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Vernacular Architecture in the Tibetan Kham Area: A Combination of Environmental Excellence and Practicality

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Abstract

With the rapid globalization and industrialization, it exists a paradoxical situation that traditional architectures are gradually replaced by modern architectures and are in danger of disappearing in the cities because of the lack of practical value, but these traditional architectures are cited as exemplary models of being friendly to environment. The article provides a positive case of Pekong houses in old urban areas of Ganzi town, the Tibetan Kham, China, where is a part of the transition zone between the plain and Qinghai-Tibet Plateau and therefore exists frequent and high-intensity earthquakes. Pekong houses are spontaneously built in the cities and villages by Tibetans with thousands of years and have a long-term viability to mitigate the effects of local climate and geography and to meet contemporary needs of Tibetans by a range of appropriate approaches. The focus of study is on the effective strategies that create the habitable indoor climatic condition out of Qinghai-Tibet plateau Region monsoon climate, perfectly deal with the relationship between architectures and mountainous terrain, make architectures have an excellent ability of anti-seismic by the use of locally recycled raw materials, such as earth, stone, wood, and how to make positive responses to meet the changes of contemporary social, economic and cultural attributes in Tibetan area while region-specific architectural features are inherited well. These show a deeper understanding of critical factors affecting the continuation or abandonment of traditional architectures and offer the experiences to really create a comfortable and cost-efficient living conditions for urban residents with maintaining a friendly relationship with the environment.

Key words: Vernacular architecture, adaptation, practicality, critical factors, high-intensity earthquakes

1. Introduction

During recent years, many modern and standardized architectures have been built in cities with the increase of urbanization rate and the effect of industrialization in China, which provides a convenient and comfortable modern life for urban residents at the expense of the consumption of high energy. However, these architectures are unsuitable for the minority concentrated region in Tibetan Kham area with extreme climatic characteristics and complex topogr aphy features. It appears to be more important to learn to construction experience of vernacular architecture over thousands of years, an example of the sustainable construction, making the best use of limited resources and avoiding adverse environmental factors by various design approaches. Additionally, the rethinking of these experiences will help with a more effective use of resources and offer a comfortable living conditions for the residences. Therefore, the paper strives to further analysis Pekong house in Ganzi town, namely a unique form of the dwellings in Kham Tibetan area, and aims to the approaches to adapt cold climate in mountainous region and the evolution of structural forms to enhance the earthquake-resistant ability with local construction materials, through a literature review, closer investigation, sketchbook documentation and on-site analysis. The research of Pekong house covers the follows:(1) the unique natural and social environment in Tibetan Kham area; (2) the introduction of Pekong house;(3) The passive design strategies to adapt the environment.

The group of vernacular architecture in Tibetan Khan area would be divided into four categories:(1) construction with wood frame; (2) Pekong house; (3) construction with rammed earth walls or masonry; (4) construction with structural adulterations (Xingguo Zhang 2011). The research focuses on Pekong house,

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which construction systems combined the use of rammed earth building, traditional in Tibetan area, and timber framework, widely constructed in the southwest forestry area, due to the Kham Tibetan area belongs to Alpine Gorge Area, where the wood resources is rich (Yanbo Wen 2007). The significance lies in: (1) Pekong house only exist in Tibetan Kham area; (2) specific architectural and structural features.

2. Pekong house in Tibetan Kham area

2.1. Geography and climate

Tibetan Kham Area is one of the three largest Tibetan-inhabited areas in southwest China, which is in the transitional region between the Tibetan plateau and the Chengdu Plain, including the geographical scope of Ganzi Tibetan Autonomous Prefecture, one part of Aba Tibetan and Qiang Autonomous Prefecture、Muli Tibetan Autonomous Prefecture in Sichuan province, Qamdo Tibet Autonomous Region in Tibet province, Diqing Tibetan Autonomous Prefecture in Yunnan province and Yushu Tibetan Autonomous Prefecture in Qinghai province, as a shown in Figure1.

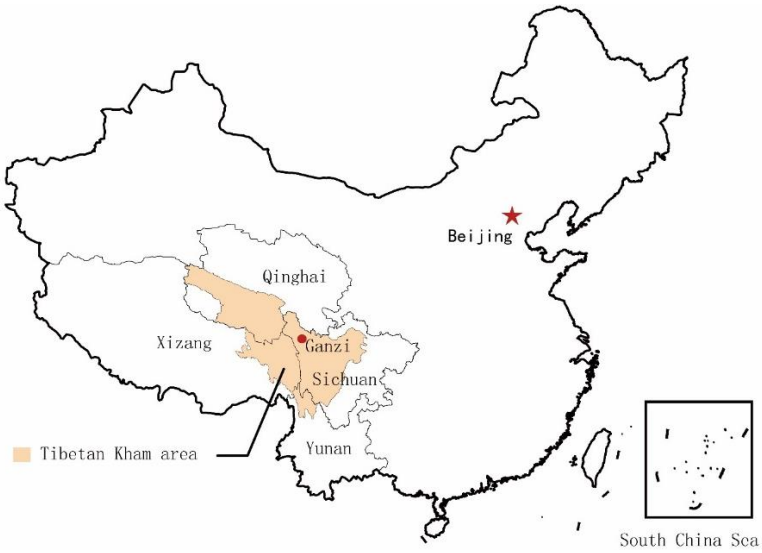

Fig. 1. Map of China and the location of Tibetan Kham area and Ganzi

It has an amazing variety of landforms and is the Qinghai-Tibet plateau Region monsoon climate in Kham. The typical features affecting Kham's climate are due to the orography, because of the cuts made by major rivers (Jinsha river, Yolong river, Lancang river and their tributaries). There the rivers and mountains are in parallel, which leads a height difference that the highest elevation is above 4000m and the lowest point is about 1000m. The vertical characteristics of the topography from high altitude mountain area, grassland pastoral area to valley farming area are especially prominent, forming obvious three-dimensional climate characteristics. The temperature difference between the top and the foot of the mountain is 20℃-30℃, and it is covered with snow all year round at the top of the mountain. The annual precipitation is from 325mm-920mm, and the annual sunshine hours are about 2,000h. In addition, it is divided into the cold and warm seasons of a year. In cold seasons, the minimum temperature of the settlements at high elevation is generally lower than -20℃. In warm season, it is wet and warm. In short, the climate in Kham Tibetan areas is characterized by abundant light, less annual rainfall but concentrated rainfall, being extremely dry and cold in winter.

There is an area of high-intensity earthquakes. In recent years, the 8.0 magnitude Earthquake in Wenchuan, the 7.1 magnitude Earthquake in Yushu, the 7.0 magnitude earthquake in Ya'an occurred in Tibetan Kham area and its surrounding areas. The Xianshuihe fault in the central area of Tibetan Kham area is the most active and the longest fault of Sichuan province. Since 1904, there have been 4 earthquakes of above magnitude 7. Therefore, vernacular Architecture in the Tibetan Kham not only is designed to deal with the extreme weather conditions and the complex terrain, but also has an excellent ability of anti-seismic.

2.2. Religion and lifestyle

Almost every Tibetan is the devout believer of Tibetan Buddhism, which directly reflected in all aspects of life. One of the things Tibetans do every morning is the Weisang, that is, Tibetans put the cypress and vanilla in the specific oven, lit them, then add the highland barley food into the burning, which means to provide food

for the gods to dispel the evil. The temples in Kham are filled with pilgrims every day, and Tibetans always recite or chant scriptures. Devotees come to the temple to worship in the first and middle day of each month. Therefore, Tibetans are willing to build their houses around the temple, convenient for going to the temples. We can say that almost every settlement has its own temple, and these temples are in the center or the highest point of the settlement, because many settlements are developed by the temples, such as, Ganzi town, Gengqing town, and there are a lot of symbols with religious overtones in the settlements, as a show in Figure 2. In addition, they also believe in Bonismo, the traditional religion of the Tibetans, which emphasizes the worship to Nature. For example, almost every settlement has its own holy mountains, and each family strives to overlook the holy mountains in its own building, there is a religious concept that Tibetans under the influence of religion think the holy mountains can provide living resources and spiritual refuge for them.

Fig. 2. The Symbols with Religious Overtones in the Settlements

2.3. The Description of Pekong house

Pekong house, the most widely used in the settlements on the north line of the Sichuan Tibet Tea Road and in Xianshuihe seismic zone, is a special type of the traditional Tibetans dwellings of indigenous people in the Tibetan Kham area, for the big differences from the typical Tibetans dwellings of Lhasa, as a show in Figure 3. The typical dwellings of Tibetans that consists of rammed earth outer walls and internal wooden framework, gradually integrate well-frame structure in forest area and wood-frame structure of Han nationality, and it forms Pekong house, as a show in Figure 4. This is to improve its own stability, giving a positive response to the complex topography and the frequent earthquake disasters in Kham, of course, it is also bases on the rich timber in the mountains and the frequent communication with other nationalities, compared with other Tibetan areas in China. In addition, this type of Tibetan residential architecture can be built in large numbers in cities and rural areas are that it can meet the needs of different people well. These buildings are generally 1-3 layers, and they can have different layout inside the buildings according to the needs of different objects.

Fig.3. Typical Tibetans Dwelling in Lasha

Fig.4. Pekong House in Tibetan Kham Area

Fig.5. The New Urban District of Ganzi Town

Fig.6. The Old Urban District of Ganzi Town

3. The introduction of Ganzi town

Ganzi town is developed from Ganzi temple, is now divided into two districts: the new urban district and the old urban district, and the Hanren temple is the oldest building in the town, which has a history of more than 700 years. The new urban district is located in the valley, most of the buildings are built after the 1980s, as a show in Figure 5; and the old urban district is built into the side of a mountain and is the core of the cites before 1980s, as a show in Figure 6. In the old urban district, Ganzi temple is located in a higher position so that people can see it far away, and therefore, it creates a sense of awe and admiration. Pekong houses, the residences of the Lama, tend to be built around the temple, reflecting the influence of religious culture on the layout of the settlement，belonging to the jurisdiction of the temples, which constitute the religious district together and are isolated from other areas with a wall. There is a situation that a Lama has a Pekong house or a house lives some Lama, they come here to practice Buddhism or Taoism, therefore, these Pekong houses only need to meet the basic living with an independent space and they are just one layer to adaptation to the terrain. The living district is the home of the indigenous people and the sites of chieftain buildings, as a shown in Figure7.

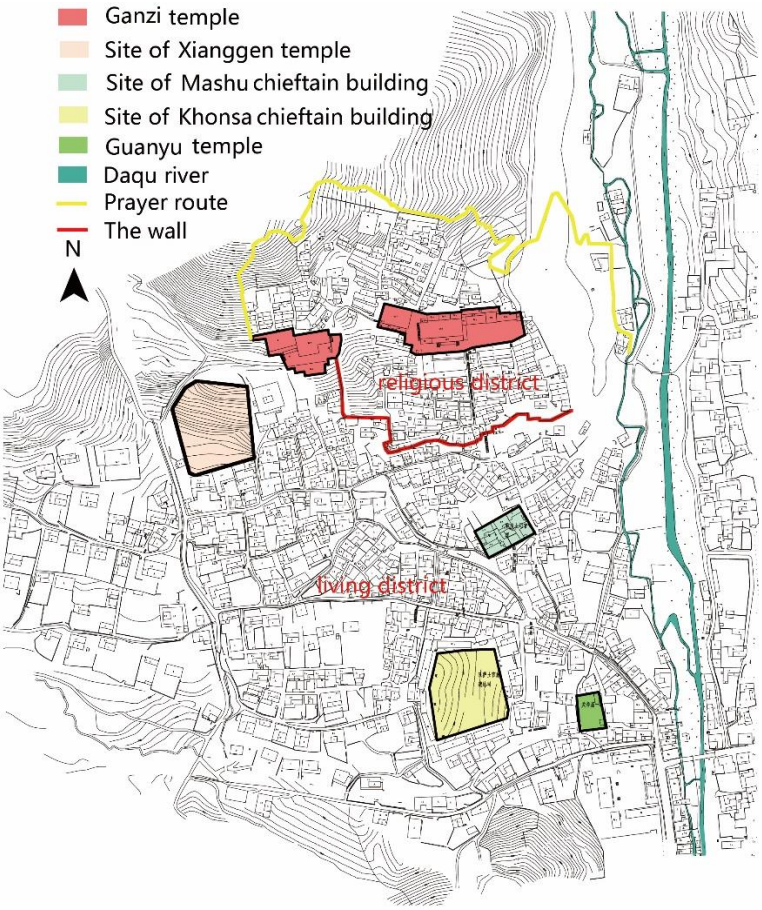

Fig.7. The Plane of the Old Urban District in Ganzi Town

4. The passive design strategies

The formation and development of settlement in Kham restricted by the natural environment for a long time, is also affected by the economic, religious, social influences and ethnic flavor, which the Tibetans want to make best use of. Due to the difference of the geographical location of the settlements, the layout types of the settlements can be divided into two categories, one type is in the slope, another type is in the valley, indicating a highly adaptability to the landform. However, no matter what kind of the layouts, there will be more than one temple in every settlement, and the temple are the core of the settlements, because most of the cities or villages are developed from the temple in Tibetan Kham area. As previously mentioned, the study focuses on effective design strategies of Pekong house in Ganzi town to provide a comfortable indoor environment and rock-steady structure for indigenous people in Tibetan Kham area by adaptation to the terrain, climate, religion and so on, through continuous trial and error over thousands of years.

4.1 The layout of the old urban district: adaptation to the terrain and climate

In religious district, the sloping mountain terrain is transformed into a series of platform by Tibetans, the height between the upper and the lower platform is the same as the height of the building, as they handle mountain farmland. There are two or three houses on each platform, the flat roof of the lower house become the terrace of the upper house and the path enter the house, to minimize the base area of the houses for highly fitting with mountainous topography, and these houses present a strip of architectures on the plane, formed a unique architectural complex of Pekong houses. Therefore, the Pekong house and the temple constitute the layout of the settlement from the center outward radiation from a distance. Of course, this approach allows every house to get more direct sunlight and withstand the northwest wind by relying on the mountain at the same time, as a show in Figure8.

In living district, the terrain is relatively flat, so, they are spontaneously constructed according to the living needs of Tibetans without the strict constraint of religion, and the layout is also relatively free. Pekong house of the indigenous people with a central courtyard is ideal for Tibetan people engaged in farming and herding, and there are many spontaneous streets, which are slowly rising with the changes of the height of the terrain

and the plane modality are tortuous, as a show in Figure9.

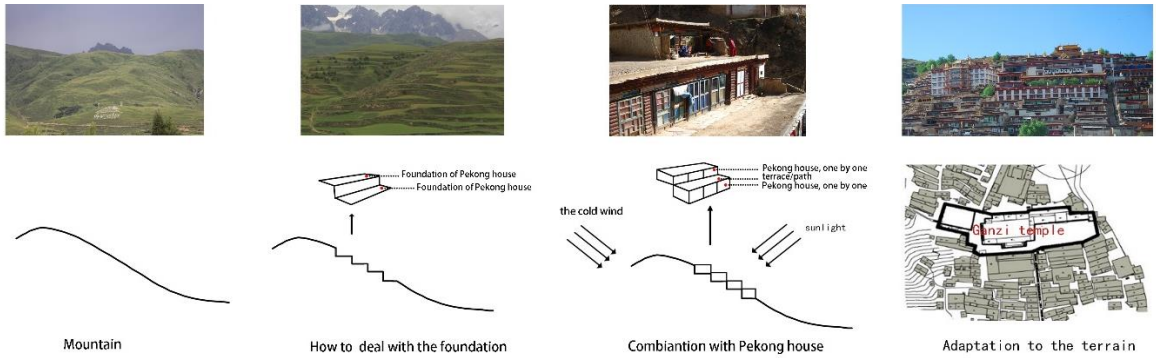

Fig.8. Adaptation to the Terrain

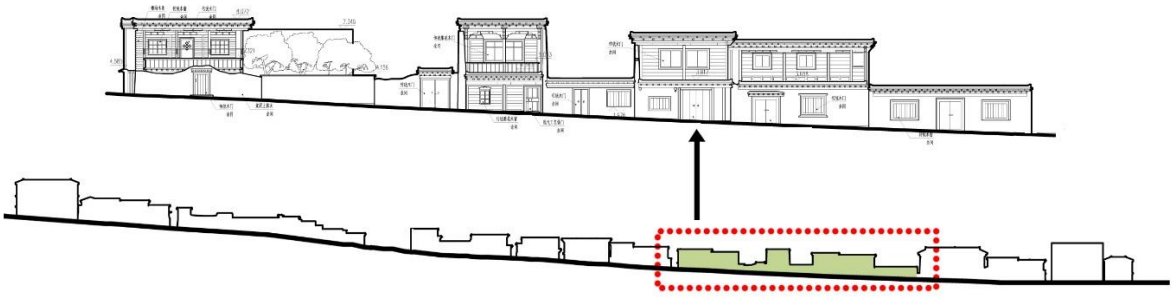

Fig.9. Elevation of Building along the Street

4.2 The style of the structure: adaptation to high-intensity earthquakes and life needs

The structural style of Pekong house is divided into well-frame structure and wood-frame structure, as a shown in Figure10.

Pekong house of well-frame structure evolved from the typical Tibetans dwellings. A Pekong is a well-framed unit that half of logs are stacked upward one by one and the four corners are formed by cross-bites. When a building is used only a Pekong, it belongs to one of China's three major architectural forms, called the log dwelling, widespread in the forest of the northeast and southwest area of China, because of it's a great consumption of wood. At first, Tibetans people in Tibetan Kham area placed one or two units of Pekong in the rooms of the typical Tibetans dwellings for storing up their harvest better, which is the prototype of Pekong house. We can still find this type of architecture in remote rural areas of Daba County and Xinlong County. Gradually, indigenous people found a Pekong with quality timber had an excellent ability of anti-seismic and had a strong adaptability of the mountain, on the base of maintaining the original structure of the Tibetans dwellings that have a good performance of reducing the let-out of heat in the rooms. So, they tried to use a Pekong as a part of the building by replacing thick rammed earth wall of the façade of the building with wood-panelled wall, the Pekong began to become the weight-bearing structure and was used to a form of the interior space division, which is the basic form. The type of Pekong house is the most typical form and the most widely distributed in Kham Tibetan area.

External wall is built of the rammed earth wall and stone wall of a thickness of 400-800mm to reduce the let-out of heat in the rooms. The wooden wall of Pekong in the second layer placed directly on the rammed earth wall, so, the deadweight of the second layer is obviously less than the first layer's, lowering the center of gravity to stabilize itself in the steep mountain, and wooden wall of Pekong in the second layer placed directly on the rammed earth wall. In addition, Tibetans placed a post every 1m in the interior of the rammed earth wall, because it was easy to collapse. In the interior of building, the pillars with a diameter 250mm-400mm and the beams of wooden constitute the major weight-bearing structure in the first floor that are independent of the external walls, the wooden wall of Pekong are used to divide the space and bear the weight of the roof in the second floor, and set up some pillars to auxiliary supports for Pekong in large spaces. That the wall in the second is often placed directly on the external wall and the floor for the layout of the function and there is a lack of close connection between internal and external load-bearing structure makes the integrity of the structure is not strong. In turn, it is convenient for the renovation of exterior walls and the replacement of components, so, the type of Pekong house can be used to live for 200-300 years.

Since 1980s, the structure of Pekong house has a great change that the main load-bearing structure of rammed earth wall is gradually replaced by wood-frame structure, because there occurred a 7.6 magnitude

earthquake in Luhuo of Tibetan Kham area. Most of traditional Tibetan houses collapsed completely, and Pekong house and wood-frame structure of the dwellings of Han nationality had also been severely damaged or tilted. The indigenous people began to try to introduce the wood-frame structure into Pekong house, and diameter of the column of the wood-frame structure is about 200mm-500mm, to resist lateral forces induced by seismic. Therefore, Pekong house built in different periods can be distinguished, based on the structural characteristics. Additionally, there is a special regularity of distribution that Pekong houses out of seismic zone were built earlier and their forms seem to be simple and unsophisticated. Pekong house of wood-frame structure is the optimized form of Pekong house of well-frame structure. The Pekong is broken down into its component parts, the wooden walls and the pillars at the four corners, that is, the wooden walls are linked together through the pillars, instead of the original form. Meanwhile, the pillars combine with the structure in the interior of the first floor to form a complete wooden frame structure, and the wooden walls of Pekong, rammed earth walls and stone walls will not bear the weight any longer. Therefore, the style of Pekong is called Pekong house of wood-frame structure, a combination of Tibetans dwelling of the rammed earth structure, the log dwelling in the forests and the traditional dwelling of wood-frame structure of Han nationality. It has a greater ability of anti-seismic, compared with Pekong house of well-frame structure.

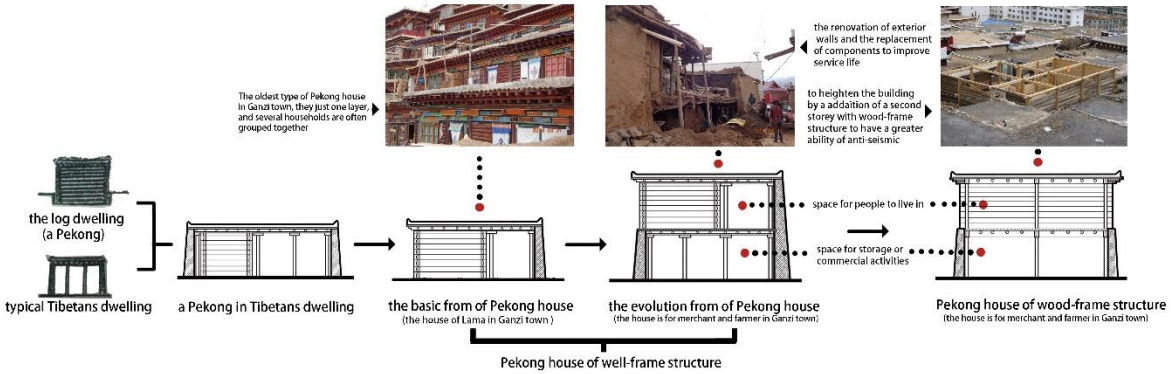

Fig.10. Evolution of the Structural Style of Pekong

4.3 The decoration with religious overtones

The decorative paint of the architecture from the local mineral raw materials, and these colors of high purity are often very bright and warm, which is an enthusiastic response to the natural landscape of the sun, moon, stars, mountains and lakes in Kham Tibetan area. Of course, it is influenced by religion, for example, the red is a symbol of the sun, means the power and the strength, the white is the color of white clouds and the snow-capped mountains, means pure and noble, the green is a symbol of the river, the yellow represents the earth. The vertical plane ornament of Pekong house often uses a sharp contrast between the window and cornice of bright decoration and the large area of soil-yellow wall, as shown in Figure 4.

5. Conclusion

It is evident that highly reasonable design strategies have been made that give these vernacular architectures a carefully considered connection with its environment, to deal with cold climate, high-intensity earthquakes, life needs and religious culture. That the structural form of Pekong house has a clear evolution represents a reasonable optimization of vernacular architecture in Tibetan Kham area, namely in a seismically active area, in a minority concentrated region, in Qinghai-Tibet Plateau. In addition, the case study results give a reminder to think about why vernacular architecture are abandoned in China, to learn lessons from sustainable design with providing a comfortablse living space for Tibetans. Finally, how to improving the qualities of vernacular architecture in specific cultural contexts, namely the area where everyone believes in Tibetan Buddhism.

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