

Study on the Ecology and Optimization Strategy of Tujia Stilted Building Under the Perspective of Rural Tourism Development

Taking Enshi Erguanzhai Village as an Example

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Abstract—The Tujia stilted building, as a form of traditional Chinese dwellings, is the crystallization of the wisdom that the predecessors used to combine the conditions of nature and the practice of people's life. With the diversified development of China's tourism industry and the National Rural Revitalization Strategic Plan proposed by the Central No. 1 Document, the rural tourism model has gradually emerged. In many excellent rural dwellings, although the existing stilted buildings have not reached the perfect level, with the changes of the times, this kind of residential form reflects the excellent qualities of being able to live and understand, and can satisfy people's aesthetic requirements in many aspects. Taking Enshi Erguanzhai Village as an example, this paper analyzes the ecological principles embodied in the traditional architectural form of the stilted building as the main architectural form from site selection, form layout, construction materials, etc., and proposes an optimization strategy for how to renovate the original stilted building from the perspective of eco-tourism.

Keywords—traditional dwellings; stilted building; ecological nature; ecological optimization; rural tourism

I. INTRODUCTION

The stilted building is located in the western part of Hubei province. The stilted building is a traditional form of residence. It is a product of the Tujia residents in the natural environment and in the long-term practice of life. From the site selection to the construction of the house, all of them reflect the ecological considerations in the design. This kind of ecological research has great practical significance for the optimization of architectural forms, the integration of terrain and space, and the development of contemporary architectural forms.

II. ECOLOGICAL ADAPTABILITY OF THE STILTED BUILDINGS

The architectural style of the stilted buildings has a long history. Although it is a product of the conditions of the past, this form has been used up to now to prove its existence value. The rich and varied ecological adaptability of the stilted buildings is based on the complex and varied terrain and climate of the local western Hubei. This kind of ecology mainly refers to a living-related adaptation mechanism exhibited by the hanging foot building to the natural environment, social changes, economic development and cultural practices. The reason why the slings have been able to experience such a long time is still in the western part of Hubei, which is perfectly integrated into the local environment and adapted to the ecological environment.

A. Adaptability to the Geographical Environment

Erguanzhai is located in Shengjiaba Township, Enshi City, Hubei Province. It is an important node between Enshi Prefecture to Tangya River Basin Scenic Area and Xingdou Mountain Nature Reserve. It is an important destination for the ecological and cultural tourism circle in western Hubei. The formation of the landscape of Erguanzhai Village is compatible with the local natural environment and conditions with a long history. The paddy field, tea field landscape and natural ecological landscape relying on the mountain are the most typical, forming a landscape pattern with unique natural scenery and harmonious integration of environmental elements such as "mountains", "water" and "field". The surrounding area of Erguanzhai village is surrounded by mountains on three sides, forming a micro-geographical form of hiding wind and gathering gas. The residential houses in the village are spread out on the wandering mountain platform. The settlement is a living area, the stream serves as a protection zone for water sources, and the mountains serve as an ecological security zone, showing the

close relationship between people's settlement choice and the natural environment.

For the special environmental conditions of the mountain, the building of the stilted building came into being. This kind of stilted buildings leans on the mountains, curves with the bend, uses the terrain to gain space, raises the living level, and lets the bottom structure freely and flexibly change with the terrain. This architectural form not only reflects the mosaic relationship between the building and the terrain, but also reduces the exploitation of the original site. Not destroying the original landform is the most economical and reasonable technical solution, and it is consistent with the current sustainable development concept, which not only shows the local people's respect and adaptability to the natural environment, but also releases more land for cultivation. (See "Fig. 1")



Fig. 1. The mosaic relationship between the stilted building and the landform of Ershizhai village in Enshi.

B. Adaptability to the Climatic Environment

Erguanzhai is located in the southwest of Hubei Province, the Wushan Mountains in the north, and the Wuling Mountains in the southeast. The overall elevation is high, surrounded by mountains, and there are mountain valleys and graben basins. The mountain forest coverage rate is extremely high, and the complex geographical location determines its unique climatic conditions. The climate characteristics of southwestern China can be summarized as "high temperature, high humidity, rainy, and slow wind", so the primary task of building residential houses is sun protection, heat insulation, moisture protection and ventilation. The stilt style architecture can be adapted to the local humid climate conditions and the complex and varied biological environment. The bottom of the stilted building is overhead, which can better protect the house from moisture and ventilating in hot and humid climates, and can also avoid the disasters caused by mosquitoes in daily life. Each function space is open and transparent to each other, which also promotes the internal air circulation, accelerates the heat dissipation, and achieves the purpose of cooling and heat prevention. The upper part of this building generally has an open or semi-opened attic as its storage space, and can

achieve the purpose of heat insulation in summer and heat preservation in winter. (See "Fig. 2")



Fig. 2. Ventilation diagram of the stilted building.

C. Adaptability to Construction Methods

Most of the construction methods of the stilt buildings are wooden frames. In the long-term development, people have summarized the "standardization" of the construction of the stilted buildings. According to the standard, the craftsman processes the wood into columns, beams, plates, etc., and at the same time, the wood removed from the old house can be reused during the building process, and then quickly installed in a self-service manner, which can be completed in a short time. And the building form is to first start the frame skeleton part, according to their own needs, the main room can be assembled first, and the rest of the room can be adjusted according to the economic strength and the amount of wood. If conditions permit, it can be done in one time. If the wood is not enough or the funds are insufficient, it can be postponed. This construction method can avoid the one-time mass use of wood.

III. THE ECOLOGICAL NATURE OF THE CONSTRUCTION TECHNOLOGY OF THE ERGUANZHAI STILTED BUILDINGS

A. The Importance of the Dragon Venture

The Tujia built houses are very much valued by the "dragon venture" (see "Fig. 3). The western part of Hubei is surrounded by Wuling Mountain and Wushan Mountain. The surrounding terrain is continuous. Therefore, in the case of the Tujia people in advance, they will carefully prepare the location of the house. Usually, a famous Feng Shui master will be invited to determine the quality of the home base by observing the mountainous terrain around the foundation, the direction of the water flow and the assistance of the compass. Therefore, the Tujia people feel that there are more and better dragon ventures in the continuous mountains.

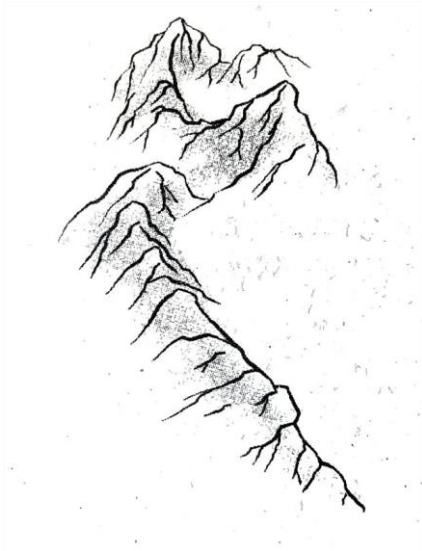


Fig. 3. Dragon venture.

B. Paying attention to the orientation

China's traditional housing has always been facing south since ancient times. Most people prefer south-facing buildings. The houses in Erguanzhai are no exception. The villagers follow the ideal orientation of traditional Feng Shui to determine the residence and the door's direction of the house. At the same time, in the specific planning and layout, the building should be constructed according to local conditions and the construction of the building should be based on the location, making the building be oriented towards the perennial and the dominant wind direction, so that abundant wind can be used to enhance the natural ventilation inside the house.

The stilted buildings rarely change their orientation from the south to the north. They are afraid the wind to enter the house from the south to the north, which will lead to a decline in the fortune of the residents, and things not going smoothly in the future. At the same time, they believe that the exit of houses in the northeast is also an unlucky thing. Therefore, the orientation of the Erguanzhai stilted buildings usually does not choose to face the north. At the same time, from the scientific point of view, the stilted building can be seen in the north and can have more sunshine in the winter. In the summer, it can also reduce the excessive heat caused by strong solar radiation, thus avoiding the overheating of the room, so as to maintain a comfortable living environment. (See "Fig. 4")



Fig. 4. Surveying and mapping color plan map of Erguanzhai village.

C. Near the Mountain and Along with the River

Water nourishes everything, and it is the source of all life. So the most important thing for Tujia people to build a house is the water source of daily life. The Erguanzhai village is built below the mountainside of the mountain, which is not only convenient for water use in daily life, but also has great convenience in irrigation of farmland. Tujia not only live in the water source, but also often choose the residential address from the mountain. Therefore, the stilted buildings usually are considered to be built by the mountains, reflecting the respect for the original landscape environment.

Tujia people introduce fresh air into the interior of the building by planting green plants around the houses they live in, which not only allows people to be close to nature, but also enhances the circulation of air in the houses where they live, thereby reducing the temperature and thus regulating the local climate in the house interior. The long-term construction practice has made the Tujia people pay attention to respecting and utilizing the original topography, combining the architecture and the environment, and fully embodying the basic ideas of the construction of the house, thus achieving the ecological harmony between man and nature. (See "Fig. 5")



Fig. 5. Geographic environment of Enshi Erguanzhai village.

IV. STRATEGY OPTIMIZATION OF ERGUANZHAI STILTED BUILDING BASED ON B&B RECONSTRUCTION

A. Structural Optimization

1) *Column-and-tie construction*: The Erguanzhai stilted buildings are mainly based on the traditional Chinese-style column-and-tie construction frame. Most of them use the whole frame system of the upper and lower collusion, that is, the lower support structure of the dry-column structure and the upper refuge structure are colluded up and down to form a whole, and then use the unique form of the general column of the Tujia nationality.

2) *Ecological characteristics of the column-and-tie construction*: The buildings in the southwestern part of Hubei Province are characterized by the arrangement of

column nets and the intertwining of beams and columns to form the characteristics of self-sustaining and self-expanding architecture. It is also the inheritance and development of the unique traditional architectural culture charm of stilt style architecture.

The Erguanzhai village buildings are built on the basis of the wooden frame. The "columns" and "barrels" in the column net are arranged in units of "steps". The column size of the "steps" is about 900mm-1000mm. The seemingly fixed size unit frame provides a spacious and flexible use space. The frame structure is relatively stable and has good earthquake resistance; all the wood comes from local cedar and pine trees, and the cost is low; the construction technology is followed and implemented by a generation of artisans, and the construction is convenient; the plastic space of the building shape is large. (See "Fig. 6")

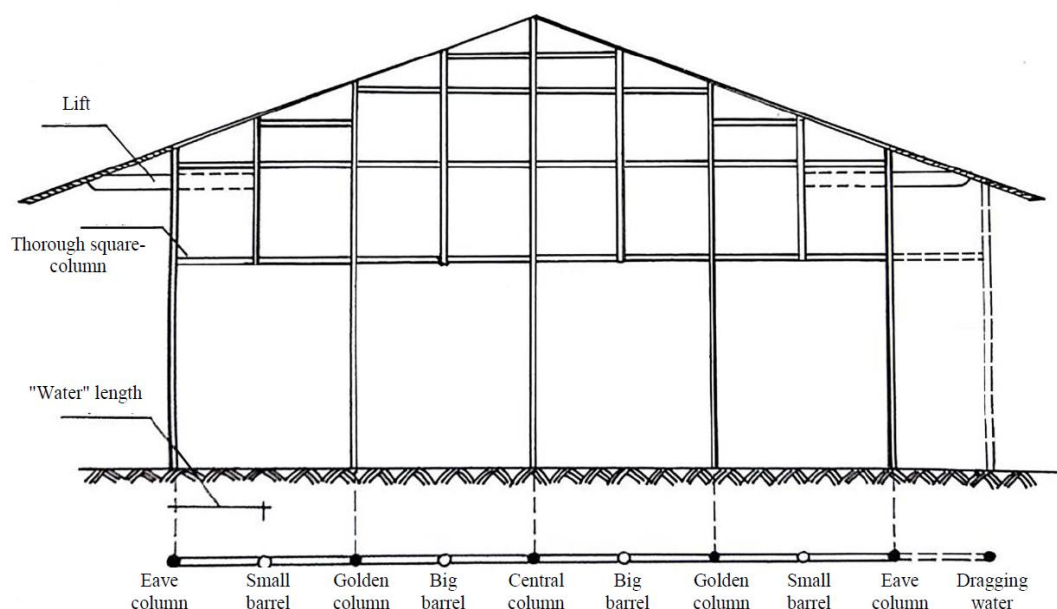


Fig. 6. Column grid's arrangement of "exhaust fan".

As a frame structure, not only the vertical columns are needed for support, but also the horizontal fixing members are needed to form an occlusal relationship with the column, increasing the stability of the house. The foot is fixed on the foundation of the column, and the beam is connected to the column and the riding barrel. The structural units are combined into an "exhaust fan", and the space structure is based on the three-opening room composed of the exhaust fan. Although the flat form of the hanging foot building is mostly in the shape of "—", "L" and "horseshoe", the flat form of the hanging building was found to be changeable during the investigation. Due to the unique column form of the wooden frame building, the addition of the indoor space and area are very flexible. The building itself has the advantage of strong renewal and expansion. In the case of abundant outdoor space, the head of the household can spontaneously add to the building according to their own needs without affecting the stability and main structure of the house.

The western part of Hubei Province is an earthquake-prone area, so the structural considerations must be considered for the seismic performance of the house. The structural shape of the stilted building gives it a good load-bearing capacity, so it has a certain ability to withstand earthquakes. In addition, the wooden frame used in the structural support points of the house can also share some forces. At the same time, most of the stilted buildings are made of wooden beams and columns for load-bearing. And the walls of the house are only used to connect and isolate. The force on the house will be transferred to the foundation through the beam and finally released to the ground. There is a mortise and tenon joint structure between the components and the components in the house, which allows a small amount of displacement between them in the vibration, so as to weaken the vibration energy, making the structure of the hopper has good earthquake resistance.

B. Functional Layout Optimization

1) *Plane layout type*: There are usually in the following ways:

"—" shape: Only the main house has no wing, it is the most basic form of residence. It is composed of three main houses. The central room is located in the middle of the room. It is usually used for sacrifices, wedding banquets, etc. The main houses on both sides of the house are called men's room for people to live in. The back is usually the bedroom.

"L" shape: It usually adds two compartments at the end of one end, that is, one main room and one compartment, and it is shaped like a key, which is the most common form of residence. The single-storey three-open bungalow is the main house, and the two sides are the compartment. The peripherals are arranged outside, and the bottom overhead layer is generally used for stacking debris or raising livestock.

The "U" shape is based on the "—" shape house, and symmetrical compartments are built at the left and right ends of the main house to form one main room and two compartments. This shape of stilted building is enclosed in the outer three-sided building, forming a form of positive, two horizontal and three sides closed, with the closure being stronger and more solemn.

In the form of a "quadrangle dwellings", a mountain gate is added in the middle of the front of the two-compartment house of the courtyard, and the upper part of the stilted building of the two ends of the main house and the two compartments are integrated into one, so that a quadrangle shape can be formed. This form is squarer than other forms, and the house has the characteristics of central axis symmetry.

2) *Functional features of the floor layout*: After the visit and investigation of the existing stilted buildings in the Erguanzhai village, most of the stilted buildings are kept intact, and the bottom floor is in form of overhead. Some are in a flat place, and there is no form of overhead. The building is mainly built according to the terrain. The slope of the terrain is larger and the old form of overhead is used. The overhead space is mainly used for breeding pigs, chickens, ducks and other poultry, toilets and other functions. It can save the horizontal space of building houses, thereby saving building materials such as tiles and saving building foundation.

The layout of the interior space of the stilted building is excellent, not only taking into account the topographical problems, but also utilizing them to create a layered interior of the building. First of all, its core space is the central room, the most important space with publicity. And more importantly, it is connected to the bedroom in most conditions. The overall space is relatively spacious and bright, and the function is clearly defined.

Around it is the overhead compartment that is supported by the stilt to support the floor. This can make the house more adaptable to the undulating environment and enhance the ventilation performance. It is more independent and

therefore more private, so it is mostly used for children's bedrooms or reception rooms.

The overhead space at the bottom is mostly used for pig pens or cowsheds. It is usually connected to the upper compartments or the huts, using the waste of the sundries in people's daily life to feed as recycling.

C. Ecological Optimization

At present, China is undergoing large-scale reconstruction of rural houses, which requires a large amount of building materials. Local materials are a method consistent with sustainable development strategies. The greatest ecological adaptability of the Erguanzhai stilted building is a reasonable local material, and the advantages of local materials should be maintained during the improvement process. Most of the building materials available locally are wood, bamboo, schist, thatch and earth. These materials can make full use of their respective advantages and make reasonable use.

1) *Integration and use of building materials*

a) *Wood*: The main building materials for the stilted buildings are wood. The main building materials in the optimization are also wood, such as the overall frame of the house, as well as the first and second floors of the house and the stairs up and down the house. At the same time, the new building can also use the wood recycled from the wood in the old house.

b) *Stones*: Stones are mostly divided into two types, one is a whole stone, which needs to be manually cut into strips, which is very time consuming and laborious, and therefore the frequency of use is low. The other is a piece of stone on the riverside that can be used for a small amount of processing. The building's plinths are based on the whole stone in order to prevent moisture. The roof behind the house is relatively shallow, so there will be rainwater erosion on the wallboard in rainy weather, which will cause the wood to rot. Therefore, the use of whole stones in the lower part of the wall behind the house can reduce the erosion of rainwater on the wooden wallboard. The piglets next to the house need to be washed frequently with water to keep the sanitation inside, so they cannot be built with wood. The slab is crushed and mixed with the soil to build it, which can be used for a long time and the construction cost is very low.

c) *Bamboos*: The use of bamboos in the construction of stilted buildings is very common. Because the second-floor attic of the stilted building is mostly used for placing unused items on weekdays, it is necessary to have good ventilation to preserve the items. In the optimization, the enclosure structure of the attic layer is changed into bamboo material, and the bamboo is first cut into a suitable shape and then arranged in a louver form, so that the building is more beautiful.

2) *Natural ventilation design*: The windows of the stilted buildings are more hollowed out in the shape of a small square lattice. At the same time, the entry of the rain

can be reduced when it is raining, and the windows on the rear walls are generally smaller. Therefore, the ventilation effect in the room is poor. In order to achieve indoor anti-theft during daily living, the interior sash is mostly fixed, which also reduces indoor ventilation. In the traditional stilted buildings, the rear wall opening method is adopted. In the optimization, the roof part and the attic on both sides are connected to each other, and the inner side is formed into an air outlet in the form of hollowed louvers, so that the wind can enter and exit through the hollow part through the second layer part.

3) *Lighting design:* Through the measurement of the building compartment plane of Erguanzhai village and the study of the distribution of the column network structure, it is found that some areas are asymmetrical on the basis of partial symmetry in the building; the newly built area has a certain degree of inclination, and the original road network construction is distinct. There is no clear road after the construction of the bathroom, only a piece of wooden board support. And there are no protective measures such as railings. The danger is extremely high. The original window of the building close to the bathroom was blocked by the bathroom. The original building was already poorly lit, and it blocked 1.5 windows, making the lighting seriously insufficient. (See "Fig. 7")

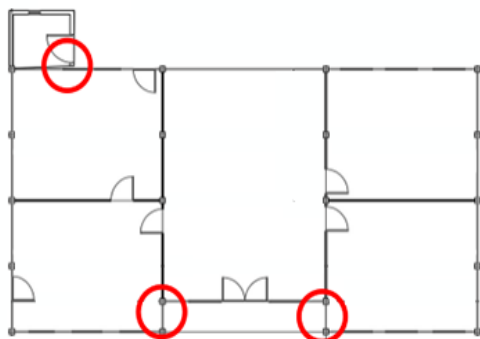


Fig. 7. Schematic diagram of the window opening of the Erguanzhai residential building.

In the process of measuring the building façade, the head of the household is renovating the second floor, and the second floor is covered with wooden boards to make the overall height drop, which makes people feel oppressed; in the homestay of Kangjia Courtyard, most of the homestays have insufficient floor heights, fewer windows, overall depression, and lack of lighting, and the interior of the room is damp and not suitable for long stays. It is recommended to keep the original roof and open the window on the roof to ensure sufficient light in the room. (See "Fig. 8")

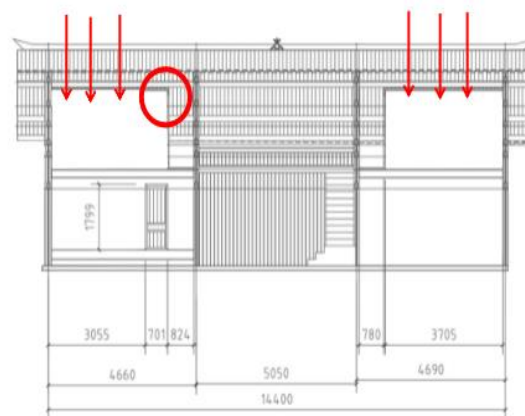


Fig. 8. Schematic diagram of the lighting shelter of Erguanzhai residential buildings.

The light entering the stilted building is relatively poor. This is not only the reason for the small window, but also the window is mostly hollowed out. This design will block the entry of light. When considering this optimization, there are several ways to solve the lighting problem: First is to simplify the window form. The windows of traditional stilted buildings are very technical, and people are pursuing exquisite carvings. However, it affects the indoor lighting and greatly increases the cost. Therefore, the engraving of the window can be simplified in the future construction; secondly, the window opening position needs to be adjusted. Dividing the upper attic floor space into bedroom space can reduce waste. Due to the large roof, the attic floor space is poorly lit, and a part of the gable can be opened as a window to introduce light into the room.

V. CONCLUSION

The traditional village of Erguanzhai is a valuable asset of traditional Chinese architecture. At the same time, in the process of continuous development of rural tourism and increasing openness, it is necessary to take appropriate measures to improve the living experience of traditional buildings, inherit and improve traditional construction techniques to make the traditional architecture shine with new brilliance. The transformation and utilization of ancient villages and ancient buildings should be based on continuous exploration and practice, combining advanced materials, construction techniques and traditional architecture to make the traditional buildings more functional and more comfortable to live. Therefore, on the basis of protecting the architectural style, it adapts to the changing and developing residential demand, and connects the Erguanzhai with the rural tourism industry, thus driving the development of the village and exploring the natural and human values of the village, so that the traditional village can truly survive and lively be continued.

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