 基于微气候改善的城市街区绿色更新策略研究[D].湖北工业大学,2014.
[47] 王振. 夏热冬冷地区基于城市微气候的街区层峡气候适应性设计策略研究[D].华中科技大学,2008.
[48] Tathiane A.L. Martins, Luc Adolphe, Marion Bonhomme, Frédéric Bonneaud, Serge Faraut, Stéphane Ginestet, Charlotte Michel, William Guyard. Impact of Urban Cool Island measures on outdoor climate and pedestrian comfort: Simulations for a new district of Toulouse, France[J]. Sustainable Cities and Society,2016,26.
[49] Evyatar Erell, The Application of Urban Climate Research in the Design of Cities, *Advances in Building Energy Research*, 10.3763/aber.2008.0204, **2**, 1, (95-121), (2008).
[50] 姜荣,陈亮,象伟宁.上海市极端高温天气变化特征[J].气象与环境学报,2016,32(01):66-74.
[51] Jun Lu, Qiansong Li, Liyue Zeng, Jing Chen, Gaoxiang Liu, Yongcai Li, Wuyan Li, Kailin Huang. A micro-climatic study on cooling effect of an urban park in a hot and humid climate[J]. Sustainable Cities and Society,2017,32.
[52] 邬尚霖.建筑密度对街区热环境影响分析[J].华中建筑,2016,34(08):46-50.
[53] 张春灵. 基于数值模拟的街区微气候研究[D].华东师范大学,2017.
[54] Giridharan R , Lau S S Y , Ganesan S , et al. Urban design factors influencing heat

island intensity in high-rise high-density environments of Hong Kong[J]. Building and Environment, 2007, 42(10):3669-3684.

[55] 王伟武,杨华杰,邵宇翎,汤书福.城市住区室外热环境三维分布特征模拟——以杭州为例[J].浙江大学学报(工学版),2013,47(07):1178-1185+1212.

[56] 杨鑫,段佳佳.不同临街空间模式对小气候环境的影响——以北京市城区典型临街空间为例[J].城市问题,2016(07):44-54.

[57] Ferdinando Salata, Iacopo Golasi, Andrea de Lieto Vollaro, Roberto de Lieto Vollaro. How high albedo and traditional buildingsâ€™ materials and vegetation affect the quality of urban microclimate. A case study[J]. ,2015,99.

[58] 邬尚霖,孙一民.广州地区街道微气候模拟及改善策略研究[J].城市规划学刊,2016(01):56-62.

[59] Bruse M , Fleer H . Simulating surface–plant–air interactions inside urban environments with a three dimensional numerical model[J]. Environmental Modelling & Software, 1998, 13(3-4):373-384.

[60] S. Tsoka, A. Tsikaloudaki,T. Theodosiou. Analyzing the ENVI-met microclimate model's performance and assessing cool materials and urban vegetation applications-a review[J]. Sustainable Cities and Society,2018.

[61] Huttner S , Bruse M , Dostal P . Using ENVI-met to simulate the impact of global warming on the mi- croclimate in central European cities[J]. Ber Meteorol Inst Univ Freiburg, 2008.

[62] 马舰,陈丹.城市微气候仿真软件 ENVI-met 的应用[J].绿色建筑,2013,5(05):56-58.

[63] Bhaskar De, Mahua Mukherjee. "Optimisation of canyon orientation and aspect ratio in warm-humid climate: Case of Rajarhat Newtown, India"[J]. Urban Climate,2018,24.

[64] T.F. Zhao,K.F. Fong. Characterization of different heat mitigation strategies in landscape to fight against heat island and improve thermal comfort in hot–humid climate (Part I): Measurement and modelling[J]. Sustainable Cities and Society,2017,32.

[65] 杨玉锦. 数值模拟工具在城市微气候研究领域的应用情况综述——以ENVI-met 软件为例[A]. 中国城市科学研究会、深圳市人民政府、中美绿色基金、中国城市科学研究会绿色建筑与节能专业委员会、中国城市科学研究会生态城市研究专业委员会.2019 国际绿色建筑与建筑节能大会论文集[C].中国

城市科学研究会、深圳市人民政府、中美绿色基金、中国城市科学研究会绿色建筑与节能专业委员会、中国城市科学研究会生态城市研究专业委员会:北京邦蒂会务有限公司,2019:5.

[66] Nabil Girgis, Sarah Elariane, Mahmoud Abd Elrazik. Evaluation of heat exhausts impacts on pedestrian thermal comfort[J]. Sustainable Cities and Society,2016,27.

[67] 匡晓明.上海城市更新面临的难点与对策[J].科学发展,2017(03):32-39.

[68] 周俭,阎树鑫,万智英.关于完善上海城市更新体系的思考[J].城市规划学刊,2019(01):20-26.

[69] 管娟. 上海中心城区城市更新运行机制演进研究[D].同济大学,2008.

[70] 施立平.多维度需求下的上海城市微更新实现路径[J].规划师,2019,35(S1):71-75.

[71] 方宇婷. 城市气候评估在空间规划中的应用研究[D].深圳大学,2017.

[72] 于泳. 街区型城市住宅区设计模式研究[D].东南大学,2006.

[73] 朱晓明.上海曹杨一村规划设计与历史[J].住宅科技,2011,31(11):47-52.

[74] 李雯骐. 城市设计视角下的街区更新解析——以上海音乐谷为例[A]. 中国城市规划学会、东莞市人民政府.持续发展 理性规划——2017 中国城市规划年会论文集（02 城市更新）[C].中国城市规划学会、东莞市人民政府:中国城市规划学会,2017:10.

[75] 唐燕,杨东.城市更新制度建设:广州、深圳、上海三地比较[J].城乡规划,2018(04):22-32.