## Analysis of Natural Ventilation Technology of Traditional Residential Houses in Southeast of Hubei Province

Take Yangloudong Village as an Example

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### ABSTRACT

Based on the theory of architectural in situ, this paper summarizes the in situ characteristics of the township architecture in southeast of Hubei province with Yangloudong village as an example. On the basis of literature and field research, we summarize and analyze the natural ventilation technology of traditional dwellings with local characteristics in southeast of Hubei province, and use it as a basis to propose optimization strategies for contemporary new rural architectural forms and design methods. Based on this, we propose optimized strategies for contemporary new rural architectural forms and design methods.

**Keywords:** In-situ construction ; Traditional Dwellings ; Ventilation technology ; Contemporary Inspiration.

## **1. INTRODUCTION**

With the gradual advancement of globalization, the cultural exchanges between the regions are gradually frequent, the barriers are gradually weakened, and the mainstream architectural thinking and design methods are increasingly accepted and applied by rural architects, which makes the forms of rural architecture in different places converge, and the local creative regional characteristics and characteristic construction methods have declined. The relationship between architecture and local environment, relationship with local culture, relationship with the actual needs and experiences of local residents, and other local considerations are not sufficiently reflected in contemporary rural architectural design and construction activities.In recent years, China's rapid economic development and urbanization have accelerated the process of construction, and most of the buildings in cities are complex in function and huge in volume. People tend to get away from nature if keeping indoor for a long time, and the main reliance on artificial equipment to regulate the internal environment consumes a large amount of resources and energy, and various "building diseases" occur constantly [1]. On the

contrary, in the past, when there was no high-energy airconditioning equipment, people were able to observe and utilize the natural environment and cleverly add passive regulation technology to the building layout and building materials, so that the building has a comfortable internal environment and can be in a longterm low-energy or even zero-energy state, and reflect rich local characteristics depending on the region.

### 2. THE IN SITU NATURE OF ARCHITECTURE

"In-Situ" refers to the specific form of architecture in a specific environment and site, and is proposed as a concept opposite to the "global" nature of architecture. In this context, "locality" emphasizes the local architectural strategy of using local materials and materials in the environment and between cultures, taking into account the concept of sustainable development and the natural climatic conditions of the area, and saving energy while preserving the memory of the original site [2].

The southeast area of Hubei mainly refers to Xianning City and its surrounding areas, which is in a

hot summer and cold winter climate zone, with hilly and mountainous terrain, rich timber and ore resources, and small mountain slopes. The area is rich in historical resources of preserved ancient buildings and unique folk customs. The building site emphasizes feng shui layout, high density of village buildings, following the mountain trend, and many lanes in the village, winding and twisting. The interior is mostly brick and wood mixed structure, the main load-bearing system is wooden frame, and the wall is only used to separate the internal space. The spatial organization mostly adopts the layout of front house and back yard, and the whole is more closed, with many patios and indoor flowers and green plants. The overall living environment is suitable in scale and comfortable in climate, and the indoor temperature can be kept relatively low in summer.

## 3. NATURAL VENTILATION TECHNIQUES IN TRADITIONAL HOUSES IN SOUTHEAST OF HUBEI PROVINCE

# 3.1. Adaptive arrangement of building complexes

## 3.1.1. Build on the mountain, choose water to live

In plain areas, villages are usually built near rivers, lakes, or areas with abundant underground water sources; in hilly and mountainous areas, villages are usually built on sunny slopes near water and high terrain. The village is built on a mountainous terrain, which can be used to protect the mountain from cold currents in winter and ensure the comfort of the thermal environment inside the building group in winter, while living near water can make use of the evaporation effect of the existing water body to regulate the internal microclimate and wind environment, so that the living environment can be maintained in a stable and livable state for a long time[3]. The village of Yangloudong is located in the Songfeng Mountain, about 26 km southwest of Chibi City, Hubei Province, with undulating hills and famous springs, which provides superior conditions for the overall location of the building. The high temperature surface of the building roofs and walls are directly exposed to sunlight, which creates a thermal pressure difference in the general environment, thus promoting air flow. There is a river passing by the village, and the natural water body regulates the air temperature and humidity in the village to a certain extent. The hot air enters the room after being cooled by the water body, and forms a thermal pressure difference with the high temperature indoor gas, which speeds up the air flow and takes away the indoor heat. In addition, the river has been transformed and used by the residents to become a natural source of water for living, which plays an important role in facilitating life and safety against fire. The "mountain and water complex" has a significant influence on the location of the village. (Figure 1)



Figure 1 Climate zoning map of national building thermai design

# 3.1.2. Group optimization effect of organized intensive construction

Yangloudong Village has a high building density, with only narrow pedestrian passages between buildings. This layout increases the overall volume of the village on the basis of a certain organizational logic, while obtaining a more stable internal climate environment. By using the buildings to block and shade each other, the area in direct contact with the external unfavorable environment is reduced, so that the external environment changes minimally affect the internal climate and achieve the effect of group optimization. This organized and dense form of construction leaves a part of the building in shadow and at a lower temperature, which creates a temperature difference with the higher temperature roof, providing the prerequisites for the use of thermal pressure ventilation in the interior of the building by means of a patio. (Figure 2)

Through an organized arrangement, alley spaces with widths ranging from one meter to three meters can be formed between buildings, which can meet daily pedestrian flow and accelerate gas flow by using thermal pressure difference and wind pressure difference to quickly remove heat, so such spaces are called "cold alleys". Cold alleys are generally along the building depth direction, mostly in the shadow of the mountain wall surface, the sun can not direct the internal temperature of the cold alley is lower, and the external sunlight direct high temperature part through the thermal pressure difference to achieve better ventilation effect. The building hill wall surface is usually made of green brick with better heat storage, which is a better cold storage body [4]. The cold storage body absorbs ambient heat during the day and releases it at night, so that it can continue to absorb it the next day.

During this cycle, the release and absorption of heat cause the flow of air and the heat is then discharged in this way. (Figure 3)



Figure 2 Single building and organized dense construction.



Figure 3 Sidewall heat circulation process.

#### 3.2. Courtyards and patios

The courtyard is the core area inside the building, and almost all the windows and doors of the house are open to the courtyard. Therefore, the courtyard becomes the main ventilation space. The courtyard of residential houses in Southeast of Hubei province is often set up with openings in the direction of the dominant wind in summer to bring in the wind and then enter each functional room through doors and windows. In order to increase the wind speed in the courtyard, multiple openings are set in the direction of the dominant wind to form a strong wind through the hall to achieve the effect of ventilation and cooling.

The courtyard will also be equipped with greenery, water bodies and other elements. On the one hand, for the creation of landscape, on the other hand, the vegetation also has a good microclimate regulation effect. Vegetation is planted along the long side of the building and on the windward side to increase the wind speed and enhance indoor ventilation by guiding the wind direction. According to the field research, if shrubs are planted in front of the windows on the windward side of the building, and the distance between the shrubs and the windowsill is within six meters, it can make the wind blowing into the room slope downward, which is conducive to the organization of indoor ventilation.

Usually, the traditional dwelling form in southeast of Hubei province is more inward-looking and the dwelling is more closed, so the patio plays an important role in the ventilation and lighting of the whole building. As the intermediary of indoor-outdoor connection, the patio makes the air change vertically, forming a rich climate gradient, that is the level of climate difference. The rich climate gradient can moderate the direct impact of external climate change on indoor comfort and adapt to the climate characteristics of southeast of Hubei province.

The patio is also an adjustable thermal buffer layer. In summer, there is a high temperature difference between inside and outside the building, the hot air rises at the top, the bottom becomes a negative pressure zone, the air flows from the bottom to the top, the patio becomes an important channel for heat outflow, and the chimney effect is formed through the temperature difference to bring heat out of the outdoors (Figure 4). The bottom of the patio can be equipped with open ditches or pools to collect rainwater, and plants are often planted to effectively reduce the temperature at the bottom of the patio by using the natural evaporation of water bodies and transpiration of plants, thus improving the regional microclimate. At night in summer, the outdoor temperature decreases and the indoor high temperature air flows to the outdoor through the patio. Good ventilation can take away the excess heat and moisture from the indoor, reduce the relative humidity

and temperature of the indoor air, and make the indoor climate more comfortable for a long time.



Figure 4 Principle of Patio Thermal Pressure Ventilation.

### 3.3. Eaves porch

The gable is a semi-outdoor space formed by roof projections, which originated in commerce but has since gained wide recognition as a culture and is commonly used in various buildings. The formation of the gable space is influenced by a variety of factors, at the macro level, by political, economic and cultural influences, and at the meso level, by climate, topography, and regional traditions and culture. Initially, in order to adapt to the rainy climate, buildings were often picked partly outward, thus achieving the purpose of providing shade on sunny days and shelter from rain on rainy days, as well as protecting the walls. [5] As the material life of the residents became richer, the humid and stuffy indoor environment in summer could not meet the needs of the residents for recreational activities, and the development of commerce required a larger outdoor space for the exchange of goods. Therefore, the width of the gable is increased and tables and chairs are placed under the gable to provide a kind of all-weather public activity space for the residents The gable is the traffic space

under the eaves of the building, and also serves as an important climate buffer space inside the building. In winter, when the sun height angle decreases, the sunlight can shine directly into the room to reduce heating energy consumption in winter. In addition, the space under the eaves, as a shared space for leisure and interaction, can carry out a variety of entertainment activities to enrich daily life. (Figures 5).



Figure 5 Eaves porch as a climate buffer space.

### **4. CONCLUSION**

The natural ecological experience of traditional residential architectural design is a kind of construction law implicit in the residential objects, and the design thinking and experience contained in it still have guiding significance for contemporary architectural design. Especially nowadays, the topic of new countryside architecture is so hot that it is more important to refer to local design thinking and local construction methods for countryside architectural design.

To fully understand its essential characteristics, contemporary rural architectural design needs to weaken the concept of self-created design, return to the local area, and learn from existing local buildings, local residents, and artisans.[6] We need to learn the original construction methods in terms of building site selection, overall layout, local materials, and detailed construction that are conducive to natural ventilation, and be inspired by them to make use of traditional construction techniques in modern times.At the same time, modern active green energy-saving technology is the advantage of the new rural architecture. By adding modern devices such as openable skylights, solar photovoltaic materials,

and liftable eaves while referring to the traditional zeroenergy ventilation technology, we can optimize its shortcomings while inheriting the traditional technology, so that the building has local characteristics and can better adapt to the higher requirements of modern residents for living environment.

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