Study on the Environmental Adaptability of Traditional Residential Buildings in Southeast HUBEI

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ABSTRACT
Traditional residential houses, which contain rich historical and cultural remains, profound cultural deposits and the wisdom to adapt to the natural climate environment of the living place, have attracted much attention recently. Based on the geographical and natural conditions, this paper takes the traditional residential buildings in southeast Hubei as an example, Combined with VENT ventilation software analysis, and summarizes its layout characteristics, architectural form, internal space organizationso as to Study its environmental adaptability and its inspiration to the current rural residential buildings.

Keywords: *Southeast Hubei; The overall planning; Monomer layout; The overall style*

1.RESEARCH BACKGROUND AND SIGNIFICANCE

Rural architecture has rich regional cultural deposits, and its limitations are relatively less than commercial buildings in cities. Therefore, many architects complete their personal architectural creation through rural architecture design, so rural architecture has a very lively vitality. The planning layout, spatial arrangement and some detailed structures of traditional residential buildings are the experience summarized by the ancients in the practice process of adapting to the environment for a long time[1].

Southeast Hubei area three provinces border，merges the ancient farming culture of the north and the south, and its geological features and climate environment are rich and diverse, thus forming a very distinctive traditional residential buildings. The southeast of Hubei province is the place where the most traditional residential buildings remain at present. Its unique geographical position and human environment have injected strong vitality into the continuous development of the residential buildings. Therefore, the study of the overall style characteristics of traditional residential buildings in southeast Hubei can provide a lot of reference materials and design ideas and strategies for contemporary rural architecture design[2].

2.THE OVERALL STYLE OF TRADITIONAL DWELLINGS IN SOUTHEAST HUBEI PROVINCE

Southeast Hubei belongs to the subtropical continental monsoon climate, with abundant precipitation, sufficient sunshine and four distinct seasons. The winter climate is cold and dry, prevailing northerly wind[3]. This area is classified as Ⅲ region in the regional division of China's building climate, that is, hot summer and cold winter region. The landform of southeast Hubei is mainly mountains and hills, each mountain directly distributed hills and basins, mountains and rivers crisscross relatively habitable.

Figure 1 Location map of southeast HUBEI

2.1. Master planning: Surrounded by mountains and water, Staggered freely

The traditional residential building in this area are generally clustered into villages, with at least 50 or 60 families and at most 100 or 200 families, and each settlement is generally arranged along the ancestral hall or temple as the center. When selecting a site, the first thing for each village is to select a site for the ancestral temple. As a settlement center, the ancestral temple will be placed in a place with the best geomantic omen. For example, some ancient books mentioned that "the mountain is surrounded by water" and "the mountain is beside the water", ancient people believed that the mountain is to rely on and the water can bring good luck[4]. Therefore, the residential settlements are generally located at the foot of the mountains with a slightly higher terrain. Since there is abundant rain in southeast Hubei, there is no need to have large rivers, and residents choose to dig Wells for drinking water. This kind of place can not only meet the living needs and provide land for farming, but also avoid some natural disasters such as floods[2].

Figure 2 Ancestral temple in the southeast HUBEI

Figure 3 Yu Wan village plane

Southeast of hubei settlement mostly USES the freestyle layout, i.e., according to the ancestral temple as the center in the doorway set square reintroduction into the village road, around the basic structure of residential building in the form of group to carry on the distribution, clouds of housing form different area, the area have formed in various single building in intervals of roadway, finally the tunnel into the main road. This kind of freestyle layout is generally formed in accordance with the terrain and road. The advantage of this layout is that the spatial streamline is rich and changeable, and the sight changes are rich, which greatly improves the fun of people's life[5].

In addition, each building area has a certain residential density, so the dense building arrangement can stabilize the residential environment inside the building complex. The intricate arrangement of monomer buildings forms some enclosed, separated and connected Spaces. In winter, the gap areas can be used as lighting and heating places, while in summer, each narrow alley can avoid strong sunshine and introduce summer wind to form the effect of "cold alley"[6].

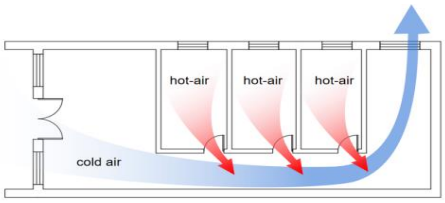

Figure 4 Principle of cold alley ventilation

2.2. Monomer layout：Dense arrangement，Neat and orderly

A group of courtyards as a module is also centered on the courtyard. There are halls in front and rear of the courtyard. There are wing rooms on both sides of the hall and the courtyard. There are also no small patios, or tiger eye patios, at the other end of the wing on either side of the courtyard to improve ventilation and light in each room of the house, and the wing usually opens to the patio. The middle courtyard plus the two sides of the tiger eye courtyard, which is the most typical southeast Hubei "five rooms, two into three patios" form[7].

Many ancient houses in southeast Hubei use patios, and the ratio of general patios to house areas is 1:3, and the style of patios has square and narrow long strips[8]. The latitude of southeast Hubei is relatively low, the requirements for sunshine are not high, coupled with a series of factors such as rainy and strong summer sunshine in the region, most of the houses in this area use this small patio form to replace large housing courtyards. On the one hand, the patio can meet some of the indoor lighting needs, in addition, it can also be ventilated, in the summer due to the chimney effect, the hot air in the room will rise, and the patio can just be used as an opening to export it to keep the indoor cool, and some of the narrower patios can also form a better wind pulling effect[9].

Figure 5 Patio of dwellings in Yangloudong, HUBEI Province

3. VENTILATION INSIDE

This project uses the multi-area network method to calculate the number of indoor ventilation in the building, the multi-area network method is to divide the indoor rooms into different ventilation and ventilation areas, with the wind pressure of doors and windows as the

boundary condition, and the data transmission between different areas is connected through the connected doors and windows, and finally the number of ventilation times in each room is obtained.

The calculation of the number of room ventilation is derived from the calculation of the air quality flow of the ventilation path, and the air quality flow based on the multi-area network method is calculated as follows:

$$Q = C_d A \sqrt{\frac{2\Delta P}{\rho}}$$

Q——Room volume flow（m^3/s）

ΔP——The difference in wind pressure between the doors and windows of the adjacent rooms；

C_d——Flow coefficient, for large building openings, take0.5，For narrow openings take0.65，This item is calculated0.6；

A——Cave entrance area（㎡）

ρ ——Air density （kg/m^3）

After obtaining the volume flow rate of a room by the above method, the number of room ventilation can be calculated:

$$Acr = \frac{Q * 3600}{V}$$

Q——Room volume flow（m^3/s）

Acr——Number of air changes（times/h）；

V——Room volume（m3）；

The results of the number of air changes are as follows:

Room names	volume (m^3)	area (m^2)	Number of air changes (times/h)
The hall	1925.72	204.88	29.39
Bedchamber 1	202.32	31.19	8.62
Bedchamber 2	206.46	31.83	5.09
Bedchamber 3	206.46	31.83	7.97
Bedchamber 4	202.32	31.19	7.88
Bedchamber 5	342.13	40.26	9.15
Bedchamber 6	349.13	41.08	10.66
Bedchamber 7	349.13	41.08	11.26
Bedchamber 8	342.13	40.26	10.73
Storage room	246.35	33.77	0.00

Wind speed distribution map:

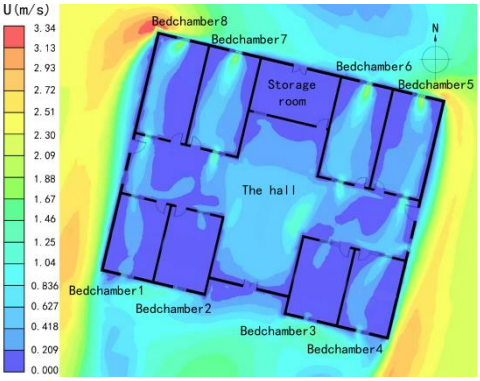

Figure 6 Wind speed distribution map

3.1. The internal space

Southeast area of HUBEI large-scale backbone family lived in for more than a dozen mouth, with a "five four into" big house, for example, its function layout is usually, the first into the yard as a servant, binary pavilion court for home owners live: the third into the yard for women and children activities places, the last into the set as ancestor's hall, such as home old men live in rooms on either side of the tang dynasty. Each entrance hall is on the axis, facing the patio and opening up to form a semi-outdoor family public space, which is the center of family activities. The semi-open hall has a back door and a screen in front of the screen when entering the courtyard[8].

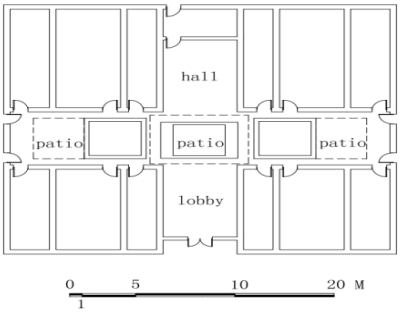

Figure 7 Gem village Shu home big house plan

3.2. Building enclosure: local materials, adapt to local conditions

There is a lot of rain in summer in the southeast of Hubei province, so the maintenance structure of the building pays great attention to moisture-proof materials. Of the residential area is the widespread use of brick wall which used in a lot of more phyletic, mainly blue bricks, clay brick, adobe and so on, but according to the construction of the materials used in the different grade, a relatively high level of construction uses is blue brick that is a type of brick burned from clay until it condenses and cooled with clean water, the moistureproof ability more strong can be exposed to damp environment for a long time; And grade relatively low a few buildings are to use earth to

cultivate brick wall, its moistureproof ability is inferior to blue brick relatively[9].


Figure 8 Square brick floor **Figure 9** Grey tile

Blue bricks as a benefit of the structure is that it can be warm in winter and cool in summer, the blue brick flies in the blue brick flies in the production of raw materials, is the most excellent brackish-water border deposited silt soil because it is by the ancient plant retting, carbide ash black shiny color, rarely sandstone impurities, the brackish-water border plant sapropel firing blue bricks, there are a lot of fine small gap During the rainy summer season, these Spaces, combined with organic matter in the brick, grow moss and green plants wrapped around the outer surface, which on the one hand can absorb water and protect the wall from direct sunlight and provide a cool living environment for the interior[10]. In winter, the plants die because of the lack of rain and drought and become a layer of dry wool that attaches to the exterior of the building and acts as an insulating layer.

In some dwellings in southeastern Hubei province, brick and stone are used to pave the ground. The basic method is to make the ground have good hardness by ramming the ground with logs and then paving bricks. The bricks used for the laying of the floor are made of clay and fired. The surface of the brick is rough after high temperature firing, and it has a better moisture absorption function and can play a moisture-proof role[8].

The roof of ancient residential buildings in southeast Hubei is generally paved with grey tiles. Sloped roof tiles can effectively play a role in drainage and moisture protection. In summer, the standing sloped roof can also form a relatively large indoor space as insulation distance, so as to keep the indoor cool. In the arrangement of tile roof relative to the surrounding brick body maintenance structure, its pores are relatively large, so in summer with the patio can also play a role in the discharge of indoor hot air[10].

4. CONCLUSION

In the work of contemporary architectural design, we should focus on the spirit and connotation of traditional architectural culture, and express our understanding of contemporary architecture and architectural culture by means of the use of spiritual symbols of traditional architectural culture[11]. On the basis of inheriting China's traditional architectural culture, the innovation of contemporary architectural design, on the one hand, reflects that contemporary architectural design contains some characteristics of traditional architecture; On the other hand, we should extend the skills of Chinese traditional architectural culture deeply, get rid of the rough and backward parts and keep the clean parts. On this basis, we should combine the contemporary architectural design culture to achieve the best effect of architectural design.

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REFERENCES

[1] Yang Zhonggui, Zhang Qiqi.,Study on site selection of traditional villages in southeastern Hubei province,Urban Construction Theory Research ,2017,(33),pp. 22–23.

[2] Xin Yifeng, Liu Chao, Gather nationality and live in the village sentiment rich east Hubei Yang new yu wan village,Interior Design and Decoration, 2016, (09),pp. 16–21.

[3] Liang Qi,Study on traditional Architectural Characteristics and Application of Modern Architectural Types in Hubei,Wuhan University of Technology Press, 2013,pp.175–189.

[4] Zhang Xin,Study on landscape Space Design of Traditional Settlements in southeast Hubei, Wuhan Institute of Technology,2019,pp. 68–91.

[5] Sun Caiyu, Su Haidong,Man and Nature from the Perspective of Chinese traditional Residential buildings,Journal of Southwest University for Nationalities humanities and Social Interest Edition,2004, (40),pp. 76–78.

[6] Cui Xilin,The regional characteristics of traditional Residential houses and its inspiration,Architectural Knowledge,2014, (3),pp. 48–50.

[7] Zhang Gan, Li Xiaofeng,Study on climate Adaptability of Traditional Dwellings in southeast Hubei ,New Building, 2006, (1),pp. 26–30.

[8] Li Rui,Exploration and Research on adaptive Modernization of Rural Residential Houses,Nanchang University,2020,pp. 241–243

[9] Xu Zhe, Zhang Yi,Analysis of spontaneous spatial characteristics of residential settlements in traditional villages and towns in southeast Hubei,Journal of wuhan university of technology,2019,(07),pp. 80–86.

[10] Huang Peng,Research on the significance and strategies of developing traditional arts for rural revitalization,Popular Literature and Art,2020,(21),pp. 214–215.

[11] Ma Yiping,Shao Mengqi and Zhang Guanyue,Inheritance and innovation of architecture in southeast Hubei province under "Rural revitalization",Beauty and Times,2021,(01),pp. 34–35.