Research and Practice of Ecological Climate Responsive Strategies based on the Interactive Relationship between Architecture and Climate in China

A dissertation submitted to the Department of Breuer Marcell Doctoral School of Architecture in partial fulfillment of the requirements for the award of the degree of Ph.D. in Architectural Engineering programme of UNIVERSITY OF PECS/ Faculty of Engineering and Information Technology

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APPROVAL SHEET

This dissertation proposal entitled Research and Practice on Ecological Energy-efficient Strategies based on the Interactive Relationship of Architecture and Microclimate in China submitted by Chu Xiaohui for the degree DOCTOR OF PHILOSOPHY has been examined and approved for PROPOSAL HEARING.

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I hope the dissertation is helpful for you and enjoy the read.

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Chapter 1. Introduction

1.1 Research Background

1.1.1 Status

There is the contradiction between natural environment and urban construction. The amount of construction is constantly increasing with the rapid development of the world economy. According to the forecast of Global Construction Perspectives and Oxford Economics, the volume of construction output will grow by 70% from $8.7 trillion in 2012, to $15 trillion by 2025, representing growth of $6.3 trillion. Especially China overtook the US as the world's largest construction market in 2010, and now accounts for 18% of total global construction in 2012. In the International Energy Outlook 2017 (IEO2017) Reference case, total world energy consumption rises from 575 quadrillion British thermal units (Btu) in 2015 to 736 quadrillion Btu in 2040, an increase of 28%.[1] The buildings sector is made up of residential and commercial end users and presently accounts for 20% of the total delivered energy consumed worldwide. Whether it is residential or commercial buildings, energy consumption is slowly increasing. Building energy efficiency has become a global issue with the increasing energy crisis. Building energy consumption is increasing with the improvement of human living standards. In the total energy consumption, the proportion of building energy consumption is a measure of economic development benchmark, reflecting the country's economic development level, climate conditions, quality of life, building technology standards. In the process of building construction for mankind's better living environment, the natural environment has been affected to varying degrees, leading to the pollution and destruction of the natural environment.[2]

The concept of sustainable development of eco-building design is gradually prevailing. The natural environment is closely related to the urban construction and human life. Human beings from the initial production to industrialization ago, human construction activities are coordinated and harmonious with natural environment; the construction of the building is respectable and friendly to the natural environment. After the industrial revolution, the productivity increased sharply. The violent intervention and destruction of the natural environment by technology-led construction have been gradually strengthened. Human destruction and plunder of nature are often crueler due to technological advances, resulting in a serious imbalance in the natural ecosystem. The Warsaw Declaration states that the task of architecture is to examine the characteristics and laws of architecture as environmental science and art and to reflect it in the design and construction practice in 1981. Nowadays the architects' design, based on respect for nature, makes every effort to ensure the comfort of the user and to improve the natural environment. Strive to achieve the organic combination of the built environment and the natural

[1] International energy outlook 2017;https://www.eia.gov/outlooks/ieo/exec_summ.php

[2] Greenhouse effect, global warming, acid rain, desertification etc.

environment. Ecological awareness of the symbiosis between man and nature has also been gradually adopted by contemporary architects as a universal design guideline, and the idea of ecological architecture has gradually entered the field of architectural design. In the design of the use of ecology and other natural science principles of knowledge and engineering and other means to create a benign ecological environment and strive to solve the construction and environmental issues.

Since January 2007, the World Economic Forum, the EU Summit, the G8 Summit, the APEC Leaders' Informal Meeting, and the UN General Assembly have all made climate change an important issue. The UN Panel on Climate Change (IPCC) pointed out in the climate change assessment report: “The objective facts of global warming are undoubtedly and are likely to be caused by human activities,” and “Climate change has negatively impacted many natural and biological systems. If no measures are taken to reduce greenhouse gases, climate change will increase,” "Under the current economic and technological conditions, there is considerable potential to reduce greenhouse gas emissions."[3] The affiliation between man and nature cannot be changed. People should respect nature and communicate with nature instead of competing with nature. For their own tomorrow mankind must live in harmony with nature.

1.1.2 Existing Problems and Defects

Extensive use of energy in exchange for environmental comfort has not only brought about an energy crisis but also brought about the urban heat island effect. Summer is an active season for the spread of disease. The air-conditioning ventilation process is a medium for pipeline-borne transmission of pathogens and is not conducive to physical health. In addition, for the ecological environment of our daily life, mechanical refrigeration undoubtedly increases the pressure on the environment.

Some architects attributed building energy saving and satisfying user comfort too much to equipment, and some also thought that ecological buildings could create a high greening rate, low density and naturalism. Being an architect lacks a sense of responsibility for the environment and human beings and cannot do it: the design of the building is designed to meet the low-energy buildings that best suit the local climate, so that it is no longer a burden on the environment, but as a natural product.

The process of globalization has brought about a series of problems while promoting the development of the world economy. The most prominent manifestation is the envy and obedience of most economically weak countries to the lifestyle, values, and culture of economically powerful countries. It has brought about the weakening and elimination of regional cultures worldwide, and the diversity of cultural forms is facing great challenges.

The architectural creation needs effective theoretical guidance, and the application

[3] Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

theory that meets the regional climate environment and cultural and social background of the architectural design project is not sufficiently researched. It is a difficult problem for the architectural design practice. Many ecological buildings or sustainable buildings mostly focus on the accumulation of energy-saving technologies. However, the use of architectural design techniques based on local climate is often not sufficiently thorough and effective, making the ecological significance of energy conservation mostly at the mechanical level of equipment.

1.2 Research Objects and Significance

The design of ecological buildings is influenced by many factors. The degree of attention of the technology is not the only one that can be adapted to the architectural level of the region and the inheritance of the culture. The principle of "appropriate technology" was proposed by Schumacher in his 1973 masterpiece "Small Is Beautiful". As a master of ecological economics, he advocated the use of technologies that conform to local industries, equipment, materials, and labor levels. Schumacher's point of view emphasizes that developing countries should be free from simple and crude learning of the production methods, consumption standards and value systems of developed countries, to develop the country' s economy with appropriate technologies, and to implement the practice of technology capital intensification through the use of small units such as human scale, economic structure diversification, and work and joint ownership of sophisticated technologies.

According to the characteristics of the microclimate in the design area, efficient use of appropriate climate responding strategies can ensure that human comfort PMV can be met with minimal energy use in the design. Build buildings that provide quality living for humans while reducing damage to the natural environment. Reduce the warming caused by environmental damage, tropical storms, rainstorms, heat island effects and rising sea levels.

This article will be more intuitive to help architects, planners, city managers, and even the general public to understand the differences in the climate of the geography and climate, and how we can more effectively use the climate resources. The theoretical innovation can be summarized as the use of new technical methods to visualize and accurately describe the effectiveness of each design strategy within the scope of the design area. The results of this study can be easily applied to the architect's initial stage of project creation. It helps architects understand the local climate characteristics and the suitability of design strategies in the creative process. It can promote the use of appropriate energy conservation strategies and avoid the use of inappropriate measures. At the same time, it has played a more active role in the diversity of architectural forms, human-oriented, sublimation of architectural traditions, inheritance and innovation of regional features.

1.3 Research Review

1.3.1 Theoretical aspects

After two energy crises in 1970, more and more architects and planners took environmental issues as their primary responsibility in the worldwide quest for human survival and development. Try to solve the problems of function and aesthetics without disturbing the environment as much as possible, and further strive to improve the natural environment in the design. Under the premise of respecting nature, architects actively creatively combine the architectural environment with the natural environment. Ecological awareness of the symbiosis between man and nature has also been gradually adopted by contemporary architects as a universal design guideline, and the idea of ecological architecture has gradually entered the field of architectural design.

Table 1.1 *Ecological Architecture related theories*

Time	Theory	Content
Before 1960s	Ecological architecture, the deep ecology, Biologic Building movement, Gaia hypothesis and the Sustainable development.	Showed the concern for the natural environment and climate in the design process, gradually formed a movement closely related to the design theory of bioclimatic regionalism and ecological architecture design.
	Frank Lloyd Wright, Organic architecture.	Put forward the design principle: the building is integrated with the natural environment of the region.
1960s-1990s	Ecological architectural design theory has been greatly enriched.	The focus of research has also gradually changed, gradually shifting towards the pursuit of harmony between people, architecture and nature.
	Architectural Magazine successively published the album "Eco-building".	Analysis of ecological building related design ideas and methods.
1963	Victor Olgyay, Design with Climate Bioclimatic Approach to Architectural Regionalism.	The design theory of "bio-climate regionalism" was proposed. To meet the comfort of the human body as a starting point, pay attention to the relationship between climate and human physiological experience.
1980s	Kisho Kurokawa	The concept of "symbiotic philosophy" is proposed, and the symbiosis between man and nature is advocated.
1994	< Passive and low energy cooling of buildings> Baruch Givioni	According to the statistical data of a certain sample, the passive cooling strategy of the building is discussed through a technical perspective.
	Narenda K. Bansal, GerdHauser, Gernot Minke, <Passive Building Design: A	The book mentioned a lot of passive design strategies and summed up the more comprehensive, guide future climate responsive design process.

	Handbook of Natural Climatic Control>	
1996	Sim Van Der Ryn, < Design for Life >	Five major principles and methods of ecological design are proposed: solutions to grow from the local, visible to nature, natural design, ecological accounting notification design, and everyone is a designer.
1998	David Pearson, < The Natural House Book >	Outlines the design principles of the Gaia-style architecture: The aim is to live in harmony with the earth, to feel at ease, and to design for health.
After 1990s	Bouehair, Sodha and Bouehai	Study on cooling methods from building structure and materials[4]
2001	< Introduction to Sciences of Human Settlement >, Wu Liangyong	Focusing on the coordination between man and nature, we will explore the interrelationship between human and environmental sustainability.
2003	< Handbuch der passiven Kühlung: Rationelle Energienutzung in Gebäuden. >	Detailed studies of the examples, discussed and summarized various passive cooling strategies.
2004	< From traditional houses to regional architecture > chinese, Shan Deqi	It is pointed out that we should not only stay at the theoretical level to study traditional dwellings. We should consider and develop the inheritance and development of traditional dwellings in contemporary architectural practice from a practical perspective.
2007	< Local architecture and suitable technologies > Chen Xiaoyang	Discussed the critical inheritance of traditional technology and the integration of modern technology, with a strong regional color.
2009	< Ecological Habitat > Zhang Anli	The traditional dwelling houses in different regions are collectively referred to as ecological homes. Through the study of different forms of dwelling houses in the world, it has been pointed out that religious culture and customs are poor, and different dwellings have common characteristics. Ingenious methods of construction and use of regional materials are all associated with the local natural climate environment.
2014	< Green architecture = Ecology, Energy Saving, Waste Reduction, Health > (Chinese translated)	A general introduction explains the effective passive design strategies for different climatic zones.

4 Ma Bo. Residential Building Passive Cooling Mode Language research. Diss. Xi’an: Xi'an University of Architecture and Technology, 2009,（Chinese translated）

For the vast regions of China, different geographical features have brought about different climatic characteristics. The research on ecological climate responding strategies seldom involves the analysis of the correlations with regional microclimates, and there is a general lack of research on the refinement and induction of local microclimate.

1.3.2 Practical aspects

In the process of construction practice, contemporary architects have tried to combine effective ecological energy conservation strategies with architectural examples through their own exploration and efforts, applied to architectural design and put forward feasible design suggestions. (Table 1.2)

Table 1.2 *Architect's Relevant Design Ideas for Ecological climate responsive Design Strategies Based on Local Climate*

Country	Name	Design method
Malaysia and England	Ken Yeang， Short Fort company	The research methods and framework design of ecological buildings are proposed and applied in practice.
England	Short Fort	The research themes attributed to how typology applies to large and deep spatial design strategies.
Malaysia	Ken Yeang	Passive design strategy applied to green skyscrapers in different regions under different climate characteristics. Proposed "bio-climatic skyscrapers" concept.
India	Charles Correa	Advocating the architectural concept of following the climate, it is proposed to start from the plane and the section, apply the architectural design method to adjust the climate and create a comfortable environment. "Chimney effect" to enhance ventilation.
Egypt	Hassen Fathy	Pay attention to the use of local materials and traditional construction methods, pay attention to natural environmental protection technology and the use of natural ventilation.
Burkina Faso	Diébédo Francis Kéré	According to the local economic, social and cultural backgrounds, consider the adapted architecture based on local cost, climate, resource availability, and construction feasibility.
china	Wang Shu	Try to re-use old local materials in new buildings to provide material sustainability.

1.4 Research Methodology

Through field survey, field measurement, questionnaires, physical surveys, comparative studies, climate analysis, computerized quantitative simulations etc., raw data were obtained, and typical buildings with climate characteristics were studied. Analyze, count, record, calculate, and organize work on a large number of climate data. Through theoretical analysis and summarization of actual operations, the conclusions are summarized and summarized. Combining qualitative research with quantitative research, using modern scientific theories to establish simplified physical models for research subjects, establishing mathematical formulae using mathematical knowledge, and drawing conclusions that architects can learn from; guiding specific design practices and verifying the practicality of results.

1.5 Research Conceptual Framework and Content

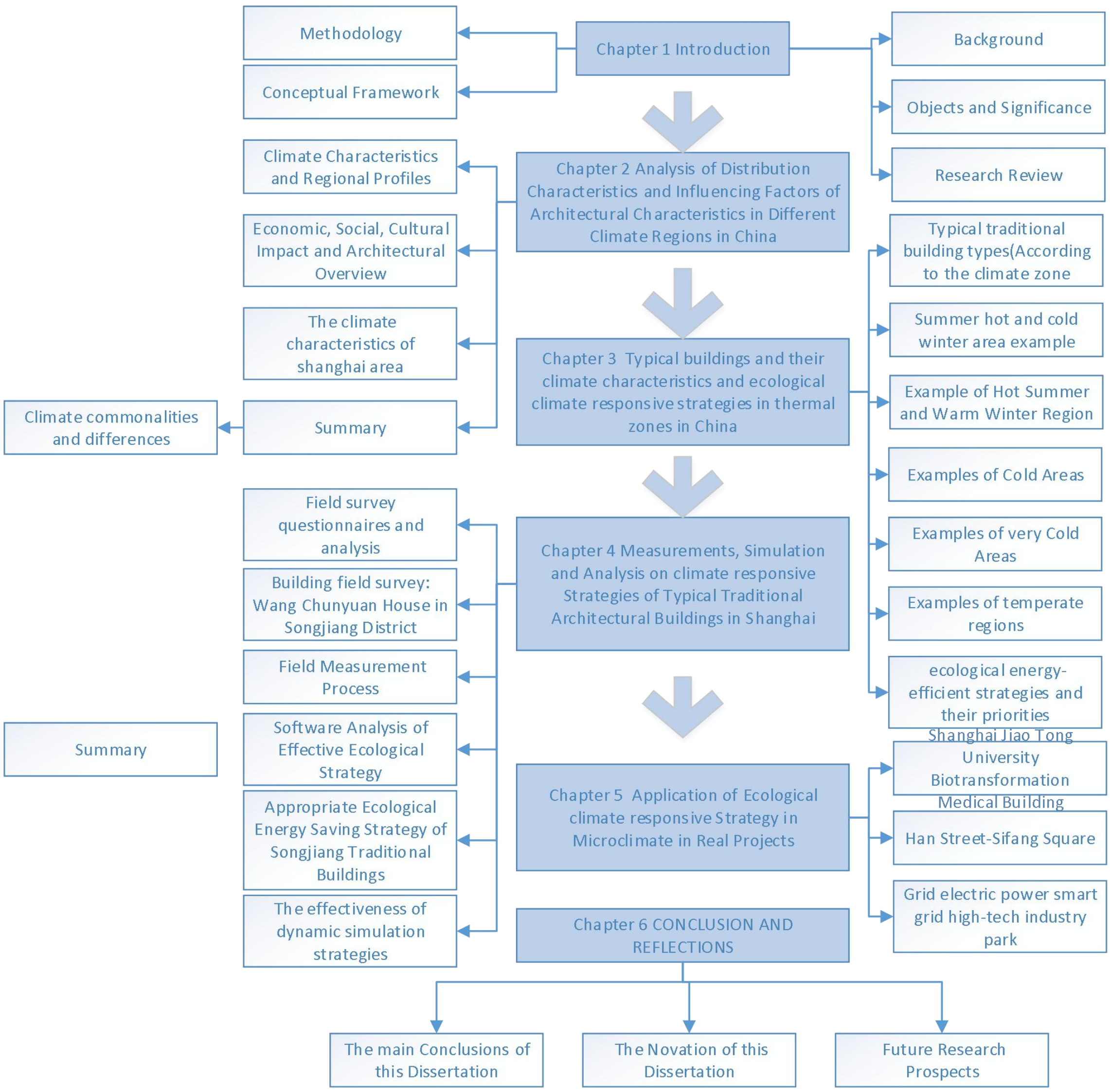

Fig. 1.1 *The framework of the dissertation*

Chapter 2. Analysis of Distribution Characteristics and Influencing Factors of Architectural Characteristics in Different Climate Regions in China

2.1 Climate Characteristics and Regional Profiles

2.1.1 Regional climate

Climate is the long-term average state of weather phenomena, or climate is the statistical average of atmospheric physical properties in a region over a long period of time.[5] As a result of long-term interactions between solar radiation, atmospheric circulation, and the geographical environment that function in this area. The World Meteorological Organization (WMO) stipulates that the shortest statistical period for determining the climate characteristics of an area through statistical analysis of meteorological parameters is 30 years. According to the influence of atmospheric statistical average state and spatial scale, climate can be divided into three categories: macroclimate, mecroclimate and microclimate. The general climate characteristics or the common climate conditions in large areas are called Macroclimate, and the climates with different features and climates formed by various local factors in a small area are called microclimates. Some scholars have subdivided the microclimate into local climate and microclimate according to the horizontal and vertical scales and time scales of the influence range of the underlying surface structural characteristics. The climate between the macroclimate and the microclimate has become a mecroclimate.[6] Form the scale range table as shown below.

Table 2.1

Climate spatial scale and time range[7]

Climate range	Climate spatial scale		time range
	Horizontal（10^3）m	vertical（10^3）m	
Macroclimate	$2*10^3$	3-10	1-6 months
Mecrocliamte	$5*10^2$-10^3	1-10	1-6 months
Microclimate (local climate)	1-10	10^{-2}-10^{-1}	1-24 hours
Microclimate	10^{-1}	10^{-2}	24 hours

The climate characteristics of the building studied in this paper refer to the microclimate range, which climate has a local with unique climate characteristics.

According to the most widely used Koppen climate zoning method in the world

5 Zhang Jiacheng, China General Climate, Beijing Meteorological Press,1991.12 page 1

6 XU Xiangde, Tang Xu; Urbanization environmental meteorology, Beijing Meteorological Press, 2002.1

7 XU Xiangde, Tang Xu; Urbanization environmental meteorology, Beijing Meteorological Press, 2002.1

(Fig. 2.1), temperature and precipitation are two major indicators of the Koppen climate zoning method. The climate is divided into the following five regions: tropical climate, dry climate, warm climate, cold climate, Ice and snow climate. Each climate zone is divided into different climate types. (Af - Equatorial Rainy Climate, Am - Tropical Monsoon Climate, BSh, BSk - Semi-Arid Climate, BWh, BWk - Desert Climate, Csa - Hot Summer Mediterranean, Csb - Warm Summer Mediterranean, Cwa, Cfa - Subtropical Wet, Dfa , Dwa, Dsa, Dfb, Dwb, Dsb - continental humid climate, Dfa, Dwa, Dsa - hot summer continental humid climate, Dfb, Dwb, Dsb- warm summer humid climate, Dfc, Dwc, Dsc, Dfd, Dwd , Dsd - with extreme climate) Af - equator and rainy climate, Am - tropical monsoon climate, Cwa, Cfa - subtropical humid climate can be collectively referred to as "humid climate", is the heaviest air conditioning load area. At the same time, the Cfa-subtropical humid climate is located in the “hot summer and cold winter regions” in the Chinese Construction Thermal Division Map (Fig. 2.2) and the Chinese Construction Climate Division Map (Fig. 2.3). As shown in the figure, Jiangnan region of China is in a hot and humid climate region (Fig. 2.4).

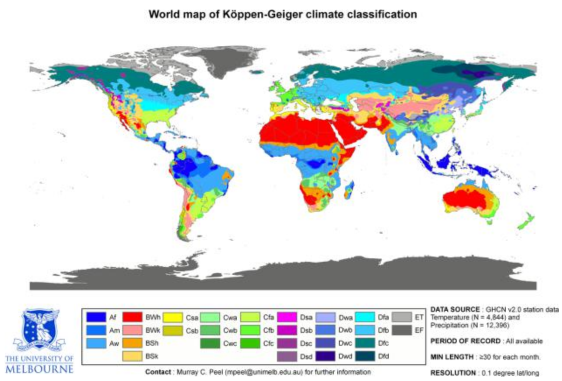

Fig. 2.1 Koppen Climate Division Map[8]

Fig. 2.2 China Construction Thermal Division Map

[8] *http://tieba.baidu.com/p/2001030624*

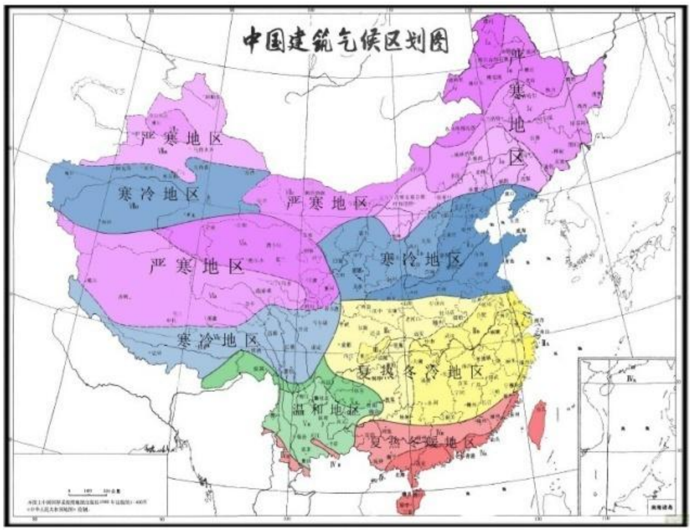

Fig. 2.3 Chinese building climate division method

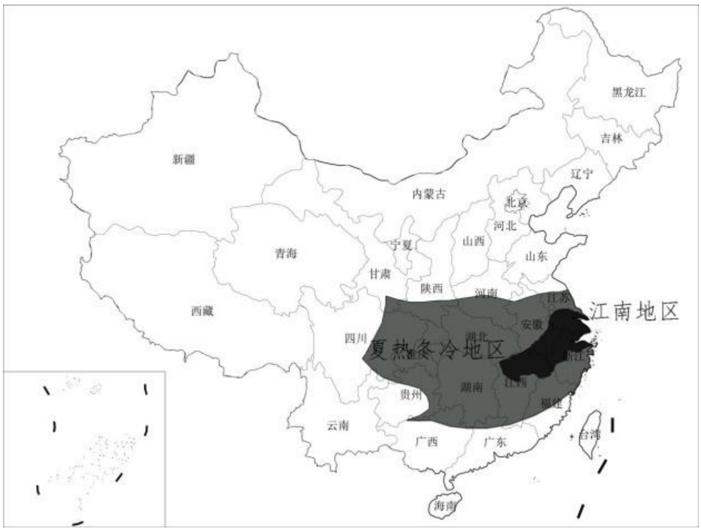

Fig. 2.4 Regional map of Jiangnan Region in China(author's draw)

According to archaeological anthropology, ancient humans originated in the warmer and moister areas around the tropical forests, that is, the hot and humid climate regions, which are the most difficult climate areas to control. The pressure of hot and humid climates does not only come from the effects of heat but also from wetness. It is more difficult to control humid and hot climates to achieve comfortable conditions. The hot and humid climate is the most air-conditioned area on the earth, and the area with the highest air-conditioning energy density, so it has also become the area with the greatest potential for energy conservation.

China's meteorologists used the sum of the daily dryness and the average daily temperature accumulated temperature value over a certain period of time as a basis to distinguish the sub-climate regions of China and proposed a classification method with China's own characteristics. Based on this climate classification method, Joanna region can be divided into the following climate regions (Fig. 2.5 and Table 2.2).

Table 2.2

Summarize the climate of Jiangnan region

Climate zone	Geographic features	Climate data	Climate characteristics
North subtropical summer humid winter cold（NA1）	Mountain terrain and hilly terrain dominate. North city: Changxing, east city: Anji, Linan.	Average temperature≥10℃, around 230 days. January average temperature≤3.2℃, hottest summer dryness ＜ 1.25.	The average annual temperature is low, winter is cold and hot in summer, rainfall is more abundant, and sunshine is relatively less. Annual average sunshine is less than other regions.
North subtropical summer moist winter cold（NA2）	Northern Plains and Hilly Areas. West city: Huzhou. Including Ningbo, Ninghai, Fenghua.	Average temperature≥10℃, around 230-240days, coldest month average temperature: 3.3-4.9℃, hottest summer dryness＜1.25.	Winter is warmer and summers rarely have very hot weather. Sunlight is rich in direct sunlight.
Subtropical Xia Arid Winter Temperature （NB3）	Along the northeast coast of Zhejiang Province.	Average temperature≥10℃, around 230 days. Coldest month average temperature: 5-6.9℃, hottest summer dryness≥1.25.	Moderate temperature in winter and cooler in summer. The temperature throughout the year is relatively modest and the rainfall is relatively small. However, the light is more abundant and the natural wind is more abundant.
North subtropical summer humid winter warmth （NA3）	The boundary between the eastern part of Jiangnan and the mid-subtropical summer climate zone from the latitude of about 30°N.	Average temperature≥10℃, coldest month average temperature: 5-6.9℃,	
Mid-tropical summer humid winter temperature （MB2）	Jinheng Basin and its surrounding areas and the western part of Jiangnan.	Average temperature≥10℃, around 240-260 days, coldest month average temperature: 3.3-3.5℃, hottest summer dryness≥1.25.	Radiation is strong, there is more sunshine, and the accumulated temperature is also more; rainfall is very abundant. In the first half of the year, rainfall accounted for a large part of the annual rainfall. Summer and autumn are more prone to drought; cold winters and hot summers have larger daily differences.
Central and	Southwest Hills and	Average temperature≥10℃,	The change of temperature is

subtropical summer humid winter（MA2）	Mountainous Region	around 240-260days, coldest month average temperature: 5-7℃, hottest summer dryness≥1.25.	more and the temperature in the valley is higher, but the temperature in some high mountainous regions is relatively lower than that in the valley, and the temperature in autumn and winter decreases earlier. The temperature in winter is relatively low, except for the hot weather in the areas of Lishui and Jinyun in the valley. The rainfall is relatively large, the climate is relatively humid, and the amount of direct sunlight is low.
Mid-tropical summer humid winter temperature（MA3）	Southeast of Zhejiang, low hilly western of Wenzhou.	Average temperature≥10℃, more than 240 days, coldest month average temperature: 5-7℃, hottest summer dryness≥1.25.	More humid. Sunshine is relatively moderate, winter temperatures are relatively high, rainfall is sufficient, but frequent typhoons
Mid-tropical summer humid winter temperature（MA4）	Hilly plains on the southeast coast.	Average temperature≥10℃, around 240-260 days, coldest month average temperature: ＞ 7℃, hottest summer dryness＜1.25.	More humid. There are more rainfalls throughout the year, moderate sunshine, and frequent typhoons.

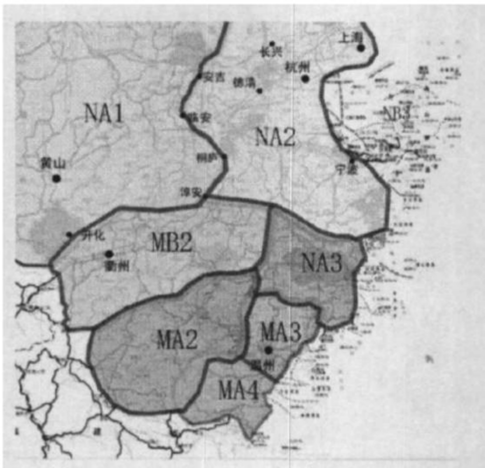

Fig. 2.5 Jiangnan climate zone distribution map[9]

[9] Zhang P. K, Guo L.M and Teng Z.L. Zhejiang Climate and Its Application. (1999): 102. (Chinese translated)

2.1.2 Geographical location and terrain

Geographically, the scope of the Jiangnan region generally refers to the area south of the middle and lower reaches of the Yangtze River and then to the north of the upper Nanling Mountains. As a relatively independent area, Jiangnan has a long history in China. Therefore, Jiangnan has its unique cultural and geographical climate characteristics since ancient times. For example, in the Baiyue district, which belongs to the Yinwen pottery culture, Jiangnan area is characterized by its large water area, which belongs to the extension area of the Huaxia cultural circle in the Central Plains, and the climate is a hot summer and cold winter area that is in full compliance with the cold and humid summers in winter. The climate features.

The Jiangnan region is relatively flat, but there are still many types of terrain: basins, hilly mountains and plains. The basins are mostly distributed in the central and western regions of the south of the Yangtze River and along the Jinheng Basin (Figure 2.6). Hilly areas are located in the southeastern coastal areas in the northwestern region of the south of the Yangtze River. The topography of plain waters is mostly distributed in the northern part of the Jiangnan.

Fig. 2.6 Jiangnan topographic map[10]

The geographical environment of the Jiangnan region is rather special, which also makes Jiangnan its unique climate. An important factor influencing the climate in the area is the Nanling Mountains. The trend of the Nanling Mountains has caused the north-south flow within the area to be obstructed. Therefore, the climate in the northern and southern parts of the Nanling Mountains is quite different. In the spring of each year, as the northerly winds gradually decrease and the southeast coastal winds increase, along with the increase of solar radiation, the surface temperature rises rapidly, the north and south air flows alternately intensify, and the cold and warm air meet frequently, forming a situation of mutual sawing. The result is cloudy weather and more rainfall. About from mid-June to early July of each year, the

[10] Zhang P. K, Guo L.M and Teng Z.L. Zhejiang Climate and Its Application. (1999): 102. (chinese translated)

average temperature in this season is not high, but the relative humidity in the air is relatively large. A long period of gloomy and rainy weather is very prone to mold, so it is also called the "mild rain" season. In July and August, the Jiangnan region was dominated by "subtropical highs." During this time, the weather was hot and dry. It is often referred to as the "drought-out" season. However, there was often a storm brought by the typhoon during this period. In the following month, the temperature dropped rapidly. After a certain period of time, with the advent of the winter, the temperature will gradually decrease. At this time, the cold air in the north will go south. At this time, the temperature in the south of the Jiangnan region will be low and the humidity will be relatively high (excluding the plateau). The special geographical environment has also formed the main climate features of the Jiangnan region: spring rain, rainy season, drought and cold winter.

2.2 Economic, Social, Cultural Impact and Architectural Overview

Culturally, there have been two major population migrations in Chinese history: The Eastern Jin Dynasty and the Southern Song Dynasty. During the two southern migrations, that is, in these two periods, the Central Plains culture entered the Jiangnan region and promoted the integration of southern and northern cultures. The strong inclusiveness and radiant ability of the Central Plains culture have weakened the long-established culture of Baiyue in the south of the Yangtze River in the south and the north. Therefore, the unique Jiangnan culture we now see is a unique culture formed after the influence of the convergence of Central Plains culture and Baiyue culture, reflecting the diversity, regionalism, and innovation of Jiangnan Architecture since ancient times. In the long-term historical development process, Jiangnan's traditional houses have continuously accumulated experience and continued to develop and have accumulated rich experience in the gradual adaptation to the natural environment. Since the development of traditional houses in Jiangnan region, we can see that it has adapted to the local geography and climate environment as well as the unique characteristics of the local community, culture and culture.

In the Hemudu site of Yuyao City, Zhejiang Province, located in the Jiangnan region, a large number of dry bar architecture sites have been discovered. A large number of tropical animals such as elephants, rhinos, and cotton trees can be found from sites unearthed in Hemudu. So, we can see that the area of Jiangsu and Zhejiang over 7,000 years ago was hotter than modern times, and it is a typical hot and humid climate. The Jiangnan region now belongs to the temperate evergreen broad-leaved forest area and there is also a short winter in the winter.

Shanghai, which belongs to the Jiangnan region, has a high degree of similarity between its traditional architecture and traditional architecture in the Jiangnan region. The earlier residence in Shanghai was Xianyitang, which was built in the late Yuan Dynasty and the early Ming Dynasty. It is located on Zhonghua Road in Huangpu District. This building is similar to the layout of the courtyard houses in the Ming and Qing dynasties. "Shanghai Zhi" records that "the streets and alleys are crowded together and the people are living together." The formation of streets and lanes leads residents to gather, and residential buildings have developed rapidly. After the middle of the Ming Dynasty, many courtyards appeared in Shanghai, such as Yuyuan Garden, Luxiang Garden, Duhehe Building, and Japan Park. In the Qing Dynasty, there were many well-preserved residential buildings in Shanghai, including Xinchang Town in Nanhui, Zhujiajiao in Qingpu, and parts of Chongming and Jiading. Compared with large-scale residential buildings, ordinary people live in smaller residential buildings for more storage. In general, the traditional architecture of Shanghai has the characteristics of a typical Jiangnan architecture, and it also has its own characteristics.

With the development of society, science and technology are also progressing. With the leap of economic conditions in our country, the standard industry for the construction of modern buildings is gradually improving. Today's society is full of high energy-consuming modern buildings, and this phenomenon is even worse in Jiangnan. Many traditional design methods and architectural forms that adapt to the local climate gradually disappear. Nowadays, many modern architects mistakenly believe that the existing technology for manual control of the indoor environment is sufficient to replace traditional construction techniques. It merely continues the traditional Jiangnan architectural style on the external form of the building and does not explore its inherent traditional energy saving. Based on the above analysis, it is very important to conduct scientific and systematic research on traditional buildings in various regions.

2.3 The climate characteristics of shanghai area

This meteorological data comes from the Meteonorm database, which originated from the Meteonorm institute in Switzerland and contains weather data from 7750 weather stations around the world. Most of the 98 meteorological observatories in China are included in the database of the software. After entering the latitude and longitude coordinates of the project site, the meteorological data of each month in the region from 1981 to 2010 can be obtained. It including 30 different weather parameters. The database consists of more than 8 000 weather stations, five geostationary satellites and a globally calibrated aerosol climatology. On this basis, sophisticated interpolation models, based on more than 30 years of experience, provide results with high accuracy worldwide.[11]

Meteorological data epw format import weather tool software Weather Tool software can simulate the climate of the building. Through the analysis of the angle of incidence of the sun (Figure 2.7) we can see that the most favorable orientation (yellow) is the most unfavorable orientation (red) the annual average solar radiation (ENTIRE YEAR) annual average solar radiation 1.12kwh/m2 cold period solar radiation 1.69kwh/ M2, superheated solar radiation 0.48kwh/m2. The discovery of the building should be placed within a 30° angle with the best solar orientation. According to the annual day-night and day-night data maps generated from the

[11] http://www.meteonorm.com/

Shanghai Typical Meteorological Year Climate Data (Figure 2.8), the average annual indirect solar radiation in the region for each month is not significantly different, and the total direct solar radiation is higher than the indirect solar radiation. From the figure, we can see that August 1 is the hottest day for the typical meteorological year, the temperature reaches 36°C from 11 to 16 o'clock, the relative humidity decreases with the increase of temperature, and the temperature is due to the increase of radiation. In the afternoon, the wind speed is the highest, peaking around 17 o'clock in the afternoon.

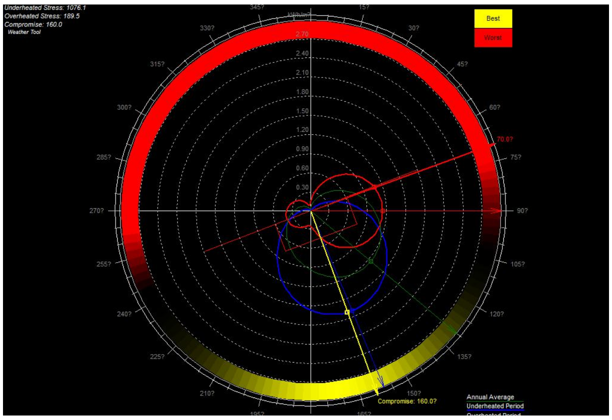

Fig. 2.7 Best sunshine angle view(Ecotect Shanghai weather data, data sources SWERA)

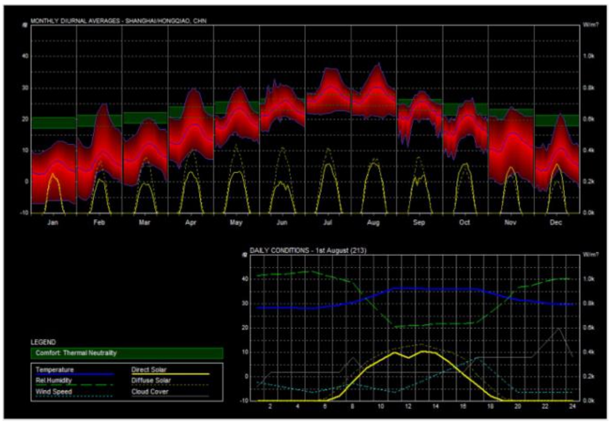

Fig. 2.8 Year-by-night data charts for the whole year (Ecotect Shanghai weather data, data sources SWERA)

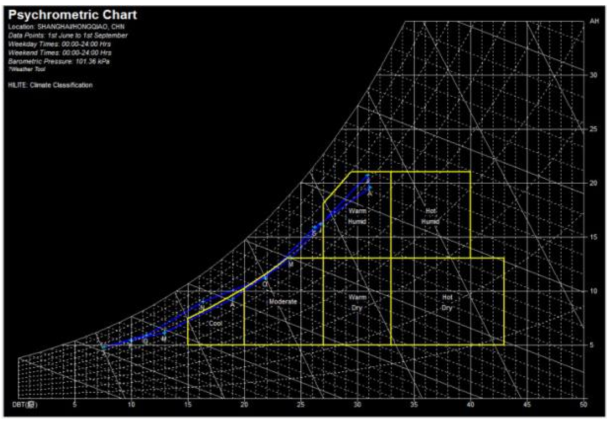

Fig. 2.9 Climate classification map(Ecotect Shanghai weather data, data sources SWERA)

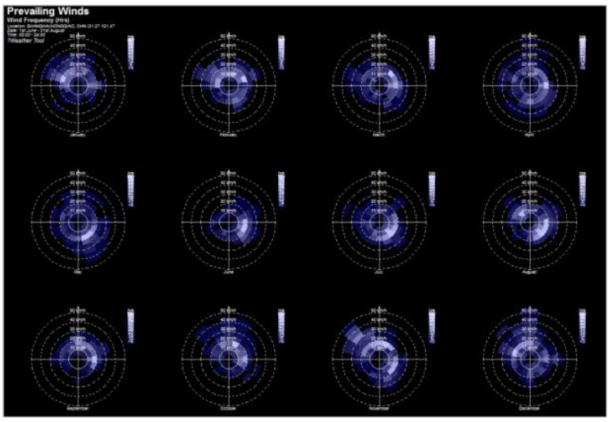

Fig. 2.10 Dominant wind map (Ecotect Shanghai weather data, data sources SWERA)

According to Figure 2.10, we can intuitively understand the dominant wind direction for the whole year. In summer, the dominant wind direction is June 6, July and August. The southeast and east winds are dominant. In August, due to the obvious land and sea breeze, the northwest wind blowing from the land to the sea at night appears. Among them, the transition in May is also dominated by the southeast wind, while in September it is dominated by the east wind and the northeast wind. Shanghai is subtropical monsoon climate in the climate zone classification. According to the climate classification map (*Fig. 2.9*), it is known that Shanghai is a hot and humid climate in summer. Although humans originate in hot and humid climatic zones, hot and humid climates have been considered the most difficult climate to control. In the pan-tropical city of Shanghai, where there is a hot and humid climate and a short winter, the type of building cannot be completely open. There must be a closed external wall to avoid cold currents and hurricanes.

2.4 Summary

Introduced China's climate profile, elaborated and analyzed the general situation, climate characteristics, economic, social and cultural and architectural profiles of Jiangnan region where Shanghai is located and further verified and discussed the climate data based on software in Shanghai.

Point out what the obvious difference is in Shanghai compared to other regions in the more similar climatic regions. The sorting order of the effectiveness of ecological energy conservation strategies.

Chapter 3. Typical buildings and their climate characteristics and ecological climate responsive strategies in thermal zones in China

3.1 Typical traditional building types (According to 5 thermal zones)

According to Chinese "Thermal design code for civil building", China is divided into five thermal divisions. Traditional buildings with typical characteristics and different forms are distributed in each division.

Table 3.1

China's Thermal Division and Typical Traditional Houses and Features

Climate zone	Hot summer & cold winter	Hot summer &warm winter		Cold		Severe cold		Temperate
Climate characteristics[12]	January average temperature 0°C~10°C, July average temperature 25°C~30°C (average daily temperature ≤5°C 0~90d, average daily temperature ≥25°C 40~110d)	January average temperature >10°C, July average temperature 25°C~29°C (daily average temperature ≥25°C is 100d~200d)		January average temperature -10°C ~0°C, July average temperature from 18°C to 28°C, and July average relative humidity was ≥50%. (The average daily temperature is ≤5°C for days 90~145d)		January average temperature≤-10°C, July average temperature ≤ 25°C, and July average relative humidity ≥ 50%. (Days with daily average temperature ≤5°C 145d)		January average temperature 0 °C ~ 13 °C, July average temperature 18 °C ~ 25 °C (day average temperature ≤ 5 °C days 0 ~ 90d)
Latitude and longitude	31.01N; 121.21E	23.54N; 102.29 E	22.03N; 100.80E	37.16N; 79.91E	37.30N ;122.57 E	45.63N; 122.84E	44.09N; 126.48E	26.81N; 106.24E
type	humid	Semi-humid	humid	Aid	humid	Semi-arid	Semi-humid	humid
Typical buildings	Huizhou Houses; Shanghai courtyard residence	Yunnan soil palm room	Yunnan Yi House; Fujian Tulou	Xinjiang Ayiwang Residence	Shandong Seaweed House	Jilin Jiantu House; Qinghai Village	Jilin Manzu Residence	Guizhou Shibanfang
Design requirements	Meet the heat protection in summer and	Meet summer heat protection, generally do not		To meet the winter insulation, some areas take into		Meet the winter insulation, generally do not consider		Some areas consider winter

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12 民用建筑热工设计规范 Thermal design code for civil building

	properly take into account the winter insulation	consider winter insulation	account the summer heat	summer heat	insulation, generally do not consider summer heat protection

Table 3.1 shows that the climate characteristics in China's different hot-spots and the typical traditional building types included; the latitude and longitude according to some of the traditional architectural cases that need to be analyzed in this paper, and the average annual weather for nearly 10 years according to the latitude and longitude of the location. Based on the meteorological data as the basic data information, the percentage of ecological energy efficiency tactics of the corresponding traditional building types in different thermal districts and different climate characteristics was analyzed. The effectiveness of the strategies is sorted and the relationship between architectural design strategies and microclimates is summarized.

The comfort and climate responsive efficiency of the building's thermal environment are affected by the outdoor climate conditions and thermal comfort requirements of the human body. Therefore, the relationship between climate, indoor thermal comfort and architectural design needs to be taken into account in the design. The building climate analysis software can combine the three organically, it can carry on the accurate analysis to the meteorological date data of the designated area for many years, propose the passive strategy suitable for the local climate in the initial stage of scheme design. Weather Tool and Climate Consultant, which are commonly used for pre-analysis of weather data and generate building climate analysis maps, are currently available. Weather Tool is a sub-software of Autodesk Ecotect Analysis, an eco-design software developed by Square One in the United Kingdom; Climate Consultant was developed by the Department of Architecture and Urban Design at the University of California, Los Angeles (UCLA), with Baruch Givoni and Based on Murray Milne's theoretical research. Both software can read weather data for 8 760 h throughout the year, and can quickly convert raw data into dozens of well-understood graphical languages, such as sunshine analysis charts, wind speed analysis charts, and psychrometric charts (Psychrometric Chart) etc. In particular, the psychrometric map function can display subtle climate attributes and their impact on architectural forms and can provide specific and effective design recommendations that are suitable for the local climate. Since Climate Consultant contains 13 passive construction strategies and 6 Weather Tool types, the former is more detailed. Therefore, Climate Consultant was chosen to analyze the weather data of Lhasa and analyze the climate adaptation strategies of local traditional houses.

There are generally two types of models for evaluating thermal comfort: static models and adaptive models. The Climate Consultant software lists four optional thermal comfort models: 1 California Energy Code Comfort Model, 2013. 2 ASHRAE Standard 55 PMV and Current Handbook of Fundamentals Models. 3 2005

ASHRAE Handbook of Fundamentals Comfort Model up through 2005. 4 Adaptive Comfort Model in ASHRAE Standard 55-2010.

The California Energy Code comfort model is a static model, which assumes that the room temperature required for thermal comfort does not change with the season, the high and low temperatures of the comfort range are static, the comfort range is relatively narrow, and it is more suitable for central air-conditioning buildings. The fourth adaptive comfort model is at the other extreme. It assumes that the space is naturally ventilated. Users can open and close the windows, adjust the clothing according to the climate, and therefore have a wider comfort than in the central air conditioning system. But this model does not involve other architectural design strategies other than natural ventilation that affect thermal comfort. Between these two extremes there are two other comfort model options—the PMV Comfort Model in the current ASHRAE Standard55 and the ASHRAE Foundation Handbook Comfort Model in 2005. Both assume that people will change clothing to adapt to the climate, so there are two comfort ranges in winter and summer. Among them, the comfort model of PMV in ASHRAE55 uses 12 g/kg as the upper limit of moisture content, but no lower limit is set. This is because it is considered that the lower limit of moisture content is set to avoid excessive drying of the skin, eyeballs, and mucous membranes. However, this approach is unreasonable, because people's hot and humid feelings are complex and complex, and it is difficult to completely separate them. Based on the above points of view, this article selected the third comfort model—the 2005 ASHRAE basic manual comfort model.

3.2 Summer hot and cold winter area example

The hot summer and cold winter areas include Shanghai, Chongqing, Hubei, Hunan, Jiangxi, Anhui, and Zhejiang, the eastern half of Sichuan and Guizhou provinces, the southern half of Jiangsu and Henan provinces, and the northern half of Fujian province, the southern end of Shaanxi and Gansu provinces, the northern ends of Guangdong and Guangxi provinces. Traditional architecture is mainly based on the distribution of Huizhou architecture. Huizhou houses are courtyard buildings or narrow inner courtyard buildings, which are surrounded by one to three floors of buildings. Select a building with obvious Huizhou architectural features located in Songjiang District of Shanghai and its climate data for specific analysis.

3.2.1 Climate characteristics

The main areas for the distribution of existing traditional buildings which are Huizhou buildings in Shanghai are (Fig.3.1): Zhujiajiao Town, Xinchang Town, Jinze Town, Innovation Village, Chuansha (New) Town, Gaoqiao Town, Nanxiang Town, Jiading Town, Xiatang Village, Fengjing Town.

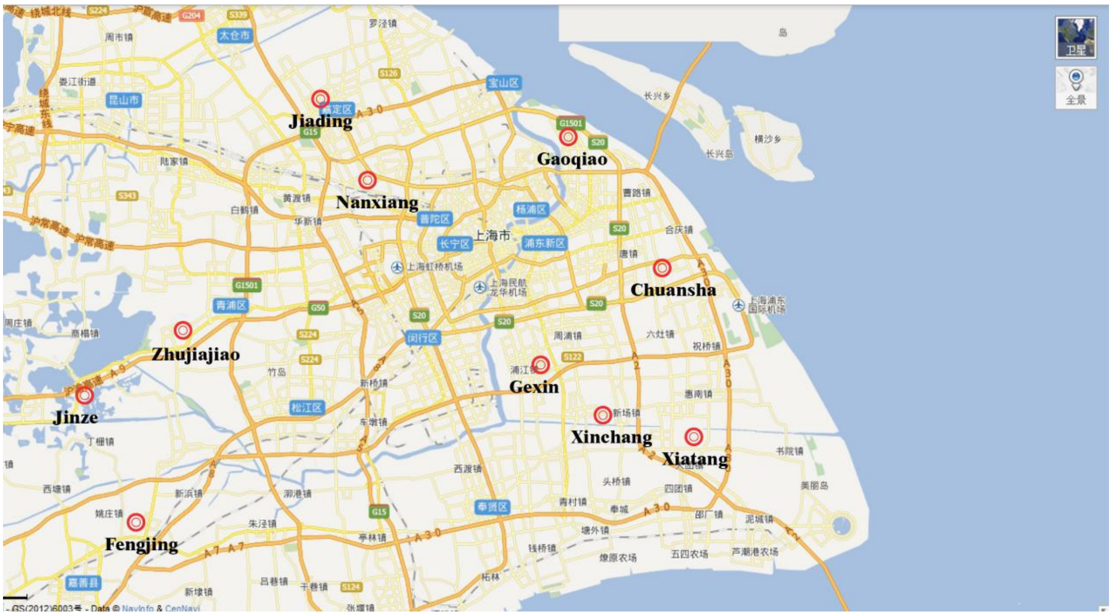

Fig.3.1 Shanghai's major distribution locations for traditional buildings (by author according to data from Shanghai Cultural Relics Protection Network)

Zhujiajiao is located on the bank of Dianshan Lake in Qingpu District of Shanghai and belongs to the western area of Shanghai. Xinchang Town is located in the south of Shanghai Pudong New Area. Jinze Town is located in the west of the Qingpu District of Shanghai. It borders on Zhujiajiao Town in the east and has been built in the early 960 (AD). It is said to be famous for its prosperity in Song Dynasty and Sheng Yuyuan; the ancient town takes water as its vein and is facing north and south. The overall layout of the "two streets and one river" layout, there are many ancient stone bridges between the rivers, linked together from the streets and alleys and houses, granite and stone shops on the Shangtang Street, shops, residential row upon row, forming a typical water town pattern. Innovation Village is located on the east side of Pujiang Town, Minhang District, Shanghai. It formed a village during the Yuan Daedian Years. It rose in the Jiajing and Wanli periods of the Ming Dynasty, and still preserves the intact former residences, traditional streets, ancient bridges and river courses, has a typical Jiangnan water features. Chuansha (New) Town is located in the east of Shanghai Pudong New Area and belongs to the eastern part of Shanghai. Gaoqiao Town is located in the northern part of Shanghai Pudong New Area. It is a typical Binhai township. Nanxiang Town is located in the southern part of Shanghai Jiading District and belongs to the northern area of Shanghai. Located at the front of the Yangtze River Delta, Jiading Town is the northwest gateway of Shanghai and is located in the center of Jiading District. Xiatang Village is affiliated to Luan Town, Songjiang District, and Shanghai. It is located in the southwestern part of Shanghai. Land and water traffic are very developed. It is a natural village formed by agriculture and fisheries.

A typical Huizhou building in Shanghai’s Songjiang District was selected as the research object. The climate data was from Meteonorm, and the average of the 10-year meteorological data was obtained.

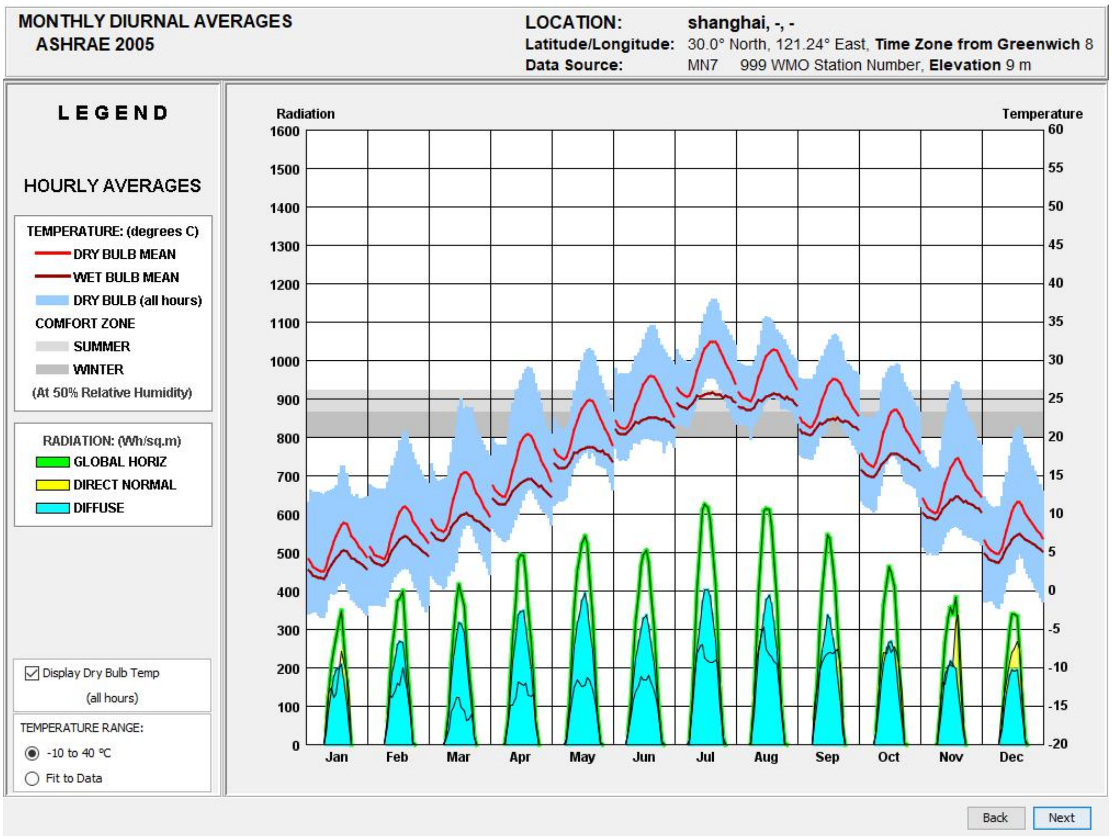

Fig.3.2 Climate features of Shanghai（30N, 121.24E）

Table 3.2 Shanghai Climate Characteristics (According to meteonorm analysis)

Location	Year average temperature(℃)	January average temperature(℃)	Extreme minimum temperature (℃)	July average temperature (℃)	Extreme maximum temperature (℃)	Precitation days	
						winter November-April	summer May-October
Songjiang	17.5	5	-3.5	28.5	38	42	52

In this hot summer season, cold winter weather, abundant rainfall, local residential design should first consider the construction of heat and shelter, while taking into account the winter insulation. After hundreds of years of inheritance and improvement, Huizhou ancestors created a unique housing for Huizhou residents from a natural and aesthetic point of view—the Huizhou residential area, which is a one-to-three-story building with a narrow confinement. Patio courtyard building.

According to Fig.3.2.1. Dry Bulb and Relative Humidity, the relative humidity is high throughout the year, the law is roughly the same, that is, the highest value of relative humidity is more than 80% in the early morning, and the lowest value is about 60% around 14:00 in the afternoon. Among the 12 months, the relative humidity in summer was relatively higher than that in the whole year. The relative humidity in June was the highest; the overall law was negative correlation with the dry bulb temperature. When the temperature is between 25 ℃ and 30 ℃ and the relative humidity is between 80% and 95%, it is most suitable for growth and reproduction of mold and bacteria,[13] which is not conducive to the long-lasting construction and furniture, and is not conducive to human health.

According to Fig.3.2.2.(Appendix) Sky Cover, the annual average sky cover is about 74%, which has a certain impact on the utilization of solar energy. From the perspective of the whole months of the year, the sky cover value in spring is higher, reaching a maximum of 90% in March.

According to Fig.3.2.3.(Appendix) Sun Shading Chart, the south, east and west facades of the summer months, almost all of the time needed to relieve the temperature overheating and gradually reduce it by mid-April. Appropriate shading measures are still needed in early March, mainly in the south and west facades. Winter from the end of September to the end of March, because the temperature is lower than human comfort, the need for sunshine radiation to help improve the microclimate inside the building.

According to Fig.3.2.4.(Appendix) Timetable Range, the range where the human body is comfortable accounts for 24% of the whole year, and the time when the temperature is too low accounts for 55% of the total time of the year. During the daytime period of the year (working time period), the proportion of overheating and undercooling is about the same.

According to Fig.3.2.5.(Appendix) Wind Velocity Range, the annual average wind speed is about 2.4m/s, the highest wind speed is 10m/s, and the highest wind speed is 10m/s in summer and winter. The average wind speed in summer is similiar with the annual average. The average high wind velocity of the transition season of March, Apirl and May are slightly higher than the other months of the year.

[13] http://www.cma.gov.cn/kppd/kppdqxyr/kppdshqx/201211/t20121124_191851.html

3.2.2 Ecological climate responsive strategies and their priorities

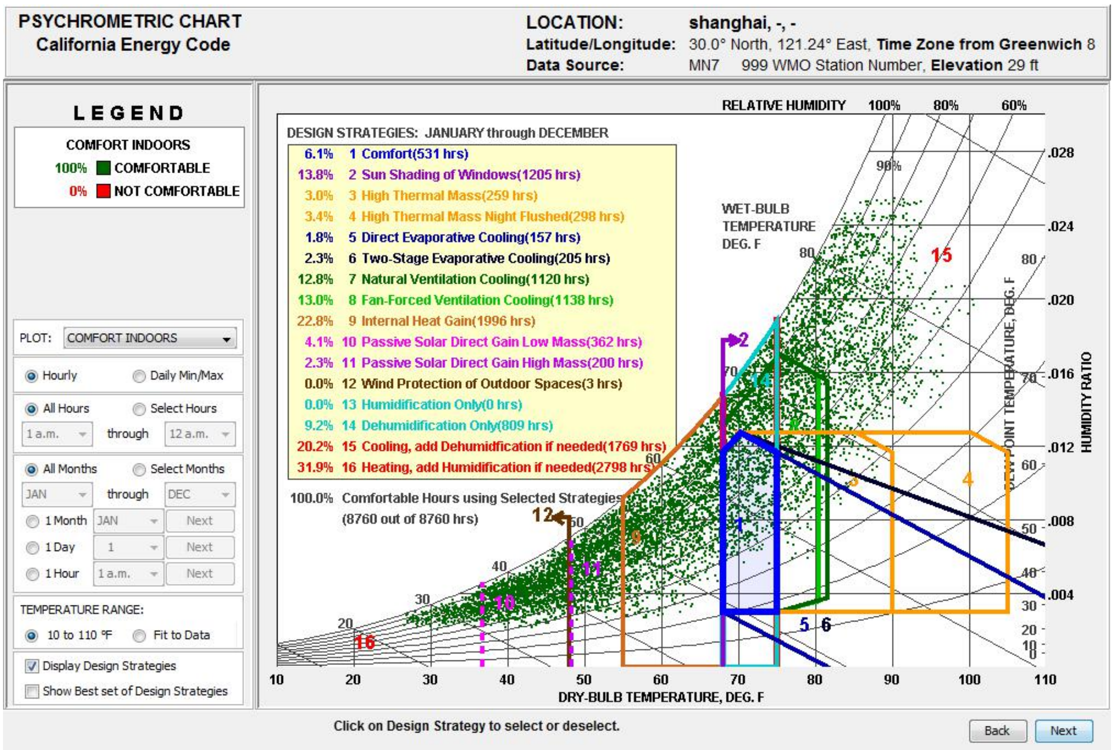

Fig.3.2.0 Psychrometric chart with Strategies Potential Sorting (Software: Climate consultant. Weather data: Meteonorm)

The climatological analysis software climate consultant was used to analyze the meteorological data of Songjiang District in Shanghai. The analysis of the figure (Fig.3.) showed that the local indoor thermal comfort area (blue area in the figure) and various design strategies helped expand the scope of the comfort zone. Choosing Show Best Set of Design Strategies in the software automatically removes contradictory and redundant options to obtain a passive building strategy that best suits local climate conditions.

Table 3.3

Shanghai Design strategies of Percentage of effective time (white is best set of design strategies)

strategy	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year%
Sun shading of window	0	0	0.7	5.7	18.4	20.1	32.8	30.4	20.6	9.5	2.6	0	11.8
High thermal Mass	0	0	0	1.7	7.1	9.9		0.1	4.6	5.0	0.8	0	2.4
High thermal Mass night flushed	0	0	0	1.7	8.6	11.7	0.3	0.1	7.4	5.1	0.8	0	3.0
Direct evaporative	0	0	0	1.7	4.7	1.9	0.1	0	3.5	3.5	0.8	0	1.4

cooling													
Two-stage evaporative cooling	0	0	0	1.7	6.2	6.4	0.9	0.1	6.7	4.4	0.8	0	2.3
Natural ventilation cooling	0	0	0	1.1	17.1	19.7	9.1	12.5	25.7	8.5	0.7	0	7.9
Fan-forced ventilation cooling	0	0	0	2.2	21.1	25.8	13.8	16	31.8	10.5	0.8	0	10.2
Internal heat gain	3.6	13.2	34.9	54.6	33.9	9.9	0	0	6.0	45.4	42.1	16.1	21.6
Passive Solar direct gain low mass	6	6.1	5.8	6.5	1.3	0	0	0	0	4.3	8.5	11.2	4.1
Passive Solar direct gain high mass	0	1.0	0.3	3.5	3.1	2.6	0	0	2.4	8.6	5.7	0.3	2.3
Wind protection of outdoor spaces	0	0.3	0	0	0	0	0	0	0	0	0	0.1	0
Humidification only	0	0	0	0	0	0	0	0	0	0	0	0	0
Dehumidification only	0	0	0	0.4	12.9	29.4	7.8	13.7	32.4	9.9	0	0	8.9
Cooling, add dehumidification if needed	0	0	0	0	0.8	33.2	83.3	79.2	27.6	2.4	0	0	19.1
Heating, add humidification if needed	91.9	82.1	61.2	23.1	1.9	0	0	0	0	2.6	45.0	78.5	31.9
comfort	0.4	0.0	2.6	19.0	37.5	12.1	0.8	0.4	17.4	32.4	9.9	0.5	6.1

Without using traditional heating or cooling systems, these strategies maximize the comfort time with the combination of minimal measures. It can be seen that only 6.1% of the local area is comfortable during the whole year, and 39.1% of the time requires active heating such as stove, air conditioning or boiler heating, and cooling and necessary dehumidification such as air conditioning are required for 20.2% of the time. According to the length of effective time, the passive building strategies are applied. The heating effects are: Internal heat gain (22.8%), Passive Solar direct gain low mass (4.1%), High thermal Mass night flushed (2.3%); The cooling effects were: natural ventilation (12.8%), Sun shading of window (13.8%), Humidification only

(9.2%), High thermal Mass night flushed (3.4%), Two-stage evaporative cooling (2.3%), Direct evaporative cooling (1.8%). Best set of Design Strategies are strategies and numbers without shading in the table (Table 3.3).

Although software analysis shows that the effective time of internal heat gain is 22.8%, in fact, the number of internal heat sources such as electrical appliances and lighting in Shanghai residential houses varies greatly, and the possibility of relying on internal heat gain is small, so this option is ignored. The following strategy analysis is only for strategies with effective ratios of 1.0% or more.

3.2.3 Building Ecological climate responsive Strategy interactive with Microclimate and Increase Comfort

According to the microclimate characteristics of the specific site in Songjiang District of Shanghai, the relative humidity is higher in summer and the number of rain days is higher. The relative humidity in winter is higher than in other climatic zones, the temperature will drop suddenly, and there will be cold winds. It is necessary to consider ventilation and heat protection as well as cold protection. In the actual traditional settlements, there are many waterfront buildings, and the buildings are mainly courtyard-style courtyards. The courtyards and courtyards form a traffic space in the form of narrow lanes. The following is a detailed analysis of the specific climate response design strategies under this microclimate feature from six aspects.

A. Settlement layout

The overall settlement of the building is compact, and the roadway space for transportation (formed by the courtyard buildings adjacent to each other) is relatively regular, and the roadway is narrow to form a cold alley that promotes ventilation and cooling. The narrow and closed open space has the effect of accelerating the airflow "channel effect", which is conducive to increasing the overall ventilation effect indoors and outdoors. Most of them have water flowing through them, and the streets are parallel or perpendicular to the water system. Courtyard-style buildings are more typical layouts.

B. Building orientation

The courtyard has a strong main axis, facing most of the north-south orientation, showing a north-facing layout, which is conducive to blocking the northwest wind in winter and enhancing the summer southeast wind.

C. Open space layout such as courtyard

There are green plants and water tanks in the patio courtyard, which has a significant effect on regulating the local microclimate. Patio space in different layouts can adjust ventilation and improve summer comfort.

D. Plan layout

The plane is squarer and the patio is narrower. The walls around the patio effectively block the direct sunlight entering the summer. The temperature difference forms hot-pressure ventilation to promote vertical ventilation. The large-area doors and windows can be completely opened on the whole surface. The open-air enclosure structure in the summer bottom layer has a strong effect of wearing the wind, and all of them are closed in winter to prevent wind.

Typical layouts of public spaces such as the living room are centered on both sides of the bedroom. If it is a few courtyards, according to the front hall and rear hall layout, the rooms on both sides of the front hall are used as the elder bedroom, and the rooms on both sides of the back hall are used as the bedroom for the younger generation. The second floor is mostly female bedroom. The east and west rooms are used as kitchens and storage functions, and the east wing rooms are mostly used as kitchens.

E. Facade layout design

The pattern formed by the wooden frame of the window plays a sunshade function in disguise. The window sash can be opened horizontally or from the bottom up and can be completely removed (the Zhizhai window), and the effect of disguised shading and ventilation at the same time. It has a fireproof gable above the roof and acts as a self-shading. The interior space is high in the roof, resulting in a higher stack height to form a certain area of buffer space. The existence of the corner wall is treated by the slanting angle, which weakens the weakening effect of the right angle turning on the airflow.

F. Building envelope structure

Most of the tiles, bricks, wood, slate, etc. are taken locally, saving environmental protection and having ecological and climate responsive features. The roof structure is placed on a wooden raft by a small blue tile (specific size chart 4), and the ground is a bluestone or blue brick. The outer wall is highly enclosed and mostly an empty wall. The wall is dominated by blue brick walls, and the outer walls of the inner courtyard of the second level are mostly wooden walls.

3.3 Example of Hot Summer and Warm Winter Region

The hot summer and warm winter regions mainly refer to the south of China, south of 27 degrees north latitude and east 97 degrees east, including the entire Hainan, most of Guangdong, most of Guangxi, southern Fujian, and small parts of Yunnan, and Hong Kong, Macau and Taiwan. The most characteristic traditional building in this area is the earth building. The building is closed to the external thick walls, forming a large courtyard inside, with two forms of round and quadrangular construction. The more typical traditional buildings are Minnan folk houses and Chaoshan folk houses.

3.3.1 Climate characteristics

The most famous Fujian Yongding County earth building was selected as the research object. According to its coordinate point (24.66N, 116.98E), the mean value of the corresponding meteorological data for nearly 10 years is derived in Meteonorm. Meteorological data uses Climate Consultant to calculate its year-by-year temperature (Fig.3.).

Table 3.4 Fujian Climate Characteristics （meteonorm 2000-2009 period temperature）

location	Year average temperature(℃)	January average temperature(℃)	Extreme minimum temperature(℃)	July average temperature(℃)	Extreme maximum temperature(℃)	Precipitation days	
						winter （ November-April）	summer （ May-October ）
Yongding	21	12	1	28	37	87	67

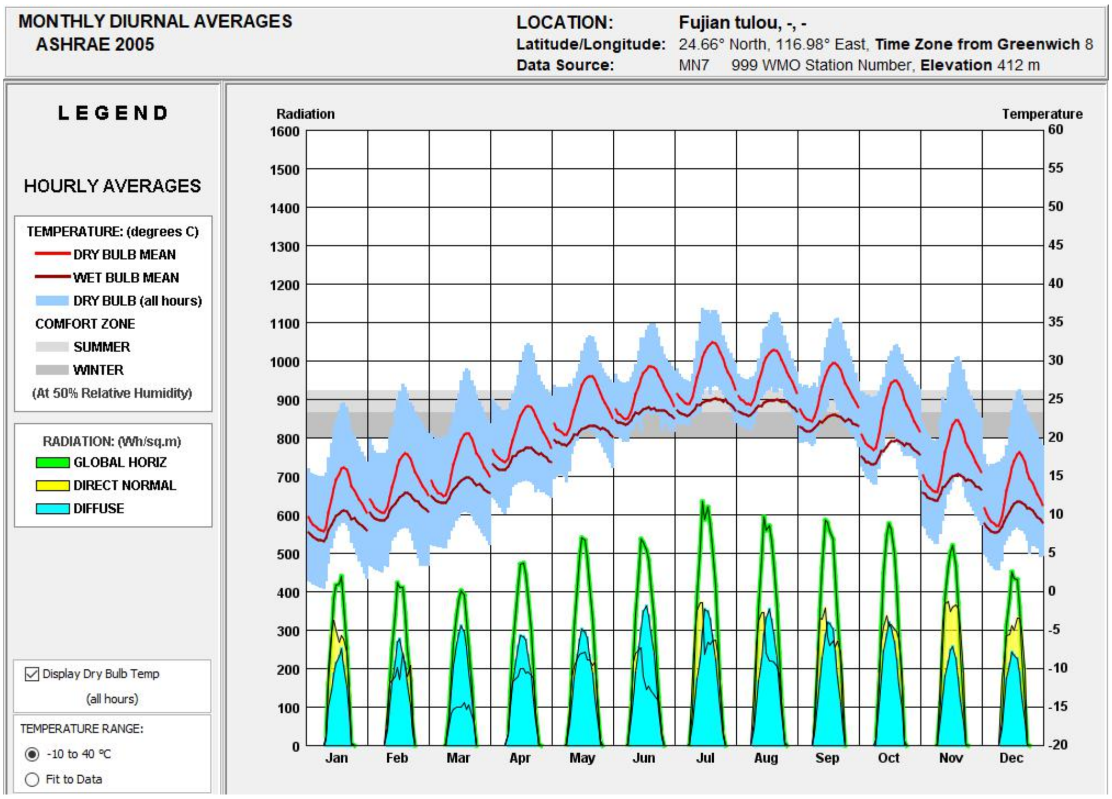

Fig.3.3 Climate features of Fujian Tulou

Hot summer and warm winters have long summers without winters, high temperatures and high wetness. Temperatures are poorer in year and worse in daily weather; rainfall is abundant, many tropical storms and typhoons strike, and large stormy weather is common. Large solar angles and small sunshine are observed. The solar radiation is strong. In the summer of buildings, the requirements for heat protection, ventilation, and rain protection should be considered. In winter, cold and heat insulation may not be considered. The overall planning, monomer design and construction should avoid the sun, and should be shaded; should be guarded against rainstorms, flood control, moisture, lightning strikes; summer construction should have high temperature and heavy rain measures.

According to Fig.3.3.1.(Appendix) Dry Bulb and Relative Humidity, the relative humidity is high throughout the year, and the fluctuation law is about the same as that in summer hot and cold winter zone, that is, the highest value of relative humidity is over 80% in the early morning, the minimum value is reached around 14:00 in the afternoon. But the relative humidity in the afternoon of winter months is lower than the relative humidity in the hot summer and cold winter zone, about 50%. In the 12 months, the relative humidity in summer was relatively higher than that in the whole year. The relative humidity in June was the highest; the overall law was negatively correlated with the dry bulb temperature. The dry bulb temperature in hot summer and warm winter zone is hotter than that in hot summer and cold winter zone.

According to the Fig.3.3.2.(Appendix) Sky Cover sky cover, the annual everage sky cover is about 74%, which is roughly the same as the overall pattern of the hot summer and cold winter zone: from the whole month of the year, the spring sky cover value is higher, The highest month March is 90%. Compared with the hot summer and cold winter zone, there are two months with significant differences. In February, the amount of sky cover is lower, and the amount of sky cover in June is higher.

According to Fig.3.3.3.(Appendix) Sun Shading Chart, the southeastern west facade during the summer months almost all need appropriate measures to alleviate the temperature overheating. The transition season also needs appropriate shading to the south and west facades.

According to Fig.3.3.4.(Appendix) Timetable Range, the more comfortable area of the human body accounts for 31% of the whole year, the temperature is too low, accounting for 43% of the total time of the year, and the overheating time accounts for 26% of the total time of the year. During the daytime period of the year (working time period), the proportion of overheating time is significantly greater than the time of overcooling.

According to Fig.3.3.5.(Appendix) Wind Velocity Range, the annual average wind speed is about 1.9m/s, and the highest wind speed is about 8m/s. The average monthly wind speed is about 2m/s in the whole year. Compared with hot summer and cold winter zone, the average wind speed and the highest wind speed are low.

3.3.2 Ecological climate responsive strategies and their priorities

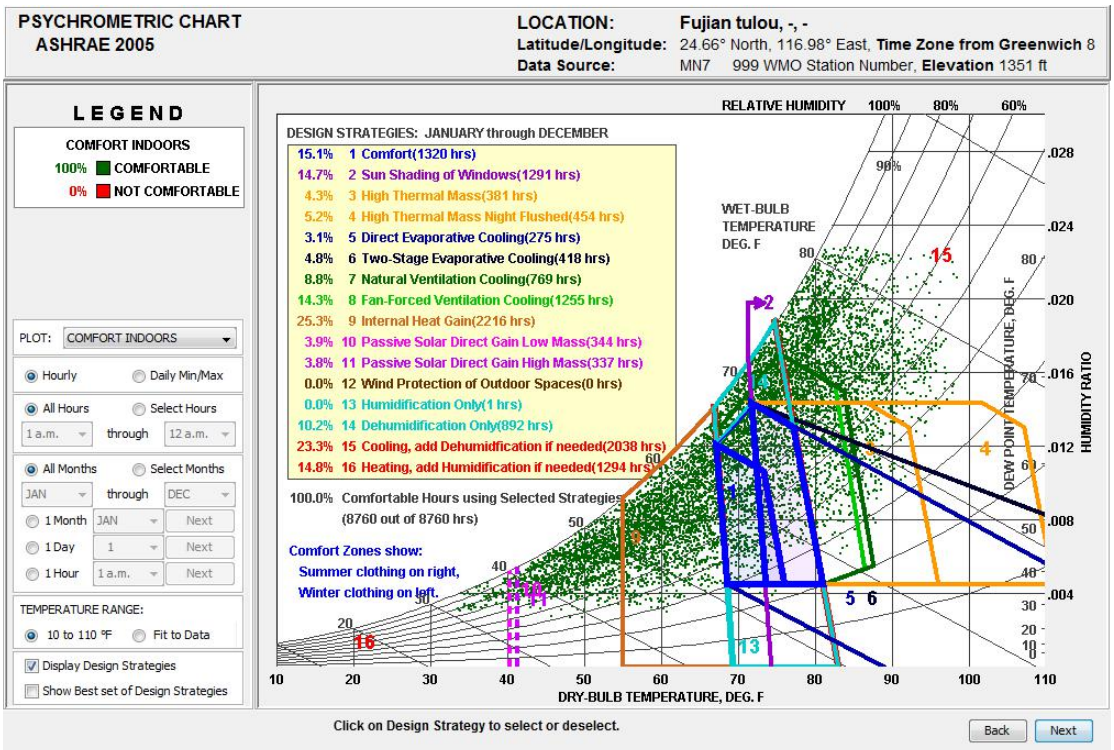

Fig.3.3.0 Psychrometric chart with Strategies Potential Sorting (Software: Climate consultant. Weather data: Meteonorm)

The climate analysis software, climate consultant, was used to analyze the weather data of Yongding County, Fujian Province. Based on the percentage of wetness maps and recommended design strategies, the percentages of the tables showing the effectiveness of design strategies for the year and month are presented. Remove contradictory and redundant options, the effectiveness of the sorting strategy and the best combination of strategies under the climatic conditions.

Table 3.5

Fujian Design strategies of Percentage of effective time (white is best set of design strategies)

Strategy	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year%
Sun shading of window	1.1	2.1	6.3	11.7	19.9	24.6	29.4	26.1	24.4	21.8	6.9	1.6	14.7
High thermal Mass	0	0.3	3.1	5.6	13.0	1.0	1.3	0.9	6.0	16.3	4.3	0	4.3
High thermal Mass night flushed	0	0.3	3.1	6.0	14.9	2.5	2.0	1.3	8.6	18.5	4.4	0	5.2

Direct evaporative cooling	0	0.3	3.1	2.8	9.9	0.6	0.1	0	5.0	12.0	3.5	0.1	3.1
Two-stage evaporative cooling	0	0.3	3.1	4.3	14.7	2.1	0.7	0.4	10.6	16.9	3.8	0.1	4.8
Natrual ventilation cooling	0	0	1.3	13.2	15.9	19.2	9.7	10.3	22.5	11.2	1.9	0	8.8
Fan-forced ventilation cooling	0	0.3	3.9	16.9	28.9	26.4	16.8	16.8	35.0	21.8	4.6	0	14.3
Internal heat gain	35.2	46.6	53.1	40.7	11.4	0	0	0	0.8	24.9	53.1	39.7	25.3
Passive Solar direct gain low mass	12.1	9.1	0.5	2.6	0	0	0	0	0	0.4	8.3	14.4	3.9
Passive Solar direct gain high mass	5.1	4.6	3.6	5.8	3.8	0.3	0	0	1.4	5.2	11.4	5.1	3.8
Wind protection of outdoor spaces	0	0	0	0	0	0	0	0	0	0	0	0	0
Humidification only	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Dehumidification only	0	0	2.7	15.4	19.5	32.9	10.1	13.2	21.4	6.2	0.8	0	10.2
Cooling，add dehumidification if needed	0	0	0	5.0	23.7	51.5	76.7	74.9	38.2	7.0	0	0	23.3
Heating，add humidification if needed	53.8	38.4	22.0	3.3	0	0	0	0	0	0	12.8	47.8	14.8
comfort	5.4	11.8	18.7	26.5	21.8	3.1	2.8	2.3	13.5	41.0	25.1	8.9	15.1

It can be seen that only 15.1% of the local area is comfortable during the year and 14.8% of the time requires active heating such as stove, air conditioning or boiler heating, and cooling and necessary dehumidification are required for 23.3% of the time. According to the length of the effective time, the passive building strategies are applied. The heating effects are in order of Internal heat gain (25.3%)，Humidification only (10.2%)，High thermal Mass night flushed (3.8%)， Passive Solar direct gain low mass (3.9%). The cooling effect is in turn Sun shading of window (14.7%), fan-driven passive cooling (14.3%), natural ventilation (8.8%), High thermal Mass night flushed (5.2 %), Two-stage evaporative cooling (4.8%), Direct evaporative cooling (3. 1%), Best set of Design Strategies are strategies and numbers without shading in the table.

3.3.3 Building Ecological climate responsive Strategy interactive with Microclimate and Increase Comfort

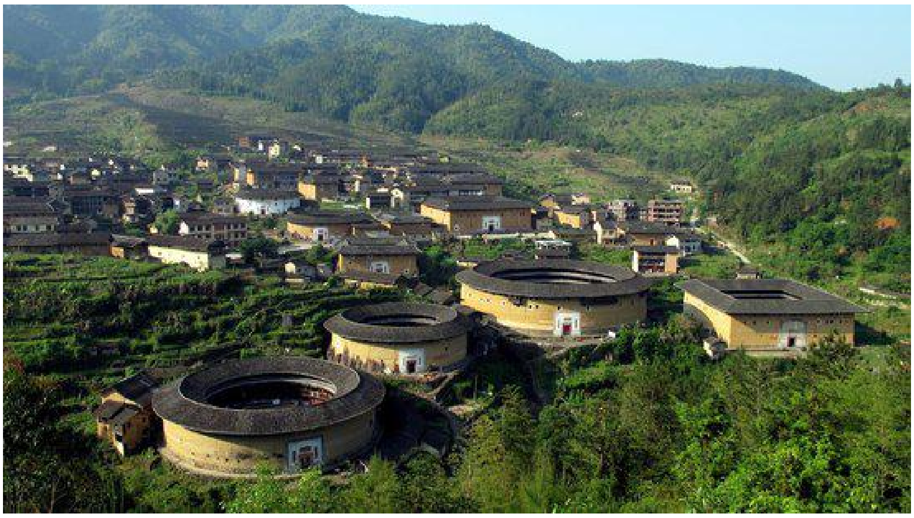

Fig.3.3.1 Birdview of Fujian Tulou.

In order to adapt to the large family settlement and pay attention to the defensive performance, a multi-story multi-storey residential building with a terracotta wall weighing is formed. Its group combination mode is rich and organically combined with the natural environment. Site selection depends on the mountain surface water, and the location of the well and the discharge of sewage are all in harmony with nature. The earth buildings are versatile in shape and are mostly round and square（Fig 3.3.1）.

A. Settlement layout

Distributed in the mountains, clever use of narrow flat construction.

B. Building orientation

The whole building is enclosed, mostly sitting south to the north, except for round enclosed buildings.

C. Open space layout such as courtyard

Due to its location in the mountains, Tulou is rich in natural vegetation. The large inner patio is mostly a place for social activities, and there is not much greenery in the bluestone pavement.

D. Plan layout

The kitchen is set on the ground floor and the kitchen chimney is located inside the earthen wall. The heat generated during cooking pushes the hot air up, and the airflow passes through the wood floor, causing the bedroom upstairs to be ventilated and dry. The first floor is the kitchen, the second floor is mostly storage function, and the third floor and above is mainly the residential function. The central axis is obvious, the main hall is on the axis, and the inner gallery links all the rooms.

E. Facade layout design

The eaves are more deep and effectively shield the sun.*Fig.3.3.2.* The windows on the exterior wall is small.

Fig.3.3.2 Fujian Tulou Real Picture of the eaves.

F. Building envelope structure

Maintenance structure construction strategy for rammed earth walls. The wall of the rammed earth wall is thicker. The material of the wall is mostly nearby materials: raw soil, wood and pebbles. It is climate responsive, environmentally friendly and ecologically sustainable. The thickness of the wall at the base of the wall can reach 30cm,[14] which is strong and resistant to enemy attacks. It played a role in earthquake resistance and temperature delay, also resistance the harassment of the beast.

3.4 Examples of Cold Areas

The cold regions mainly refer to Beijing, Tianjin, Hebei, Shandong, Shanxi, Ningxia, most of Shaanxi, southern Liaoning, central and eastern Gansu, southern Xinjiang, Henan, Anhui, northern Jiangsu, and southern Tibet. The range of cold areas

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[14] Energy-saving design of rural bauxite houses in hot and humid areas——taking "Fujian Tulou" as an example. P36 Huazhong University of Science and Technology Zhou Wei

is relatively large, and the types of traditional buildings are also abundant, including the traditional buildings of sea grass in Shandong and the houses of Ayiwang in Hetian, Xinjiang. The latitude and longitude of sea grass house in Weihai, Shandong Province is 37.30N; 122.57E.

3.4.1 Climate characteristics

In cold regions, the winter season is long and cold and dry. The plain areas are hotter and wetter in summer. The plateau areas are cooler in summer and the precipitation is relatively concentrated. The temperature is relatively poor and the sunshine is rich; spring and autumn are short, and the temperature changes drastically; the spring rain and snow are scarce, how windy and windy is the weather, and hailstorms and thunderstorms occur in the summer and autumn.

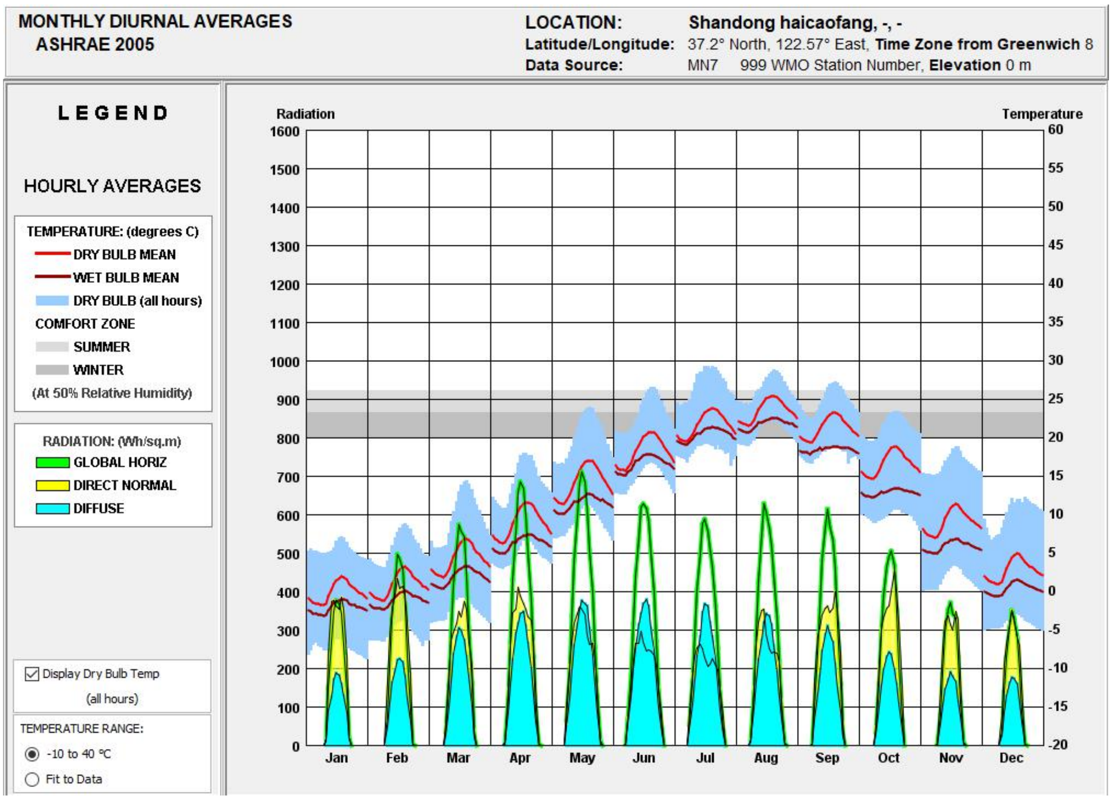


Fig.3.4 Climate features of Weihai

Table 3.6 Shandong Weihai Climate Characteristics （meteonorm 2000-2009 period temperature; August has the highest mean temperature 23℃)

location	Year average temperature(℃)	January average temperature(℃)	Extreme minimum temperature(℃)	July average temperature(℃)	Extreme maximum temperature(℃)	Precipitation days	
						winter (November-April)	summer (May-October)

Weihai	12	0	-8	22	29	25	44

Buildings should meet the winter cold, heat preservation, antifreeze and other requirements, in some areas in summer should take into account the heat. The overall planning, monomer design and construction processing should meet the requirements of winter sunshine and defense against cold wind. The main room should avoid the sun; it should be guarded against rainstorms; Buildings should be used to reduce the exposed area, strengthen the airtightness in winter and take into account the summer ventilation and solar energy conservation measures. The structure should consider the adverse effects of large temperature and large winds; the building should have anti-hail and lightning protection measures; the construction should take into account the characteristics of a long cold winter and heavy rain in summer.

According to Fig.3.4.1.(Appendix) Dry Bulb and Relative Humidity, the relative humidity changes greatly throughout the year, especially in the summer of June, July and August which relative humidity is 80%. The relative humidity fluctuations in other months are roughly the same as those in the hot summer and cold winter zone but a little lower. Reaching the highest value of relative humidity in the early morning, reaching the lowest value around 14:00 in the afternoon. In the 12 months, the relative humidity was the highest in July; the overall law was negatively correlated with the dry bulb temperature, but the temperature fluctuation of the dry bulb was small. The dry bulb temperature in Weihai near the coast in the cold winter is around zero.

According to the Fig.3.4.2.(Appendix) Sky Cover sky cover, the annual sky cover is about 57%, which is significantly lower than the hot summer and cold winter zone and the hot summer and warm winter zone. From the perspective of the whole month of the year, the spring sky cover value is lower, and the April mean sky cover is 40%. The summer mean sky cover value is higher, reaching 70% in August. Compared with the hot summer and cold winter zone and the hot summer and warm winter zone, it provides better conditions for the utilization of solar energy.

According to Fig.3.4.3. (Appendix) Sun Shading Chart's annual range of overheating period is a short period of time in the middle and late June. Almost no shading measures are required throughout the year, and a short overheating period can start with a dynamic sunshade at the south and west facades from 11:00 am to sunset.

According to Fig.3.4.4.(Appendix) Timetable Range, the more comfortable area of the human body accounts for 23% of the whole year, and the undercooling period accounting for 75% of the total time of the year, of which 9% is below 0 ℃ . Overheating time only accounts for 1% of the total time of the year. The undercooling period in the area is far greater than the overheating time. The requirements for heating are high and the requirements for refrigeration are not high. Overheating time is concentrated in the noon and afternoon periods in late August and early September.

According to Fig.3.4.5.(Appendix) Wind Velocity Range, the annual average wind speed is about 6m/s, the highest wind speed is about 23m/s, the summer mean wind speed is lower at August 5m/s, and the winter mean wind speed is higher at December which the monthly mean wind speed is about 8m/s, and the recorded high wind speed is 23m/s. Compared with the hot summer and cold winter zone and the hot summer and warm winter zone, the average wind speed and the highest wind speed are much higher.

3.4.2 Ecological climate responsive strategies and their priorities

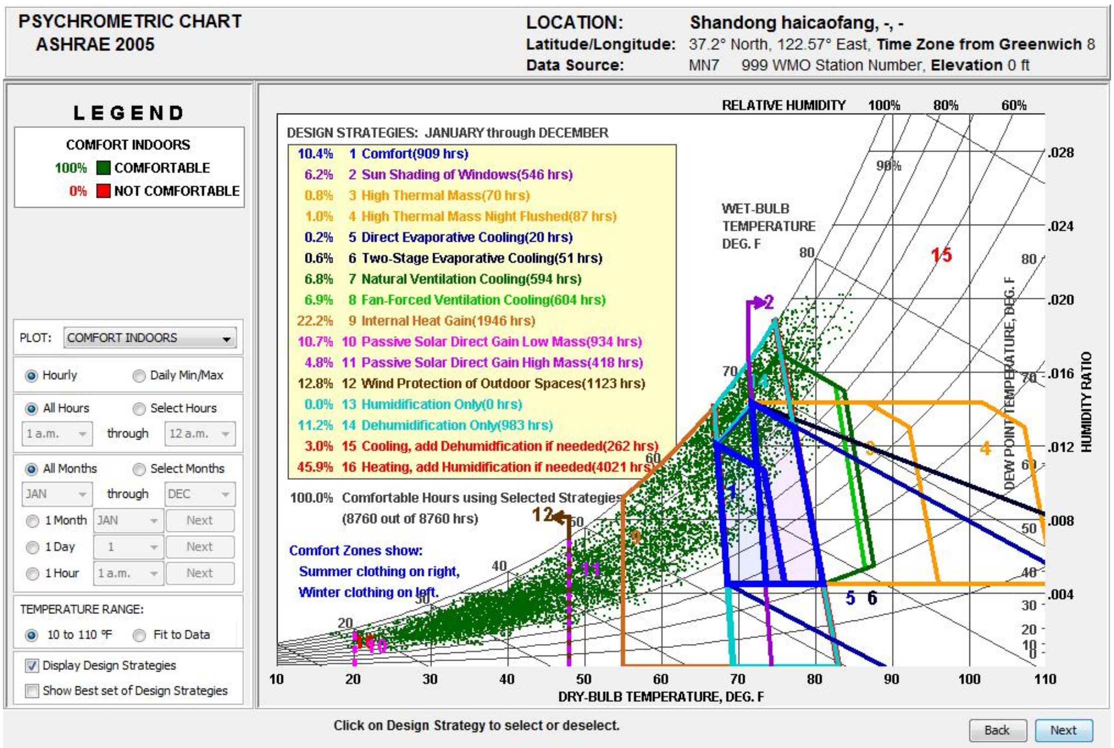


Fig.3.4.0 Psychrometric chart with Strategies Potential Sorting (Software: Climate consultant. Weather data: Meteonorm)

Table 3.7

Shandong Design strategies of Percentage of effective time (white is best set of design strategies)

strategy	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year%
Sun shading of window	0	0	0	0	0.8	4.6	21.8	28.0	17.9	1.1	0	0	6.2
High thermal Mass	0	0	0	0	0	0	3.8	0.9	4.9	0	0	0	0.8
High thermal Mass night flushed	0	0	0	0	0	0.3	4.8	1.1	5.7	0	0	0	1.0

Direct evaporative cooling	0	0	0	0	0	0	0.1	0.1	2.5	0	0	0	0.2
Two-stage evaporative cooling	0	0	0	0	0	0.1	2.2	0.8	3.9	0	0	0	0.6
Natrual ventilation cooling	0	0	0	0	0	7.9	27.4	32.4	12.8	0	0	0	6.8
Fan-forced ventilation cooling	0	0	0	0	0	7.9	27.4	32.9	13.6	0	0	0	6.9
Internal heat gain	0	0	0.8	9.6	57.9	66.5	17.5	0.8	21.5	73.7	16.9	0	22.2
Passive Solar direct gain low mass	7.4	7.7	10.6	22.6	23.8	13.1	0.4	0	0.7	19.1	15.8	6.7	10.7
Passive Solar direct gain high mass	0	1.0	0.3	3.5	3.1	2.6	0	0	2.4	8.6	5.7	0.3	4.8
Wind protection of outdoor spaces	36.4	28.9	26.1	11.3	0.3	0	0	0	0	0	14.2	37.5	12.8
Humidification only	0	0	0	0	0	0	0	0	0	0	0	0	0
Dehumidification only	0	0	0	0	0	12.2	56.3	47.6	16.9	0	0	0	11.2
Cooling，add dehumidification if needed	0	0	0	0	0	1.1	8.7	26.1	16.9	0	0	0	3.0
Heating，add humidification if needed	92.6	92.3	89.4	74.0	31.6	0	0	0	0	10.6	73.3	93.3	45.9
comfort	0	0	0	0	37.5	12.1	0.8	0.4	17.4	32.4	9.9	0.5	10.4

3.4.3 Building Ecological climate responsive Strategy interactive with Microclimate and Increase Comfort

The overall layout is compact, the building is oriented from north to south, and the traffic space of the roadway is mainly east-west, roughly parallel with the dominant wind direction of the lower level, and is roughly perpendicular to the dominant wind direction in winter. The road network is arranged in a well-word format.

Fig.3.4.1 Real photo

A. Settlement layout

The summer is short, the winter is cold and the sun's altitude is low. In order to fight for sunshine, the distance between the houses is large.

B. Building orientation

The north and south are mostly oriented.

C. Open space layout such as courtyard

The layout of the courtyard is relatively simple. There are 1~3 deciduous trees in the courtyard. In the summer season, the trees in the courtyard are leafy and can cover the narrow courtyard. The temperature in the courtyard is lower than normal temperature, which creates a difference between the inside and the outside, which leads to the flow of air. The effect of extracting the wind is formed, which brings about the cool air and promotes the evaporation of water, which plays the role of dehumidification and heat dissipation.

The Jiaodong residential courtyards are surrounded by short walls, and the courtyard has a small scale and a small footprint. The door and window openings are all open to the inner courtyard, and the space surrounded by the four sides makes the courtyard effectively avoid the winter cold wind.

D. Plan layout

The east and west rooms are used for kitchen and storage functions. Mainly in a courtyard, the middle-facing room facing the south is used as the living room, and the rooms on both sides are used as the bedroom for better sunshine, especially in winter.

The fire of the residual heat of the stove is used to increase the temperature of the room through the heat dissipation. The heat of the fire bed is actually the reuse of the heat of the stove, which is the full use of energy. However, since the fire bed was built directly on the ground, a considerable amount of heat was lost through the ground.

E. Facade layout design

The roof of the seaweed house is high, making the roadway in a cool shade. The thickness of the roof is large, and the thickest part of the roof can be as large as 1 meter, which can effectively resist the cold wind.

F. Building envelope structure

The seaweed that covers the roof is a plant that grows in the shallow sea. It has the characteristics of insect-proof, mildew, and non-flammable. It is a kind of night algae such as the seaweed, which has good thermal insulation effect. The stone used in the wall is commonly used in the area. Rugged granite with excellent thermal stability. In traditional dwellings, in order to enhance the air tightness of the building, and at the same time limited by the technology at that time, the door and window openings are generally small, which makes the building lighting affected.

3.5 Severe Cold Area Examples

The distribution of cold regions in China is mainly in the northeast, Inner Mongolia, northern Xinjiang, northern Tibet, and Qinghai. Qinghai Zhuang Wrapped Residences, Jilin Alkaline Earth Houses and Manchu Dwellings. The location of Jilin Alkaline Earth Building was selected as the climate analysis location. 45.63N, 122.84E.

3.5.1 Climate characteristics

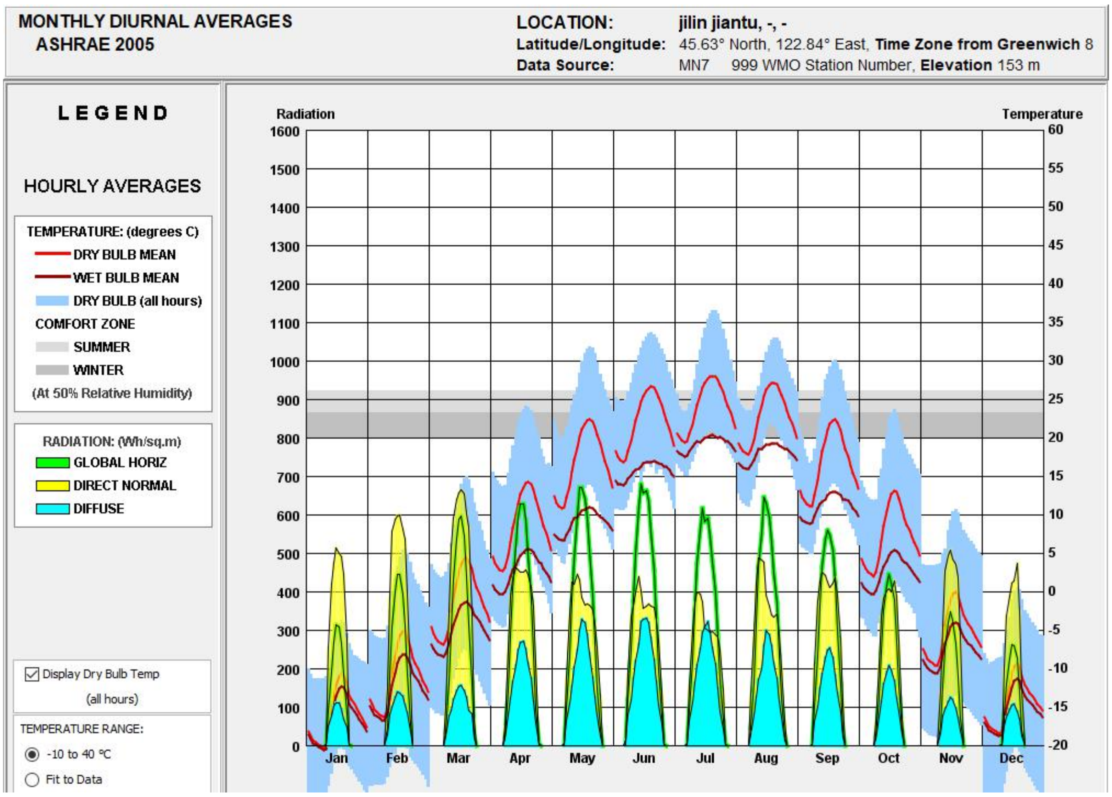


Fig.3.5 Climate features of Jilin

Table 3.8 Jinlin Climate Characteristics （meteonorm 2000-2009 period temperature）

location	Year average temperature(℃)	January average temperature(℃)	Extreme minimum temperature(℃)	July average temperature(℃)	Extreme maximum temperature(℃)	Precipitation days	
						winter (November-April)	summer (May-October)
Jilin	6	-5	-25	24	36	7	39

Severely cold winters and long duration, with short and cool summers, dryness in the west, wetness in the east, poor year-on-year temperatures, long ice-cold periods, deep frozen ground, and snow accumulation; large solar radiation. Sunshine is abundant; winter often blows strong winds.

The buildings in this area must fully meet the winter cold, heat preservation, anti-freeze and other requirements, and summer heat protection may not be considered. Master planning, monolithic design, and construction processing should enable buildings to meet the requirements of winter sunshine and defense against cold winds; Buildings should be used to reduce the exposed area, strengthen the airtightness in winter, make reasonable use of solar energy and other climate responsive measures; the structure should take into account the adverse effects of large temperature and high winds; Roof construction should take into account snow cover and freezing and thawing hazards; construction should take into account the characteristics of the long and cold winter, and take appropriate measures.

According to Fig.3.5.1.(Appendix) Dry Bulb and Relative Humidity, comparing the hot summer and cold winter zone, hot summer and warm winter and cold zone, the relative humidity of the whole year is quite different between day and night. The relative humidity is relatively high in winter and summer months and slightly higher in summer, ranging from 40% to 80%. The relative humidity in the transitional season is relatively small, and the relative humidity in spring (March, April and May) is from 20% to 60%. The fluctuation law is roughly the highest value of relative humidity at 5:00 am, and reaches the lowest value around 14:00. The dry bulb temperature has a negative correlation with the relative humidity, and the dry bulb temperature in winter is below 0 ℃.

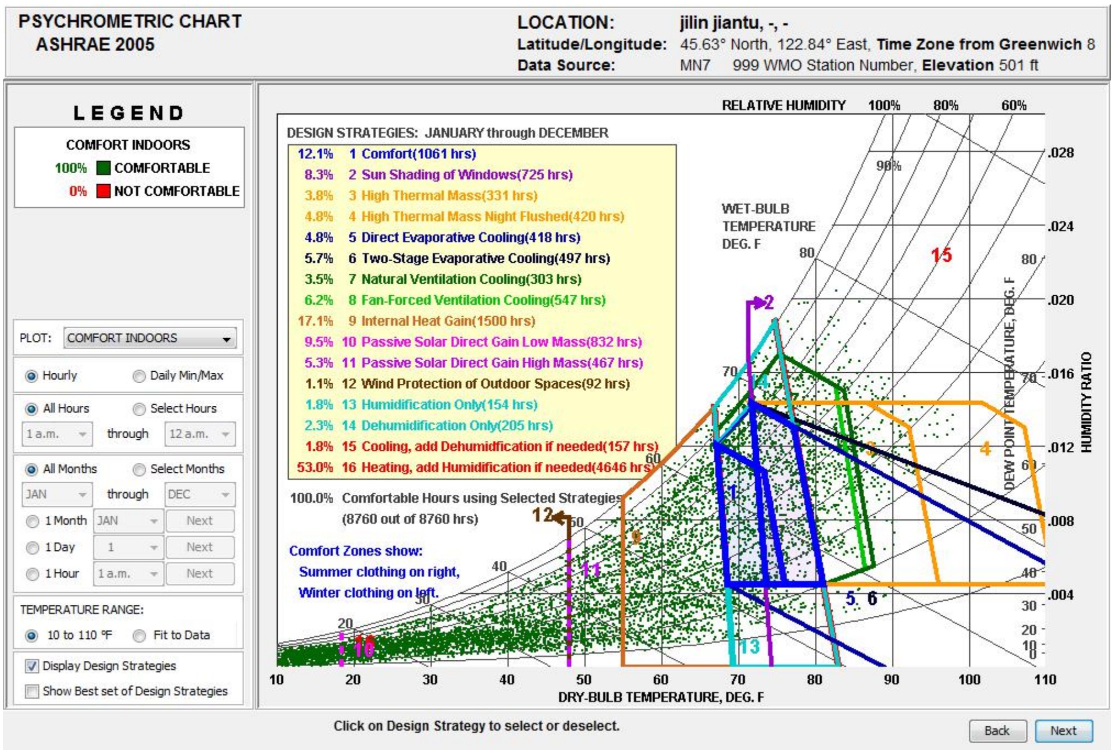
According to the Fig.3.5.2.(Appendix) Sky Cover sky cover, the annual sky cover is about 51%, which is significantly lower than the hot summer and cold winter zone and the hot summer and warm winter zone, slightly lower than the cold zone. From the perspective of the whole month of the year, the winter sky cover value is lower, and the April to October mean sky cover is higher which about 60%. The minimum of the mean sky cover is in February which is about 34%. Compared with the hot summer and cold winter zone and the hot summer and warm winter zone, it provides better conditions for the utilization of solar energy.

According to Fig.3.5.3. (Appendix) Sun Shading Chart's annual range of overheating periods is June and July. Shading measures focus on the south and west facades, from 9:00am to sunset.

According to Fig.3.5.4.(Appendix) Timetable Range, the comfortable area of the human body accounts for 18% of the whole year, and the temperature is too low, accounting for 75% of the total time of the year, of which 33% is below 0 ℃. Overheating time accounts for 8% of the total time of the year. The undercooling period in this area is greater than the overheating time, which requires higher heating. Appropriate heating measures are required from October to April, and the overheating time is concentrated in the noon and afternoon periods in late May and early September.

According to Fig.3.5.5.(Appendix) Wind Velocity Range, the annual average wind speed is about 3m/s, and the recorded high wind speed is about 15m/s. In summer and winter, the mean wind speed is lower, the spring mean wind speed is higher in spring, and the mean wind speed in April is 4m/s. In summer, the mean wind speed is about 3m/s, and the winter mean wind speed is about 2m/s. But recorded high wind speed appeared in December at 15m/s. Compared with the hot summer and cold winter zone and the hot summer and warm winter zone, the average wind speed and the highest wind speed are higher than those in the cold zone.

3.5.2 Ecological climate responsive strategies and their priorities



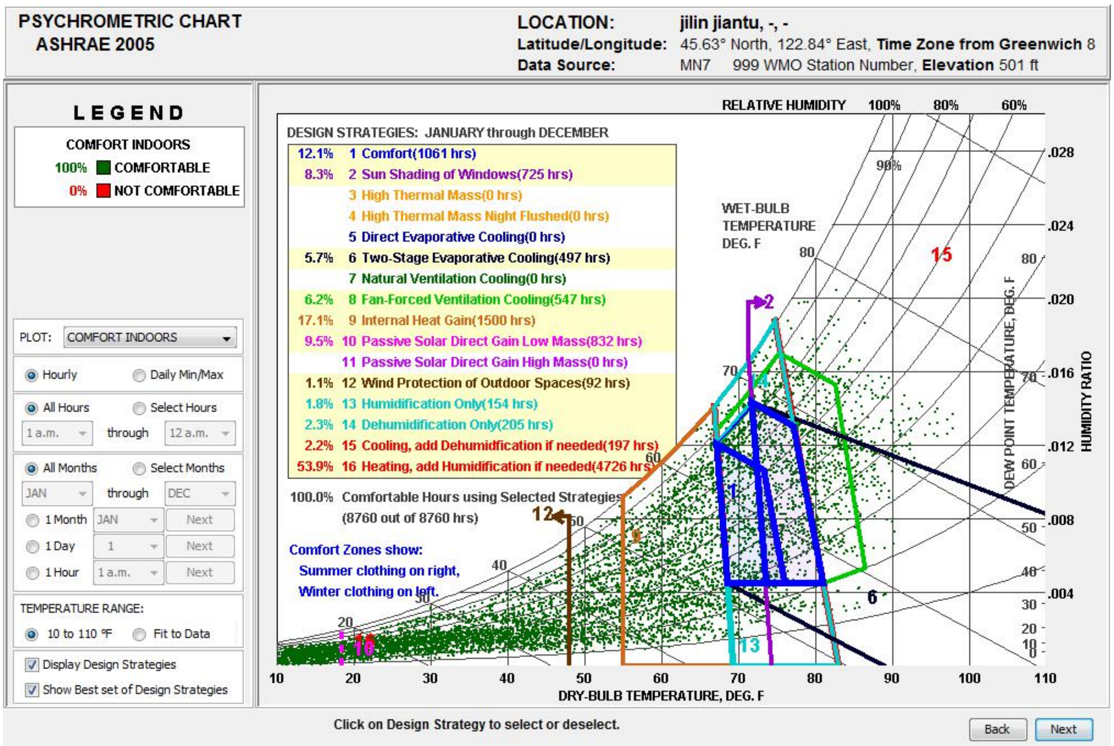


Fig.3.5.0. Psychrometric chart with Strategies Potential Sorting (Software: Climate consultant. Weather data: Meteonorm)

Table3.9

Jilin jiantu Design strategies of Percentage of effective time (white is best set of design strategies)

strategy	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year%
Sun shading of window	0	0	0	0.4	9.4	26.7	28.5	25.3	8.1	0.3	0	0	8.3
High thermal Mass	0	0	0	0	2.2	9.4	12.4	18.1	2.8	0	0	0	3.8
High thermal Mass night flushed	0	0	0	0	2.3	12.4	16.8	22.7	2.8	0	0	0	4.8
Direct evaporative cooling	0	0	0	0	11.3	12.8	12.2	15.1	4.7	8.7	0	0	4.8
Two-stage evaporative cooling	0	0	0	0	11.3	15.3	16.9	18.5	4.7	0.7	0	0	5.7
Natrual ventilation cooling	0	0	0	0	0	9.2	19.5	12.2	0.1	0	0	0	3.5
Fan-forced ventilation cooling	0	0	0	0	1.3	17.8	29.8	22.7	2.5	0	0	0	6.2
Internal heat gain	0	0	1.2	22.2	45.7	32.4	14.4	22.8	46.5	19.6	0	0	17.1
Passive Solar direct gain low mass	0.1	5.8	21.4	26.0	14.1	4.4	0	1.7	12.2	19.4	8.5	0.4	9.5
Passive Solar direct gain high mass	0	0	0	3.6	13.6	14.6	4.6	10.5	15.4	1.6	0	0	5.3
Wind protection of outdoor spaces	1.7	1.9	3.0	1.4	0	0	0	0	0	0.7	1.7	2.3	1.1
Humidification only	0	0	0	1.7	14.9	1.0	0	0	2.1	1.2	0	0	1.8
Dehumidification only	0	0	0	0	0	4.0	15.6	8.1	0	0	0	0	2.3

Cooling， add dehumidification if needed	0	0	0	0	0	5.4	11.8	4.0	0	0	0	0	1.8
Heating， add humidification if needed	99.9	94.2	78.6	60.7	21.5	2.1	0	0.3	21.4	69.5	91.5	99.6	53.0
comfort	0	0	0	1.3	9.8	36.8	33.6	40.3	22.6	0.1	0	0	12.1

3.5.3 Building Ecological climate responsive Strategy interactive with Microclimate and Increase Comfort

Most of the local areas are marsh-alkali land that does not grow any plants. The peasants who migrated to the abandoned land in the Qing Dynasty adapted to local conditions and used alkaline earth to build houses, forming a unique Jilin alkaline earth dwelling. The alkaline earth dwelling is a civil-structured house with earthen walls and earth-top roofs.

A. Settlement layout

The harsh northeastern region is sparsely populated. People generally choose to open a flat and open space in a sunny area. The city adopts a spacious determinant layout, while the countryside presents a scattered star-point layout. The large spacing between the houses creates conditions for the entire house to receive good sunshine during the winter, ensuring that the sun is unobstructed and projected to the windows or exterior walls to meet the heating needs of the building in winter.

B. Building orientation

Mostly north-south orientation.

C. Open space layout such as courtyard

The alkaline earth bungalows have a spacious courtyard structure unique to the northeast residential buildings, and most of them are with a courtyard, but also in the form of two courtyards or three courtyards. Around the outside of the room, an alkali wall with a width of 40 cm and a height of about 1.5 m is formed to form an inwardly enclosed courtyard. The tall and spacious courtyard is located in the south of the center, which is convenient for the entry and exit of the horses and other labor tools.

D. Plan layout

In order to adapt to the severe cold and long winter, the scale of the residential courtyard is large and very wide. Since much production work in winter has to be carried out indoors, the wing rooms are often used as mills, warehouses, stables, etc. The wide inner courtyard provides the necessary space for parking horses and labor tools. The backyard is often used as a storage space for outdoor food. In order to withstand the cold to ensure that buildings receive more sunshine, the scale of the courtyard in the northeastern region is much larger than that in the temperate climate.

D. Facade layout design

Due to the low temperature in winter, most of the individual households in the alkaline earth in Northeast China are regular, short and compact, and the plane is generally rectangular. In order to adapt to the severe cold, the east-west and north-facing small windows open the south window to open the window to the characteristics of the window, so that the need for winter insulation and maximum heat can be achieved to a greater extent.

F. Building envelope structure

The main masonry materials for the roof of Jilin alkaline earth dwellings include clay, Leymus chinensis, and Cangba. Alkaline soil is mixed with a small amount of shofar as a wall of material. In order to extend the service life, the inner and outer surfaces of the outer wall can be smoothed with the fine sheep grass mixed with alkaline earth mud once a year. Most of the residents in the spring smashed the wall, and after the wall was dry, it went up to the fall.

3.6 Examples of temperate regions

The temperate regions mainly refer to Yunnan and Guizhou provinces. Cases of Guizhou Shibanfang and Yunnan Tuzhangfang and Qiang-style dwelling houses. Select Guizhou Shibanfang as the climate preference for 26.81N, 106.24E.

3.6.1 Climate characteristics

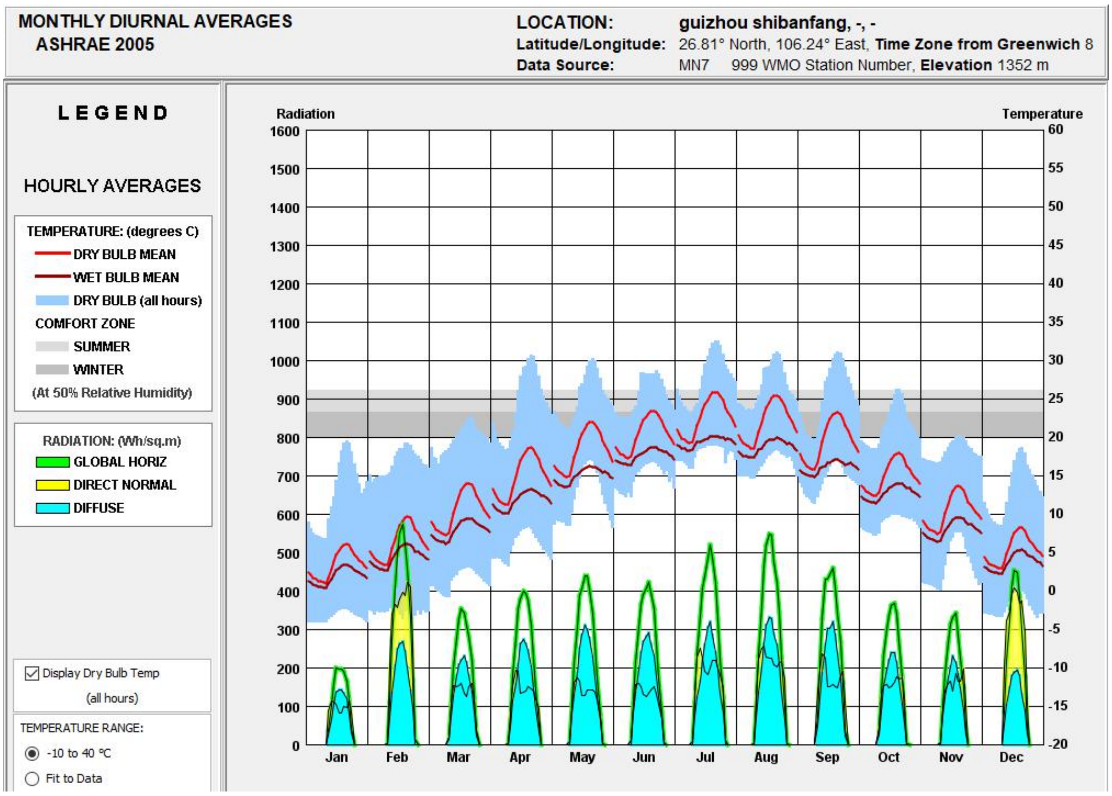


Fig.3.6 Climate features of Guizhou Shibanfang

Table 3.9 Guizhou Shibanfang Climate Characteristics （meteonorm 2000-2009 period temperature）

location	Year average temperature(℃)	January average temperature(℃)	Extreme minimum temperature(℃)	July average temperature(℃)	Extreme maximum temperature(℃)	Precipitation days	
						winter (November-April)	summer (May-October)
Guizhou	14	4	-4	23	32	32	67

In the temperate regions, the three-dimensional climatic characteristics are obvious. In most regions, the temperature is cool in winter and cool in summer, and the wet and dry seasons are distinct. There are thunderstorms and fogs all year round. The annual temperature difference is relatively small, the daily difference is relatively large, the daily radiation is less, and the solar radiation is intense. The winter temperature is low.

Buildings should meet the requirements for protection against rain and ventilation in the wet season, and heat protection may not be considered. The overall planning, monomer design and construction treatment should allow better natural ventilation during the wet season, and the main rooms should have good orientation; buildings should be protected against moisture and lightning strikes; construction should be rain-proof measures.

According to Fig.3.6.1.(Appendix) Dry Bulb and Relative Humidity, the relative humidity of each month is about the same, and the variation law and amplitude are roughly the same between 60% and 90%. The relative humidity in the winter afternoon is slightly higher than the summer afternoon time. The relative humidity in summer and winter is slightly higher than the transition season. The dry bulb temperature has a negative correlation with the relative humidity. From May to October, the dry bulb temperature changes are relatively flat at around 20℃, and the dry bulb temperatures from November to April are between 0℃ and 20℃.

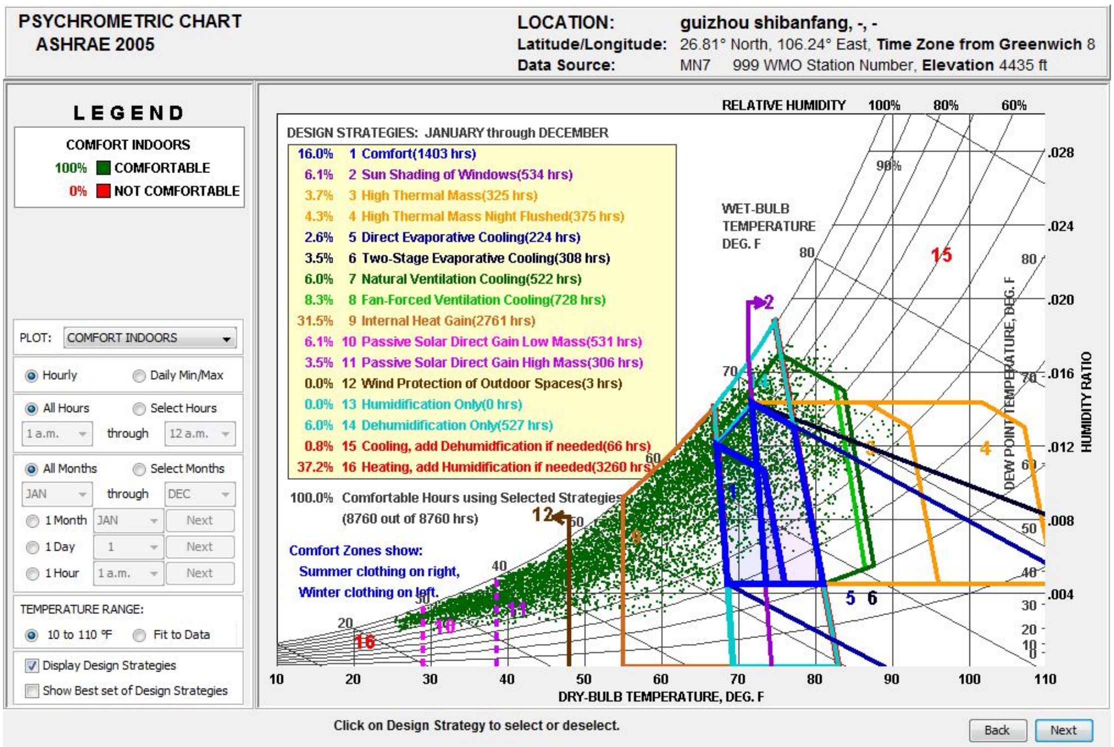
According to Fig.3.6.2.(Appendix) Sky Cover is high, and the annual sky cover is about 80%, which is the highest compared to the climate zones in the country. The spring sky cover is higher, followed by the summer and the winter is relatively low. In February and October, the mean sky cover was the lowest, at 60%; in May, it was relatively high at nearly 90%. Solar energy utilization conditions are relatively poor compared to other climate zones.

According to Fig.3.6.3.(Appendix) Sun Shading Chart's annual range of overheating period is early May, in June and late July, appropriate shading measures are required in the south and west facades, during the afternoon time mainly considered the west facade from 11:00am to sunset.

According to Fig.3.6.4.(Appendix) Timetable Range, the comfortable area of the human body accounts for 22% of the whole year, and the temperature is too low, which accounting for 74% of the total time of the year, of which 4% is below 0℃. Overheating time accounts for 4% of the total time of the year. The undercooling period in this area is greater than the overheating time, which has certain requirements for heating. The overheating period is more dispersed and distributed in the afternoon time of summer. Compared to other climate zones, the daylight period comfort zone area is relatively large.

According to Fig.3.6.5.(Appendix) Wind Velocity Range, the annual average wind speed is about 2m/s, and the annual mean wind Velocity fluctuates less at 2m/s; the tiny rises in the spring. Recorded high wind speed is nearly 10m / s, appearing in Apirl. Similar to the hot summer and cold winter regions.

3.6.2 Ecological climate responsive strategies and their priorities



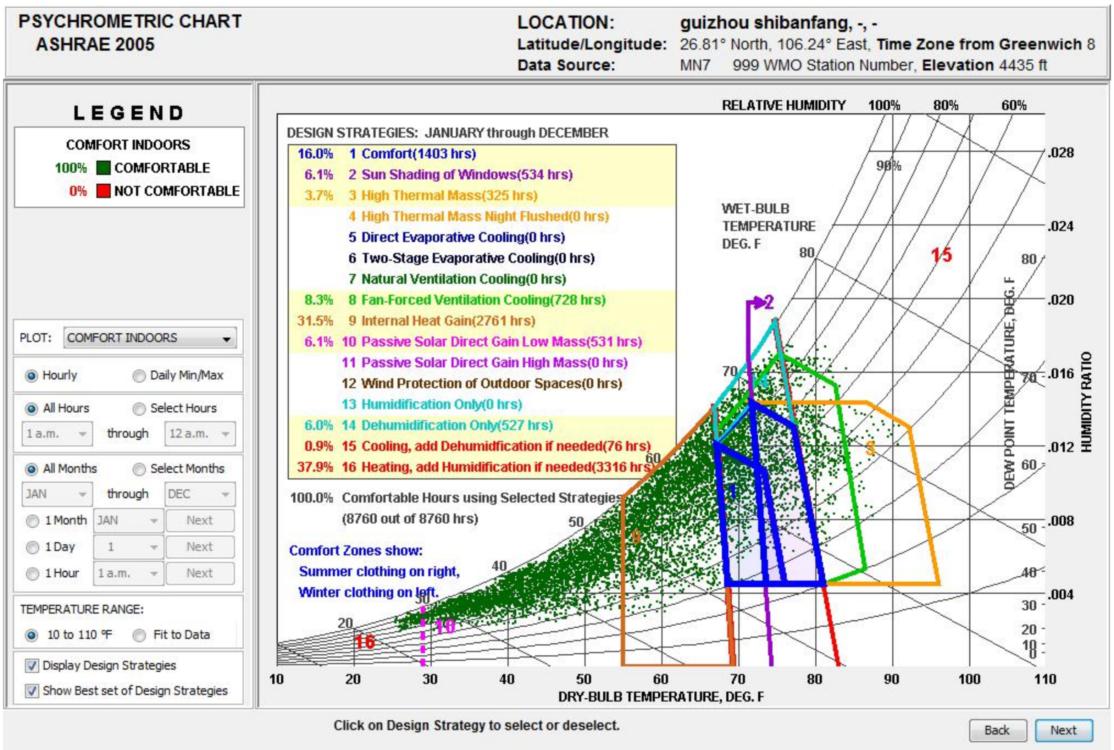


Fig.3.6.0 Psychrometric chart with Strategies Potential Sorting (Software: Climate consultant. Weather data: Meteonorm)

Table.3.10

Guizhou Design strategies of Percentage of effective time (white is best set of design strategies)

strategy	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Whole year%
Sun shading of window	0	0	0	3.9	5.2	11.0	19.2	20.2	11.4	1.7	0	0	16.0
High thermal Mass	0	0	0	2.6	3.6	6.1	10.2	14.7	6.9	0	0	0	6.1
High thermal Mass night flushed	0	0	0	2.6	3.9	6.9	12.2	16.7	8.6	0	0	0	3.7
Direct evaporative cooling	0	0	0	2.6	4.3	3.3	6.3	9.3	4.6	0	0	0	2.6
Two-stage evaporative cooling	0	0	0	2.6	4.7	5.6	9.4	12.9	6.7	0	0	0	3.5
Natural ventilation	0	0	0	0.3	6.0	14.7	24.5	19.0	5.8	0.5	0	0	6.0

cooling													
Fan-forced ventilation cooling	0	0	0	2.2	8.9	19.3	31.5	26.2	10.3	0.5	0	0	8.3
Internal heat gain	4.2	15.3	30.6	45.1	52.8	40.3	18.4	25.9	53.8	56.5	31.9	3.2	31.5
Passive Solar direct gain low mass	5.6	17.1	8.9	5.3	4.6	0.8	0.1	0.4	0.7	6.9	8.8	14.4	6.1
Passive Solar direct gain high mass	0.1	2.1	0.8	5.3	3.9	5.4	4.6	6.5	6.5	5.0	0.6	1.2	3.5
Wind protection of outdoor spaces	0.3	0.1	0	0	0	0	0	0	0	0	0	0	0
Humidification only	0	0	0	0	0	0	0	0	0	0	0	0	0
Dehumidification only	0	0	0	0.1	7.0	16.5	27.8	15.1	4.2	0.8	0	0	6.0
Cooling，add dehumidification if needed	0	0	0	0	0	1.3	3.8	3.8	0.1	0	0	0	0.9
Heating，add humidification if needed	93.5	72.5	61.3	35.1	7.4	0.1	0	0	2.2	29.4	63.6	83.2	37.9
comfort	0	0	3.9	15.7	26.5	33.9	30.4	37.2	31.5	11.8	0.3	0	16

3.6.3 Building Ecological climate responsive Strategy interactive with Microclimate and Increase Comfort

The formation and development of slate building is the result of local geological conditions. These areas are limestone and dolomitic limestone. These rock formations are exposed, the hardness of the material is moderate, and the rock joint fissures are distributed in large areas. The local people can adapt to local conditions, take local materials, use simple artificial and chisel to open cold, and then uncover the thick and even slabs layer by layer, and then process them into various slabs of different specifications according to the purpose, and build a building. A stone house with ethnic characteristics. In addition to the roofing of the sandstone and the rafters are wood, the whole house is made of stone. The foundation is the stone foot, the indoor floor is paved with slate, the walls are made of wool stone, and the roof is all neat diamonds or lay out with scales and slabs, even for the daily use of water tanks and chilled peppers. Appliances and partitions between households and households, vegetable garden fences, roads in stockades, etc.

A. Settlement layout

The use of sloping land near the mountain not only saves the earth, but also forms a beautiful situation in which the building group is high and low. The near water uses the advantage of water to regulate the microclimate to create a comfortable and pleasant climate.

B. Building orientation

Mostly North-south orientation, at the same time according to the terrain.

C. Open space layout such as courtyard

The courtyard wall is relatively short, and the courtyard belongs to a semi-open space. Mostly located in the mountainous area, the vegetation coverage is high, and the courtyard ground is mainly composed of bluestone and loess.

D. Plan layout

The unitary plane is nearly squared, adapting to the topography and climate, forming a high and low patchwork, and the inwardly thick and heavy building outlook, such building community can fight for sunshine and resistant wind and earthquake.

E. Facade layout design

The facade is staggered and the roof is double sloped. The slope is small and the slope is about 1:1.8 to 1:2.0.

F. Building envelope structure

Stone is a natural material, one of the richer local building materials, and one of the more ecological materials. It is durable and does not increase substances that are difficult or non-degradable in nature, and does not increase the burden on the ecological recycling system. At the same time, stone can be recycled, which is conducive to the sustainable development of local architecture. As a kind of common stone, shale stone not only has the common advantages of most stone, but also has excellent physical properties superior to other kinds of stone. A unique local stone, the shale, is widely distributed in Guizhou and is available for use. The shale plate has a large heat capacity, is dense and impervious to water, and begins to break when a good fire resistance temperature reaches 700 ° C. The surface of the mountainous areas in most parts of Guizhou has only a thin layer of soil, and it is not suitable to develop clay bricks and rammed earth walls with large soil content.

3.7 Ecological Climate responsive strategies and their priorities

Because vernacular architecture is limited by the background technology of the era, the use of passive strategy is the main. Detailed summary classification as shown in *Fig.3.7*.

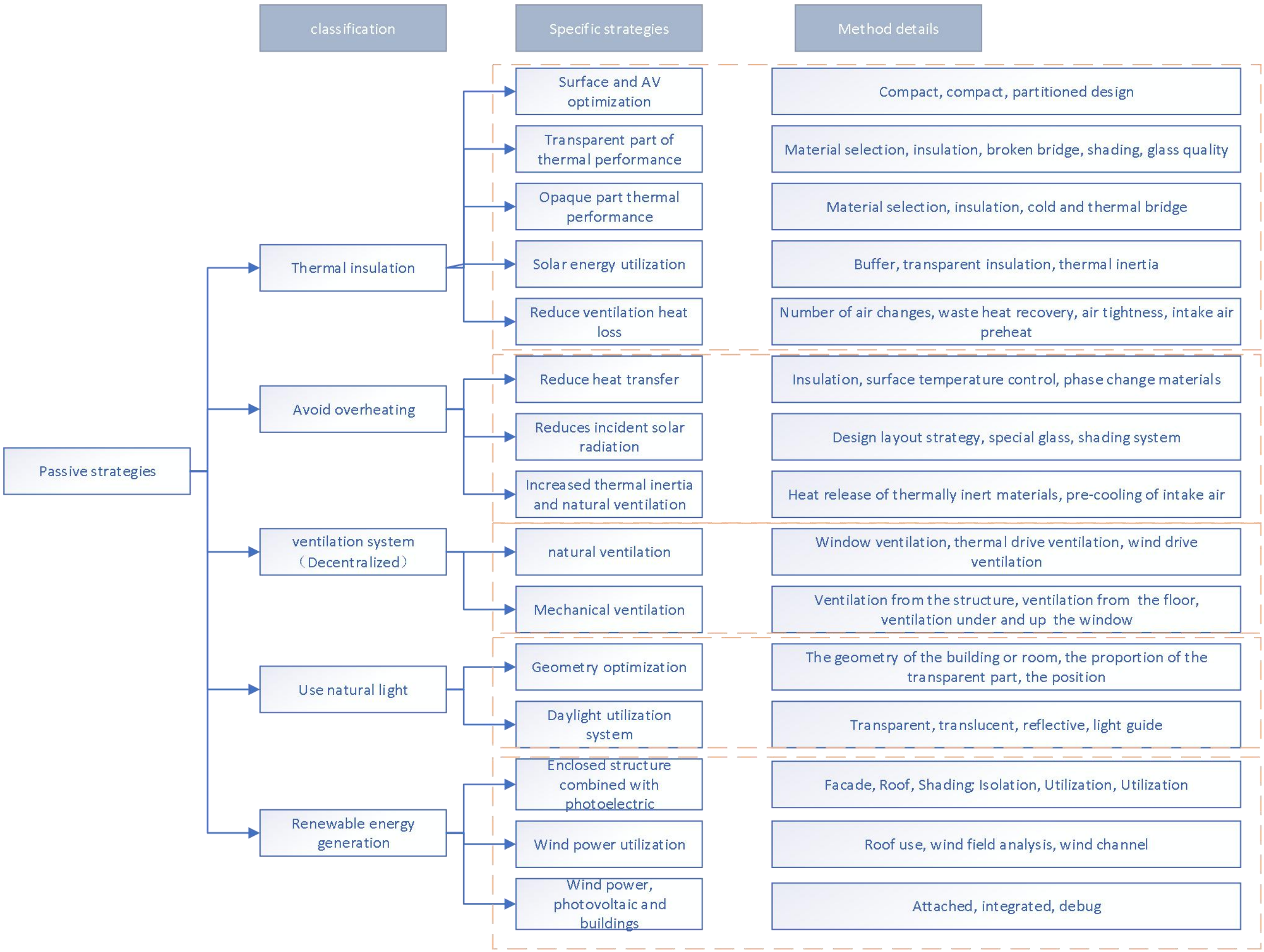


Fig.3.7 Passive design strategies classification and methods

3.8 Summary and Further research

This chapter organizes the traditional buildings with typical characteristics in the climate zone and analyzes the corresponding strategies of their needs. According to the microclimate characteristics of typical traditional buildings in each zone, the percentage of effectiveness of the ecological climate response strategy is analyzed. For various types of buildings, from the layout of the settlement, building orientation, courtyard and other open space layout, layout, facade layout design, building envelope structure and other aspects of the analysis of the architectural design of the ecological climate responsive strategy.

Chinese climate varies widely. It is divided into five climate zones. The climate within each climate zone has different microclimates due to differences in topography and geomorphology. The climate difference has an important impact on the study of architectural differences in the same climate zone. In the next step, for more in-depth research, the data of the more uniform sample cities in different climates within each climate zone can be used to extract, analyze and compare their data, and the effectiveness of microclimate differences and ecological climate response strategies in the climate zone. Analyze. The visual distribution map of the energy saving strategy is compiled by the interpolation calculation method (ArcGis). Ultimately, the results of scientific analysis correspond to empirical strategies.

Next, for a specific building of a microclimate, through the combination of field measurement and digital model, the specific quantitative analysis of the specific strategy under the control of energy consumption, wind environment and comfort.

Chapter 4. Measurements, Simulation and Analysis on Ecological climate responsive Strategies of Typical Traditional Architectural Buildings in Shanghai

The crystallization of the traditional wisdom of traditional architecture people is that it is a product that conforms to the long-term development of climate and has regional characteristics. It is also the most significant product of the interaction between architecture and climate.

This chapter first conducted a questionnaire survey on the area where traditional buildings in Songjiang District of Shanghai were concentrated, and the user's feelings about the modern use of traditional architecture. Through a survey and draw of a Qing Dynasty old building in Songjiang District, Shanghai, it was repaired according to the traditional architecture. Based on the strategic analysis of the renovated buildings, based on comfort PMV and energy consumption analysis, try to find out the relationship between building strategies and climate.

4.1 Field survey questionnaires and analysis

The field surveys were divided into two parts: questionnaire surveys and actual surveys of traditional residential buildings. The questionnaires surveyed included Shanghai residents living in buildings built before the reform and opening up in 1978; the survey site was Wang Chunyuan, located in Songjiang District, and Shanghai. Through the combination of research questionnaires and field research, an actual and effective ecological climate responsive strategy for dealing with climate is analyzed to provide assistance for subsequent research.

4.1.1 Questionnaire research

Questionnaires were randomly distributed using in-depth interviews to understand the residents. The distribution process took into account gender differences and age differences, as far as possible to ensure that the survey sample is more average. The main research questions are also relatively objective. Questionnaire questions will not be excessive or have been privately confusing the respondents with mood fluctuations. Effectively understand the actual user's subjective perception of the built environment and the actual application of related strategies.

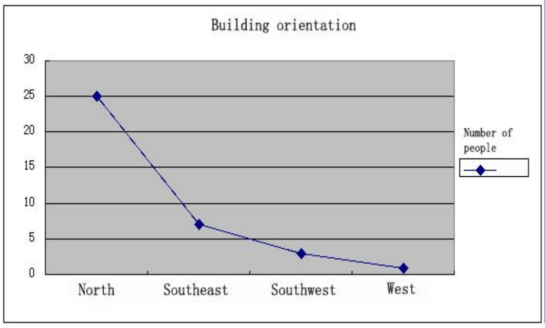
The basic information of the survey: From the perspective of buildings, there are architectural groups of buildings, building orientation, architectural styles and shapes (roofs, bays), materials and structures of buildings (wall roofing materials, construction of architectural elements) (Features), architectural color and light and shade (color content, motivation, proportion, positional relationship), architectural group characteristics and individual characteristics, local characteristics. From the aspect of the user, ask about the satisfaction with the thermal comfort of the room, the feeling of humidity, the length of ventilation of the room, and the use of cooling equipment. Finally came to a preliminary survey result.

4.1.2 Questionnaire Statistics

This questionnaire surveyed 36 residents using traditional architecture in Shanghai at the current stage, of whom 20 were females and 16 were males. The age range was relatively random. (Fig.4.1)

Fig.4.1 *Questionnaire distribution map (self-drawn)*

A. building orientation and organization



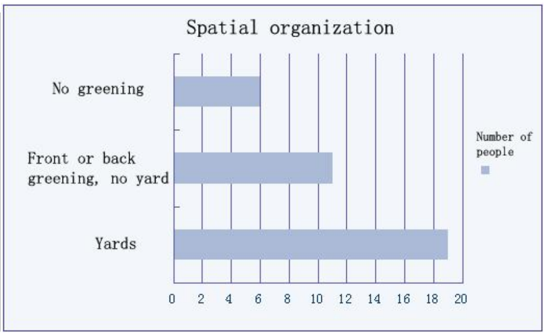


Figure 4.2 Distribution of building orientation (self-drawing) Figure 4.3 Distribution of architectural space organization (self-drawing)

From Figure 4.2 we can see that most of the buildings inhabited by residents surveyed are oriented in the south, and some are in the southeast or southwest direction, and only a few are in the west direction. The reason for the analysis is from the perspective of the natural environment because Shanghai belongs to the Jiangnan region, the dominant wind direction in the summer is the southeast wind, and the south orientation helps the building to have a good ventilation effect when the summer wind passes through. At the same time, the south orientation introduces a large number of solar rays into the room, which contributes to the sterilization effect of the indoor environment.

The spatial organization of architectural forms (Figure 4.3), after previous data query, the traditional buildings can be divided into buildings with courtyards, single buildings without front yards or rear buildings with their own greening and no green buildings before and after the separate buildings. According to the questionnaire, the traditional architecture with courtyards or courtyards in architectural design is the most common form. The majority of the remaining traditional architectural forms also have frontal or rear greening, and only a few of the traditional architectural bases are not green within or around the area.

B. architectural style layout and shape characteristics

The types of traditional buildings in our country are various and each has different patterns, forms, structures, decorations and components. These are all derived from the diversity of China's rich and diverse regional climate, humanities, and geology. Because the author's energy is limited, the object of this study on traditional architecture in the Jiangnan region is the residents of the traditional buildings mainly located in the Shanghai area. The traditional buildings inhabited by these households mainly focus on different types of buildings before 1949. The traditional building types include: the traditional courtyard buildings in the Ming and Qing Dynasties such as Xinchang Ancient Town in the south of the Pudong New Area, Zhujiajiao Town in Qingpu District, and Cangqiao Town in Songjiang District; around 1860, the Rigoon architecture For the first time in Shanghai, there were many types such as Shikumen Lane, New Lane Lane, and Apartment Lane, typical of which were the Verdun Garden (Changle Village) in Xuhui District built in 1925 and built in 1927. Year's Xifei Feifang (Huaihaifang). According to the above users who actually live in the traditional buildings in the Shanghai area, questionnaires were issued.

Table 4-1Architectural style layout survey questionnaire statistics

Roof style	Slope	91.7%	33p
	Flat	2.8%	1p
	Mixed	5.6%	2p
Courtyard or patio	Yes	83.3%	30p
	No	16.7%	6p

From the results of the above survey questionnaires, it can be seen that among the actual users' impressions, the type of sloping roof construction accounts for the vast majority, and most living traditional buildings have either a patio or an inner courtyard. (There was a case of sharing with people in the survey process, so there was some deviation in the surveyed courtyard data.) The traditional courtyard house is basically a flat roof, while in the form of a new Shikumen building in the Lane building type there is an annex to the rear of the building. The roof is a flat roof phenomenon.

C. Building Materials and Construction

In order to comprehensively understand the overall situation of the building during the investigation, a preliminary understanding of the status quo of the structure and materials of traditional buildings was made. The questionnaire specific survey results for users are as follows:

Table 3-2Building materials and construction survey questionnaire statistics

Roof materials	Brick and wood	77.8%	28p

	mixing		
	Concrete	19.5%	8p
Wall construction	Brick wall	8.3%	3p
	Cavity Wall	44.4%	16p
	Brick and wood mixing	47.2%	17p
Roof insulation	Yes	5.6%	2p
	No	94.4%	34p
Floor materials （main）	Stone	63.9%	23p
	Brick	22.2%	8p
	Wood	13.9%	5p

Because the climate in the south of the Yangtze River is relatively hot and humid, the ventilation, sunshade, and rain protection are usually the most important issues. Traditional courtyard building walls are usually dominated by empty walls, and there are also bamboo plastering walls. The walls are whitewashed; the materials are mostly brick and wood. There are masonry stones on the bottom of the wall. Courtyard-style traditional buildings are mostly made of slate in the interior and brick-and-wood flooring are the main features of the interior. The roof is also mainly based on bricks and wood, while concrete materials also appear in some of the new style buildings.

D. building color and light and shade

According to observations and conclusions during the survey, most of the traditional buildings in Shanghai are light tones and do not have deep shades. The results of the survey are shown in the table below. The color of most traditional buildings is grayish and light in color. This color and hue can reflect more short-wave radiation in summer, absorb relatively less radiant energy, and the temperature rise of buildings will not be so obvious.

Table 4-3. Architectural style layout survey questionnaire statistics

Traditional buildings shanghai	Hue (light and dark)	Color	Style
Xinchang	light	Grey and white	Traditional courtyard
Songjiang	light	Grey and white	Traditional courtyard
Qingpu	light	Grey and white	Traditional courtyard
Minhang Old street	light	Grey and white	Traditional courtyard

Xuhui Huaihaifang	Middle	Ash and meteorite	Shikumen(Long)

E Subjective feelings of users

Table 3-4. User subjective feelings survey questionnaire statistics

	Physical environment evaluation options				
	Very satisfied	Quite satisfied	Normal	Slight discomfort	cannot stand
Summer daytime temperature	0	25.0%	27.8%	44.5%	2.7%
Summer night temperature	0	38.9%	19.5%	36.6%	2.7%
Overall temperature condition	2.7%	22.2%	47.2%	25.0%	2.7%
Ventilation status	27.8%	52.8%	13.8%	5.6%	0
overall evaluation	2.7%	30.6%	25.0%	36.1%	5.6%

In the summer of Shanghai, the residents were surveyed and found out. The results showed that most of the residents feel relatively satisfied with the summer thermal comfort. According to relevant research, the Shanghai area has been long-term from April 2003 to November 2004. The questionnaire survey[15] shows that the temperature range that occupants can accept in naturally ventilated buildings is 14.7°C-29.8°C. Most of the temperatures in traditional buildings are in this range.

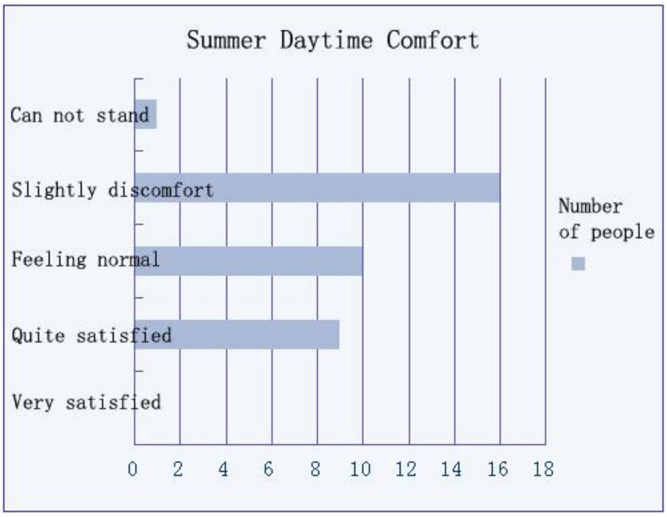


Fig.4.4 Summer daylight thermal comfort (self-drawing)

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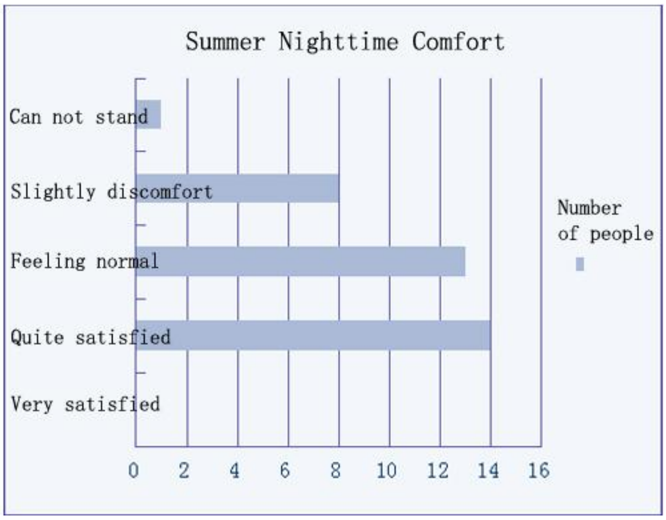


Fig.4.5 Summer night thermal comfort (self-drawing)

4.1.3 Questionnaire analysis

Through the analysis and comparison of survey data of traditional building users in some parts of Shanghai, the following characteristics can be summarized:

1) With the climate characteristics of the Jiangnan region, most of the traditional buildings in Shanghai and its surrounding areas are oriented towards the south, and the building shape follows the street direction; indoor and outdoor spaces are interspersed and interposed by setting up courtyards and large and small patios.

2) The form of traditional buildings in Shanghai and its surroundings is mainly sloping roofs, and the roofs are mostly of mixed brick and wood structure. The structural materials of the walls are not the same, and most of them are empty walls. The indoor floor is dominated by slate, and its material characteristics are better moisture-proof and heat-insulating effects. The main colors of the buildings are relatively light, and the traditional courtyard buildings are mainly based on white gray plaster. The Lane Lane buildings are dominated by gray and ochre.

3) Through the analysis of the subjective feelings of the users, most of the people living in traditional buildings are relatively satisfied with the comfort of the microclimate of the building, and the ventilation effect of the building space is obvious.

4.2 Building field survey: Wang Chunyuan House in Songjiang District

4.2.1 Basic Information of Wang Chunyuan’ s House

Wang Chunyuan’s house is located at the junction of Zhongshan West Road and Yushu Road in Songjiang District of Shanghai which was built during late of Qing Dynasty (1840-1912). Wang’s house was consisted of three courtyards buildings which are one on the north side (courtyard B) and two on the south side, the north side courtyard building is used as a dyeing workshop. It is an early Chinese light industry family-style workshop and the southwest side courtyard (courtyard A) is well preserved. It has a certain protection value and now has been registered as an immovable artifact by the government of Songjiang District of Shanghai. The entire building covers an area of 2,108 ㎡, and a protective renovation was carried out in 2015. The area before renovation was 2500 ㎡, and after renovation was 2736m2.The southwest courtyard building is oriented south and north in line with the orientation of Chinese traditional courtyard building, the other two courtyard buildings are oriented east and west which are less common in Chinese traditional buildings.

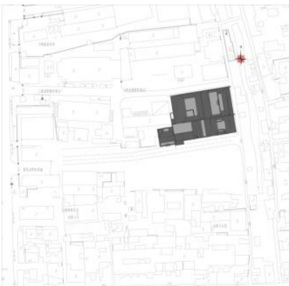
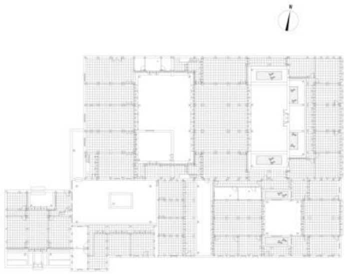
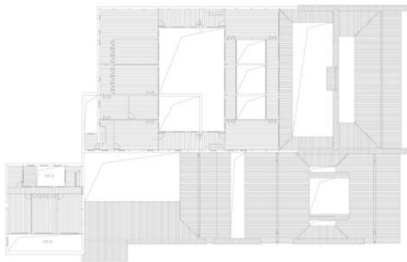




Fig.4.10 Master Plan(self-drawing) *Fig.4.11* First Floor Plan (self-drawing) *Fig.4.12* Second Floor Plan(self-drawing)

The area of southwest side courtyard is 180 ㎡.It has two layers and three bays[16].The original purpose was established for residence. The northern side of the patio had two wings and the south also had a narrow courtyard about 3m width. Before the repairs, there were phenomena of additions and alterations, and some indoor and outdoor doors and windows were altered and lost. There are cracks in several gables, part of the roof leakage. Some damage is to floor, some wood of structure decay, many walls have efflorescence[17] problems. In response to the above problems, the alterations and additions were demolished. At the same time, reinforce the problematic structure; renovate the roof with adding the waterproof layer; repair and replacement of wooden components; repair the hardware for doors and windows. According to the original ground form and material to repair; repair the outdoor floor of preserving and restoring the indoor and outdoor drainage ditch, courtyard, vegetation, pavement and stepping stone; Do a good job of building pest control and other technical measures. Under the principle of guaranteeing authenticity and minimal intervention, based on textual criticism and historical research, after repairing, the Wang's house has ensured the original features and materials and even the construction process of the previous building. This can be said to be a minimum update.

[16] Chinese Bay: It is a space enclosed by two roof trusses. <Chinese architectural history>chapter 4

[17] Clathrin is a phenomenon in which alkalis and salts in building materials are dissolved out due to the quality problems of construction materials and the environment is wet, and they accumulate on the surface and surface of the wall, and the wall peels off softly.

4.2.2 Causes and status quo

Shanghai is located in the plain water area of the Jiangnan region of China. It belongs to the subtropical monsoon climate, with hot and humid summers and cold and wet winters. There are significant seasonal changes in temperatures throughout the year. As part of the Jiangnan culture in China, its architecture serves as a carrier of early culture and has profound research value. Shanghai's traditional architecture consists mainly of traditional Chinese Jiangnan courtyard buildings and traditional Long[18] buildings which start during the 1960s.As a result of the long-term wisdom of local residents, buildings have the characteristics of adapting to the climate in accordance with local cultural, economic, and social factors, which are worthy of protection that can be used as references for modern architectural design. In recent years, the economic level of Shanghai, China has developed rapidly and is relatively developed. As a non-central area in the southwest of Shanghai, Songjiang District, with the development of the city, the protection of traditional rural architecture has gradually gained attention and put the restoration and renovation on the process. Traditional architecture, as a symbol of regional culture, witnessed history and became an irretrievable feeling in the hearts of the people of Shanghai. However, for people pursuing more modern housing, most people report poor living experience. In addition to the old environmental factors, the poor thermal environment of the building itself does not satisfy comfort. In order to improve the indoor thermal environment and human comfort, it is necessary to carry out climate responsive retrofit designs for traditional rural buildings while carrying out repair protection. Try to conduct ecological climate responsive protection and renovation reform on the basis of protecting the original building form. If it can effectively solve the problem of the integration of traditional building conservation repairs and energy conservation strategies. It will not only reduce energy consumption but also enhances its comfort. The value of protection and practicality of use have all been met. In similar projects in the future, they can serve as reference and gradually promote their use, bringing considerable cultural, economic and social value.

4.2.3 Microclimate characteristics

Shanghai is located in the plain water area of the Jiangnan[19] region of China. It belongs to the subtropical monsoon climate, with hot and humid summers and cold and wet winters. There are significant seasonal changes in temperatures throughout the year. During summer from June to august, the average temperature is 26.7℃,the average temperature of hottest month(July) is 28℃, and the highest temperature is 38℃, the average relative humidity is 80%,the prevailing wind is southeast wind, the average wind speed is 2.6-4.0m/s. (fig1,fig2) During winter from December to February, the average temperature is 5.7℃, the average temperature of coldest month(January)is 4℃, and the lowest temperature is -6℃, the average relative

[18] https://baike.baidu.com/item/%E9%87%8C%E5%BC%84 time

[19] https://baike.baidu.com/item/%E6%B1%9F%E5%8D%97/73?fr=aladdin

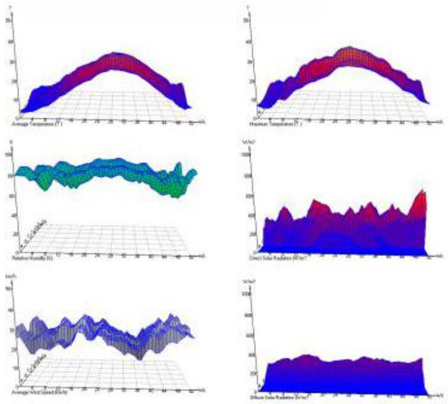


Fig.1 Average temperature, maximum temperature;

Relative Humidity (%), Direct Solar Radiation;

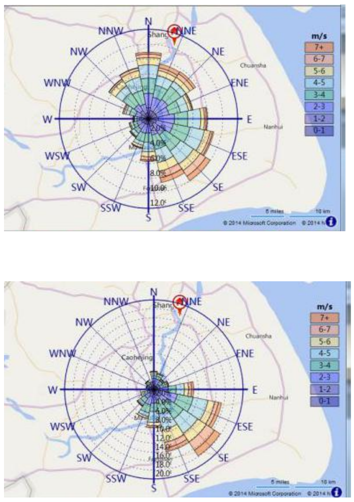


Fig.2 Year average wind speed;

humidity is 30%, the prevailing wind is northwest wind, the average wind speed is 2.6-3.0m/s. At the same time, during autumn from September to November the average temperature is 18.1℃, during spring from March to May the average temperature is 14.5℃.

4.3 Field Measurement Process

Samples and Analysis of Research Reports: Wang Chunyuan

Research Period: September 21

Instrument used: Wise anemometer: GM816 (Fig.4.8) Electronic hygrometer: Boyang HTC-1

Wind range	0.3-30m/s
Accuracy	±5%+0.1dgt
Resolution	0.1m/s
Principle	Electromagnet
Units	m/s,Ft/min,Knots,Km/h,Mph
Max. Min,	Yes
Average	Yes
grade	Yes
LCD	Yes
Prompt	Yes
Temperature	-10℃-45℃
Accuracy	±2℃
Power	9V
Size	160*52*35mm
Package	Paper

Fig.4.8 measuring instrument GM816 *Fig.4.9*Aerial photography（red point is the location）

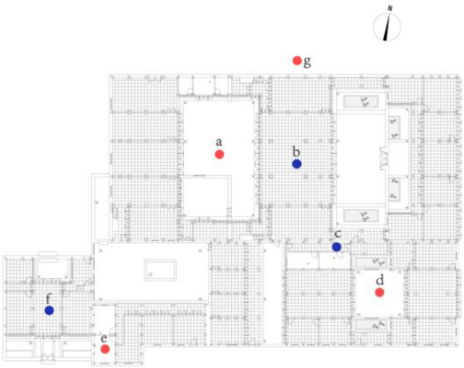


Fig.4.13 Indoor and outdoor measurement points(self-drawing) *Fig.4..14* Real photos（shoot by author）

In the actual measurement process, one day is selected to measure all days of the day; seven measurement points are selected, three indoor outdoor patios and three courtyards, and a comparison measurement point is selected outside the building (Fig.4.13); the specific measurement data is shown in the following table. Drawn by.

Wang Chun Yuan Zhai is a traditional courtyard-style building in the Jiangnan region. The entire building is composed of 3 main courtyards, 5 main patios and architectural bodies interspersed. The building roof is paved by Xiaoqingwa and the roof is a sloping roof. Patio and courtyard are scattered in the main body of the building. The natural wind and light can affect the interior environment of the building through the courtyard and the patio interspersed therein. The front of the building stands behind two continuous facades of wooden grille. The facade of the main facade facing the courtyard is continuous and can be fully opened. The summer wind can flow freely through the interior of the building; More open windows, but also conducive to the passage of natural wind. The thickness of the wall is relatively thick, and the empty bucket wall lapped by the blue brick has better thermal insulation and heat storage properties. Stone paving is applied to the indoor paving of buildings; paving of outdoor spaces such as courtyard courtyards is paved with small blocks of green bricks, and herbaceous vegetation grows in the voids.

The overall architectural style is solemn and grand, with the elegant architectural features of the Jiangnan region's building. The layout is founder and complete, with one courtyard in south and one patio in the north, beside the north patio has two wing rooms. The outer walls of the north and south courtyards are enclosed by high walls with the same height as the building. As a two-story residential building which are fully functional with the living room and bedroom etc. The structure uses Chinese fir as support column, beam and floor slabs; the wall uses empty bucket wall as the practice material is blue brick, and the east-west side gable is higher than the south-north side wall which is functioning as a firewall. The wooden beam and the wooden Ling[20] in the roof layer that acts as a structure is covered with wooden rafters.

[20] https://zh.wikipedia.org/zh-hans/檩 Horizontal structure in the building, parallel to the front of the building, perpendicular to the beam.

The Wang brick covered over the rafters and been covered by waterproof membrane and Huibei, on the top is base tile and cover tile. The doors and windows are kept in traditional solid wood, and the clear part of the window uses glass now which used transparent paper (oil paper) before. The yard and patio pavement will be supplemented with raw materials, Jinshan Stone and Qinghai Stone, retaining the original vegetation. Colors uphold the tradition "Fenqiangdaiwa": white wall and young black tiles.

Table 1 The materials of Wang's house

Location	Material	Size (mm) length*width*thickness	Supplement (fig)
wall	Blue brick	240*120*60	
First floor	Bluestone	300*300*20	
Second floor slab	Chinese fir wood	150width	
Roof	Rafter (Chinese fir)	700*70*40	
	Wang Brick	210*105*17	
	Huibei(Lime cream and fine clay)	50thickness	
	Waterproof membrane(sbc120)	1thickness	

	Tile	200*160*10	
window	Wood and glass	Diversity	
door	Wood	Diversity	

Summer Physical Environment

A summer indoor and outdoor space temperature measurement and summer indoor and outdoor relative humidity measurement.

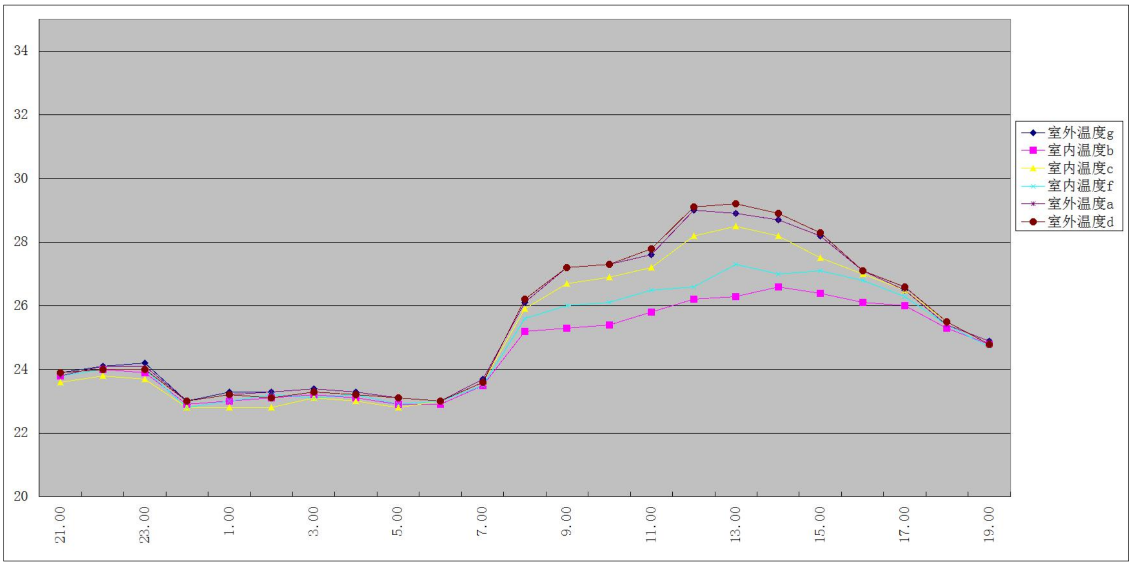


Fig.4.15 Indoor and outdoor temperature map in summer(*by author*)

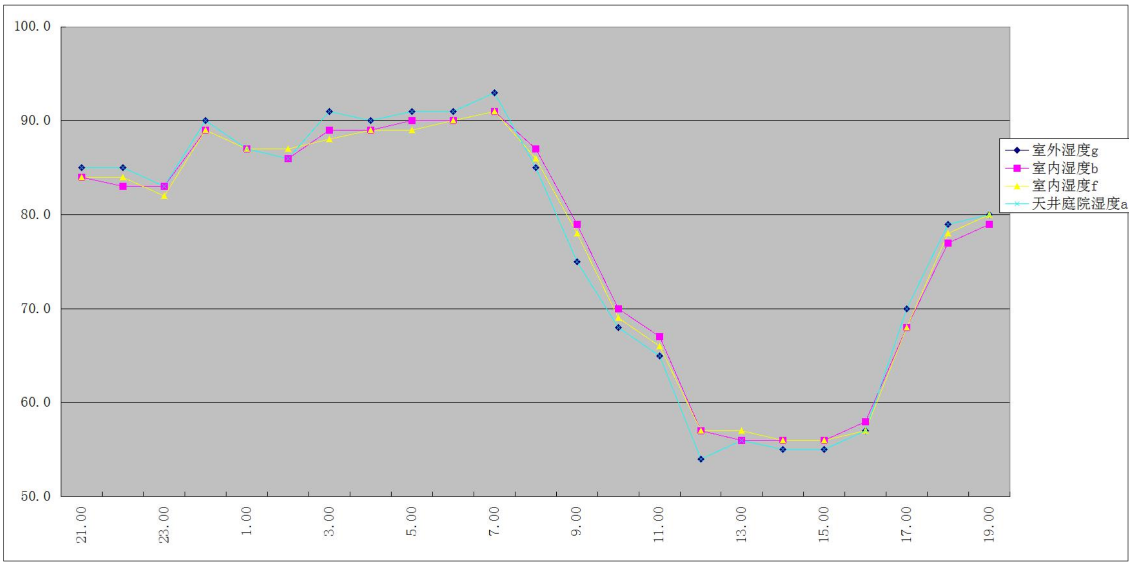


Fig.4.16 Indoor and outdoor humidity map in summer（*by author*）

Through the measurement and recording of Wang Chunyuan's temperature and humidity throughout the day, some climate features can be observed from the map. From the temperature map (Figure 4.15): The temperature of the patio and courtyard space is basically the same as the outdoor temperature g, and the indoor temperature is almost the same as the outdoor during part of the time (especially at night), which indicates the thermal storage of the building's maintenance structure. not ideal. However, in the hottest days of the day, the indoor temperature of the building is still lower than the outdoor temperature, and the maximum temperature difference is about 3°C.

The relative humidity is known by measuring room b, f, outdoor g, and courtyard a (Figure 3.16): The relative humidity data of courtyards and patios is basically the same as that of outdoor ones; the indoor relative humidity is generally different from the outdoor ones, and there is a certain degree of relative humidity. Lag phenomenon. The relatively high humidity periods are morning and night, and the human body is less comfortable during this period of time.

B summer indoor and outdoor wind speed measurement

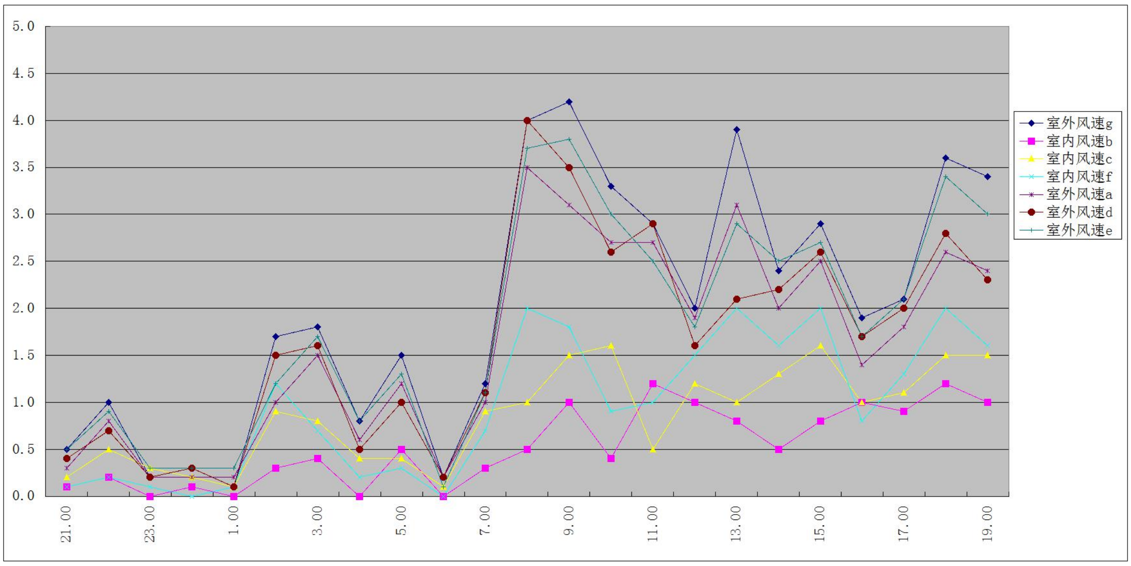


Fig.4.17 Indoor and outdoor wind speed map in summer(by author)

From the above figure, the wind speed fluctuations are greater throughout the day, and the average wind speed during the afternoon is greater than the rest of the day.

From the temperature map, it can be known that the afternoon is due to the sun, the building and its microclimate temperature all day high period, and the actual mapping shows that in the afternoon due to the higher wind speed (Figure 4.17), and the humidity is relatively low throughout the day, so the ventilation effect is good in the interior space, the overall temperature is not high.

Architectural space organization methods:

According to Wang Chunyuan's spatial organization, most of the traditional buildings in the Jiangnan region are the outdoor-patio-domestic-bedroom interspersed space layout. This spatial layout can solve the adverse effects of sunlight and ventilation caused by excessively large buildings. The presence of the patio can encourage the natural wind from outside to pass through the interior of the building and reduce the overall temperature.

in conclusion:

After continuous actual measurements, the indoor air temperature during the day is lower than the outdoor day air temperature by 1°C-3°C, and the air humidity is not much different between the indoor and outdoor air. Through the actual measurement data of wind speed, the overall indoor wind speed is less than the wind speed of the external environment of the building. The narrow walkway between building function rooms has a higher wind speed. The building is more obvious when the doors and windows are open to the main wind, and the wind speed at the second-floor height is greater than one floor height. The measured value sometimes exceeds the speed of the outside of the building. There are vertical winds passing through the courtyard, and horizontal winds are most noticeable in corridors and main function rooms.

The use of a compound courtyard on the layout of the building reduces the entrance of the building and facilitates the passage of the natural wind. Through the organization of the courtyard and the ventilation of the cold lane, there is also a small patio to improve the effect of pulling out the wind. The direction of the main body is the same as that of the surrounding streets and lanes. It conforms to the urban wind tunnel and is well accepted by street wind. The perimeter of the building and the inner courtyard of the building and the patio have greenery. The planting of trees in addition to the turf can block solar radiation, release less long-wave radiation (compared to buildings and hard paving) and can reduce the microclimate temperature. The garden floor is made of green bricks with strong water permeability. Rainwater can infiltrate into the soil to irrigate the plants. The abundant capillary water in the soil can also reduce the ambient temperature of the building through natural evaporation. The towering horse head wall on the one hand can play a role in preventing fire. On the other hand, it also shields the solar radiation to a certain extent. The thick blue brick wall of the building can absorb more radiant heat and effectively relieve the environmental heat pressure. The color of the building adopts the common walls of the traditional buildings, and the light-colored outer wall can reflect more radiation and reduce the temperature increase caused by absorbing radiation. Based on the above surveys and surveys of traditional buildings in the Jiangnan region, we can see that traditional building design methods fully consider the impact of environmental heat pressure on users and take corresponding measures in building design.

4.4 Software Analysis of Cliamte Responsive Strategy

With the advent of the computer age, computer simulation software can be used to perform complex data calculations and dynamic real-time simulations. This provides a new reference for the design of green climate responsive buildings, and also provides a new design method for the architectural design stage: the architectural design phase is not Simply relying on the analysis of the surrounding environment of the base, the analysis of the flow of people, the analysis of traffic, etc., the impact of climate on the building is in a decisive position in the architectural design stage.

Much effective climate analysis software assists in architectural design. For example, the independent software Weather tool included in Ecotect can be used to import meteorological data from typical meteorological years in different regions. The meteorological data can be exported in the form of images and the weather in the region can be visualized. There is a preliminary judgment. Similarly, the Autodesk Vasari software based on the BIM engine introduced in recent years can also be applied to the analysis of building site climate and the simulation of building energy consumption. This software can analyze and edit the hourly climate data visually. You can either read existing climate data or manually edit climate data. He offers a variety of visual analysis possibilities, including two-dimensional or three-dimensional graphic icons, such as wind rose, solar track map. The software can not only analyze and edit according to the data of typical meteorological years in different regions, form a visual analysis chart, and guide the design phase. By analyzing the environmental characteristics of the internal space of the building body, it helps to design the scientific and rational layout and spacing of the building body and can also provide a certain reference for the space design.

4.4.1 Psychometric analysis

The wetness map is an important means and form used in the analysis of meteorological data. Through the drawing of the indoor temperature and humidity distribution map, the early stage energy saving effect of the program design is estimated. The humidity of the air, relative humidity, air flow velocity, and radiation temperature of the surrounding environment determine the comfort zone in the psychometric chart. Therefore, some of the cross combinations of these parameters will form a comfort zone that most people will recognize on the psychometric chart. That is, the comfort zone in the wetness charts. Ecotect's meteorological data analysis module analyzes the weather data of a certain place and analyzes the changes of different designs in the comfort zone on the wetness map, so as to select the optimal climate responsive design plan. Because the complexity of climate change is neglected during the conceptual design phase of a building project, and the radiation temperature and airflow velocity of the environment are assumed to be constant, the temperature and humidity on the enthalpy chart is a measure of the thermal comfort of the building.

According to weather tool software Shanghai data station's wetness map (Figure 4.18), there are a variety of passive cooling strategies can effectively expand the range of human comfort temperature and humidity. The strategies in the figure are: 1 passive solar heating 2 high heat storage and cold storage material 3-night ventilation 4 natural ventilation 5 direct evaporation cooling 6 indirect evaporation cooling. The main research direction based on this paper is the passive cooling strategy in summer, so the more effective measures are the last five items. At the same time, the most effective passive cooling strategy is the natural ventilation strategy.

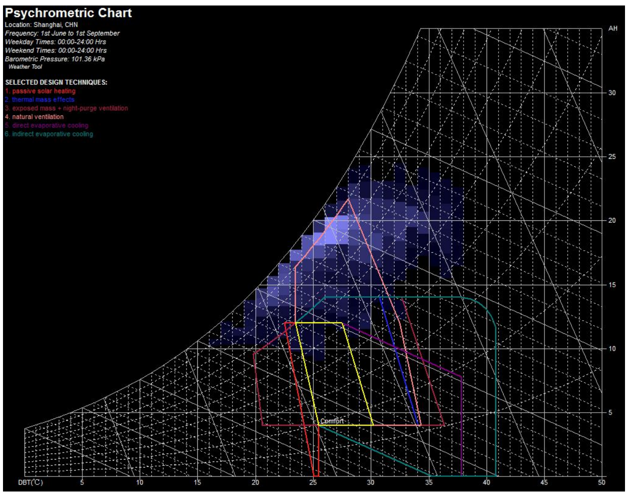


Fig.4.18 Psychrometric

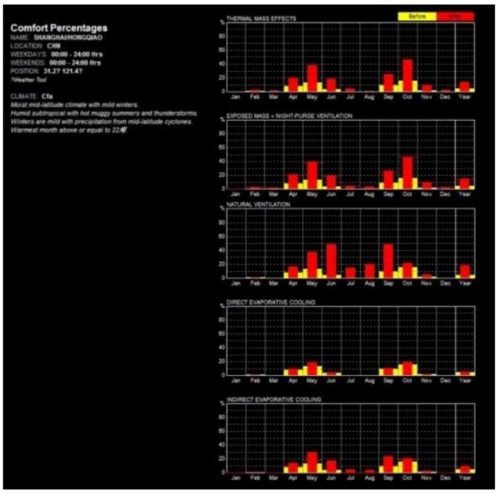


Fig.4.19 Percentage of human comfort

4.4.2 Effective Passive Strategy Analysis

Using the Weather Tool, you can see the effects of different passive design strategies on improving human comfort. After effectively using these passive design strategies, the percentage effect of improving human comfort can also be clearly compared from Figure 4.19. From top to bottom in the figure, there are five strategies for heat storage and cold storage of building envelope materials, night ventilation, natural ventilation, direct evaporative cooling, and indirect evaporation cooling. It can be seen from the figure that natural ventilation is the most effective passive design strategy in summer and in the transitional season, and the effect of direct evaporative cooling and indirect evaporative cooling is weak. The yellow area indicates that before the passive measures are used, the red area indicates that the passive design measures are most effective from April to June and September to November after the use of passive measures, and the effect is not significant from July to August due to the high temperature and high humidity in the south of the Yangtze River region. The climate has a negative impact on cooling. Through the above software analysis, in the architectural design process we should consider the natural ventilation strategy as the main, and comprehensively consider the night ventilation and material heat storage and cold storage performance strategy. Under the conditional conditions, we should also consider direct and indirect evaporation strategies. The natural ventilation is most effective in the passive cooling strategy, so the ventilation design should be considered in the architectural design process.

4.5 Appropriate Ecological Climate Responsive Strategies of Songjiang Traditional Buildings

Shanghai has its unique climate characteristics, so it also has different design features in architecture. In a large number of existing traditional buildings, there is a wealth of Chinese architectural experience to deal with changes in the climate. In the process of modern architecture design, it is necessary to draw lessons from the traditional experience of excellent architectural design. In the modern architectural design, it incorporates the effective ecological strategies learned from traditional architecture and provides new ideas for architectural design.

4.5.1 Master Plan（Layout and environmental design）

(1) Natural Terrain

In the evolution of traditional architecture, the choice of terrain has always occupied a very important role. The traditional architectural forms or the layout of the buildings are all in harmony with the natural topographical environment. Some rely on mountains and some drowning water. These fully take into account the advantages and characteristics of the natural environment, and the adaptability to the environment. Has continued to this day. Therefore, at the beginning of architectural design, it is necessary to integrate environmental concepts and fully consider environmental characteristics, base characteristics, and climate characteristics.

(2) Favorable orientation

Advantageous buildings are oriented to not only make full use of solar energy but also to make full use of natural ventilation.

In addition to guaranteeing sunshine for a certain period of time, the architectural orientation of the Jiangnan area has an important factor that is the influence of natural wind. In the general plane design of the building, when the design is mainly oriented, it is necessary to ensure that the included angle between the orientation and the dominant wind direction is less than 45°, because the summer is relatively hot and requires effective ventilation and heat dissipation, so the dominant wind direction is taken in summer. Wind rose figure dominates the wind. In this way, the interior space of the building can be effectively accepted by the natural wind to be introduced into the interior of the building and smoothly pass through the interior space of the building, so that the inner space can obtain the most draught. In the design process of the complex, we can refer to the villages of traditional buildings. The layout of the overall layout is usually in line with the axis direction of the street and the layout is determinant; like the layout relationship between the building monomer and the dominant wind, the construction community may be There is a certain optimal relationship with the prevailing wind direction. In order to be most conducive to the natural ventilation effect of the interior, the overall layout of the building community needs to be 30° to 60° with the dominant wind direction angle of incidence. The dominant wind here is also the wind direction that dominates the wind in summer.

(3) Optimization of the wind environment

The main contents of the optimization of the wind environment are the following aspects: the maximum use of natural ventilation in the summer, which requires the corresponding design means to make all the buildings in the planning range can form larger windward and leeward surfaces on the dominant wind direction. The pressure difference ensures the natural ventilation of the building in summer, the sheltering effect in winter, and the comfortable wind environment. The strong wind speed corridor can be eliminated during the design process and windless corners can be eliminated.

In addition to factors such as dominant wind direction and intensity in winter and summer within the construction base, topographic wind (deep valley wind, land-land breeze) caused by specific terrain and wind field changes caused by surrounding structures; and due to differences in thermal storage performance of surface subsurface, Or because of the difference in the absorption of solar radiation caused by topography and undulation, the topographic wind resulting from the air flow resulting from the difference in the pressure generated by the regional temperature difference is also an integral part of the wind resources within the base.

Due to the ever-changing geographical forms of the Earth's surface, different atmospheric pressures are formed, and as the altitude changes, atmospheric pressure also changes. It is because of the existence of air pressure difference that the air flow is generated and the wind is formed. Different wind systems are formed according to the size of the wind. The atmospheric circulation, which is one of the important background conditions for local weather formation and climate change, affects small-scale wind systems such as large-scale wind systems such as typhoons and land-sea winds such as mesoscale wind systems and tornadoes. The monsoon is a phenomenon in which the prevailing winds in a large area in a year change significantly with the changes of the season. The Jiangnan region is located in the subtropical monsoon climate region. The climate change in the region depends on the advance and retreat of the monsoon.

In the process of architectural design, we must pay attention to different wind effects. In the process of architectural community design, we need to pay attention to four kinds of effects: channel effect, shelter effect, airflow effect, and vent effect.

The channel effect is often mentioned in urban planning. In the process of planning and designing buildings, attention is paid to the division of streets and roads and the passage of natural winds, which is conducive to the passage of natural winds. (Figure 4.20) If Shanghai Pudong considers urban wind corridors at the time of planning and design, a 250-meter-wide urban wind gallery will be planned, and air pollution will be alleviated by guiding winds.

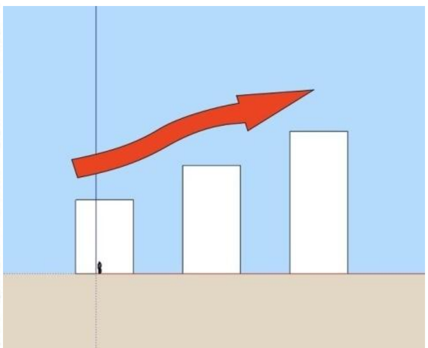


Fig. 4.20 Shanghai city wind gallery design(baidu) *Fig. 4.21* The pyramid effect(by author)

Shelter effect refers to the focusing place between buildings in a building community, which creates a shadowing effect on the oncoming winds, forcing the airflow to bypass the upper side of the building group, while the interior region exhibits a low wind speed, whereas the strong wind is generated. The pyramid effect (Figure 4.21) is another effect of the interaction of the building community during the planning process. For a building group that gradually rises and recedes, the separating shear layer at the top part of the building is subject to a successively rising boundary. Affected, the air flow gradually rises. Therefore, in order to mitigate the effect of rising air flow, the upper floors of tall buildings should be properly designed to allow air flow through.

The "venture effect" (figure 4.22) is the effect of the wind speed increasing when the natural wind passes through a narrower channel. This should be fully taken into account in the design of the building community.

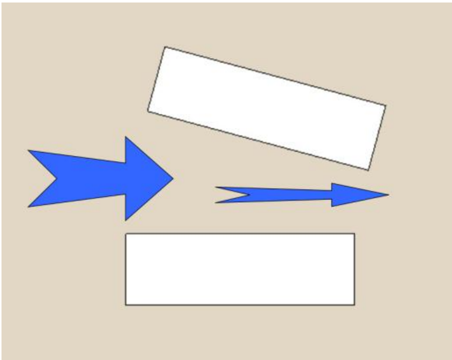


Fig. 4.22 venture effect (self-drawing)

(4) Outdoor Green Water Organization

In view of the causes of urban climate, a certain area of greenery and water bodies should be arranged within the external space of the building; roads, yards, walls and green roofs should be developed according to different spaces; grass-grooving bricks, gravel roads and other water-permeable road surfaces should be used as far as possible. .

Outdoor greening refers to the greening of the outdoor grounds of buildings. Outdoor greening regulates the microclimate and helps reduce surface radiation to the sun, which in turn reduces the external temperature.

The choice of vegetation is also very important. Planting trees is better for cooling the environment than for planting grass, because tree planting provides more shadow for the environment and reduces the direct radiation of the sun. Research shows that the green coverage rate is below 16%, and the difference between planting trees and planting grasses is not obvious.

4.5.2 Details（structure)

(1) Shading

The purpose of building sun shading is to prevent excessive direct sunlight from entering the room through transparent enclosures such as doors and windows, leading to an uncomfortable indoor thermal environment.

According to the properties of the shaded objects, the buildings are classified into self-shading and mutual shading.

Since the building is shaded, it is to use the changes of the architectural body's own concavities and convexities, so that the components or the corresponding building components and window holes reach depth, blocking the sun from reaching the purpose of shading. The grey space of the building can effectively shade and shelter the building. The building uses its own shape to form shadows of different sizes to form the shade. The choice of shade member depth is based on the local sun angle.

The shading members are divided into horizontal type, vertical type, integrated type and baffle type according to different forms. The horizontal type is mostly used on the direct sunlight side of the building body, and the vertical type is mostly used on the east and west sides because the horizontal type shields the direct light directly above and vertically blocks the oblique side direct light. The integrated shading and sun shading effect is more balanced and can be applied to windows near the southeast or southwest. The baffle type sunshade can effectively block the sunlight of the orthographic window with a small height angle and is suitable for the window near the east and west directions.

In the planning and design process, due to the shade formed by the building mass, mutual sunshades are formed. External blocking reciprocal shading: Roadways in the south of the Yangtze River mostly retreat. Although there are many winding roadways in the traditional buildings, the traditional houses on both sides of the building have reciprocal shades from east to west and from north to south, and the shading effect mainly depends on shadow conditions.

Shade wall shading effect analysis:

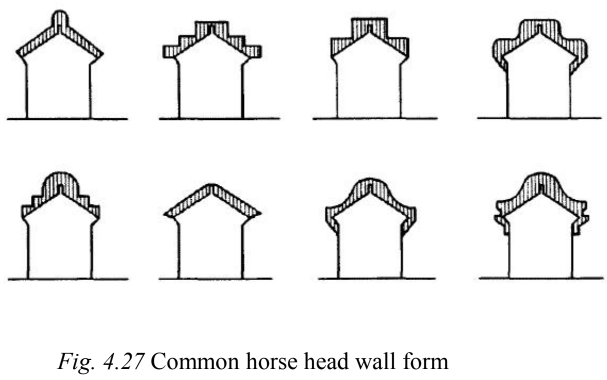


Fig. 4.27 Common horse head wall form

The higher the height of the horse's head wall is, the more obvious the shading effect will be. The reason why the horse head wall in the south of the Yangtze River is doing a lot is not only because of the fire protection but also because of the shading factor. As shown in Figure 4.27, in the form of a common concentrated Ma Tau wall in the south of the Yangtze River, different forms of the Ma Tau Wall produce different shadow effects, naturally producing the wall with the largest area of shadow, resulting in the best shade effect and more favorable for the passive cooling of the building.

In addition to the aesthetic effect, vegetation greening can also play a role in shading. For example, the trees in the base form shades to shade the buildings. Wall greening plants shade the walls. Roof greening shades the roof structure. The plants in the traditional building's patio can also play a role in shading.

(2) Thermal insulation design of roof and wall

The roof laying materials of traditional buildings in the Jiangnan region can be mainly divided into two types: small blue tiles and cylindrical tiles. According to a large amount of survey data, the traditional residential roof materials are mostly made of small green tiles, while the slightly larger scale of public building types of roof materials and garden building types of roof materials or building wall top decoration are Tile-based. Roof paving depends on the material, such as small blue tiles and tile, different practices: Xiaoqing tile roof practice: many houses directly on the rake on the laying of the tiles, and then paving tile and some paving tiles, looking at the roof or brick Paste the plaster, and then lay the base tile down on top of the paste. Place the base tile up and down. Two-thirds of the length of the tile is not less than two-thirds of the entire tile. The law, that is, each tile stacking, Luming. Tile roofing practices: There are two methods of clean water and mixed water in the tile roof, clean the surface of the tile and the mortar waste inside the joint, and the mixed water method is to use the finished surface of the cover. The gray ash is used as the base, and then the paper ash surface layer is used. The surface layer of paper ribs is mixed with appropriate quantified black water and the surface of the powder is uniform in size and uniform in arc potential.

Xiaoqingwa is a product made by firing clay, clay silicate minerals after long-term weathering, with the effect of moisture-proof heat insulation. When the tiles are overlapped on the roof, one cavity is created between the tiles and an air layer is formed to facilitate heat insulation. The calculation of the thermal performance of the roof is mainly based on the analysis of the thermal resistance and the thermal inertia index of the roof. The magnitude of the thermal resistance reflects the thermal insulation performance of the roof and the thermal inertia index reflects the thermal radiation speed of the roof.

The earth wall may be used in only a few areas due to its inconvenient construction process, but in fact its thermal resistance index and thermal insulation are good in thermal stability, and it can effectively store daytime heat radiation inside the wall material and transfer heat to it. Has played a lag role, help to improve the thermal comfort of the building.

In addition to the use of highly heat-retentive materials and water storage, the structure of the roof can also reflect sunlight and heat insulation through the roof surface, and the double-storey roof is insulated by the ventilation effect of the intermediate layer. In modern practical applications, we can not only avoid ventilated and insulated roofs, but also use roofs to form ventilated and insulated roofs.

Ventilation Floor Cooling The insulated roof uses the air circulation between the two layers of the roof to remove heat from the air layer. Two heat transfer forms on the roof (Figure 4.28), making the temperature of the floor more slowly and slowly.

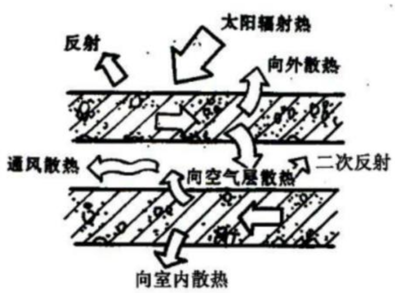


Fig. 4.28 Roof ventilation diagram

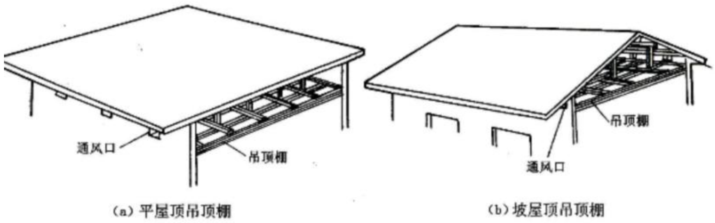


Fig. 4.29 Ventilation is set on the cooling and insulation roof below the roof structure

The ventilation layer may be disposed below the roof structure layer or may be disposed thereon. The ventilation layer is arranged below the roof structure layer (Fig. 4.29). A ceiling is provided below the structure layer, and a vent hole is provided at the dome wall. The ventilation layer can also be placed on top of the roof structure layer, that is, the tile surface of the slope roof is made into a double layer form, an air inlet is formed at the eaves, and an air outlet is provided at the ridge.

(3) Doors and windows

The window opening style of Jiangnan traditional houses is roughly divided into two categories. In some traditional residences, only small windows are open outside and high windows are used. In order to prevent theft, there are iron bars installed on the stone windows. The lighting mainly depends on the inside of the patio. Opening the window, the form of the dwellings is therefore also introverted. In some areas, the forms of opening the windows are relatively free, the external windows are relatively large, and the forms of the windows are also rich. The most common windows are partitioned with windows, windows, windows, windows, double windows, etc. The common doors in Jiangnan houses are partition doors.

Partitioned windows (full-circle windows): Partitions and windows are relatively large, and they are often set up on the entire wall that needs to open the window, which is conducive to convection and heat dissipation, and will quickly dissipate indoor heat.

Branch windows (and windows): These windows are opened and there are three fans in the row. The two upper and lower fans are fixed. The middle fan is outwardly supported and does not occupy indoor space. This window has a good lighting effect. Open upwards in the summer, forming a sunshade for the window, which is good for summer sun protection.

Double-layer windows: the windows, windows and screens for the outer windows, shade protection, light control and ventilation, as well as the protection of windows for windows, flower rights or flat stick windows, ensure ventilation and lighting, and The thermal performance is superior to other types of windows and helps to fully improve the indoor thermal environment of the building in winter and summer.

Grid door: The grid door can be disassembled differently depending on the function of the room. With the opening and closing of the door, the size of the door is divided into four and six, and eighteen and eighteen. Generally, the exterior door of a residential house adopts a grid-textured paper, which is both warm in winter and sun-protected in summer.

In addition to the window types of the external walls of the above-mentioned building interior spaces, there are window windows outside the building courtyard. The design of the leak window can guide the street wind into the interior space of the building. (Figure 4.30)

Fig. 4.30 Leakage window schematic(self-shoot)

(4) Others

Application of wind deflector

In addition to the guiding effect of the building space and the surrounding vegetation, the building can also be guided by natural ventilation by means of wind-guiding elements. The wind guide members mainly include wind deflectors, windward walls, and window grilles. With these components, positive pressure zones and negative pressure zones can be artificially formed around the building, and the natural winds can be guided from the positive pressure zone to the user's active space inside the building body and blown out from the negative pressure zone.

Ground moisture

Raising the ground level at the first floor will make the indoor floor higher than the outdoor ground. On one hand, it will prevent the intrusion of rain on rainstorm days, and on the other hand it will relatively reduce the groundwater level, which will help reduce the opportunities for groundwater intrusion.

In the selection of materials for the ground floor, the floor of the hall generally adopts slate paving, and a layer of bedroom floor usually adds a layer of overhead wooden floor. The slabs are dense and impervious, so the halls are not as damp as indoors.

The passive design of the structural plane also includes some special design forms, such as the special structures related to the passive solar house and the structural design of the roof covering and the straight greening wall surface, which are combined with the construction drawings.

4.5.3 Materials and colors

When selecting building materials, it is necessary to consider the selection of green and climate responsive building materials while clarifying the heat storage and thermal conductivity of the materials. Select a material with a small thermal conductivity and a large thermal storage coefficient to ensure that outdoor temperature changes have little effect on the indoor environment temperature through the wall.

A light-colored surface can reflect more solar radiation than a dark-colored surface, thereby reducing the absorption of heat by the building envelope structure, reducing the transfer of temperature to the interior space of the building, and reducing the temperature in the room. The Huizhou-style architecture is a kind of façade, and the architectural tone is dominated by light-colored walls, which can effectively reduce the summer temperature.

Light-colored surfaces can be applied not only to building facades but also to paving and roofing. The colored asphalt pavements that have emerged in recent years are examples of applications that reduce heat absorption. In modern applications, architects have also considered designs with reflective surfaces, but they must prevent glare from high reflectivity.

4.6 The IDA ICE dynamic simulation of Wang Chunyuan's house

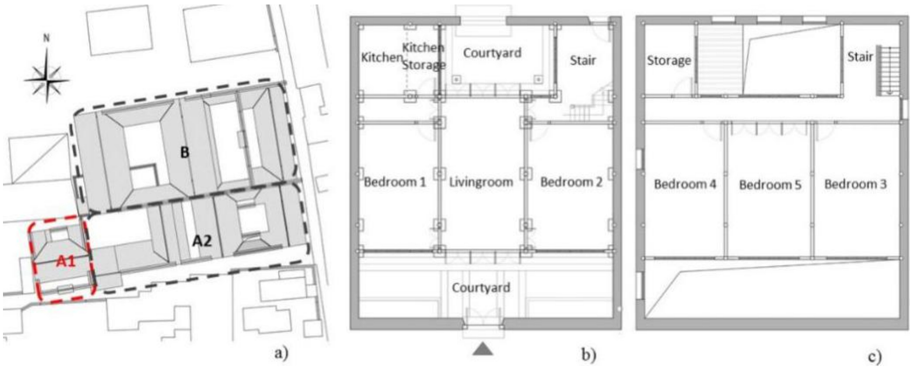


Fig.4.6.1. a) B: The North side courtyard, A1 and A2: Southwest side courtyard; b) First floor plan of A1; c) Second floor plan of A1

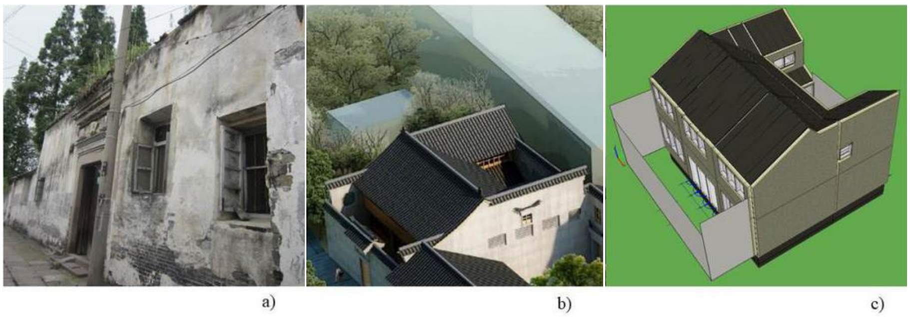


Fig.4.6.2 a) Real photo of Author 1, a) A1 rendering picture c) IDA ICE simplified 3D simulation model

The objective of this study is to perform thermal and energy assessment analysis of Wang's House, which is a historical architecture located in China. Wang's House is located at the junction of Zhongshan West Road and Yushu Road in Songjiang District of Shanghai and was built during the late Qing Dynasty (1840-1912). Wang's House is a good example of an early Chinese light industry family-style workshop and the government of Songjiang District of Shanghai has recently registered the house as a historical structure. The house has three courtyard buildings: two located on the Southwest side (Courtyard A1 & A2) and one on the North side (Courtyard B) (Fig.4.6.1a). The southwest side courtyard is well preserved (Fig. 4.6.1b) while the north side courtyard building was used as a dyeing workshop. The entire building compound covers an area of 2,108 square meters. In this paper, the Southwest side was selected as the case study, which has a total area of 180 square meters. The resulting investigation will therefore be used as energy saving measures that would also contribute to the preservation of the original architectural expression of the house. In this analysis, the dynamic simulation software IDA ICE 4.8 was used (Fig. 4.6.2).

In Wang's House, the ceilings are made of wood and the perimeter walls are made of Chinese blue brick. The brick is a traditional process in which clay is blended with water and calcined in a brick kiln. The brick is then water cooled in order to completely oxidize the iron in the clay to form a low-cost iron (FeO). The interior walls are wood; all exterior doors are wood; all existing windows are made by wood and glass, 1-pane glazing. In the second floor, the floor slab is Chinese fir wood and the roof is made up of blue clay tiles with Chinese fir as the supporting rafters. There is no heating ventilation and air-conditioning (HVAC) building system in this house. The materials specifications as input the data for IDA ICE are depicted in Table I(appendix) and Table II(appendix).

In this study, the thermal 3D model was generated in IDA ICE 4.8 dynamic energy and climate simulation program. The boundary conditions have been set precisely due to actual condition of the building, before generating the thermal model. The materials specifications for instance the thermal conductivity (W/ (m•K), density (kg/m3) and specific heat J/ (kg • K) were then assigned for the basement, external walls, internal walls and the roof. The orientation of the house and the climactic conditions of Shanghai was then used in IDA ICE weather data file (ASHRAE IWE). The thermal bridges for the external wall, window, floor slab and roof were set between poor and very poor considering the actual situation of the house (External Wall/Internal Slab: 0.5 W/K/ (m joint, External Wall/Internal Wall: 0.5 W/K/ (m joint), External Wall/External wall:0.272 W/K/ (m joint), External windows perimeter: 0.616 W/K/ (m perim), External Doors perimeter: 0.616 W/K/ (m perim), Roof/External Walls: 0.544 W/K/ (m joint), External Slab/External walls: 0.78 W/K/ (m joint), Balcony Floor/External walls: 0.928 W/K/ (m joint), External Slab/Internal walls: 0.272 W/K/(m joint), Roof/Internal walls: 0.256 W/K/ (m joint), External walls, Inner corner: -0.034 W/K/ (m joint), External Slab/External Walls/Inner corner: -0.0216 W/K/ (m joint), Roof/External Walls, Inner corner: -0.0272 W/K/ (m joint)). Pressure coefficients set to 'semi exposed' due to the location of the house. Additionally, ten zones were specified in this study and each of these zones differs in the number of occupants, equipment and lighting. In this analysis, one occupant was assumed in each zone while two occupants were assumed in the living room. The heating-cooling temperature set-points were defined between 21-25 ℃ , relative humidity between 20-80% and CO2 at 700-1100 ppm. The objective of the paper is to have an assessment of energy demand of the building with respect to the required thermal comfort. Since in first step of the investigations focuses on architectural properties, the authors used simplified ideal heater and cooler in the models, without specific definition of different HVAC systems. The schedule has been created base on the former experience in such a family houses. In this schedule, the whole year has been divided into to 3 main season which are heating & cooling season and transaction season. For example, from January 1st until 28th of February in workdays the windows are open twice, for each time 5 minutes, once is between 8:00-8:05 and afternoon 17:00- 17:05 and at weekend and holidays it is open 3 times and each time 5 minutes, 9:00-9:05, 12:00-12:05 and 15:00-15:05. Windows and frames are set to 1 pane glazing with solar heat gain coefficient of 0.85, the solar transmittance of 0.83 and light transmittance of 0.9, respectively. The frame u-value was set at 2.0 W/ (m2 ℃), glazing value at 5.8 W/ (m2 K), internal emissivity at 0.837 and external emissivity at 0.837, respectively. Finally, in this analysis, only the storage, kitchen storage and stair case are considered as the lower comfort conditions variables, because these are inhabitable spaces and therefore the usage of these areas are low. Thus, the temperature settings for these zones were set between 18-27℃.

From the resulting analysis in Table III (appendix) it can be perceived that 76% of the total annual energy demand was used on heating the building while 15% was used on cooling and 7.9% on lighting, respectively.

The general information and thermal behavior of the given zones with respect to the total energy demand (44885.2 kWh) are shown in Table IV(appendix).

The energy balance information of Wang's House is shown in Table V(appendix). The various heating and cooling energy loss are dependent on: the building envelope, walls, openings, number of occupants, equipment, lighting, local heating and cooling. The thermal loss of the envelope and thermal bridges is as high as 26178.9 kWh, the heat loss from window solar reaches 5660.6 kWh, and the total energy consumption for heating is 34132.8 kWh. Furthermore, the highest heat loss is due to the building envelope and the thermal bridges especially during the winter season.

Fig.4.6.3(appendix) show that the living room has the best Predicted Mean Vote (PMV) rate compared to other thermal zones. This is due to the presence of more openings during the summer periods. Furthermore, the presence of the one external wall had an effect on the resulting PMV rate. The living room is in middle of the apartment and it is surrounded by the heated zones, it will prevent the zone against the thermal bridges since the living room is not connected to outside temperature directly.

Fig.4.6.4(appendix) show that most time of the year relative humility is above 70% due to the local high relative humility of Shanghai climate, it is quite uncomfortable during summer time with high temperature.

In Table VI, *Fig.4.6.5*(appendix) the annual thermal comfort percentage rates of the zones are shown. From this analysis, the best thermal comfort is in the months of January to March and November to December.

Fig.4.6.6(appendix) the Parts Per Million (PPM) graphs demonstrate that the CO2 level of the chosen thermal zones, means two bedrooms, living room and kitchen. The data shows that the CO2 concentration rate in the month of June, July, August and September were relatively low due to the more frequent opening of the windows and higher air exchange rate which resulted in better air quality.

Table VI

Thermal comfort percentage rates selected zones

Zones	Best [%]	Good [%]	Acceptable [%]	Unacceptable [%]
Bedroom 2	63.3	20.0	15.5	1.2
Bedroom 4	48.3	37.6	12.0	2.0
Living room	57.2	23.7	17.5	1.6
Kitchen	43.3	32.0	22.1	2.6

For future studies, the proper size of thermal insulation, the new frame and glass type of windows and doors which belonging to material modifications, different radiative, convective or conductive heat transfer system, different plants and energy sources like geothermal earth probes, liquid chiller, gas etc. are determined by next research (Table VII appendix).

The main goal of the Wang House project is to decide the most optimal solution based on the concept of the refurbishment, which is to preserve the historical building without destroying the cultural heritage of the building and having the best solution energy, comfort and aesthetics. The current situation of the building should be investigated to expose the failures, weakness and future potential improvements. Due to this reasons a yearly energy simulation assessment was performed on Wang ‘s House using the dynamic thermal simulation software, IDA ICE. Based on the investigation, the amount of energy required for lighting, cooling and heating was also being identified. From the resulting information, 76% of the annual total energy being used was on heating the entire house. This is evident because of the absence of thermal insulation (walls and glazing) on the house. Furthermore, due to the poor thermal bridges and the building envelope, the cooling energy consumption is only about 1/3 of the heating energy consumption. At the same time it is lack of enough thermal mass. Thermal insulation as well as thermal mass (structures or PCM) should be added in order to increase thermal comfort and energy performance. Additionally, from the resulting investigation 15% of the annual total energy used was on cooling and 7.9% on lighting. The use of passive and active sustainable strategies can decrease energy use, especially during summer and winter time, also using proper type of HVAC system will influence the thermal comfort in a very effective way. By respect to this information the next step for the pre refurbishment phase has been illustrated and the critical points which need improvements are known. By applying these sustainable strategies as well as modifying the materials used in the house, detailed investigation will be carry on to decide the best refurbishment strategy.

4.7 Summary and Further research

This chapter conducts on-the-spot investigation and mapping, questionnaire survey, climate data collection, and summarizes the application of an effective ecological climate responsive strategy for a typical traditional building in Songjiang District, Shanghai.

Further research, through long-term energy analysis and short-term CFD wind environment analysis, more accurate analysis of architectural design under different strategies. Differences in simulated quantitative effects from microclimate scales to city scales. Establish relationships with comfort and energy and health. At the same time combined with building parameters, single building area, residential opening and discreet, layer and height, body shape coefficient, window to wall ratio, window to floor ratio, patio projection area and so on. Do a more comprehensive basic research to explore differences in different microclimates and links to building parameters.

Chapter 5. Application of Ecological Climate Responsive Strategy in Microclimate of Real Projects

5.1 Shanghai Jiao Tong University Biotransformation Medical Building

5.1.1 Project Introduction

Shanghai Jiao Tong University Biotransformation Medical Building is located in Minhang District, Shanghai Minhang District, No. 800 Dongchuan Road, Shanghai Jiaotong University Minhang campus. It belongs to Shanghai Jiaotong University and is a comprehensive office building that integrates office, teaching and scientific research in order to strengthen the interdisciplinary links and improve the infrastructure construction.

On the south side of the base are the new administrative office building, the existing system biological hospital research center and medical school building on the north side, the bio pharmacy building on the east and the river (17m wide) and Jiaotong University Botanical Garden on the west side. Siyuan North Road to the south, Longpo Road to the west, Zhenyi Road to the north, Wenzhi Avenue to the east, and driveways around the base. The total land area is about 41,400 ㎡. The building requirements are concentrated in the 2/3 area on the east side and 1/3 on the west side as reserve for development. The design is landscape afforestation. Construction area of 60,000 ㎡ Total investment 300 million RMB.

Fig. 5.1.1 Master plan *Fig.5.1.2* Rendering picture

5.1.2 Comfort analysis

Shanghai belongs to the subtropical monsoon climate. From the climate classification map, it can be known that Shanghai is a hot and humid climate in summer, with cold winters and significant seasonal changes in temperature throughout the year.

Psychrometric maps are important means and forms of meteorological data analysis. Drawing the distribution of indoor temperature and humidity on the dampness map can estimate the energy saving effect of the conceptual design of the scheme. The comfort zone in the psychometric chart is determined by the humidity of the air, the relative humidity, the air flow velocity, and the radiant temperature of the surrounding environment, so some combinations of these parameters in the psychometric chart will form most people think of the comfort zone. The area is the comfort zone in the wetness chart. Ecotect's meteorological data analysis module analyzes the changes in the comfort zones of different energy conservation plans based on the ground-level data of a site to select the best climate responsive design option. The conceptual design phase of a building project usually assumes that the ambient radiation temperature and airflow velocity are constant, so the thermal comfort of the building can be analyzed using the temperature and humidity on the wetness map.

The blue part is the actual summer and winter weather conditions. It can be seen that the relative humidity of air in summer and winter are both higher than 50%. In summer, the air has high moisture content, and the summer temperature is concentrated at 20-35°C. The winter season focuses on the temperature range of 0-15°C. The range of the yellow line is in line with the comfort level of the human body. If it is completely natural, it is difficult to reach the human comfort range in summer and winter.

5.1.3 Suggested ecological strategies

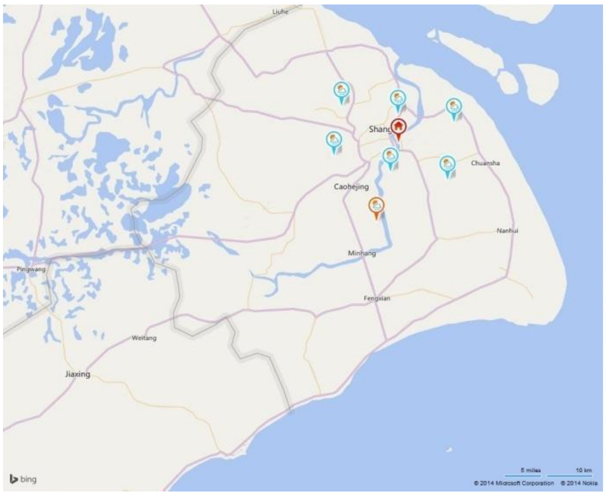
According to the annual eco-policy psychometric chart display, according to the weather tool software Shanghai data station's psychometric chart, there are a variety of passive cooling strategies that can effectively expand the range of human comfort temperature and humidity. The strategies in the figure are:1 passive solar heating，2 thermal mass effect，3 exposed mass +night purge ventilation，4natural ventilation.

The conform percentage chart can be used to show the effect of different passive design strategies on improving the comfort of the human body. From the top to the bottom of the figure, there are four strategies for heat storage and cold storage of building envelope materials, night ventilation, and natural ventilation. These are used effectively. After the passive design strategy, the human body comfort percentage increase effect chart can also be clearly compared. The yellow region indicates that before the passive measures are used, the red region indicates that the passive design measures are most effective from April to June and September to November after passive measures are used. Obviously, the effect is not significant from July to August because the high temperature and high humidity climate in the south of the Yangtze River has an adverse effect on cooling. It can be seen that natural ventilation is the most effective passive design strategy in the summer and transitional seasons. In the architectural design process, we should consider the natural ventilation strategy as the main method, and comprehensively consider the night ventilation and material heat storage and cold storage performance strategies.

5.1.4 Design Explanation

Based on the consideration of local climatic conditions, the program integrates green technologies and architectural design with environmental advantages and features of land plots, including traditional building materials and design methods to create rich and diversified spatial and indoor and outdoor landscape environments. At the same time, using simple soil cover and roof greening, natural ventilation, sunshade, vertical breeze and other technical measures, highlighting the green and climate responsive design, creating low-carbon health, green and ecological laboratory buildings.

Beginning with a microclimate from the very beginning of the architectural design, the vasari chart shows that the prevailing southerly winds in spring and summer are southerly winds southerly, and the northeast winds gradually change in autumn. From the figure, we can see the change of wind speed at different time of day in different seasons of the year. Related human body comfort temperature wind speed study, combined with the measurement thermometer, we can see the human body can comfortably comfort comfortable wind speed under the conditions of natural ventilation time and conditions to infer the time strategy can be implemented passive cooling conditions.



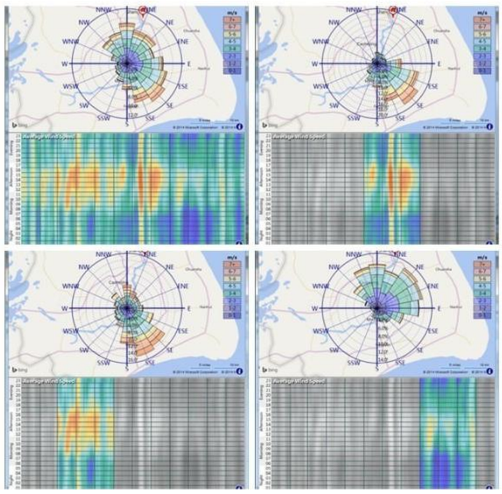


Fig. 5.1.3 Location (by author) *Fig. 5.1.4* Wind rose of different periods of year(Vasari Autodesk)

Architectural form, combined with the natural hot summer and cold winter area of natural ventilation, natural lighting design, the body will be controlled in certain depths, body length longer, so the body will be divided into six small horizontally divided by the outdoor courtyard. The south side of the building block is more dispersed, the gap between the body blocks to promote the summer monsoon, thus taking away the heat through the building. According to the users' demands, the function of translational medicine is mainly to transform the basic achievements of medical biology into the theory, technique, method and medicine that can be applied in clinical practice quickly and effectively. It is necessary to set up bench to bedside, referred to as B2B) to set up a fast-track, so as to be more concise solution to the close relationship between the two types of rooms, and according to research (R & D magazine) that translational medicine laboratory building design is the most crucial five elements of function, space, flexibility Sexuality, cross-cutting cooperation and sustainability.

In order to form a flat surface conducive to ventilation, office and experimental areas are controlled within 14cm depth, because a layer of functional requirements of the larger depth of the second and third floors over the formation of local Patio, the depth of control in the 14m below. At the same time try to adopt an open space layout to reduce the impact of space partition on the natural ventilation. The most conducive to the lighting of the south of the layout of the main office space, including some open-plan office, east-west room as far as possible layout of non-important room, or teachers and students will not stay in the room, including bathroom, stairwell, entrance Hall and so on. The plans are showed in appendix (Fig.5.1.5.Fig.5.1.6.Fig.5.1.7.Fig.5.1.8.Fig.5.1.9).

Facade design (Fig.5.1.10 appendix), through the same body mass arrangement, to create an introduction and rich rhythm of the overall image, solemn and elegant, calm and restrained, in line with the style of college construction requirements. In the foundation part of the building, the building and the environment are naturally integrated through the use of soil covering and greening. The ventilation and guide skylight on the roof of a building is not only a technical measure for ecological energy conservation, but also enriches the architectural sense of the times and reflects the technical beauty of the laboratory building.

5.1.5 Project Ecological Design Strategy

1 Natural Ventilation

The prevailing wind in the south of the Jiangnan Region in summer is southeast wind with the average wind speed in the urban area being small at 2.8m / s and in other districts at 3.0 ~ 3.6m / s. The use of natural ventilation and cooling strategy in Shanghai is the most effective, can expand the range of human comfort, reduce the use of mechanical cooling and reduce energy consumption. The main body of the biotransformation medical building in Shanghai Jiaotong University is basically the south-easterly direction, while the dominant wind direction in summer is also the southeasterly wind direction, which basically matches the prevailing wind direction. Architectural design of the floor to fully consider the size of the ventilation limit, conducive to summer prevailing winds through the building body, depth control in the 14m below the facade of the building facing the wind side to expand the layout. Through the opening of the sunroof to form a wind tower, the setting of high spaces and partial glass roofs, ventilation channels are formed to enhance air pressure ventilation and heat ventilation to ensure ventilation under low wind speed conditions. Layout of the building interior space layout, as far as possible the use of open office, laboratory and teaching space, reduce the partition wall, reduce the resistance of natural ventilation. At the same time, through the circulation of natural wind in the building space, reducing the use of air conditioners, saving energy, providing high quality indoor air environment and more comfortable research environment for teachers and students who work and study in this space.

1) Ventilation at different times

With the help of software analysis, the wind direction and wind direction map in summer months and seasons in September are divided into four periods: morning, afternoon, evening and morning. The dominant wind direction in the afternoon is the easterly wind and southeaster wind Strong; morning, early evening is southeast wind-based. As the temperature during the summer afternoon is the highest throughout the day, the temperature of the incoming air during the afternoon should be fully taken into account during the natural ventilation. It is the best time to ventilate the building in the early hours of the night. Although the wind speed is not the strongest at this time, the wind temperature is relatively low in the afternoon after long time of sunshine, which can effectively evacuate the heat accumulated during the daytime in the building, Work environment provides lower temperature.

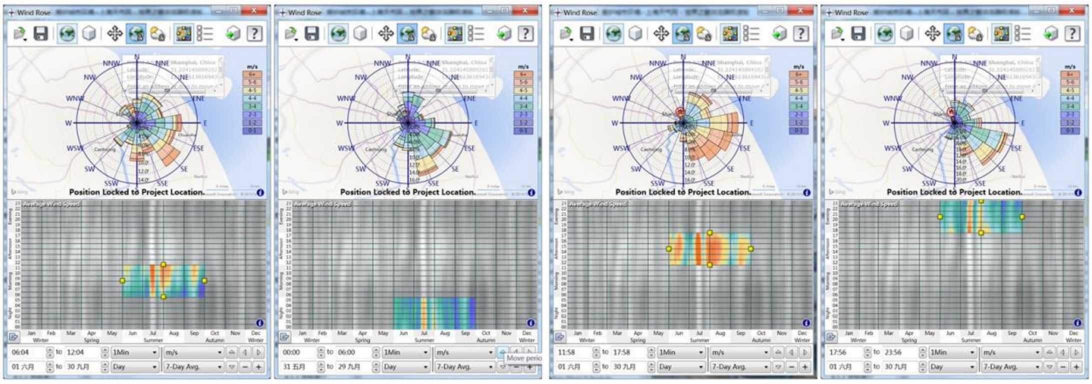


Fig.5.1.11 Wind rose with different period

(2) Plan layout ventilation measures to improve the effect

After Vasari analyzed the overall wind field and set the dominant wind speed and direction, the buildings around the base had little effect on the conversion center building. The conversion center building slightly obscured the wind environment on the north side of the building and sheltered the north side of the base Windward wind speed of the building is still up to 3m / s or so.

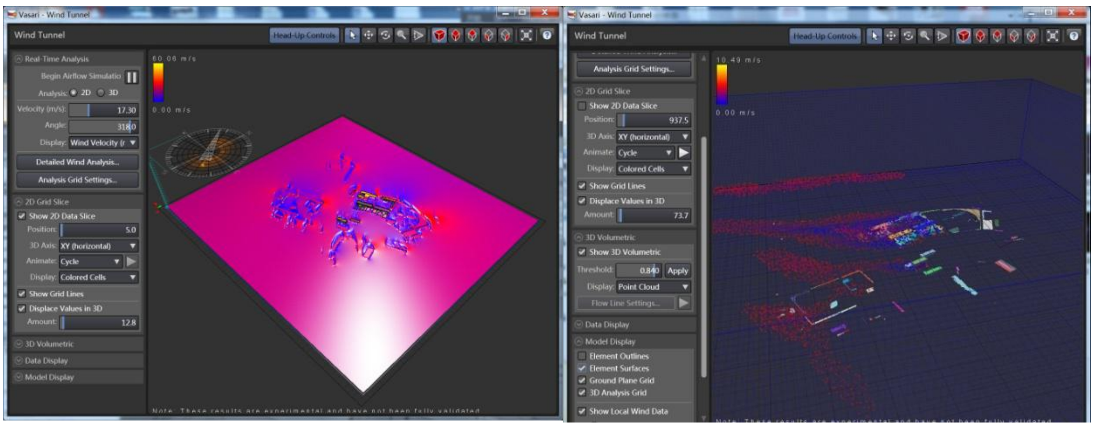


Fig.5.1.12 Wind tunnel simulation (vasari)

The model is input into the CFD of Ecotect for visual ventilation simulation. The data show that overall summer ventilation in the building is good and the wind speed on the windward side is relatively large. Opening up the leading peak in summer not only makes the southern experimental unit obtain better natural ventilation, the atrium obtained the possibility of natural ventilation and precooling the wind entering the atrium through the green courtyard between the south experimental units. At the same time, it can be seen that although the continuity of the building body is longer, the ventilation to the two buildings to the north is less affected.

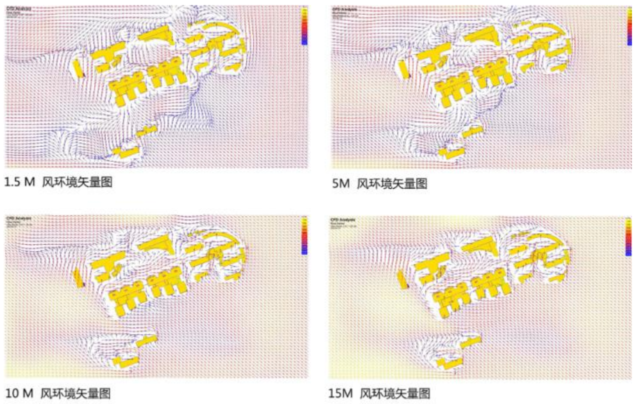


Fig. 5.1.13 Wind simulation with ecotect

(3) Improvement measures of air pressure ventilation effect of section wind pressure

Each experimental unit in the design scheme has a relatively independent ventilating tower to organize the ventilation. The external cold air passes through the interior of the laboratory and is forced to go outdoors through the top of the wind tower under the combined effect of wind pressure and heat pressure. By enhancing ventilation, summer can also achieve effective dehumidification.

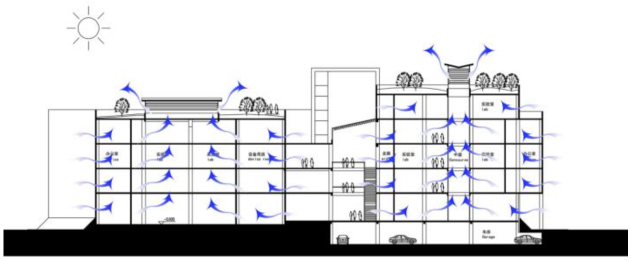


Fig.5.1.14 Section analysis

2 Sunshade Components

Under the conditions to meet the sunshine spacing, the design of building shade. According to cad sunshine analysis, the cold day at 8 am to 16 pm sunshine time to reach more than 1-hour sunshine time.

The buildings in the base area are located between 120°52'and 122°12' east longitude and between 30°40'and 31°53°north latitudes. Sunshine in summer is more adequate. The solar roof on the building has the highest solar radiation, the solar radiation on the south, the west, the east and the north relative to the roof. Different shades are designed according to the different solar radiation intensity. The south façade adopts the horizontal sunshade structure and the east-west façade adopts the vertical sunshade structure.

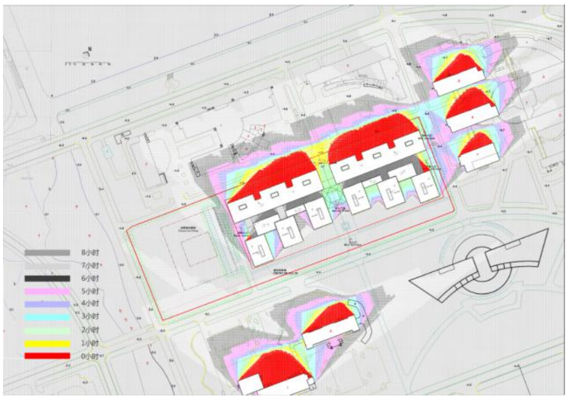


Fig.5.1.15 Great cold day sunshine time

3 Vegetation greening

In the landscape design of the building, taking into account the as high as the tree around the base of the main bases within the low shrubs and lawns based on the west side of the base for the development of land, the base is a major landscape environment. The elevation of the building is 1.5m. The building and the ground pass slowly through the lawn, and the multi-level environment space is designed through the design of buildings and afforestation sites. The roof garden is designed on the roof, which not only assists the landscape environment but also helps the building's thermal insulation. A green courtyard to the south of the experimental unit, a small garden dominated by lawns and low trees and some landscape objects beautify the environment, create a campus culture and landscape and regulate the architectural microclimate. West of the landscape with simple geometric patterns of land use square, enclosed space, and enhance the introduction of new and popular, simple and beautiful, for the later development to provide more convenience. Covering the roof of a building, in addition to the greening effect, the thermal inertia of the soil can be utilized to absorb the heat of the building into the soil and reduce the heat load of the building.

4 Other Strategies

Building materials insulation technology, passive cooling strategy, has a very Building materials insulation technology, passive cooling strategy, has a very important position. The wall should be equipped with appropriate insulation and air layer, building materials using high thermal storage coefficient of the material, the color of the outer wall of the building to light-based, the use of coatings with high reflectivity.

The basement pavement design fully considers the water permeability of the paving materials. In the concrete design, multi-and-empty interlocking bricks are adopted in the pedestrian-oriented roadway area. The grass green brick pavement is used in the leisure green area, which can increase the vegetation greening range without affecting the life of the soil microorganism surroundings. In the transport of moving lines, such as parking and unloading area parking area, the use of high-load permeable concrete pavement, to achieve good water permeability purposes.

Interior decoration materials try to choose wood decoration, wood material is less heat-absorbing, less impact on the indoor environment temperature; glass material selection Low-E glass, improve the insulation effect, reduce indoor air temperature changes.

The building fully combines the advantages of climate and environment and the characteristics of land parcels to create rich and diversified spatial and outdoor landscapes. With simple technical measures such as soil cover and roof greening, natural ventilation, sun-shading and vertical pull-out, the building highlights green and climate responsive design, create low-energy, healthy, eco-friendly laboratory buildings designed to meet Samsung's green building standards and designed with interior blinds, double-glazed windows and sun visors to reduce heat buildup. Other skill features include heat recovery from ventilation energy, automatic lighting control, natural lighting maximizing the use of natural ventilation during the transition season and availing of natural day lighting strategies in atriums and lighting wells. According to the internal area of the base is divided into the following functional blocks as shown in the figure, the yellow area is the lighting atrium, blue area for the laboratory functional unit, the red area is the vertical traffic space dark blue area for public service space, green for the landscape Green Square, pink area for the entrance square space.

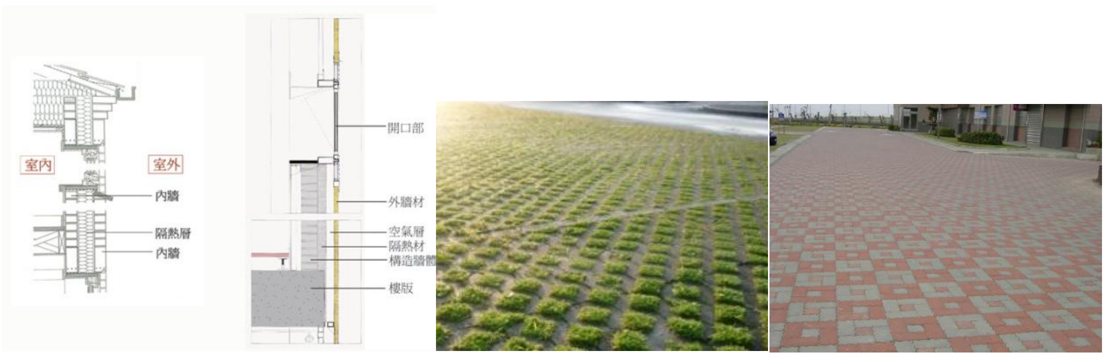


Fig.5.1.16 Details

5.2 Han Street-Sifang Square project

5.2.1Design Explanation

Pei County is located in the northwestern part of Jiangsu Province, northwest of Xuzhou City, and is located at the junction of the four provinces of Jiangsu, Shandong, Henan, and Hebei. Peixian County is located at 34 degrees 28 minutes 34 degrees 59 minutes north latitude, 116 degrees 41 minutes east longitude, and 117 minutes 09 minutes east, with a total area of 1576 square kilometers. All of them are alluvial plains, with elevations falling from 41 meters in the southwest to 31. 5 meters in the northeast. Peixian County is a semi-humid monsoon climate with warm winters. It is cold and dry in winter, hot and rainy in summer, warm and fresh in autumn and spring. The average annual sunshine is 2307. 9 hours, the annual average temperature is 13.8 degrees, and the average annual precipitation is 766mm.

Pei County is the hometown of Emperor Liu Bang of Han Emperor and to be the county during Qin dynasty. It is known as the "the dragon flies out, Emperors comes out generation by generation" and is known as the birthplace of Han culture. Pei County is also the ancestral hometown of Zhu Yuanzhang, the Ming dynasty ancestor, and is known as the "first family of the Ming Dynasty". Pei County has convenient transportation and the Beijing-Hangzhou Grand Canal passes through. The highways lead in all directions to form transportation hubs linking Lunan, Yubei, Yudong and Subei.

Han Street is a cross-shaped imitation Han Street built in recent years in the center of Pei County. It has a total length of nearly 1000 meters. Both sides are all imitation Han-style buildings with black bricks and black tiles. It was once the largest and most concentrated imitation Chinese style commercial street in the country.

Sifang Plaza is the second phase of the Han Street project and is closely adjacent to the first phase of the Han Street project. The west side of Sifang Square is close to Xiangyang Road, the north side is about 100 meters away from Seoul Road, and the east and south sides are connected with the first phase of Han Street. The total land area is about 18738 square meters, and the floor area ratio is controlled below 2.0. Including the first floor, the second floor of the commercial floor, part of the three- to four-story apartment, as well as part of the three to five-story resettlement housing. Specific considerations are as follows:

1. Street businesses include supermarkets, apartments and restaurants;

2.the middle of the north to take counter-competition, to create high-end business district, to adapt to middle and high-end goods such as famous stores, stores stationed; the middle of the south to the tourism culture, local characteristics, build Pei County characteristics.

Fig. 5.2.2 South Elevation

Fig. 5.2.3 East Elevation

3. The introduction of Jinjiang Star, KFC and other national brand-name chain stores joined to enhance the brand and grade of the entire commercial street.

5.2.2 Analysis of the status quo

Topographic Analysis ： The plot is located in the prosperous central area of Pei County, close to the first phase of the Han Street project. The surrounding communities are mature, commercial and prosperous. There are some shabby and low-rise buildings surrounding the current status of the block, with a parking lot in the middle and less demolition and relocation. The terrain within the block is flat and the geological conditions are good, which is conducive to development and construction.

Functional layout: the location of the site is easily accessible, especially along the west side of Xiangyang Road. Each part of the commercial content must be combined with location conditions and be developed in line with local conditions. At the same time, the accessibility of the second floor should be improved to provide convenience for stimulating business on the second floor. The three to four floors along the west side are less accessible and are part of the apartment.

Style shaping：As the birthplace of Han culture, Pei County has the advantages and responsibilities of inheriting and continuing Chinese culture. Han Street is a commercial complex with distinctive local characteristics and traditional Han architectural style. The Square Plaza project should achieve a win-win situation in shaping the commercial space and shaping the cultural environment. Design Description Pei County, Jiangsu. Han Street Square Plaza construction detailed planning.

The actual pictures and analysis pictures showed in Fig.5.2.1 appendix.

5.2.3 Overall layout

1. Layout idea

The function of Sifang Square can be divided into three parts: commercial, apartment, and residential. In terms of space planning, commercial buildings are located on the first and second floors of all buildings, and apartments and houses are divided into more than three levels. The apartments are mainly located along Xiangyang Road and are located on the west side. The houses are mainly on the east side. The results of a comprehensive analysis of multiple factors such as sexuality, quiet zones, etc.

Fig. 5.2.4 North Elevation

Fig. 5.2.5 Wast Elevation

2. Traffic organization

The commercial traffic in the entire region mainly comes from the west side of Xiangyang Road. According to the functional planning, the streamline organization includes the following five items: commercial streamline, residential streamline, apartment streamline, firefighting streamline and parking, in which the streamlines of commercial streamlines and apartments (also serving as office business services, etc.) can be merged. The residential streamline is introduced from the east side, and the firefighting streamline includes the firefighting ring line and the pedestrian street route in the middle. In general, business streams are organized from west to south and residential streams are organized from east to north. The perimeter motorway is 6 meters wide.

3. Business planning

The business function of Sifang Square is planned based on urban roads and commercial pedestrian streets. According to the location relationship, it can be divided into five categories :(1) Introducing the main store to drive the formation of the entire commercial circle. Has successfully negotiated with the Shanghai Jinjiang Star Tourism Chain Store as a business attraction project to enhance the taste and grade of the commercial circle;(2) Businesses facing the street, focusing on tourism, culture, and catering, accelerating the formation of the commercial circle;(3) Commerce on both sides of the pedestrian street, through the introduction of Jinjiang Star and condensing popularity, pulling the commercial value of both sides of the space;(4) The east side of the ring road is a commercial street with narrow roads, but is located on the street level with high accessibility.(5) The second-floor commercial buildings are accessed through a single-story single-family staircase. The width of each room is 4 meters as the basic unit.

4. Relocation Residential

According to the requirements of the urban construction management department, the site development needs 8680 square meters of resettlement area and a total of 89 residential buildings. In the planning plan, the resettlement house includes all 87 houses with a total area of 9,500 square meters. The net height of the top floor loft is more than 2.2 meters in total, and half of the area is between 1.2 and 2.2. According to the "Regulations on the Administration of Urban Planning Technology of Jiangsu Province," the sunshine in Xuzhou is required by the Great Cold Day for 2 hours according to the time. New residential houses in the transformation of old districts can be exposed to sunshine for 1 hour on the Great Cold Day. Each dwelling in this design scheme is controlled by a 1.44 pitch factor, and all sunshine measurements provide for meeting the sunshine requirement.

Fig.5.2.6 Rendering night view *Fig. 5.2.7* Partial rendering view

5. supporting facilities

The garbage station is located on the northernmost side of the site, public toilets are located on the north side, activity rooms and properties are located on the second floor on the north side, and public green spaces and fitness sites are planned at the northeast corner of the site. According to the "Regulations on the Technical Management of Urban Planning in Jiangsu Province", commercial vehicles are sold at 50 vehicles per 10,000 square meters, and residential vehicles are allocated according to 0.6 units per household. The calculation results are 194 vehicles, all of which are arranged in underground garages. The ground is temporarily parked in the base of a 6-meter-wide circular motor vehicle lane and unilaterally parked.

5.2.4 Architecture design

1. Function

To maximize the commercial value of land development, the ground floor and the second floor are all equipped with commercial facilities. The commercial building area of Sifang Square covers an area of more than 8,500 square meters of the first and second floors. All of them have a main surface width of 4.2m, a height of 5.1m, a height of 3.6m in the second floor, and a height of 3.3m in the three-story and four-story apartment buildings. Residential houses are divided into six types of houses A, B, C, D, E, and F. The flat design of residential buildings is based on functional requirements, and the floor height of residential buildings is designed to be 2.8 meters. Satisfy the planned height limit of 15.6 meters for the limited roof opening.

2. Form

The facade of the commercial building reflects the architectural style of the Han Dynasty. Most of the two-story parapet walls have imitation Hanpo ceiling decoration. The house is modelled on the simplified Han Dynasty architecture. The white walls, the terracotta tiles, the vermilion columns, and the swaying eaves, are displayed through the organically-combined structure of the delicate detail nodes and the materials. Strive to achieve a style and higher grade by imitating the structure and texture of the wooden structure. The top floor of the resettlement house is designed as a loft, with the form of a crest, and the attic space adopts the original dual-ridge skylight lighting method. (Fig.*5.3.8 Appendix)*

3. climate responsive measures

Most of the main housing plans in this project are facing south, and almost all rooms (including most toilets) can be naturally ventilated and lighted.

The vast majority of building plans are as regular as possible, and the depth of residences and apartments is very large, so as to reduce the shape coefficient of building as much as possible.

The windows with good airtightness (including balcony doors) should be used in the design of this project, and the airtight grades can refer to the requirements of <energy saving design standards for civil buildings>.

Green roofing. Most of the commercial roofs of the second floor are designed as roof vegetation, and the green roof area is approximately 1200 square meters. Roof greening can effectively increase the thermal resistance of the roof, and play an climate responsive role. At the same time, it can also improve the microclimate and improve the living environment.

To ensure the architectural style of the façade, the attic of the commercial building adopts the skylight inner courtyard and the residential loft adopts the original dual-ridged skylight lighting method, which is invisible from the street view angle, and can effectively reduce the lighting energy consumption. (*Fig.5.4.8 Appendix)*

4. Landscape Greening

The design landscape system consists of the street square landscape and the pedestrian street landscape. The elements of the street square and pedestrian street landscape include the facades of antique buildings, unified planning of shop moves, shopping activities, and square furniture and greenery. The scale, color, font, and style of the shop's move must obey the overall planning requirements of Han Street. Square paving and pedestrian street paving should pay attention to texture, pay attention to non-slip, green along the street plaza can consider tall trees, pay attention to summer shade. The greening of the pedestrian street shall take into account the landscape effect and reserve fire passages. It is suggested that the rest seats be closely combined with the greening. Greenland rate indicator is 15%. Based on this, the roof of the second-floor commercial residential roof design between residential buildings is greened, and the green roof area is 1,180 square meters.(*Fig.5.5.8 Appendix)*

The current stage of the project is in the stage of construction(*Fig.5.6.9 Appendix).*

5.3 Grid electric power smart grid high-tech industry park project

5.3.1 Project Introduction

During the "Twelfth Five-Year Plan" period, we persisted in implementing the scientific concept of development, making building energy conservation and green building a priority theme and development priority in the field of urbanization and urban development, facing the national goals for energy conservation and emission reduction, and people's livelihood needs, and focusing on transforming the development mode of the construction industry. Solve the outstanding problems in the industrial development of the industry and strengthen the research on technical systems that support the sustainable development of green buildings, form a complete set of green building technology systems and evaluation systems with China's independent intellectual property rights and in line with national conditions, and build a demonstration platform, train innovative teams, and cultivate green buildings. And supporting the development of emerging industries, improving the living environment, and enhancing the comprehensive capacity of sustainable development of urban construction.

Emphasizes the "people-oriented" planning and design philosophy and pays attention to the construction and cultivation of the ecological environment. The land in the area is flat, with good geology and high topography. Infrastructures such as roads, power supply, water supply, natural gas, communications, sewage discharge, and rainwater discharge have all been basically completed. The park has set up an international life supporting community with convenient traffic and clean air. The strong industrial base enables the park to have superior industrial supporting capabilities.

The base is adjacent to Shenzhou Road to the east, Taiyun Road to the north, and both the west and the south are planned land. The surrounding facilities of the base are abundant, and there are multiple health service centers in the surrounding area. There are several secondary school and elementary school school district resources around the base, which make it convenient for the children of factory workers to receive good cultural education nearby. In the north of the base, there are the Shanghai Rose Garden Trade City and the Haitai agricultural and sideline products wholesale market. On the south, there are the Shanghai Touqiao Xiaoyang Market and other farmer trading markets. These surrounding trading markets can provide company staff with the convenience and benefits of living.

The functional settings of this project include: Getty Power Headquarters Administration and R&D Center, Research Institute Headquarters Administration and R&D Center, Experiment and Testing Center, Academic and Training Center, Science and Technology Building (Academician Workstation, Postdoctoral Workstation, etc.), Logistic Service Center (Employees Restaurant, staff apartment, activity center, etc.). Getty Power Headquarters Administration and R&D Center (16,000m2), Research Institute Headquarters Administration and R&D Center (13,000m2), Experiment and Test Center (13,000m2), Academic and Training Centre (6,000m2), Science and Technology Building (1,000m2) Logistic Service Center (6,000m2).

5.3.2 design explanation

The podium is adorned with green roofs and four levels of height, with different sizes of atriums interspersed. The height of the towers is 5, 6, and 8 floors, respectively. The functions of the tower are mainly academic centers, research and development centers, experiments and testing centers. The main function of the podium is logistics service and scientific research.

Fig.5.3.1 Overall functional layout

5.3.3 Sustainable strategy

Three major benefits: economy, the earth and humanity. Economy encourages innovation in technology and production; reduces annual energy and operating and maintenance costs; reduces transport and waste disposal costs; reduces liability due to poor indoor air quality; enhances market value of buildings and visibility into tenants; attracts and retains talent, tenants, buyers and consumer groups. The Earth protects and conserves limited resources; reduces pollution; protects the natural ecological environment; and reduces carbon emissions. In the human aspect, it improves the tenacity of the resident population; improves the comfort of the resident population; enhances the satisfaction of the resident population; and supports local economic development.

The project uses an intelligent system, an operating environment that is effectively regulated and has all aspects of related systems, as an ecosystem covering energy, emissions, services, etc.; and optimal management at the building or park level, and its internal Systems (such as building automation systems) work together and organically form part of a smart city. They send key event information to the city command center and accept instructions from the city command center. (Fig.5.3.2Appendix)

Building intelligent system utilizes modern communication technology, information technology, computer network technology, monitoring technology, etc. Through automatic detection and optimization control of buildings and construction equipment, optimal management of information resources, and intelligent control and management of buildings. Satisfy the user's needs for building monitoring, management, and information sharing, so that intelligent buildings are safe, comfortable, efficient, and environmentally friendly to meet the goals of investment and meeting the needs of the information society.

Using Vasari to analyse the wind environment, according to the southeast wind, which dominates the wind direction in the summer, the southeast corner of the building is opened, conforming to the prevailing winds. In the north-western corner of the building complex, the building blocks the flow of cold winds from the northwest during the winter, preventing certain heat losses and reducing operating costs.

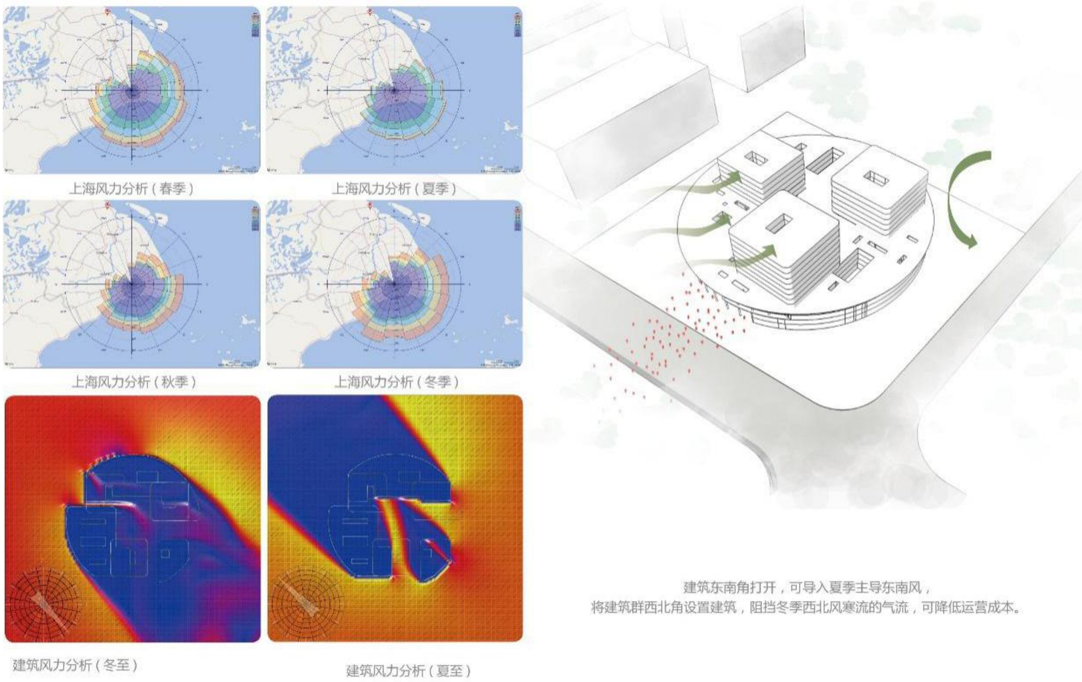


Fig.5.3.7 Wind analysis

According to the analysis of the Sundial Map, solar radiation is severe in the south and west of the building. It is necessary to adopt certain measures. The north and east sides have little radiation throughout the year and do not need to use a lot of shade measures. (*Fig.5.3.7*, *Fig.5.3.8*)

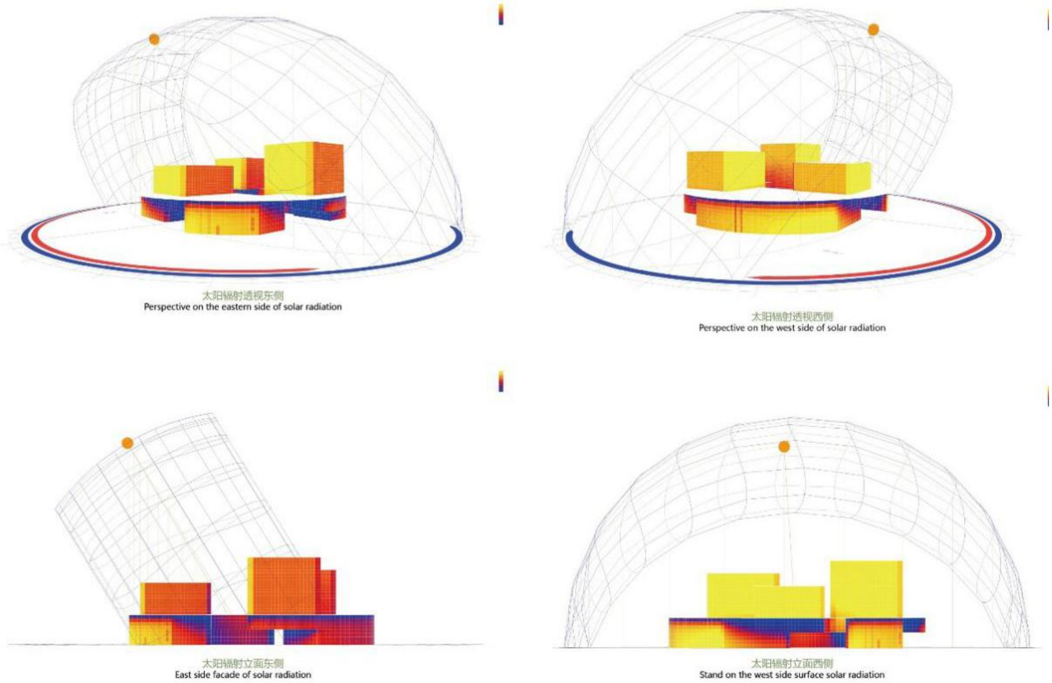


Fig.5.3.8 Sundial map

Fig.5.3.9 Shading elements

In the maintenance structure design, three glass materials were used for solar radiation analysis and solar radiation. Considering economic factors at the same time, the plan adopts double-layer ordinary glass. (*Fig.5.3.9*)

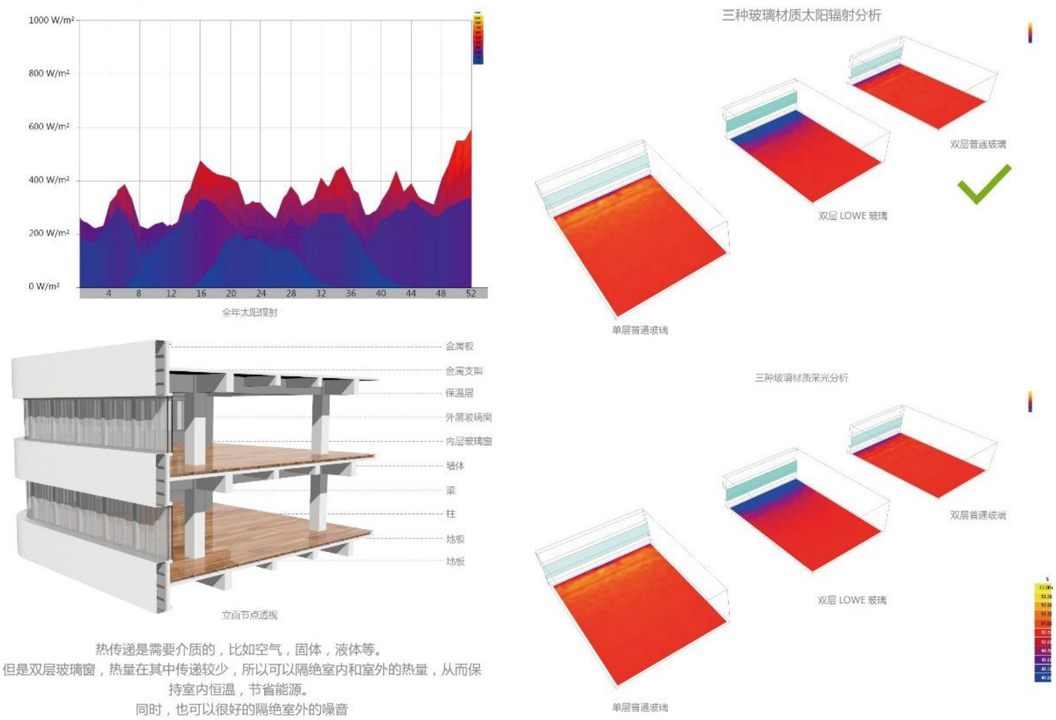


Fig.5.3.10 Sunshine and radiation analysis

In terms of HAVC, the uppermost tower uses centrally-controlled air-conditioning, which is economical and climate responsive. The host computer is controlled by a micro-computer-controlled end fan tray. The system is automatically operated according to the actual load, effectively saving energy and operating costs. The top of the skirted house is covered with greenery to reduce the loss of energy consumption and reduce the use of air conditioning systems. The logistic service staff part adopts a separate type air conditioner, which avoids the disadvantages of the central air conditioner fully open and closed and reduces energy consumption. The office and study area of the podium uses VAV-type air conditioners, and through some of its sensors, it is possible to adjust the air in various parts. Light wells are installed in the basement to reduce mechanical ventilation and achieve air circulation, while reducing equipment costs.

In the use of water resources, rainwater is absorbed by roof plants and excess rainwater is collected by buildings. The toilet uses small-flow drainage faucets, water-free sanitary ware, and twice-washed toilets use the above measures to reduce water consumption by 40%. Water and rainwater collected by the building is reused to reduce water consumption.(*Fig.5.3.10*)

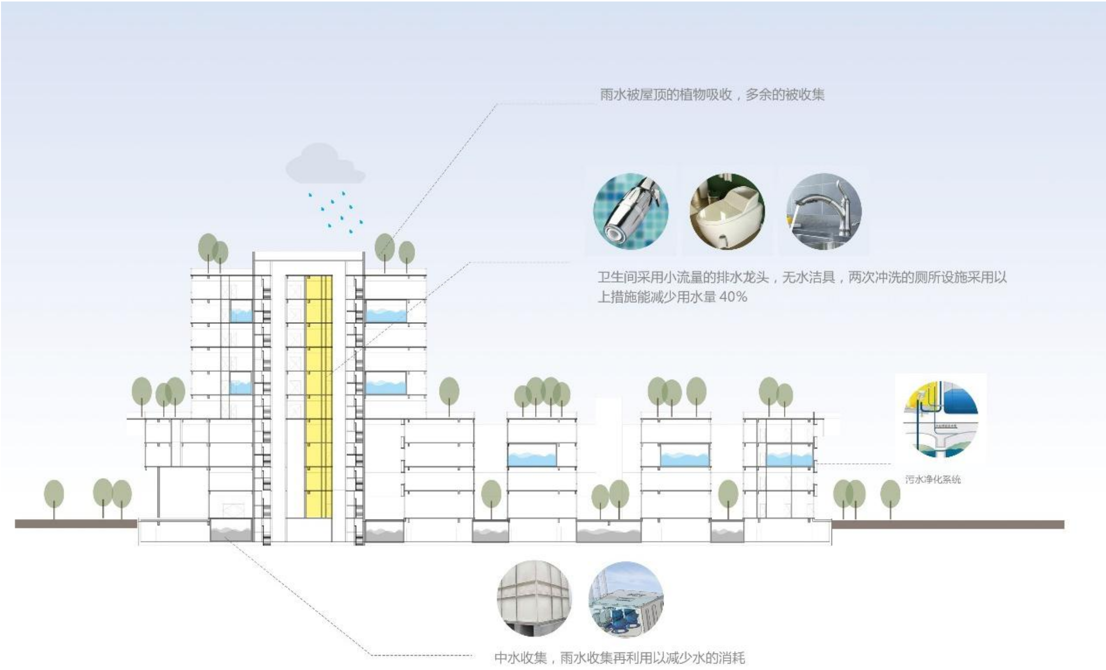


Fig.5.3.11 Water use

The podium and the interior of the tower allow vertical greening of the interior of the building. At the same time, as much natural light as possible is introduced into the building to reduce the energy consumed by the artificial lighting. The chimney formed by the patio takes away the hot air and exhaust gas from the building. (*Fig. 5.3.11* Appendix)

5.4 Summary and Further research

Through three practical design projects from climate, the specific application of effective ecological strategies in the design process under local climatic conditions is analyzed.

In the future, the actual design project, while inheriting the traditional design strategy, is aimed at the changing climate phenomenon, while constantly seeking the aesthetics of the building while satisfying the cultural, social and economic requirements of the user. The continuation of the responsive architectural design concept combines the dynamic skin, dynamic space, and virtual interaction system with the design; thus enabling the building to respond to climate change in a more targeted and real-time manner.

Chapter 6. Conclusion and Reflections

6.1 The main Conclusions of this Dissertation

Statements: （according to the 6 chapters）

1. It is imperative to explore the issue of how the building adapts to the microclimate characteristics in order to play the most effective ecological climate responsive strategy in the local architectural design that adapts to local climate conditions.

-- The relationship between ecological **environment**, **architecture and mankind** is closely related, and people and nature need to live in harmony.[21]

-- Scholars and architects around the world have **tried** different ecological and energy conservation strategies combined with architectural design in their academic and practical fields in response to their different climate characteristics, but still in the process of exploration.

-- **Efficient** ecological climate responsive strategies can ease **energy crisis**, reduce **natural disasters** and ensure the **comfort** of users.

-- Architects need effective and detailed **findings as a reference** or guideline for the design process.

• The Expression of Regional Culture of Contemporary Large Space Public Buildings under the Background of Globalization[J] is connected with the first chapter.

2. Investigate the **classification** and **characteristics** of the climate zones in China and the zoning and differences of the internal climate in the hot summer and cold winter blocks.

-- Classify the geographical characteristics, climate characteristics and climate data of the five climate zones. Analyze the more detailed **climate** zones and **geographical** zones in the hot summer and cold winter regions. It is found that there is a certain **correlation** between climate and geographical terrain.

-- The analysis of the formation of typical traditional buildings from the perspective of **economic, culture** and **society** is not only affected by the local climate, but also influenced by other factors.

-- According to the **Shanghai** meteorological data, we can visually analyze solar radiation, temperature, humidity, wind and other **climatic** factors.

3. According to China's five thermal zones, the use of **typical traditional building types** with typical characteristics in the district and their ecological climate responsive strategies are sorted out. Investigate the microclimate characteristics of typical

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[21] Chu Xiaohui .The Expression of Regional Culture of Contemporary Large Space Public Buildings under the Background of Globalization.[J] Urbanism and Architecture (Chinese. Aug. 2014, Vol 23, Issue 8).

traditional buildings in different thermal zones.

-- Analyze the **corresponding strategies** for climate characteristics and needs in different microclimates.

-- According to the microclimate characteristics of typical traditional buildings in each sub-region, showing the percentage of **effectiveness** of ecological climate responsive strategies.

-- The **concrete embodiment** of ecological climate responsive strategies in architectural design is analyzed from the aspects of settlement layout, building **orientation,** courtyard and other open space **layout**, plane layout, facade layout design, and building **details**.

4. A **field survey, questionnaires, simulation and measurements**[22] were conducted for a typical traditional building in the mircroclimate of Songjiang District of Shanghai. The effective use of **ecological climate responsive strategies** was summarized and analyzed.

-- Investigate the **distribution** of traditional buildings in Shanghai and survey the **characteristics** of traditional buildings and user **satisfaction**.

-- According to the analysis of the status quo of a typical traditional building, after field measurement, and the microclimate data inside and outside the building were found to be different through the microclimate data measurement of the building part, but there was a **certain correlation**.

--According to the software analysis data and the field research results, the **specific ecological climate response strategies** of traditional buildings under the microclimate conditions are **compiled**.

-- Through the simulation of simulation software, the **comfort and energy consumption** of the current status of Wang House are **accurately quantified** from the microclimate scale, and the existing practical problems are analyzed, and the possible climate response strategies are **proposed**.[23]

• Study on the Passive Cooling Design Strategies of Traditional Architecture in Jiangnan Region and Application. Environmental Architecture [J] and Comfort and Energy performance analysis of a heritage residential building in Shanghai [J] are connected with chapter 4.

5. Appropriate ecological climate responsive strategies can be effectively **combined** in and **applied** to the design process of different actual building projects under different microclimate conditions.

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[22] Chu Xiaohui and Dr. LYU Aimin. Study on the Passive Cooling Design Strategies of Traditional Architecture in Jiangnan Region and Application. Environmental Architecture [J] (Chinese. Sep. 2014, Vol 8, Issue 5), (Chinese translated).

[23] Chu Xiaohui, Mohhammd Reza Ganjali, Tsovoodavaa Gantumur and Rowell Ray Lim Shih.Comfort and Energy performance analysis of a heritage residential building in Shanghai. [J] Pollack Periodica, Dec. 2019 Vol. 14

-- In the design of the Shanghai Jiaotong University Biomedical Transformation Center, according to the characteristics of the analyzed climate elements, measures such as the **Atrium Tower** and **courtyards** to increase natural ventilation efficiency were used to analyze the effectiveness of the strategy through software. At the same time try other effective ecological climate responsive measures combined with architectural design.

-- Through the combination of the Pei County architectural design project (Bottom Commercial Upper Residential buildings) in Xuzhou, China, and the effective ecological climate responsive strategies, the **problem of ventilation and sunlight** caused by the poor and deep housing conditions of the returning households will be solved.

-- The Shanghai Getty Ecological Industrial Park project uses **intelligent system** strategies to monitor and reduce energy consumption in building operations, simulates the flow of summer winter winds, designs a compact distribution of architectural features, and simulates the intensity of solar radiation to design dense shading of building facades. According to the radiation simulation, architectural details such as glass materials were selected, and **the water and rainwater collection system** was integrated with the building, and the **courtyard** and the patio (**atrium**) were designed according to the depth of the building etc.to improve the microclimate.

• The Research on Application and Development of Interactive Architecture-senses and responses. Architecture and Culture [J] is connected with chapter 5.

6. Summarized all the conclusions and innovations of the paper and gave suggestions for future research.

6.2 The Novation of this Dissertation

1. Use innovative methods to combine **modern building projects** with effective ecological climate responsive strategies for design and analysis.

2. Analyze the products of human intelligence - -traditional architecture and **extract** effective ecological climate responsive design **strategies** that target the local climate.

3. Compare the efficiency of climate responsive strategies in all of **China's thermal zones** and identify the differences in **efficiency percentage** and effectiveness of the region due to the climate.

6.3 Future Research Prospects

1. Long-term **energy** consumption simulations and longer-term **CFD s**imulations of building models and actual buildings are needed to **accurately** determine the relationship between microclimate and architecture.

2. Meteorological measurement and **recording instruments** need to be set up on the building body to **accurately collect** microclimate meteorological data to eliminate the error of data provided by the nearest meteorological station.

3. The use of simulation software requires the use of more **accurate visualization software** to achieve data reliability and visual intuition.

4. In the actual project application, on the basis of the architectural discipline, the **multi-discipline** is combined to explore the **interactive architecture** and its components of the corresponding microclimate.[24]

[24] Chu XiaohuiGe Dan, Shang Wen. The Research on Application and Development of Interactive Architecture-senses and responses. Architecture and Culture [J] (Chinese. Mar. 2018, Issue 5)

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Appendix

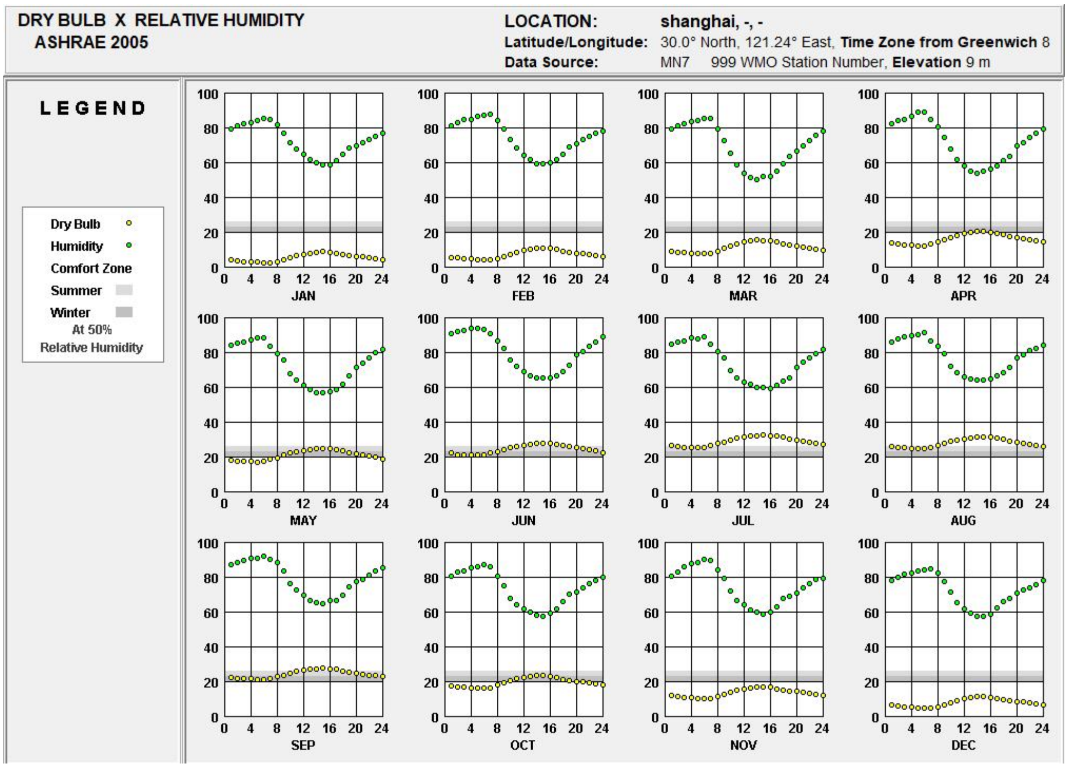


Fig.3.2.1. Dry Bulb and Relative Humidity(Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

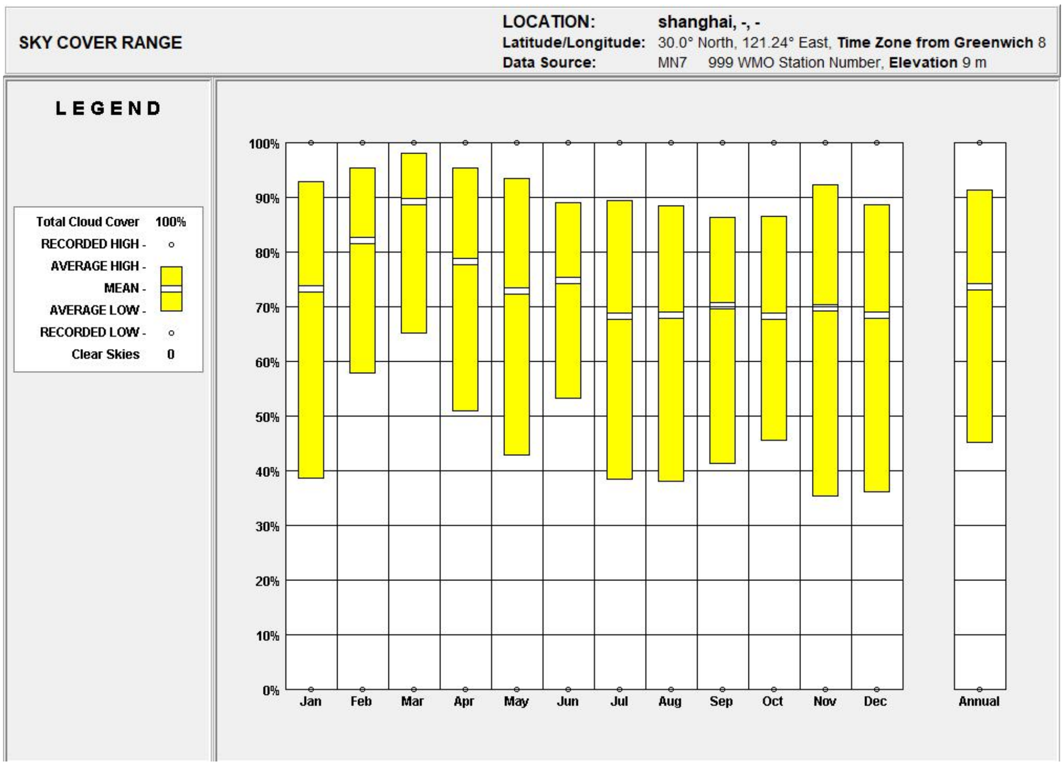


Fig.3.2.2. Sky Cover (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

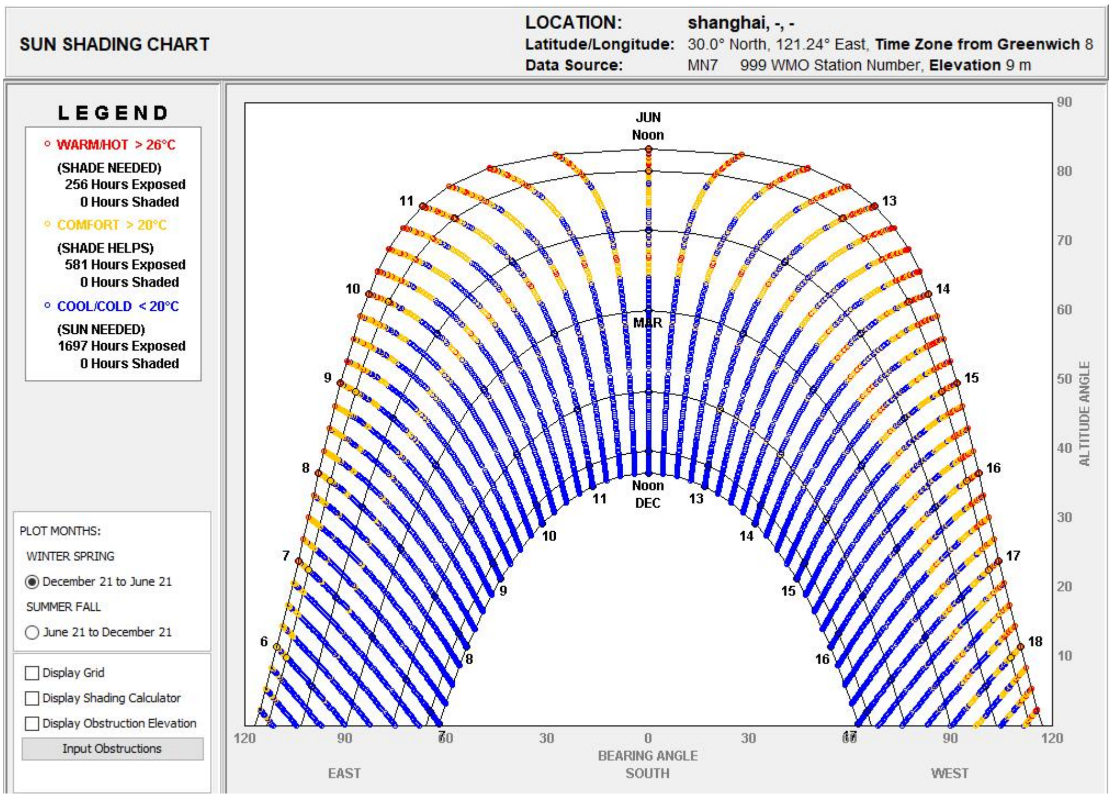


Fig.3.2.3. Sun Shading Chart (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

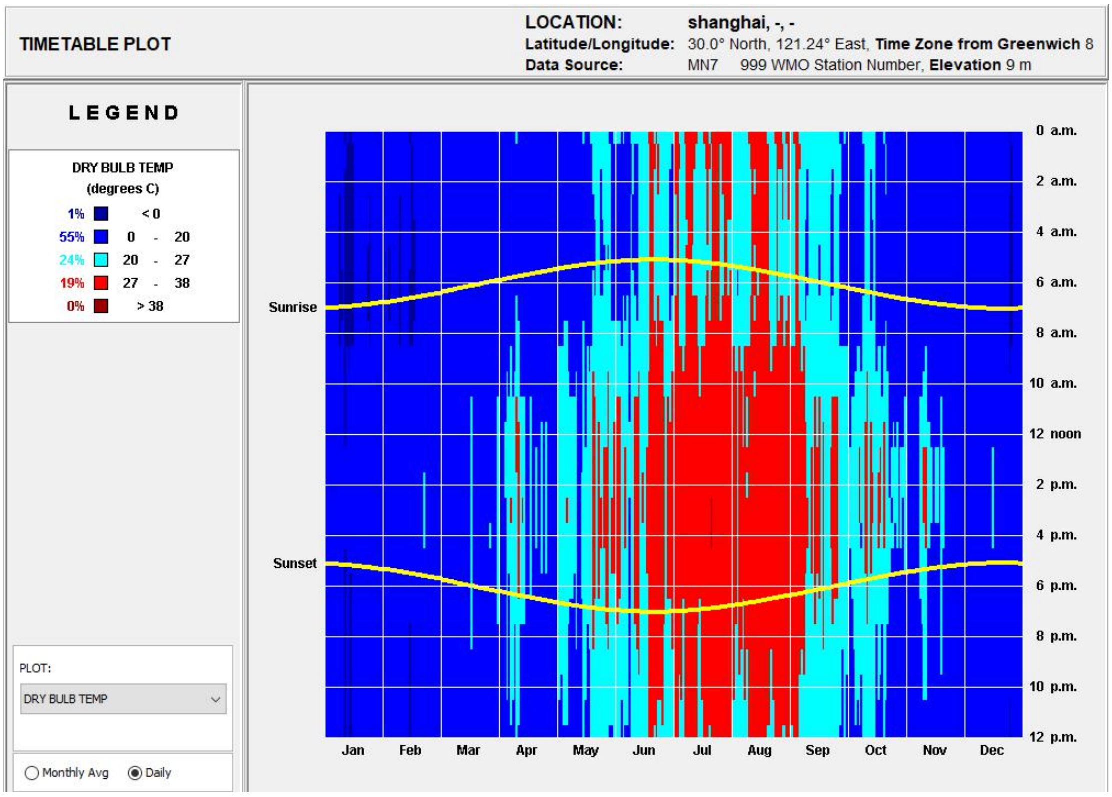


Fig.3.2.4. Timetable Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

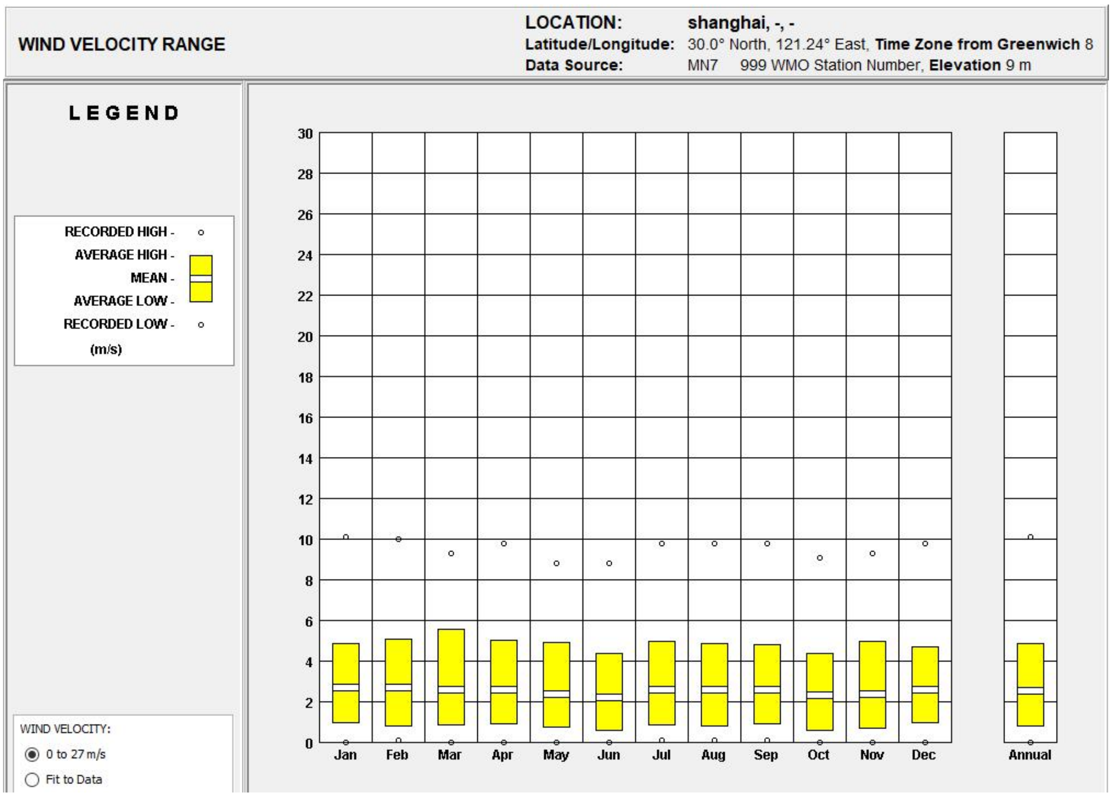


Fig.3.2.5. Wind Velocity Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

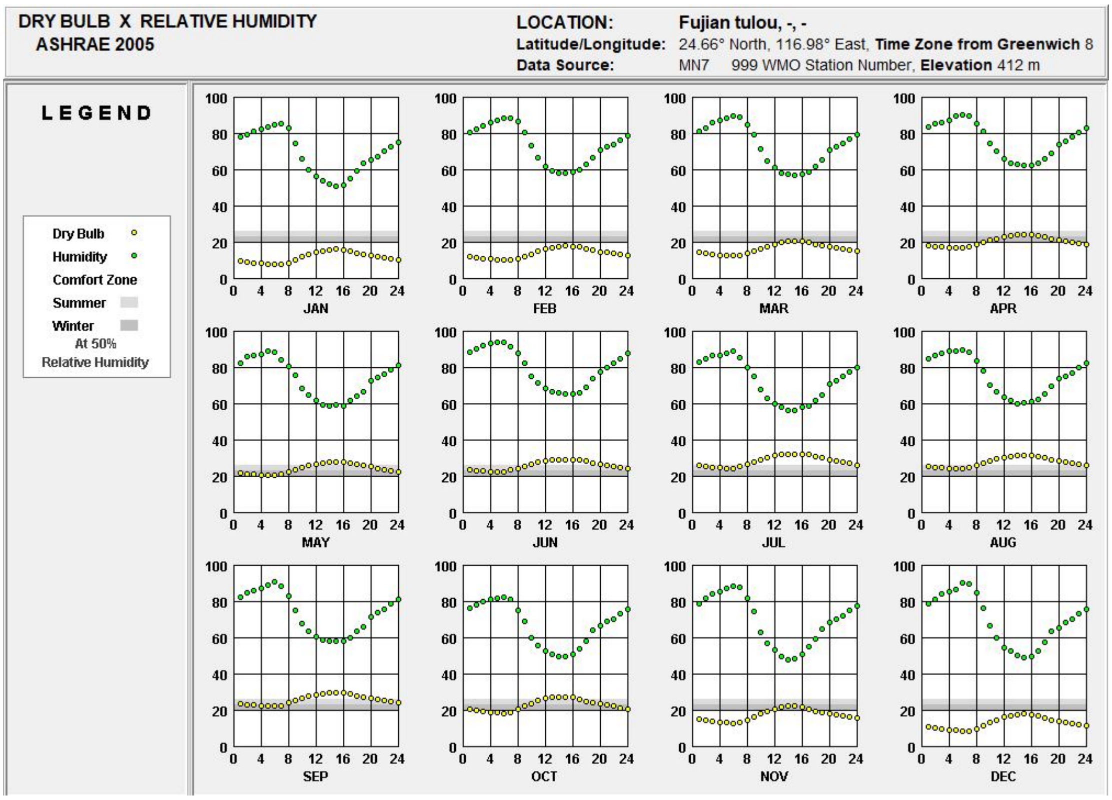


Fig.3.3.1. Dry Bulb and Relative Humidity(Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

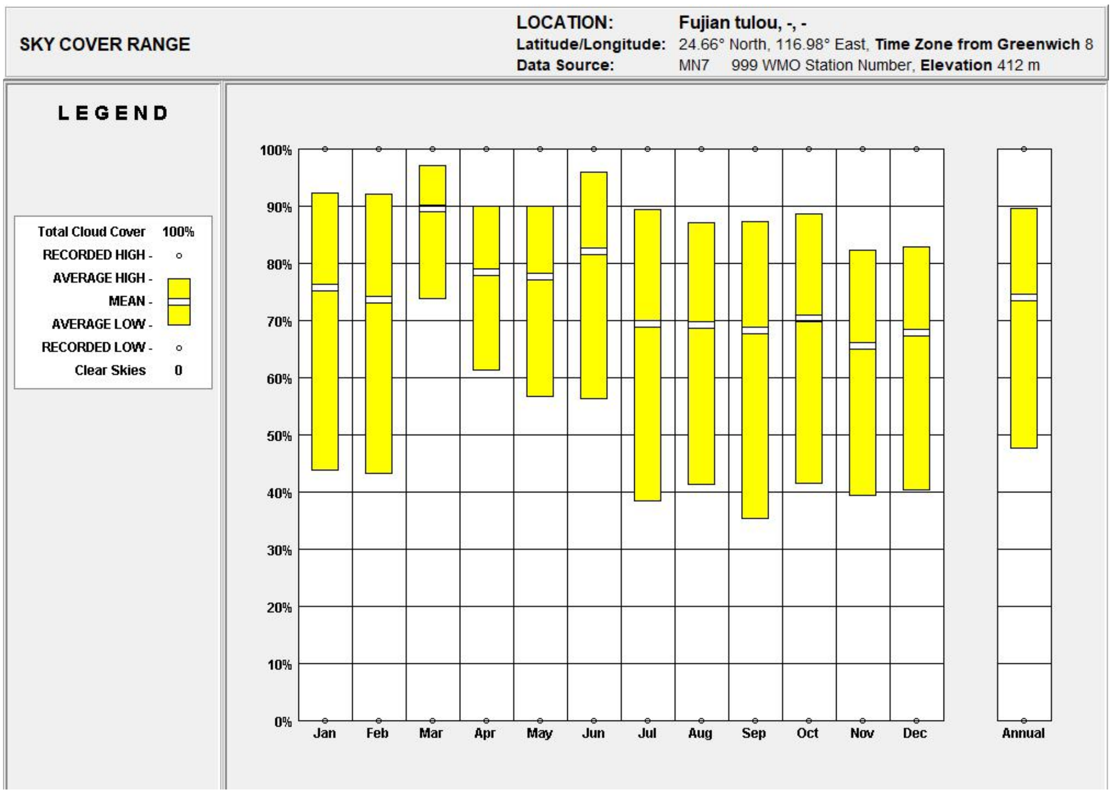


Fig.3.3.2. Sky Cover (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

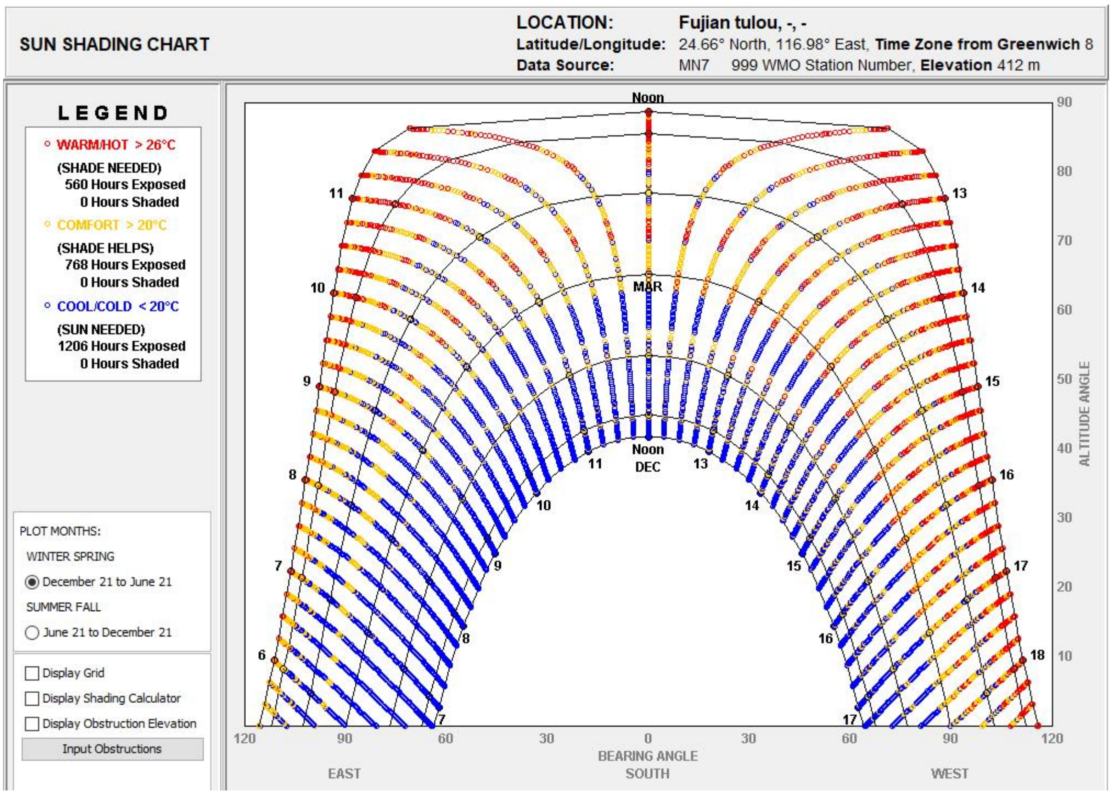


Fig.3.3.3. Sun Shading Chart (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

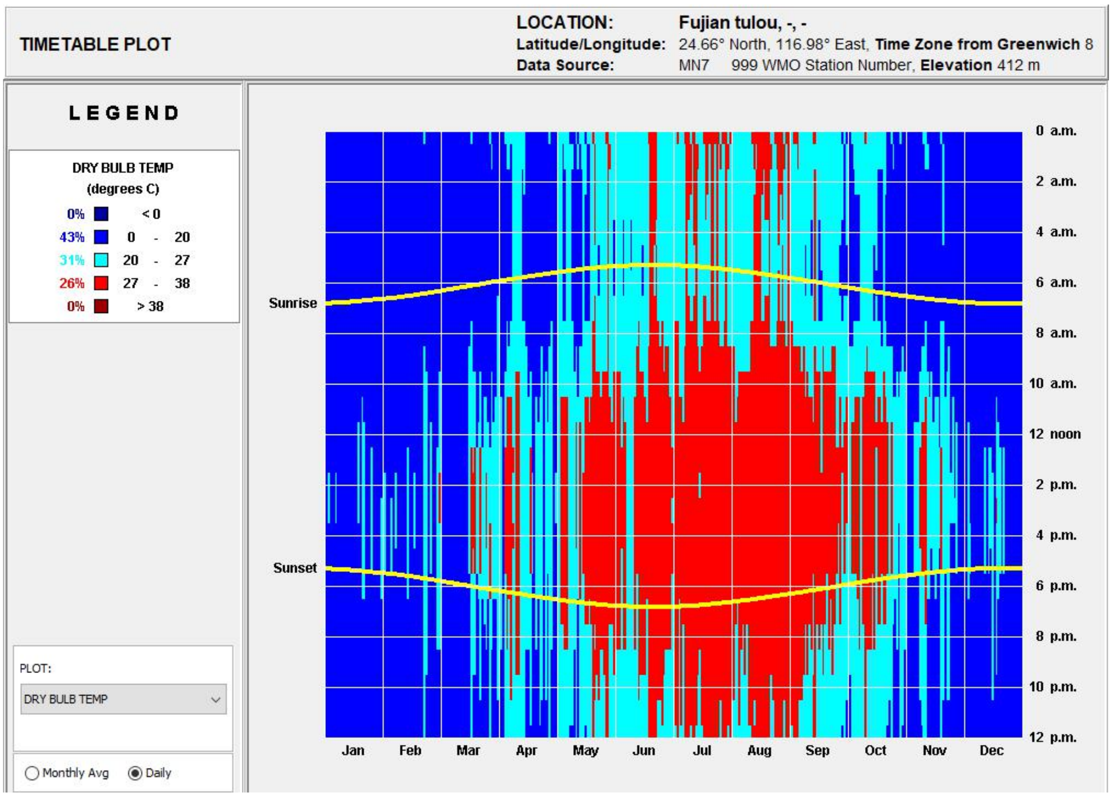


Fig.3.3.4. Timetable Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

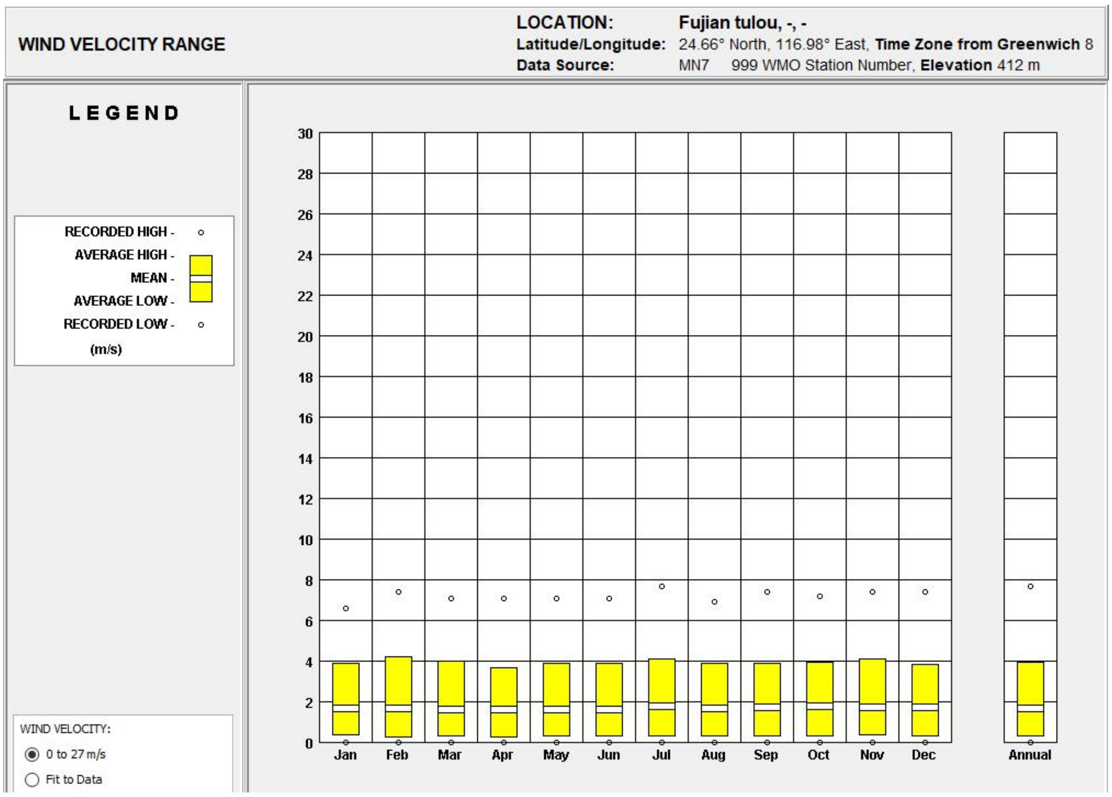


Fig.3.3.5. Wind Velocity Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

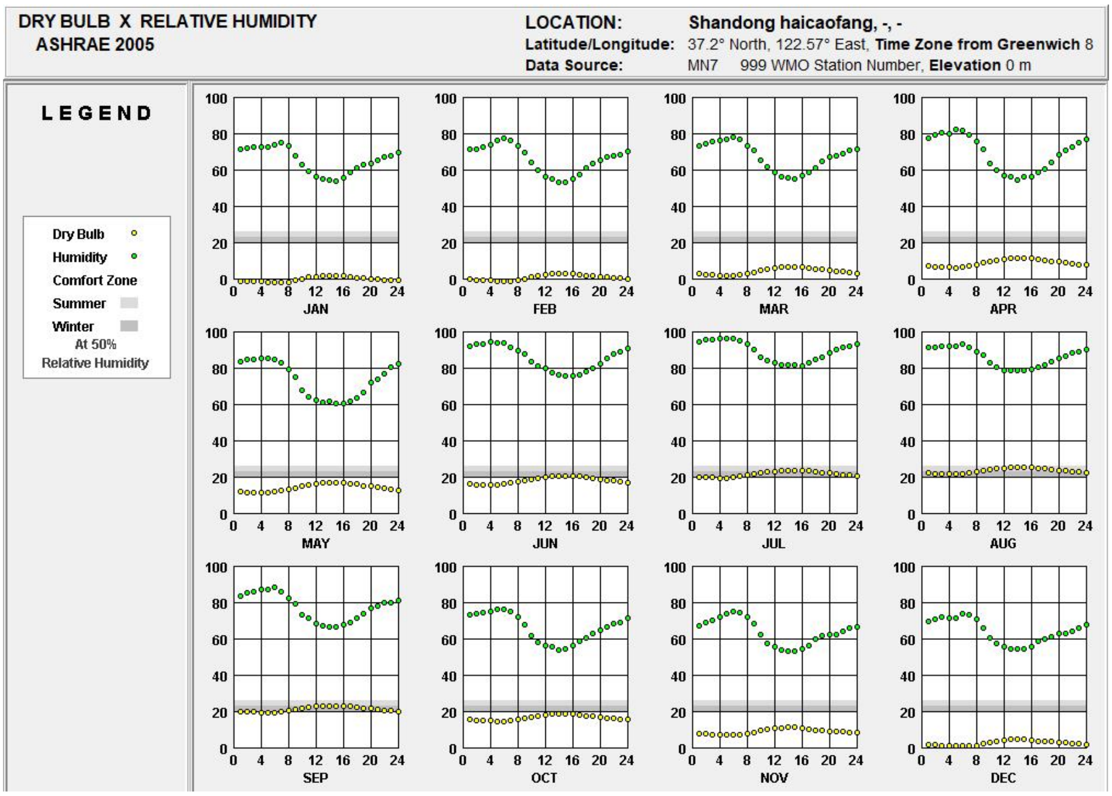


Fig.3.4.1. Dry Bulb and Relative Humidity(Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

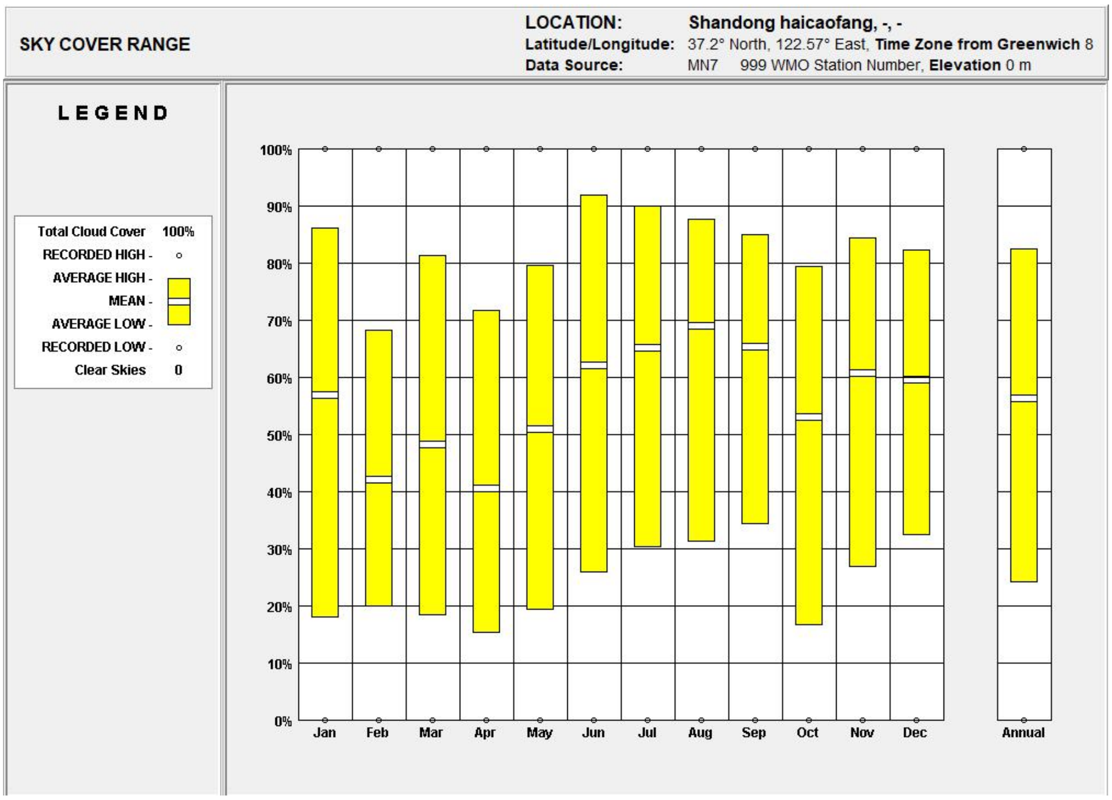


Fig.3.4.2. Sky Cover (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

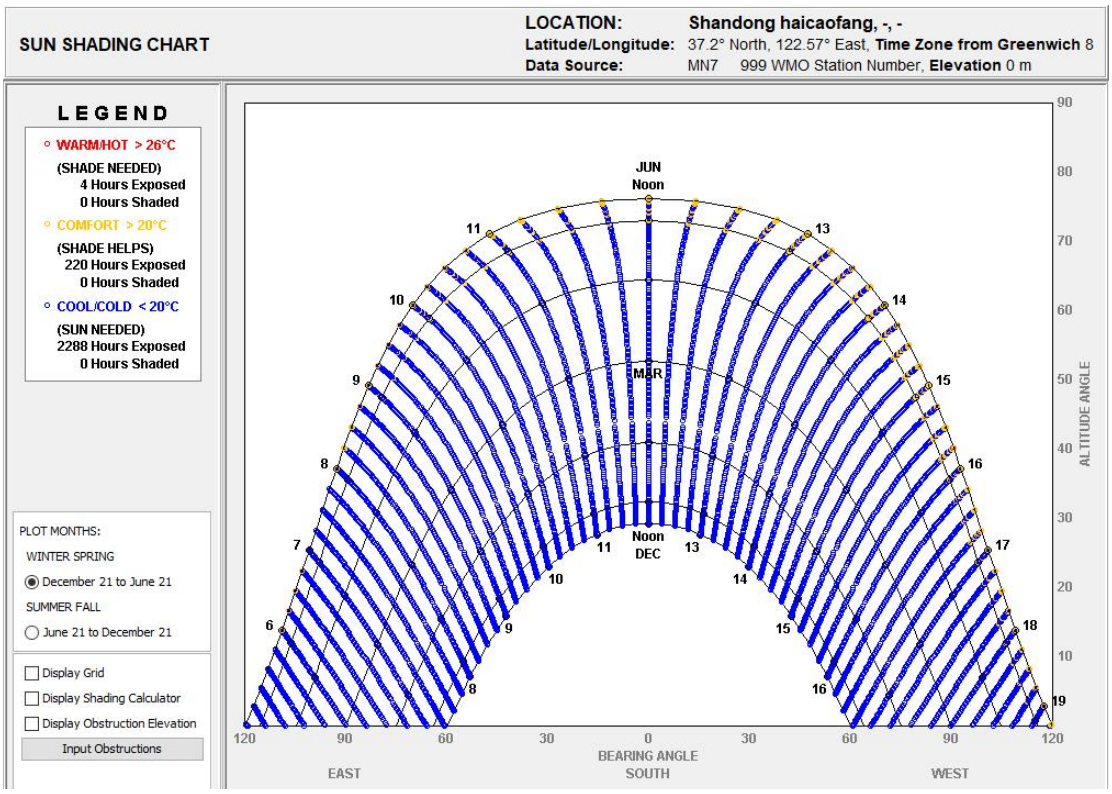


Fig.3.4.3. Sun Shading Chart (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

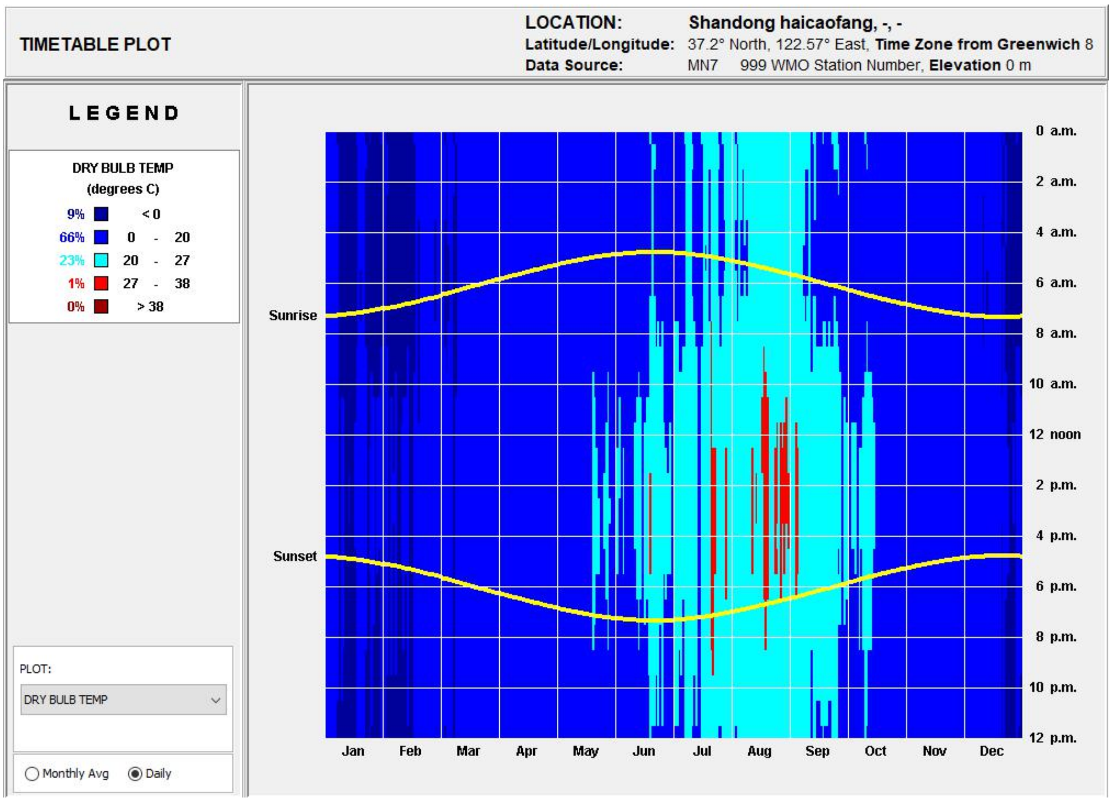


Fig.3.4.4. Timetable Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

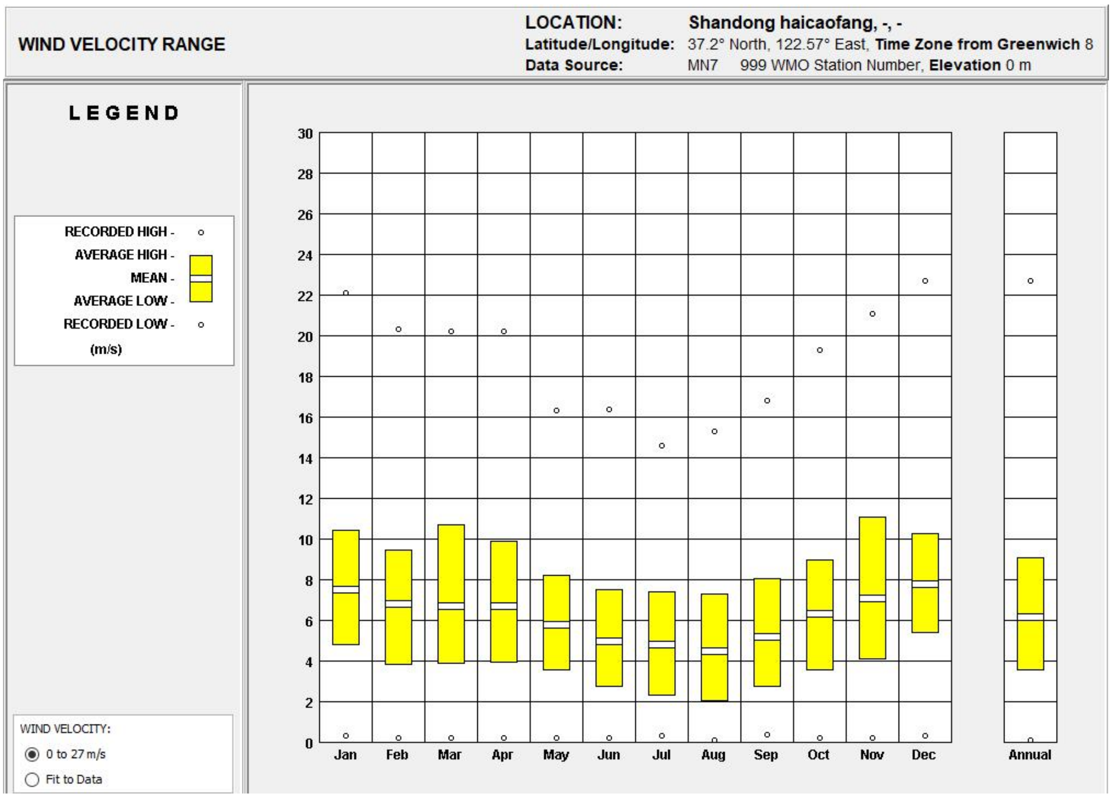


Fig.3.4.5. Wind Velocity Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

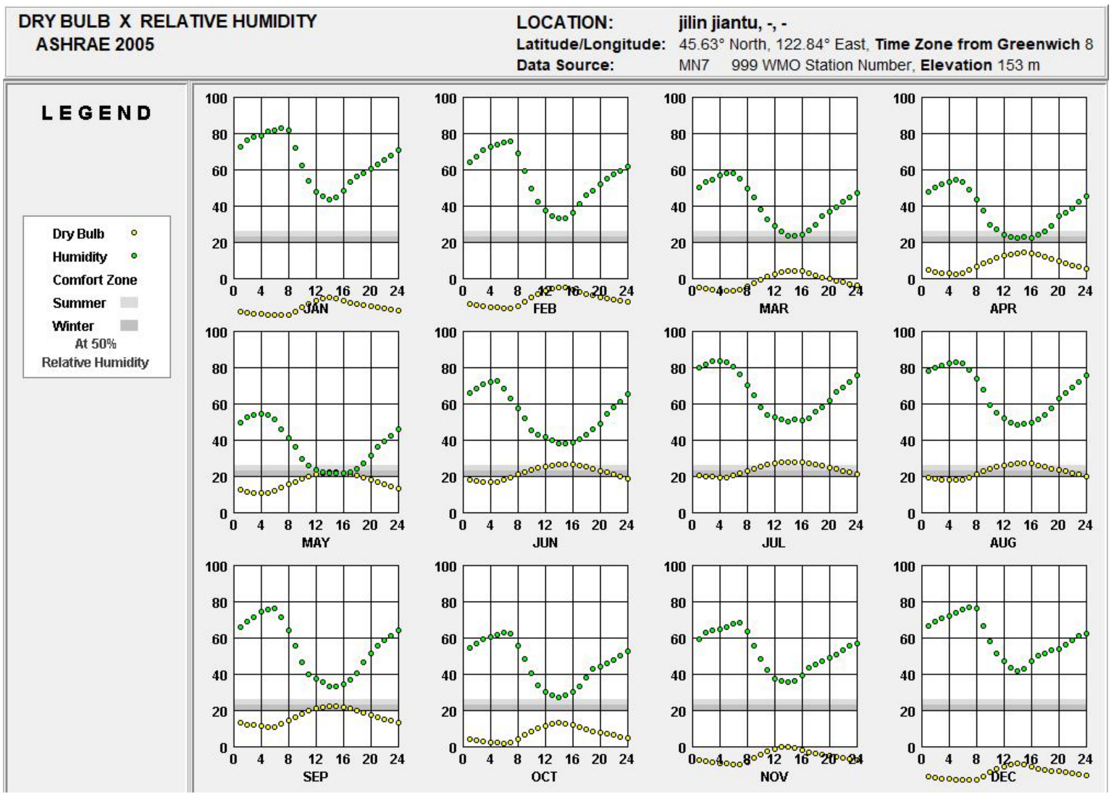
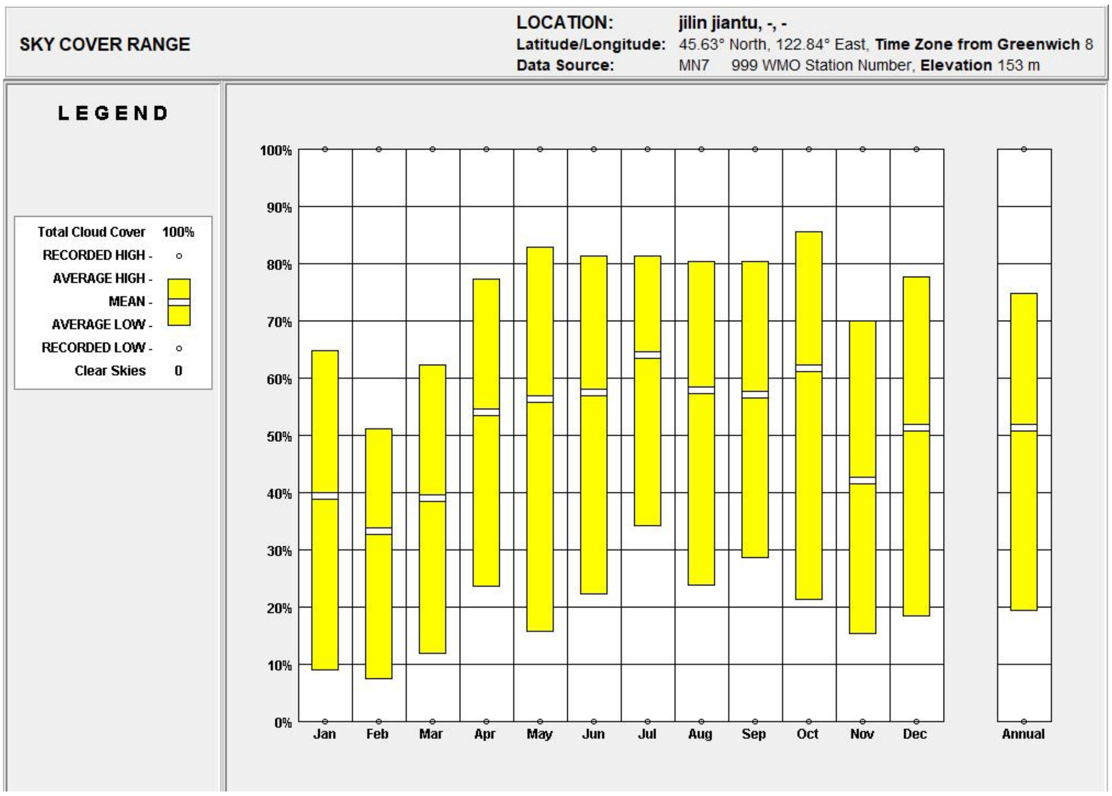


Fig.3.5.1. Dry Bulb and Relative Humidity(Meteonorm 7.0 weather data; Cliamte Consultant 6.0)



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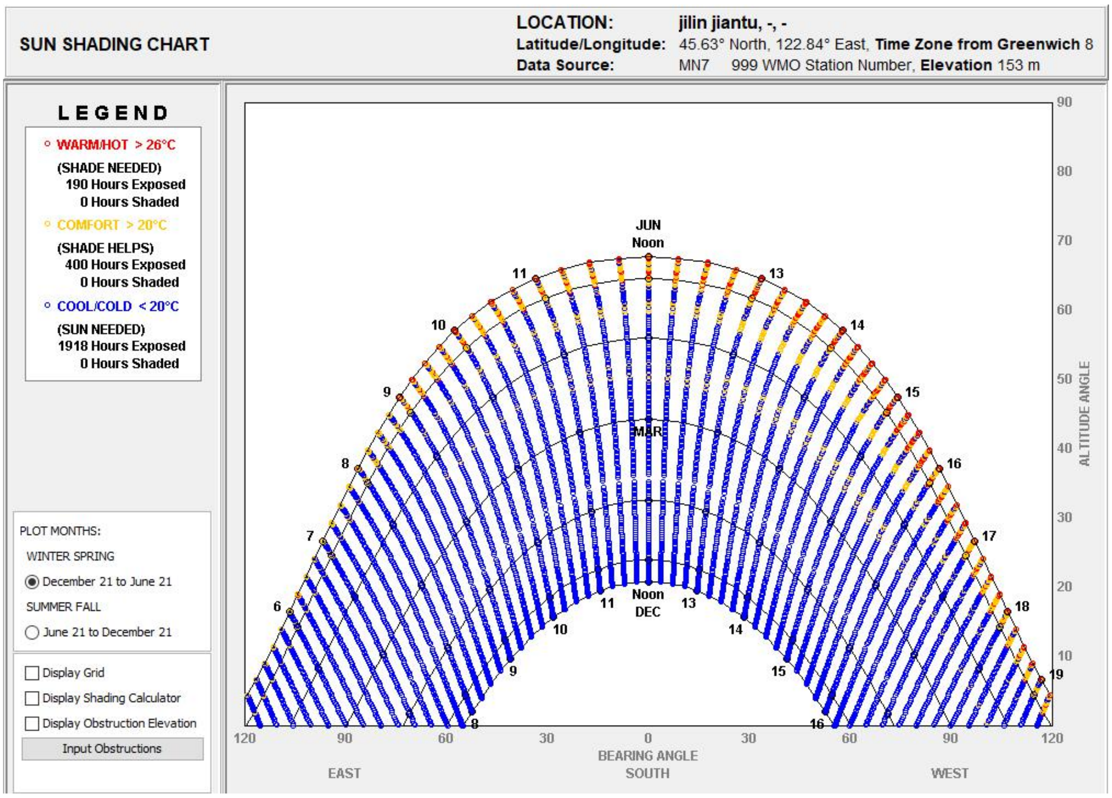

Fig.3.5.3. Sun Shading Chart (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

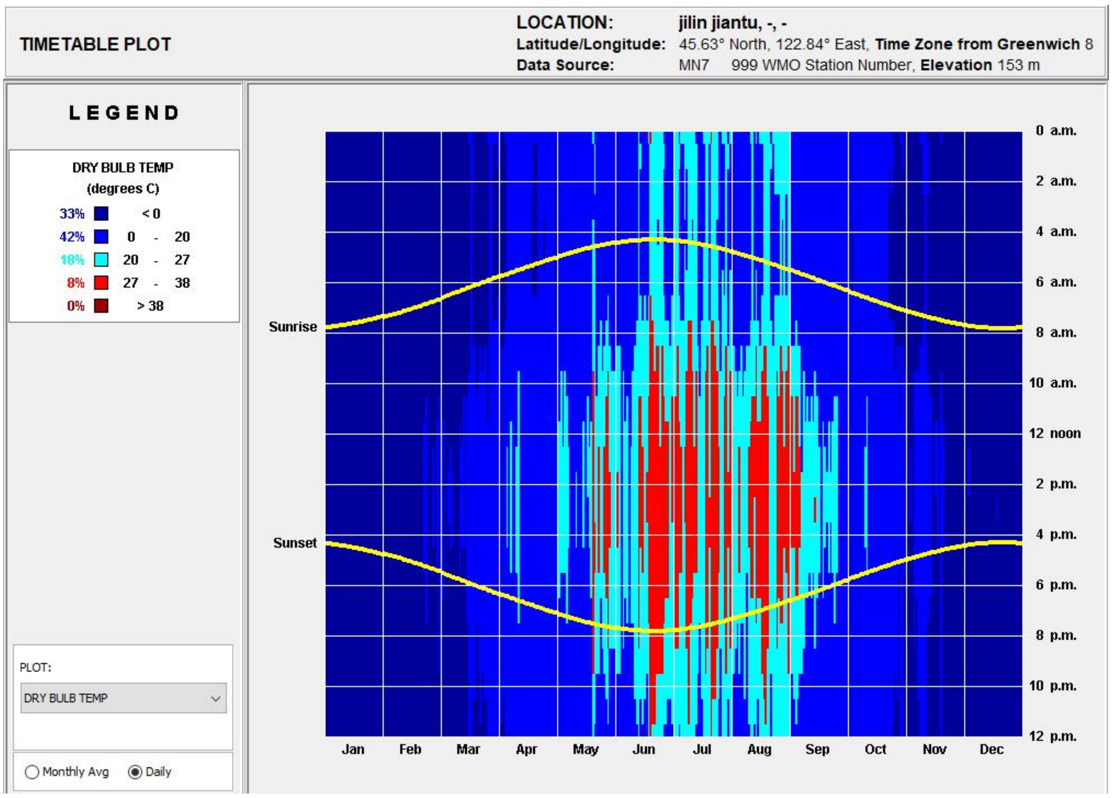

Fig.3.5.4. Timetable Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

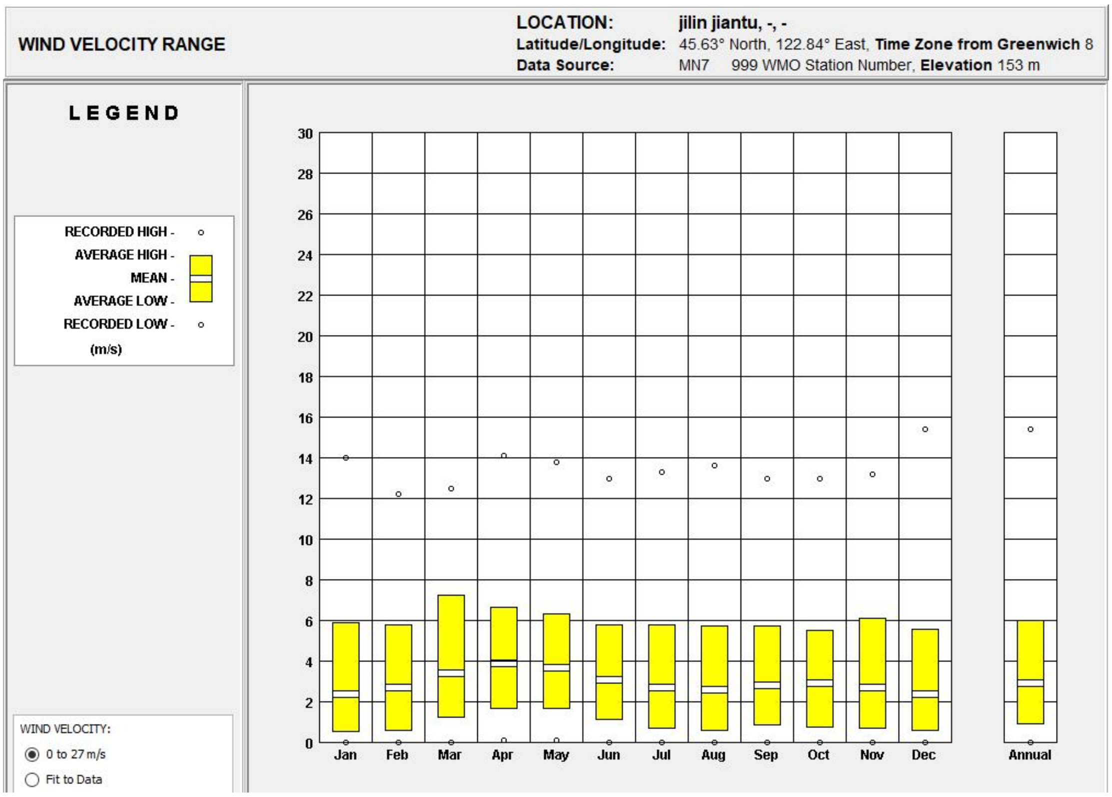

Fig.3.5.5. Wind Velocity Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

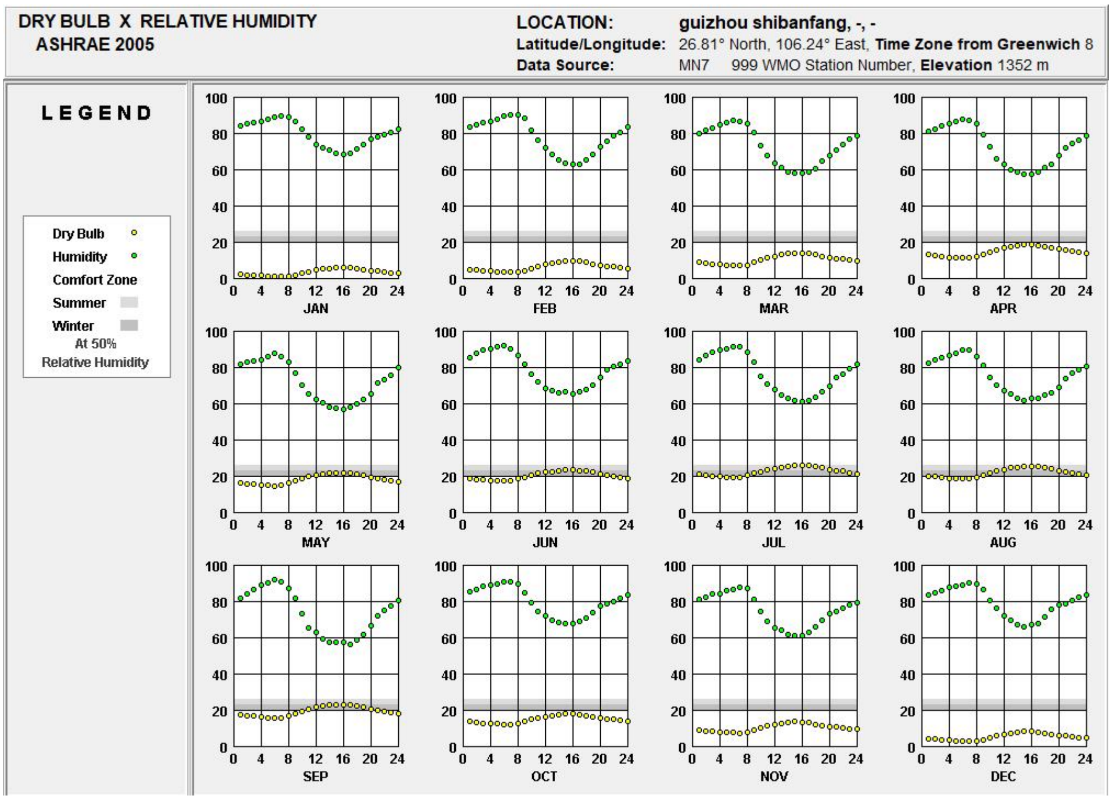

Fig.3.6.1. Dry Bulb and Relative Humidity(Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

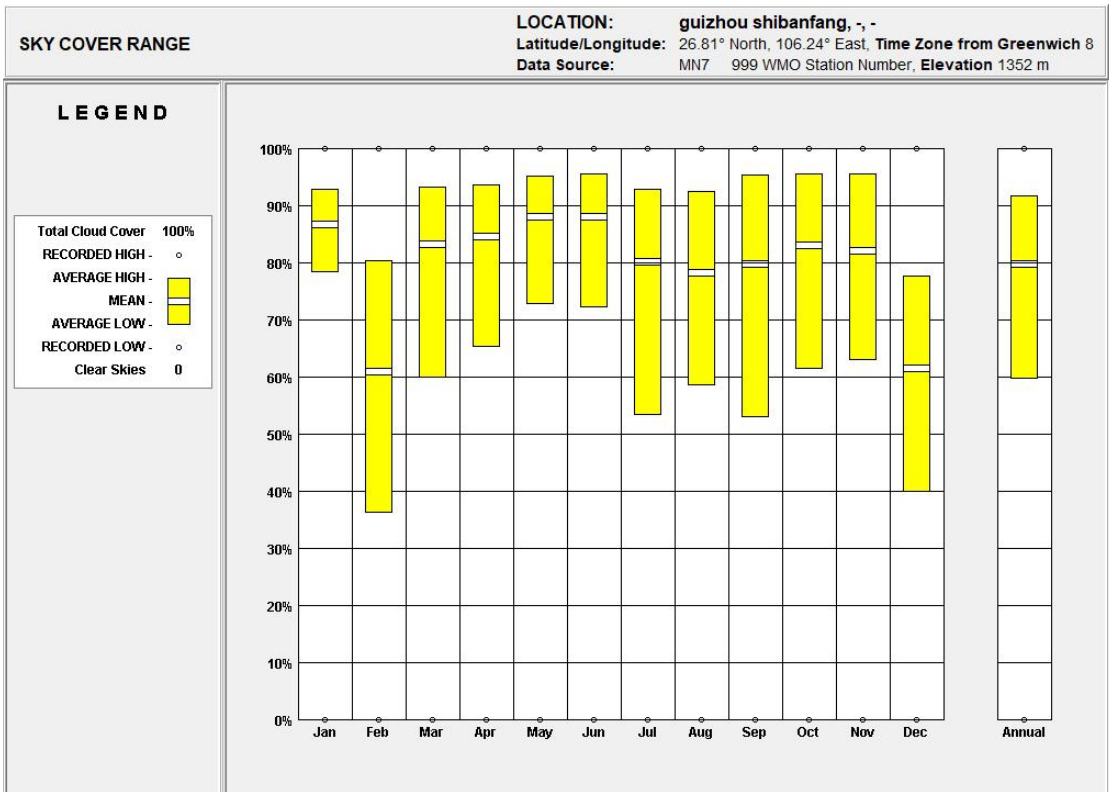

Fig.3.6.2. Sky Cover (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

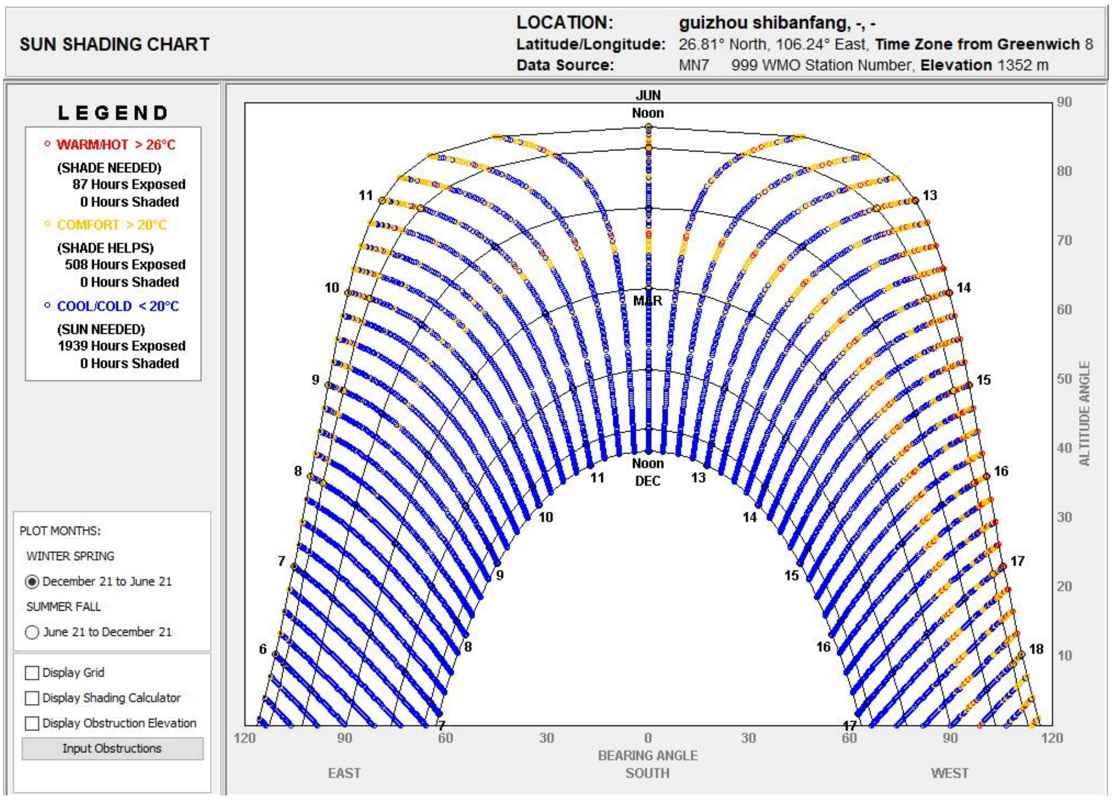

Fig.3.6.3. Sun Shading Chart (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

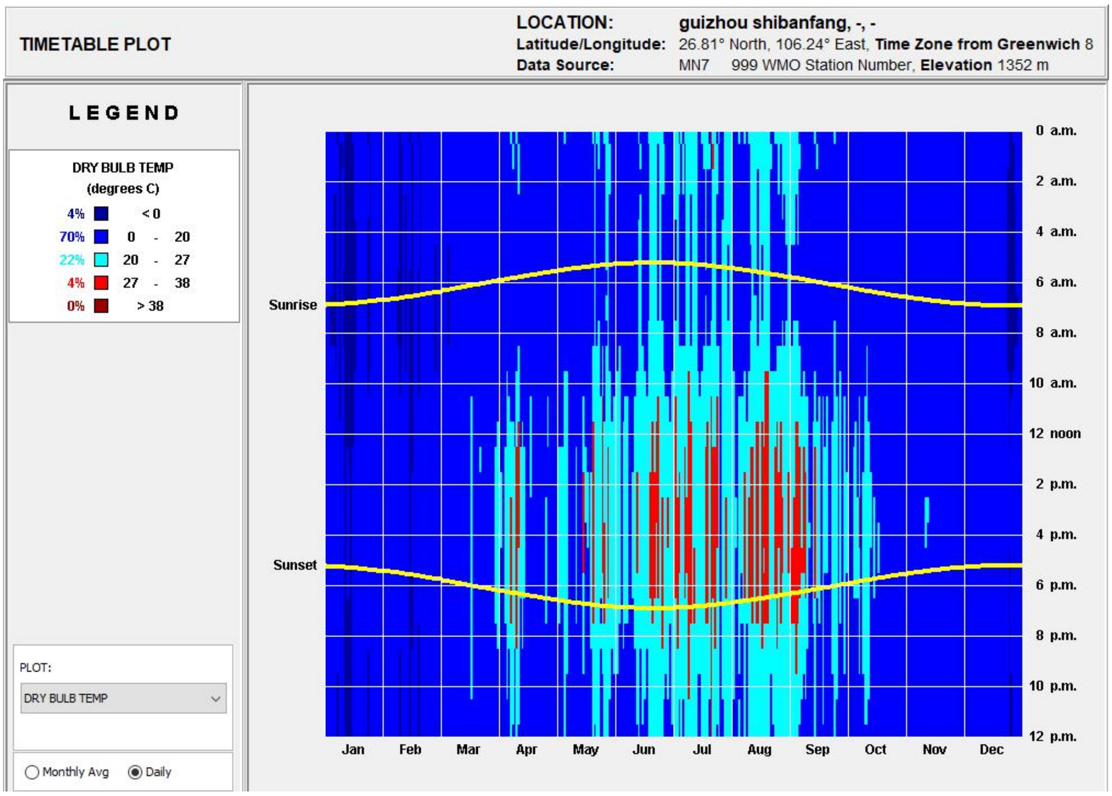

Fig.3.6.4. Timetable Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

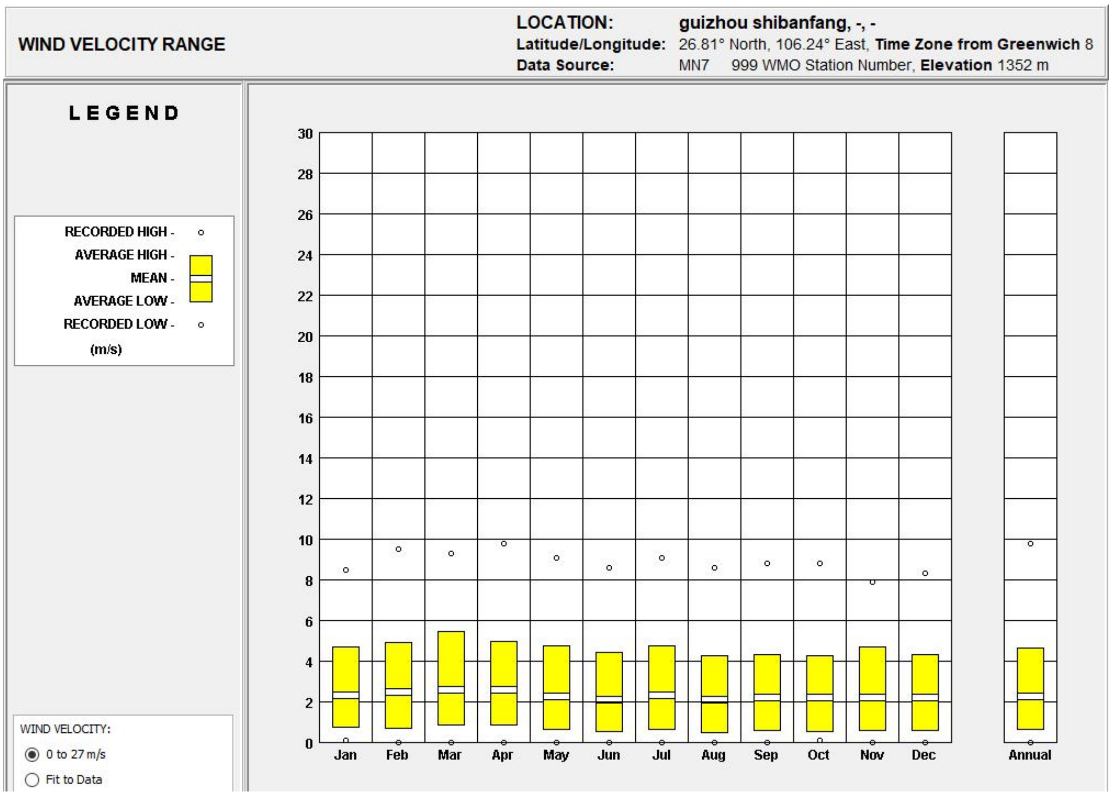

Fig.3.6.5. Wind Velocity Range (Meteonorm 7.0 weather data; Cliamte Consultant 6.0)

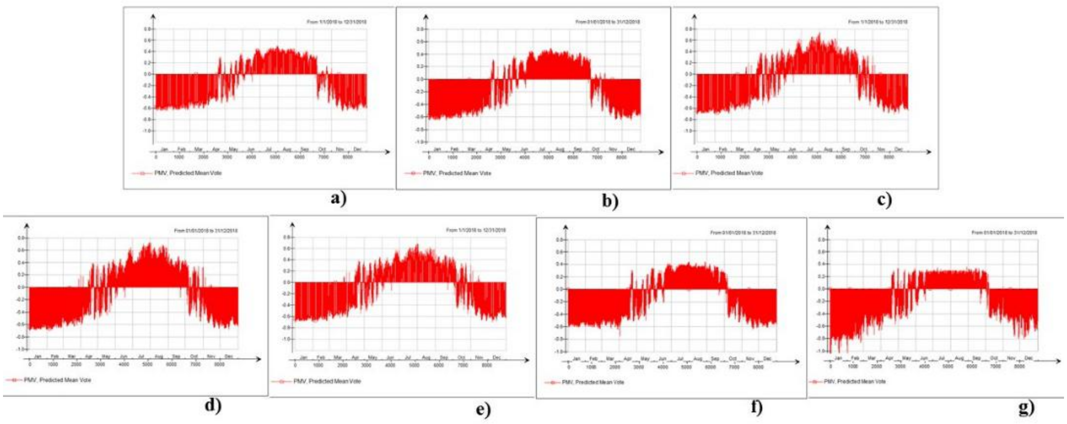

Fig. 6.6.3 PMV (Predicted mean vote), a) Bedroom 1, b) Bedroom 2, c) Bedroom 3, d) Bedroom 4, e) Bedroom 5, f) Living room, g) Kitchen.

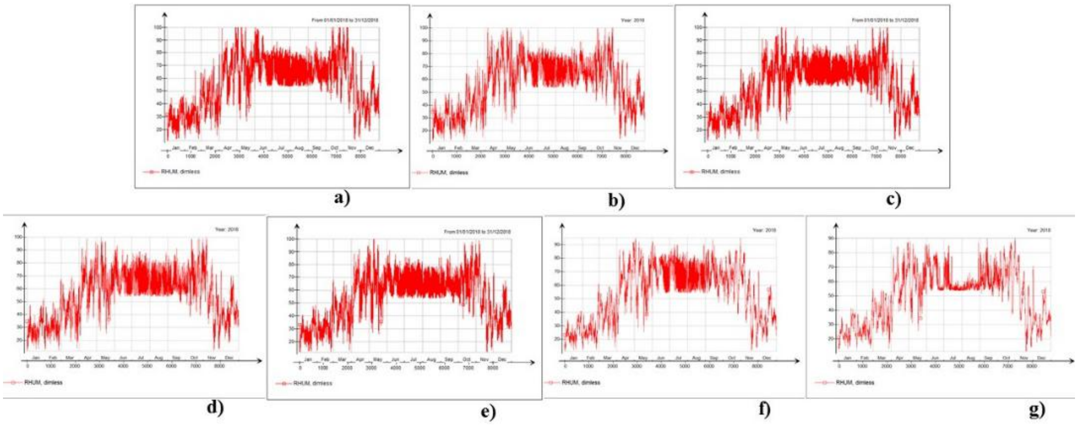

Fig.6.6.4 RHUM (Relative humidity), a) Bedroom 1, b) Bedroom 2, c) Bedroom 3, d) Bedroom 4, e) Bedroom 5, f) Living room, g) Kitchen.

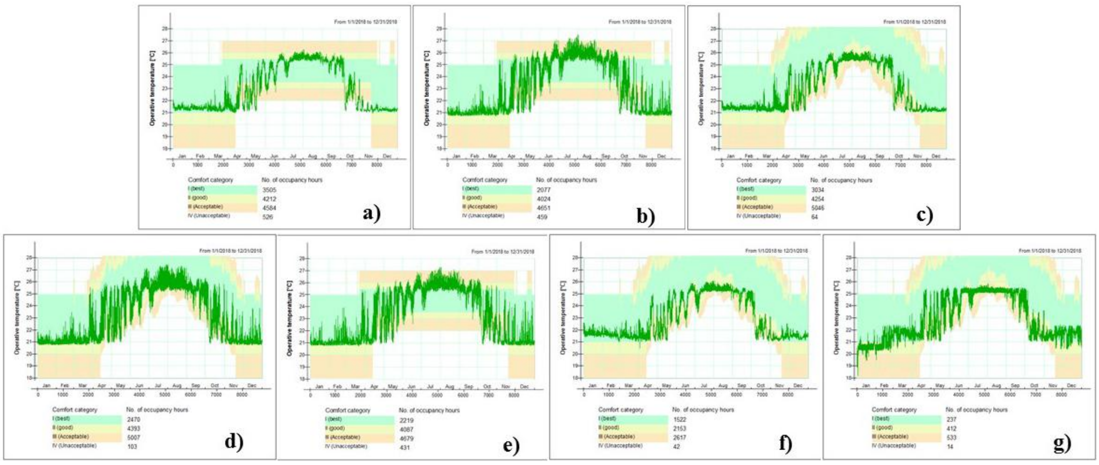

Fig.6.6.5 Operative temperature and comfort category, a) Bedroom 1, b) Bedroom 2, c) Bedroom 3, d) Bedroom 4, e) Bedroom 5, f) Living room, g) Kitchen.

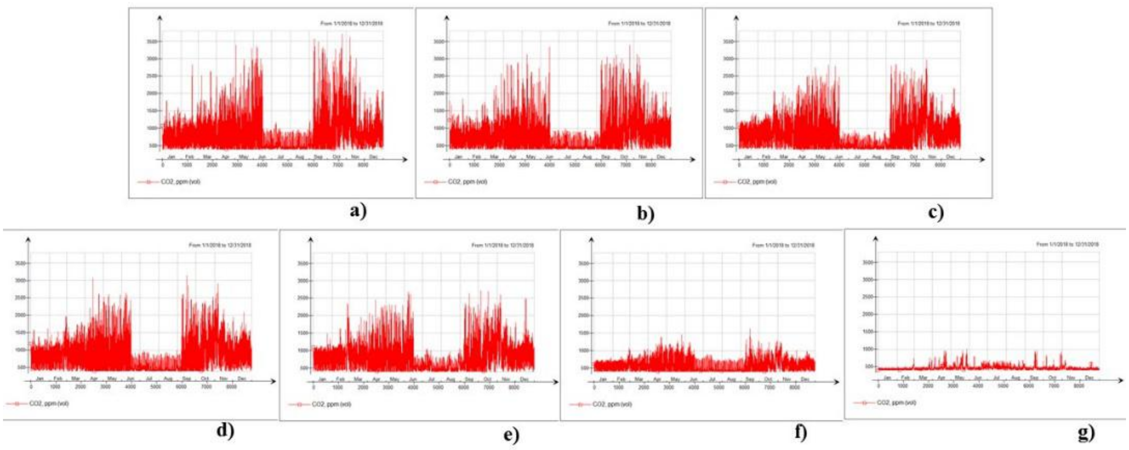

Fig. 6.6.6 CO2, ppm volume, a) Bedroom 1, b) Bedroom 2, c) Bedroom 3, d) Bedroom 4, e) Bedroom 5, f) Living room, g) Kitchen.

Table 1.

The existing building materials used in Wang's House

Location	Material	Size (mm) LxWxH Thickness of material	Thermal conductivity λ W/(m·K)	Specific heat c J/(kg·K)	Density ρ (kg/m^3)
Wall	Blue brick [10]	240x120x60 totally 240 thickness	0.65	860	2000
First floor	Bluestone [10]	300x300x20	0.18	920	1100
Second floor slab	Chinese fir wood	150 widths	0.14	2300	500
Roof	Rafter (Chinese fir)	700x70x40	0.14	2300	500
	Wang Brick	210x105x17	0.65	860	2000
	Huibei (Lime cream and fine clay)	50 thickness	1.41	1900	1000
	Waterproof membrane(sbc120)	1 thickness	0.5	1700	1000
	Tile	200x160x10	0.498	1121	837
window	Wood and Glass				
door	Wood	40 widths	0.14	2300	500

Table II

Glass parameters

	g, Solar Heat Gain Coefficient (SHGC)	T, Solar transmittance	Tvis, Visible transmittance	Glazing U-value W/(m^{2}K)	Internal emissivity (0-1)	External emissivity (0-1)
Glass	0.85	0.83	0.9	5.8	0.837	0.837

Table III

Annual delivered energy

Meter	Total (kWh)	Per m2 (kWh/m^2)	Peak demand (kW)
Lighting, facility	3567.5	19.89	1.221
Electric cooling	6782.5	37.81	13.39
Electric heating	34133.9	190.3	31.48
Equipment, tenant	401.3	2.237	0.1978
Total	44885.2	250.2	46.29

Table IV

General information of the zones (annual average)

Zone	Min Temp (°C)	Max Temp (°C)	Max Heat supplied (W/m^2)	Max Solar gain (W/m^2)	Min Rel hum. (%)	Max Rel hum. (%)
Bedroom 1	20.88	25.1	105.3	97.32	11.25	100
Bedroom 2	20.88	25.1	102.6	97.78	11.93	100
Bedroom 3	20.85	25.13	125	107.5	11.81	100
Bedroom 4	19.76	25.23	145.5	109.1	11.71	100
Bedroom 5	20.89	25.09	96.32	91.52	11.75	100
Kitchen Storage	15.61	26.74	426.5	282.2	12.41	90.31
Stair	15.74	27.9	173.4	44.73	13.71	97.9
Storage	17.88	27.16	180	104.6	13.66	93.13
Living Room	17.82	25.1	113.2	48.99	11.27	94.9
Kitchen	16.87	25.14	109.8	219.7	11.53	90.29

Table V

Energy balance of the Wang's House

	Total	During heating	During cooling	Rest of time
Envelope & Thermal	-23752.1	-26178.9	4497.8	-2071

Bridges (kWh)				
Internal Walls and Masses (kWh)	-26.5	647.6	-793.3	119.2
Window & Solar (kWh)	-469.4	-5660.6	4675.6	515.6
Infiltration & Openings (kWh)	-2746.2	-5981.4	2523.4	711.8
Occupants (kWh)	2398.7	1143.8	962.9	292
Equipment (kWh)	401.3	210	143.3	48
Lighting (kWh)	3567.5	1670.7	1515.7	381.2
Local heating units (kWh)	34133.8	34132.8	0	1
Local cooling units (kWh)	-13456.4	0	-13456.5	0.1

Table VII

The optimization strategies based on existing situation for next step

Problems and critical points		Comfort			Energy					
		-Thermal Comfort	-IAQ(R.H &CO2)	-Illumination Demand	-Thermal bridges	-Infiltration	-Heating Demand	-Cooling Demand	-Ventilation Demand	-Lighting demand
Passive Strategies	Rearrangement of spaces (orientation)	+	+	+			+	+	+	+
	Thermal insulation	+			+	+	+			
	Glazing, window, Lighting	+	+	+			+	+	+	+
	Thermal Mass	+					+	+		
	Shading	+		+			+	+		+
	Operation strategies for passive ventilation	+	+				+	+	+	

Active Strategies	Different heating – cooling transfer system	+	+				+	+	+	
	HVAC system size	+	+				+	+	+	
	Ventilation system	+	+						+	
	Automation	+	+	+			+	+	+	+
	Operation strategies for heating, cooling and mechanical ventilation	+	+				+	+	+	
	Photovoltaic						+	+		+

Fig.5.1.5 First plan *Fig.5.1.6* Second plan

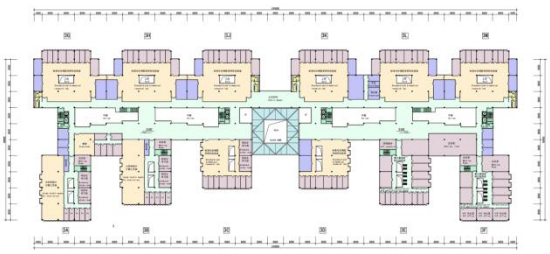

Fig.5.1.7 Third plan *Fig.5.1.8* Fourth plan

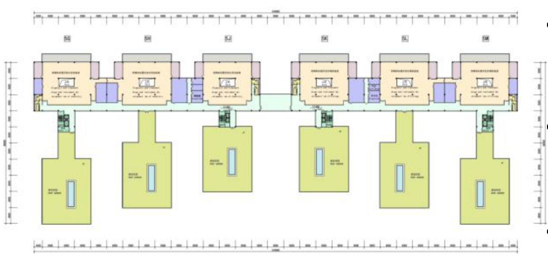

Fig.5.1.9 Fifth plan and Roof plan *Fig.5.1.10* Elevation

Location map

Location map and Completed period

Surrounding buidlings

Surrounding buidlings

Aerial view

Surroundings

Traffic

Terrain

Fig.5.2.1 status quo

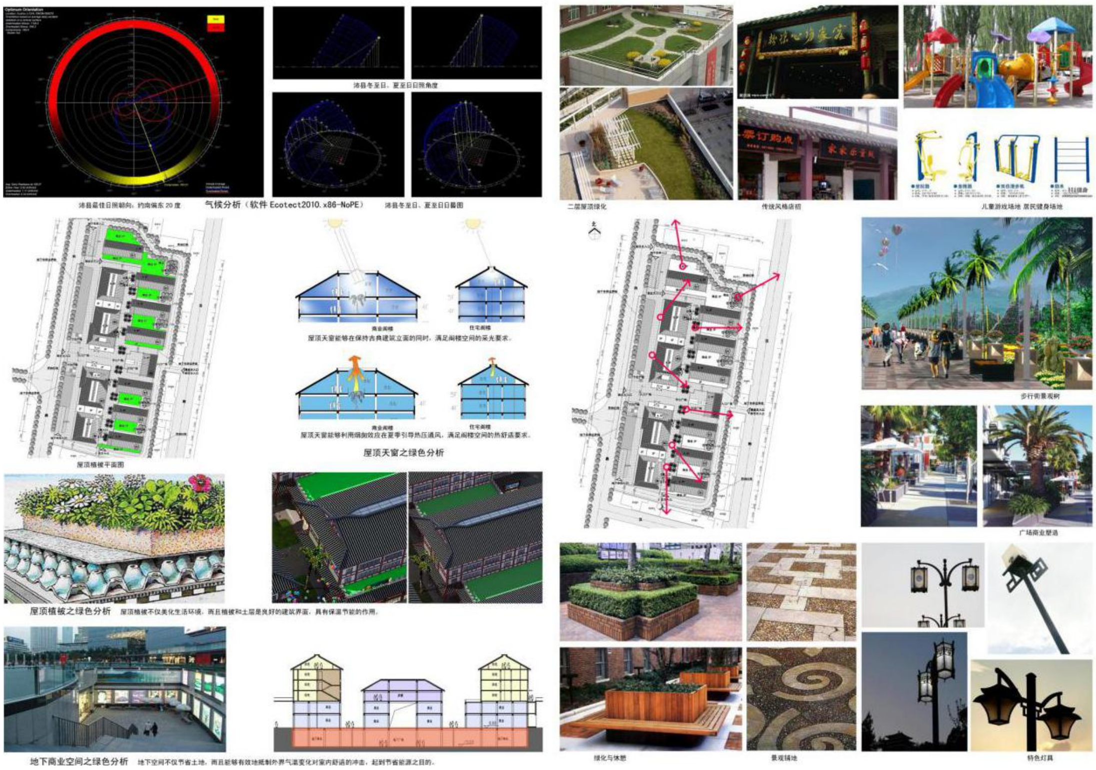

Fig.6.1.8 Details Design

Fig.6.2.9 Actual construction process picture

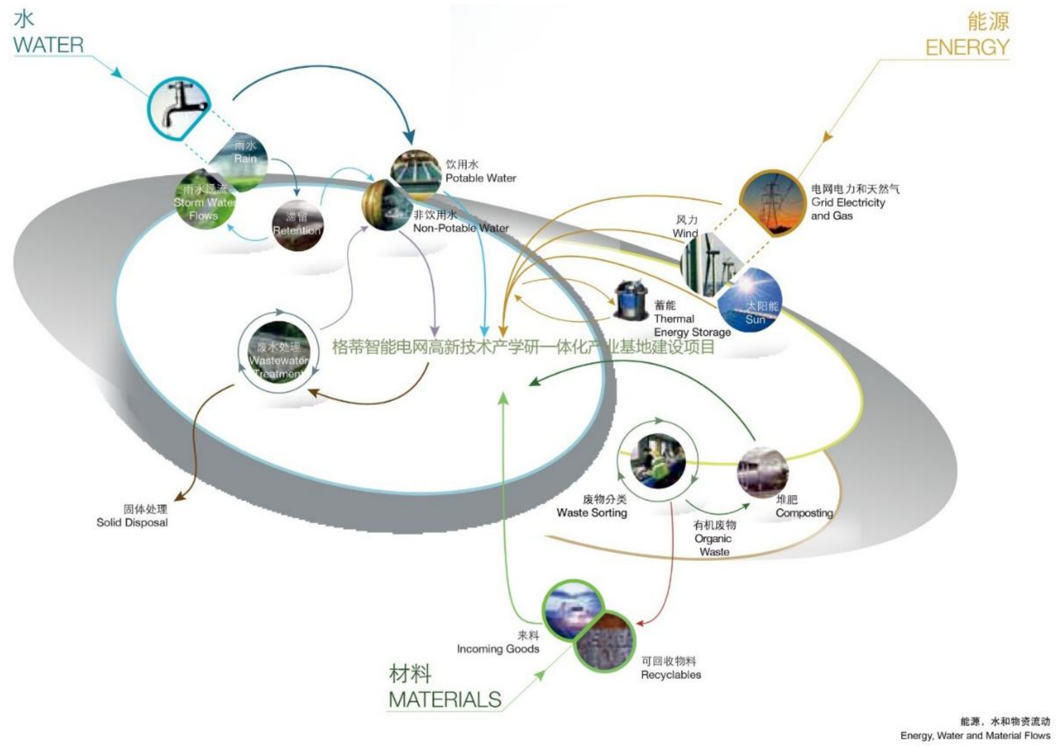

Fig.6.3.2 Overall system consideration

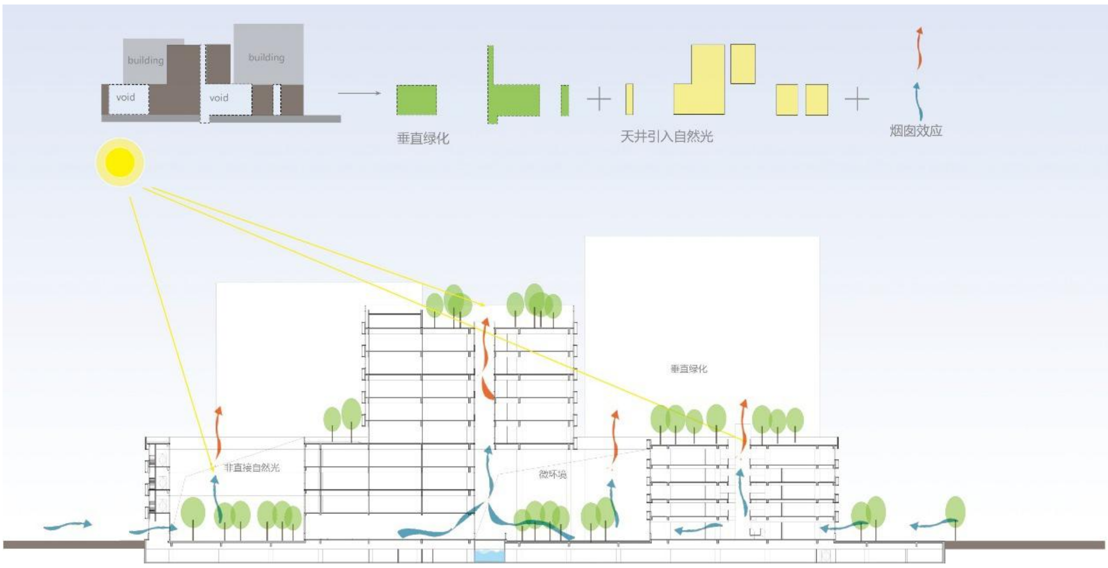

Fig. 6.3.11 Section design ideas

List of Published Papers

(As of October 5, 2018)

1. **The Expression of Regional Culture of Contemporary Large Space Public Buildings under the Background of Globalization.**

   Author: Chu Xiaohui

   Journal: Urbanism and Architecture (Chinese. Aug. 2014, Vol 23, Issue 8).

   ISSN 1637-0232, CN 23-1528/TU

   Abstract:

   The article explores design methods and expression from modeling space in contemporary regional culture, material and technology, based on the analysis of representative examples of large-space public buildings under the age of globalization, helping for the future of large-space public buildings design how to respond to the trend of globalization.

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褚晓慧 同志:

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文章编号：NO.1673-0232(2014)

(148-8239-N)

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（3）图或表必须有名，图表必须清析，必要时须附原始文件，提供电子文档。

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2. Study on the Passive Cooling Design Strategies of Traditional Architecture in Jiangnan Region and Application.

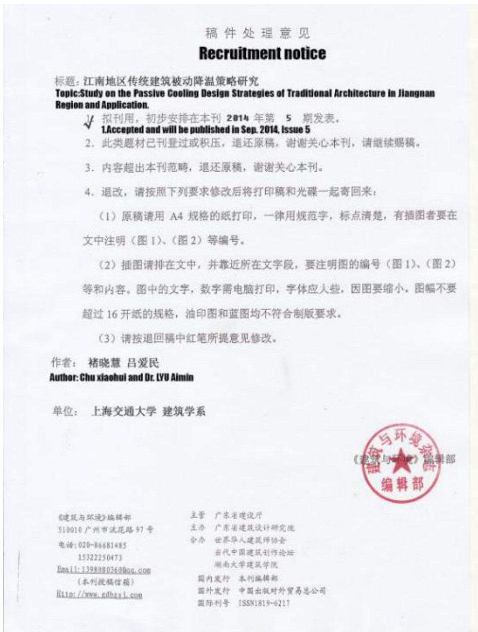
Author: Chu Xiaohui and Dr. LYU Aimin

Journal: Environmental Architecture (Chinese. Sep. 2014, Vol 8, Issue 5).

ISSN 1819-6217

Abstract:

The article extracts effective passive cooling measures from the research of traditional architecture in Jiangnan region which combined with climate data analysis in sustainable building design software. These summary and research are effective and practical design strategies in Jiangnan climatic conditions, providing theoretical guidance of passive cooling strategies in modern architecture design.



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（2）插图请排在文中，并靠近所在文字段，要注明图的编号（图 1）、（图 2）等和内容。图中的文字，数字需电脑打印，字体应大些，因图要缩小。图幅不要超过 16 开纸的规格，油印图和蓝图均不符合制版要求。

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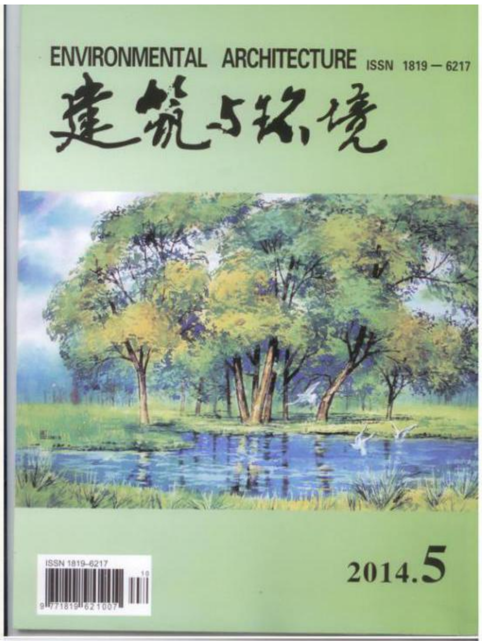

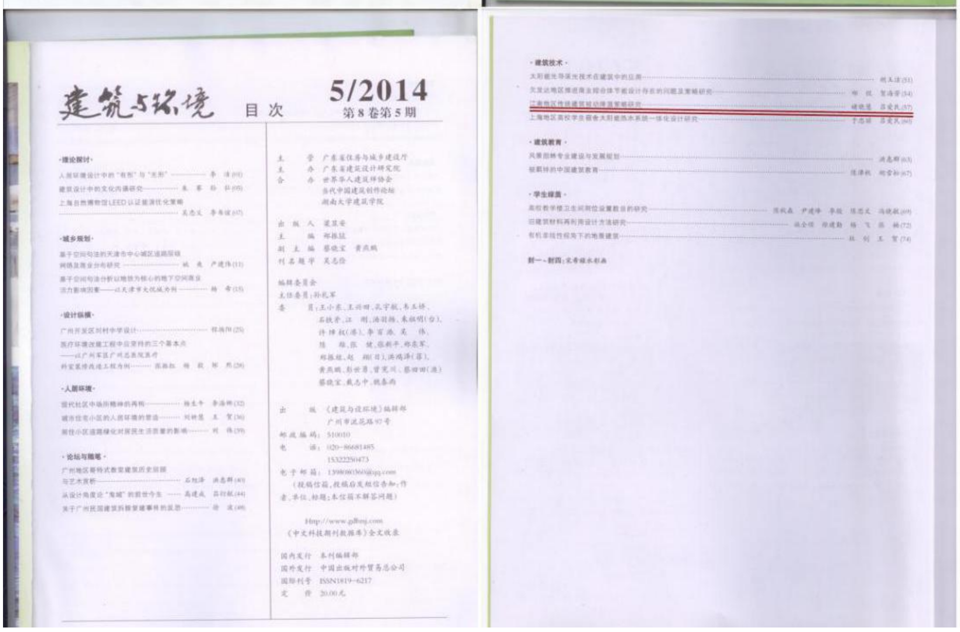

3. **The Research on Application and Development of Interactive Architecture-senses and responses.**

Author: Chu Xiaohui, Ge Dan and Shang Wen.

Journal: Architecture and Culture (Chinese. Mar. 2018, Issue 5).

ISSN 1672-4909, CN 11-5058/Z

Abstract:

This paper combs the realization (presentation) and its framework in different stages of interactive architecture design, reviews the application and development of interactive architecture design. Explore and think about the trend and future of interactive architecture design with the development of science and technology. The combination of architecture and interaction is the re-examination and reflection of the dominance of human in architecture.

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Chu Xiaohui, Ge Dan, Wang Jie

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4. **Comfort and Energy performance analysis of a heritage residential building in Shanghai.**

Authors: Chu Xiaohui, Mohhammd Reza Ganjali, Tsovoodavaa Gantumur and Rowell Ray Lim Shih.

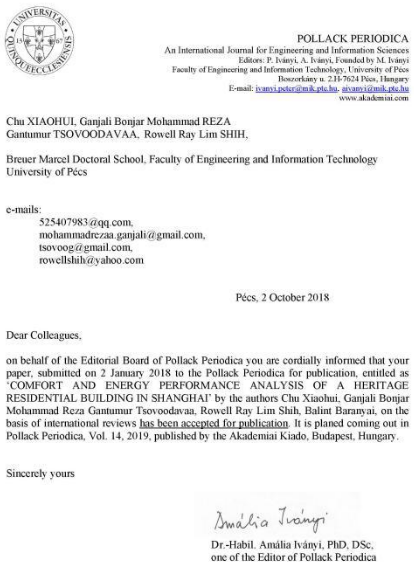
Journal: Pollack Periodica. 2019 Vol. 14

ISSN 1788-1994

Abstract:

Along with its rapid growth in economy, the protection of heritage buildings has recently gained importance and awareness in China. This paper investigates the energy performance of

a heritage building (Wang's House) in Shanghai, as well as the thermal comfort of the users, using dynamic thermal simulations. The analysis showed that heating accounts as the highest energy demand, followed by cooling and lighting. The resulting study will help the authors to identify various sustainable strategies to improve users comfort as well as reduce the energy demand of heritage buildings in China.



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Pécs, 2 October 2018

Dear Colleagues,

on behalf of the Editorial Board of Pollack Periodica you are cordially informed that your paper, submitted on 2 January 2018 to the Pollack Periodica for publication, entitled as 'COMFORT AND ENERGY PERFORMANCE ANALYSIS OF A HERITAGE RESIDENTIAL BUILDING IN SHANGHAI' by the authors Chu Xiaohui, Ganjali Bonjar Mohammad Reza Gantumur Tsovoodavaa, Rowell Ray Lim Shih, Balint Baranyai, on the basis of international reviews has been accepted for publication. It is planed coming out in Pollack Periodica, Vol. 14, 2019, published by the Akademiai Kiado, Budapest, Hungary.

Sincerely yours

Amália Iványi

Dr.-Habil. Amália Iványi, PhD, DSc,
one of the Editor of Pollack Periodica

Conferences

1. 12th International Miklós Iványi PhD & DLA Symposium

   Date: November 3–4, 2016

   Pecs, Hungary

   Paper title: *Traditional Building Preservation and Restoration Project-Wang's house.*

   Tutor: Dr. Donát Rétfalvi

2. 13th Miklós Iványi International PhD & DLA Symposium

   Date: November 3–4, 2017

   Pecs, Hungary

   Paper title: *Application and Development of Interactive Architecture.*

   Tutor: Dr. Donát Rétfalvi

3. 14th Miklós Iványi International PhD & DLA Symposium

   Date: November 29–30, 2018

   Pecs, Hungary

   Paper title: T*he evolution of amusement parks'spatical configuration in china from 1990s based on spcae syntax.*

   Tutor: Dr. Donát Rétfalvi

Workshops

1. This Is Me Now Workshop

   Date: October 27-30, 2015

   Location: Pecs, Hungary

   Reward: Hello Loneness | Szia Autism

2. Vasarely's Journey

   Date: April 15- May 4th, 2016

   Location: Pecs, Hungary

   Rewards: Let's meet Vasarely

Cooperation with international students

1. "Set Foot in Sittard" (Phidias Community Cooking) International Competition

   Date: November 1 to December 4, 2015

   Tutors: Dr. Donát Rétfalvi, Dr. Akos

Real Projects

1. Han Street-Sifang Square: design of multi-story residential upper and commercial street.

   Date: 2014

   Workload: Independently.

   Stage: Portfolio of design phrase; now it is under construction.

   Location: Xuzhou, Jiangsu

2. Shanghai Jiao Tong University Translational Medicine Building.

   Date: 2013

   Workload: Independently.

   Stage: Portfolio of design phrase.

   Location: Shanghai

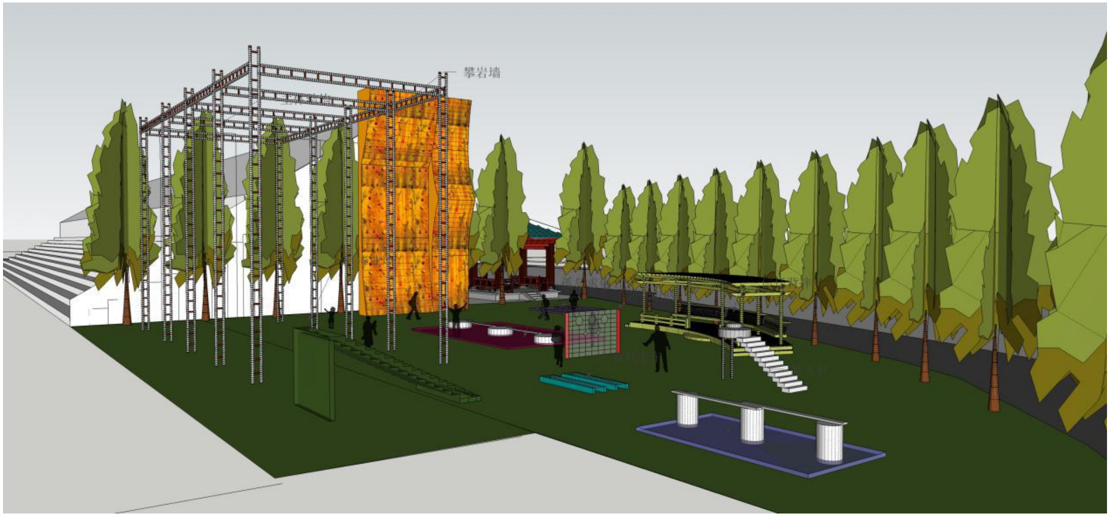
3. Shanghai Jiao Tong University Mental Development Training site.

Date: 2013

Workload: Independently.

Stage: Portfolio of design phrase.

Location: Shanghai



4. Wang Chunyuan’s house Restoration.

Date: 2014

Workload: Cooperated with other 3 colleagues.

Stage: Portfolio of design phrase. Construction Completed.

Location: Shanghai

5. Bailian Nanjing Outlet® Project.

Date: 2013- 2014

Workload: Participated with other 5 colleagues.

Stage: Portfolio of developed design. Construction Completed.

Location: Nanjing

6. Vanguard® Living Mall in Xinyu.

Date: 2013

Workload: Participated with other 2 colleagues.

Stage: Portfolio of developed design. Under construction.

Location:Xinyu,Jiangxi

7. Jieheng Economic Office Park.

Date: 2014

Workload: Participated with other 1 colleague.

Stage: Portfolio of concept design.

Location: Shanghai

8. Da Beilv Temple.

Date: 2014

Workload: Participated with other 3 colleagues.

Stage: Portfolio of concept design.

Location: Zhoushan, Zhejiang

9. Northwest University New Residential Quarters Planning.

Date: 2015

Workload: Participated with other 2 colleagues.

Stage: Portfolio of concept design.

Location: Xi’an

10. Baoji Zoomlion® International Square Facade and Interior Design.

Date: 2015

Workload: Participated with other 4 colleagues.

Stage: Portfolio of concept design.

Location: Shanxi

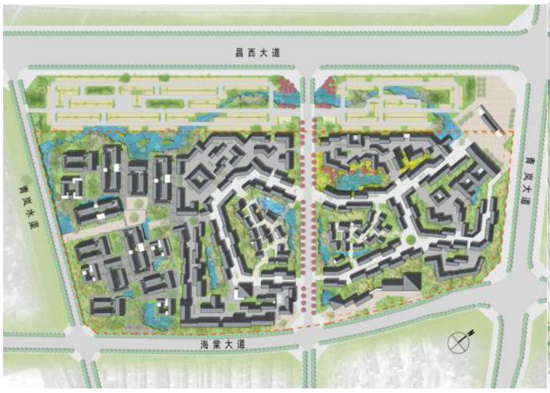

11. Nanchang Impression Project of Planning and Architecture Design.

    Date: 2015

    Workload: Participated with other 2 colleagues.

    Stage: Portfolio of design proposal.

    Location: Nanchang, Jiangxi




12. Grid electric power smart grid high-tech industry park project.

    Date: 2016

    Workload: Participated with other 5 colleagues.

    Stage: Portfolio of concept design.

    Location: Shanghai.

The Author

Chu Xiaohui is a Chinese architect; whose major is architecture for 11 years. She took up Maters at the University of Shanghai Jiaotong University in March 2015 and got the Bachelor degree of architecture at the Yantai University in 2012. Chu has been active in the design area and academic field since 2012, who has already completed several projects and published many research papers at journals. She cares about ecological architecture, sustainable architecture, vernacular architecture, interactive architecture and climate diversity studies. This dissertation study is conducted with the support of the University of Pécs in Hungary. One of the basic aim of this study is to apply innovative design thinking and scientific quantification methods to the application of actual architectural design.