A Study on the Traditional Residential Living Patterns of Residents in Tibetan Agricultural Area Based on Natural Environment and Regional Culture

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Abstract. Tibet’s agricultural production area (referred to as agricultural area) is located in the average altitude of 3500 meters above the plateau. It is the region with the highest population density in Tibet, has one of the most representative types of residential buildings in Tibet. The plateau climate characteristics of this area, with cold and dry winter and large temperature difference between day and night, and the mode of production, which is mainly farming, supplemented by animal husbandry, together gave birth to a unique traditional architectural mode. Tibetan Buddhist culture and farming folk culture also produced direct impact on the architectural mode. The study is based on the investigation of the natural environment and the living and producing style, and the analysis of the impact of folk culture and religious culture on resident mode. The study summarizes the traditional residential living patterns of Tibetan residents from the aspects of building materials, construction technology, architectural form, building site selection, architectural function space and architectural decoration, in order to provide the basis for integrating renewable technologies into Tibetan residential buildings.

1. Introduction

Residential buildings are formed under the influence of the natural environment and the regional culture, which is more intuitive and obvious in the Tibetan area. The particular natural geographical environment and building materials in Tibet have created its characteristic form of traditional residential buildings, which have become more mature and complete under the influence of the production and living styles. At the same time, the Tibetan people have created a splendid national culture since antiquity. The cultural system, with Tibetan Buddhism at the centre and folk culture as the carrier, has had a profound impact on the traditional Tibetan residential building model. However, with the development of science and technology as well as the improvement of transportation in recent years, how to find a balance between using advanced construction technology and building materials and respecting the local living habits and living culture has become an urgent problem that needs to be solved. Therefore, the study of the traditional residential living pattern in Tibet is an indispensable preliminary research for the renovation of Tibetan residential buildings in the future.

Due to the vast territory and varied terrain, the latitude, longitude and altitude differences in Tibet are very large, and the natural environment is also quite diverse. Each region of Tibet has a production and living style suitable for the local climatic conditions. According to this situation, Tibet can be divided into three areas: agricultural, forest and pastoral, and their architectural forms are also different. The Tibetan agricultural area includes Lhasa, Shigatse and Shannan (Fig. 1), which is a
suitable area for living and has the highest population density in Tibet. There are about 1.78 million residents in the agricultural area, accounting for about 41% of the total population of Tibet, and about 1.7 million Tibetan residents, accounting for roughly 95% of this area's total residents. The agricultural area has the most representative forms of architecture in Tibet, so it is important to explore the mode of residence in this area for the study of the Tibetan architectural model.

2. The Natural Environment and the Emergence of Traditional Residential Buildings

Under the unique natural climatic conditions, the Tibetan agricultural area has been formed by a geographical environment suitable for farming, with a deep soil layer and fertile soil. The proportion of cultivated land is the highest in Tibet.

2.1. Natural environment characteristics

The Tibetan agricultural area is located in the south of Tibet. The latitude and altitude are both relatively low, with an average elevation of about 3800 meters. The terrain changes greatly and contains many glaciers. The area has typical plateau climate characteristics with low average temperatures; a large temperature difference between day and night; and cold, dry, windy winters. The average annual temperature is 4–9 degree Celsius. The coldest monthly average temperature is -3 degree Celsius, and the hottest is 13 degree Celsius. The lowest recorded temperature is -32.5 degree Celsius. The number of heating days is about 158 per year. Solar radiation in the area is strong; the annual sunshine hours total about 2600–3300 hours, which is the highest solar radiation area in China. Under these climatic conditions, the most important demand for the traditional residential buildings is to meet the need for heating and thermal insulation during the cold winter and sun shading during the summer.

2.2. Building materials according to local conditions

Traditional building materials in Tibet are very different from the other areas of China, mainly because the transportation of building materials from the outside into Tibet is very difficult. The high altitude and complicated terrain caused extremely backward transport. The history of the transport of Tibet has been dominated by humans and animals. Therefore, the traditional Tibetan residential building followed the local conditions in the use of building materials and construction technology. The rich stone and clay on the plateau become the main material for most buildings.

Lhasa, in the agricultural area, is rich in stone, especially granite with excellent strength and compression resistance. Therefore, building walls are mostly made of stone. The Nyangqu River Valley and the upper reaches of the Brahmaputra area have less stone and more soil, so the building walls are mostly made of adobe. In addition to the basic building materials like stone, adobe and wood, there are some special building materials, such as Aga soil and Bianma grass, that are mainly used in Tibetan temples or aristocratic buildings.

2.3. The formation of traditional residential buildings

Figure 1. Tibetan agricultural area
In the process of constantly adapting to nature, the Tibetan agricultural area gradually formed its unique architectural system. Special climatic conditions and the geographical environment also gave birth to the flat-roofed building form with a wooden framework and mud- and stone-wall structure.

In the internal layout of the building, for the sake of warmth and shelter, the traditional buildings in this area put all the rooms together, with the living room as the centre which contains the fireplace, in order to reduce the heat loss. The living room and master bedroom usually face south, and the living room is small in depth so that the sun shines indoors and reaches the less important rooms that face the north. In order for houses to absorb more sunshine, people build them in a sunny position and control the distance between the buildings. The architectural layout of the courtyard is generally low in the southern direction and higher to the north so that the buildings in the back can be exposed to sunlight. In addition, to reduce the loss of building heat, the construction of the leeward side opens a large window, while the windward side has no window or just a small one. The size of the side window is between that of the windward and leeward sides. Additionally, the walls of the building are very heavy, and the building’s structure uses thicker walls at the bottom, which taper off a bit at the top. The facade is gradually retracted upwards and has a good insulation function. The building is like a regenerator, naturally forming a greenhouse effect that uses solar energy. The construction is effective for preserving heat, protecting the interior from the cold and keeping sand out, and can effectively coordinate the temperature difference between day and night.

3. Production and Living Style of Residents

3.1. Production mode and traditional residential architecture

Agriculture is one of the main production methods in Tibet. In the agricultural area, the crops are dominated by highland barley and wheat. However, there is no single mode of agricultural production in Tibet. Along with farming, the Tibetan people also keep livestock, as well as hunt. In the Tibetan agricultural area, the mode of production – dominated by agriculture and supplemented by animal husbandry – is also reflected in the traditional residential buildings.

In the traditional agricultural society of the Tibetan agricultural area, people mainly depend on the land to survive. Irrigation must be carried out for agricultural production. The mountains and the rivers are staggered geographically, forming a large number of valley plains, which have evolved into cultivated land. In spite of their small size, a large number of settlements along the river valleys have formed into a branch-like distribution. In relatively wide river valleys, residential areas developed into larger towns. However, the area of the plains suitable for construction is limited in this mountainous area. Due to labour and economic reasons, people there were not capable of adjusting the natural terrain. In order to avoid excessive occupation of the valley's limited farmland, and because of security needs, relying on the mountain has become one of the important principles of residential site selection in Tibet. At the same time, in terms of the position of the building in relationship to the cultivated land, in the larger settlements in which buildings are densely distributed, the cultivated land is arranged outside the village. In the form of the small group-arranged settlements, the cultivated land is mostly around the group. While the residential buildings are scattered along the valley, the cultivated land is arranged around the house.
3.2. Residential lifestyle

The basic production and living mode of the combination of agriculture and animal husbandry in this area makes a space for captive livestock in residential buildings extremely important. In the form of traditional residential architecture of the Tibetan agricultural area, whether or not there is a courtyard, livestock space would be regarded as an important consideration. In the residential buildings with a courtyard, if it is a single-storey building, there will be a separate space there for livestock and fodder. In a two-storey residential building, most of the livestock are housed inside the building. The first floor is set up for livestock and storage space for debris, food and feed. The second floor is used for living. In the residential buildings without courtyards, the first floor of the building will also be used to keep livestock. In areas where the building density is high, the livestock are sometimes scattered on cultivated land around the buildings. In addition, some buildings would have a space on the top floor for drying crops.

4. The Influence of Religious Culture

Buddhism culture is at the centre of the native culture of Tibet. Tibetans are all religious believers and the influence of Tibetan Buddhism’s religious consciousness penetrates into many aspects of Tibet. The particularity of the common religion leads to the construction of Tibetan architecture, both in the internal structure and the external decoration, with clearly religious qualities. The special religious culture has had an impact on the architectural function space and the architectural decoration.

4.1. Architectural function space

Due to the extensive and profound influence of Tibetan Buddhism, the Tibetan religious atmosphere makes the "Buddhist room" the necessary functional space of Tibetan residential architecture. The Buddhist room occupies a very important position in the daily life of the Tibetan people. Regardless of one’s level of wealth, the Buddhist room space is indispensable, but the interior decoration would be different due to economic conditions.

By the influence of the theocratic system, the hierarchical system of Tibetan society has long been quite strict. This characteristic is also reflected in the architecture. Rooms are increasingly important in order from the bottom to the upper storeys of the building, which is also the layout of the traditional residential buildings' internal functions, so the upper rooms get more attention to lighting and ventilation. Usually the windows at the lower part of a building are smaller than those in the upper part. At the same time, due to the high status of Tibetan Buddhism, the Buddhist room is often the most important space in residential buildings, and thus is generally located at the top of the building.

4.2. Architectural decoration

The early religious worship in Tibet permeated all aspects of people's lives, and also directly affected the selection of architectural colours, forming a unique form of architectural decoration. Most of the residential buildings in the agricultural area would paint the doors and windows black, on the one hand to "exorcise evil spirits" from using them, and on the other hand so they can absorb more heat. The building’s walls are mostly white. The external walls would be painted with a mixture of white pulp containing lime, milk and honey each year. When building a house, people use the local fine soil to wipe the walls, and create a curved, semi-circular or wheat-like pattern with their fingers from the top to the bottom. The natural beautiful sculpture means growth. Residents usually insert a branch with blue, white, red, green and yellow prayer flags attached on the four corners of the residential building's roof. The prayer flags are the symbols of the five elements of Tibetan Buddhism, namely water, fire, wind, air and sky. At the same time, due to the profound influence of the Tibetan Buddhism Tantric ideology and the theocratic system on the whole construction system, only the higher status buildings that occupy an important position can use high-grade colours, such as red and yellow. White is commonly used in secondary positions and low-level buildings.
5. Traditional Residential Architectural Patterns in Tibetan Agricultural Areas

Due to the decisive effect of the natural environment and the production and living modes on the traditional residential buildings in the Tibetan agricultural area, as well as the profound influence of the religious culture and folk culture on the further formation of the traditional architectural model, the Tibetan agricultural area finally formed several representative residential architectural patterns. Classified according to the architectural plane form, the main forms include the "U"-shaped residential architectural pattern, the "L"-shaped pattern and the homocentric squares-shaped pattern.

5.1. "U"-shaped residential architectural pattern

The "U"-shaped residential architectural pattern is the most widely distributed, which appears everywhere in the Tibetan agricultural area. The number of storeys is mostly one or two. For buildings with only one floor, the livestock are always raised in the courtyard, and the toilet is also located there. For buildings with more than one floor, the livestock would be raised in the courtyard or housed on the ground floor with storage space. The hanging dry pail latrine is generally located on the second floor. The "U"-shaped residential architectural pattern usually sets the living room, bedrooms and other important functional spaces on the south side of the building, with the living room in the middle, and the other spaces arranged on both sides. In general, the "U"-shaped residential architectural pattern would usually divide the space for raising livestock and placing fodder in the courtyard. The wall thickness is typically 300–400 mm, with soil or stone as the main building material. This type of architectural pattern usually occurs in clusters or settlements where buildings are more concentrated, and the cultivated land is mainly distributed outside the settlements.

5.2. "L"-shaped residential architectural pattern

The "L"-shaped residential architectural pattern is mainly distributed in Lhasa and Shigatse at areas of low altitude. The number of storeys is mostly two. The first floor is always used for livestock and storage space, and its form is often not limited to the shape of an "L". However, the residential functional space of the second floor is always set to the shape of an "L" and faces the south to obtain the maximum amount of sunlight. Usually, no rooms are located on north side. All rooms are arranged along the "L" shape. Wall thickness is about 300–400 mm, with soil or stone as the main building material. This pattern often appears together with the "U"-shaped building.

5.3. Homocentric squares-shaped residential architectural pattern

The homocentric squares-shaped residential architectural pattern is mainly distributed in some areas of Shannan and Shigatse, where the altitude is higher and the weather is relatively cold. The main walls of the building are enclosed on all sides, the central atrium is built as a courtyard, and the rooms are built around the atrium. There are usually few courtyards outside the building. This layout of the residential buildings is generally two storeys or higher. The ground floor is for livestock and fodder use, and above the first floor is residential functional space. This layout form can maximize the effect of insulation against the cold. The building’s structure uses thicker walls at the bottom, which taper off a bit at the top. The wall thickness is about 400–600 mm, with stone as the main building material.
The exterior walls are mostly stone primary colours. This kind of residential architectural pattern appears in the more loosely settled areas, and the cultivated land is always arranged around the house.

![Figure 4. The plan of the three different residential architectural patterns](image)

6. Conclusion
Under the conditions of the cold and dry climate, the people of the Tibetan agricultural area have explored and created a traditional residential architectural pattern that is suitable for the natural geographical environment. The unique and long history of traditional regional culture in Tibet, together with the foreign culture from the surrounding areas, formed a far-reaching and indelible influence of traditional residential living patterns for residents in the Tibetan agricultural area. It is a significant foundation to study the entire Tibetan agricultural system in Tibet, in order to provide theoretical support for the renovation of residential buildings in Tibet and the integration of renewable energy technologies in the future.

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