

Lessons from and Comparison of Vernacular Housing: Review of Low-income Tropical Housing in Xishuangbanna, China

Working Paper – ELITH

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This is part of the literature study on specific tropical housing of the Southern Yunnan Province, China. A journal paper is proposed to be developed from this working paper.

Abstract

Xishuangbanna Dai autonomous is the southernmost city in the Yunnan province. Many minorities live here and Dai people are the majority of population. Their traditional domestic house is called “Zhulou”, which directly translated as ‘house made with bamboo’. This appearance of building has still been used in some rural areas of Xishuangbanna. Some newly-built domestic houses are also based on the shape of “Zhulou” with some material changes in construction. The layout of these new houses is updated significantly to fit modern life style.

1. Location of Xishuangbanna

Xishuangbanna Dai autonomous prefectures located at the south of Yunnan province. Many ethnic minority groups live here. The major population is made up by Han people and Dai people.

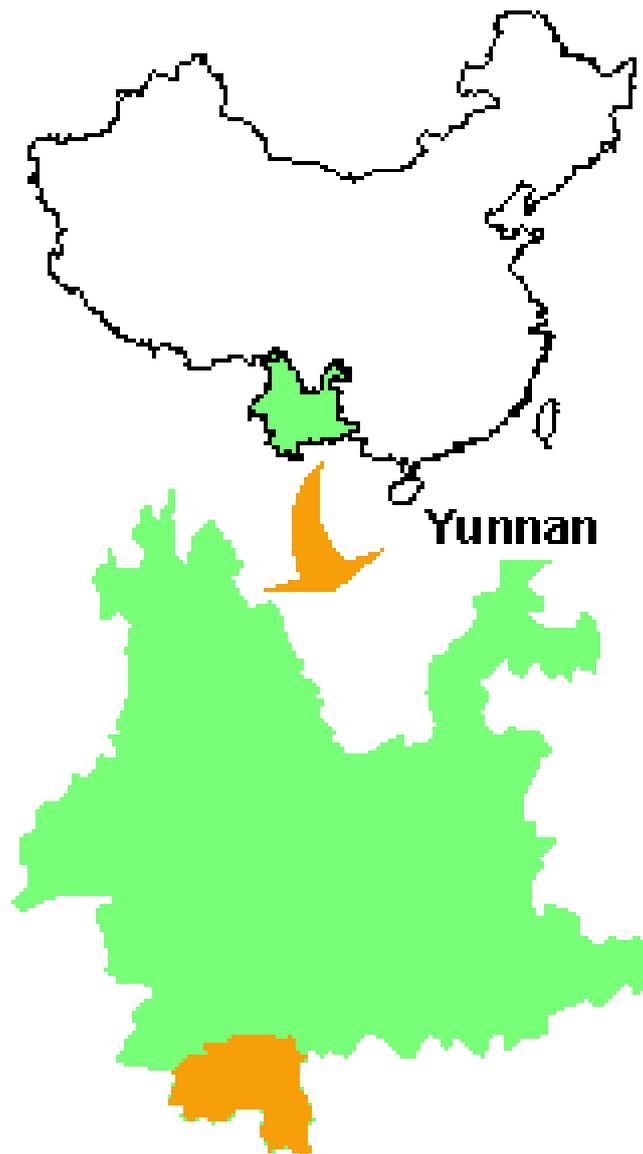


Figure 1 - Location of Xishuangbanna in the Context of China ^[1].

1.1 Weather conditions

According to the official website of Xishuangbanna government, 18% of the total lands are tropical zone with an area about 3452 square kilometer ^[2]. This area has the largest tropical forest in China and is considered as a major place for tropical crops production.

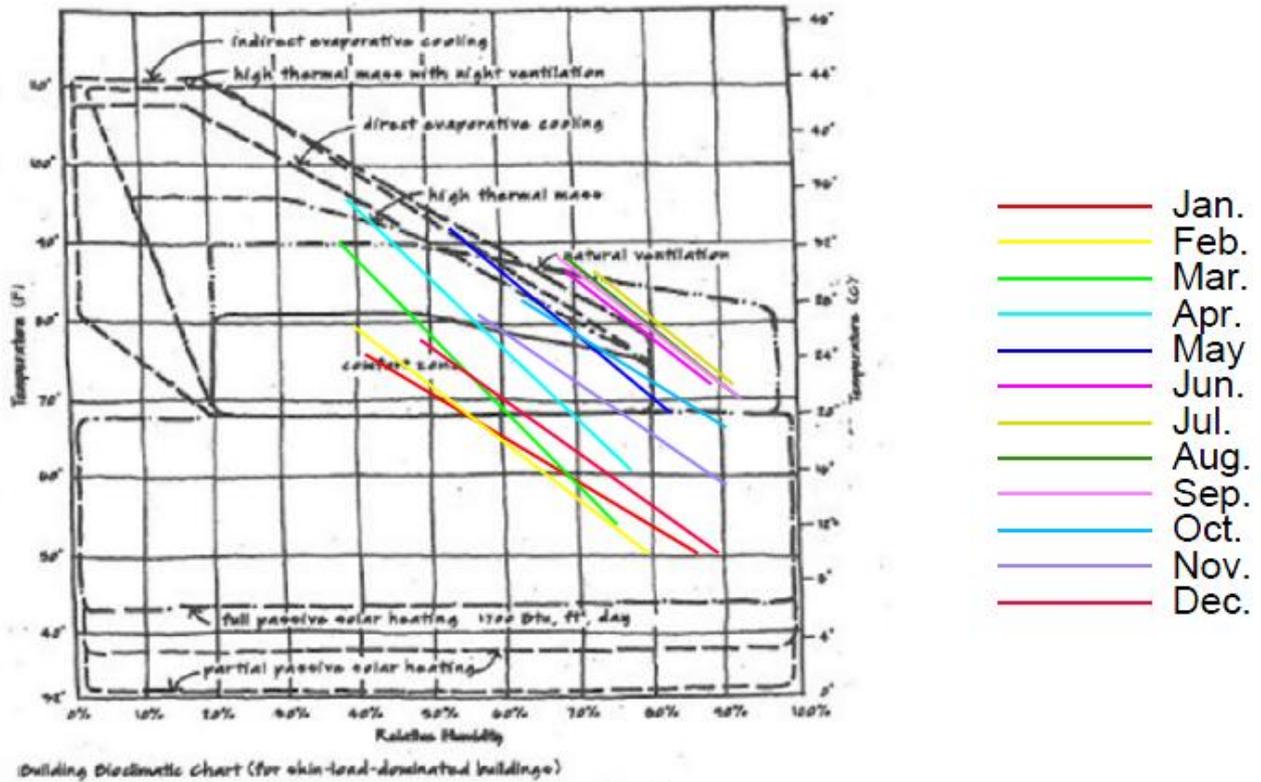


Figure 2 - Bioclimatic chart analysis for Xishuangbanna, Yunnan Province, China .

The bioclimatic chart (figure 2) shows that building design in Xishuangbanna needs heating between the months of November and March/April and requires significant cooling during summer time.

1.2 Economic conditions

Xishuangbanna has been developed well due to the improvement of infrastructure (road conditions in particular), tourist industry and agriculture.

In 2007 the GDP per capita increased to 10,754 RMB^[3]. This is roughly 1,000 GBP per person per annum. However, there are still many minorities lived in remote areas (i.e. mountainous areas) who are troubled by the existing poor communication and transportation systems. The education level and agricultural development are fairly deprived in these places.

Currently, the mountainous area occupied 95% of the total land in Xishuangbanna, where 36.24% of the overall population live. Also, within 120,000 low-income people in Xishuangbanna, 95% of them are minorities. They normally prefer to live scattered, therefore, due to the not very well development and poverty among these areas, the sideways connected between the communities are usually not easily accessible.

The transportation problems have in recent years resulted in a huge increase in the price of construction materials like bricks, cement and stones. Their prices are much higher than the

normal market price. Most importantly, half of the total cost is dedicated to the transportation fees.

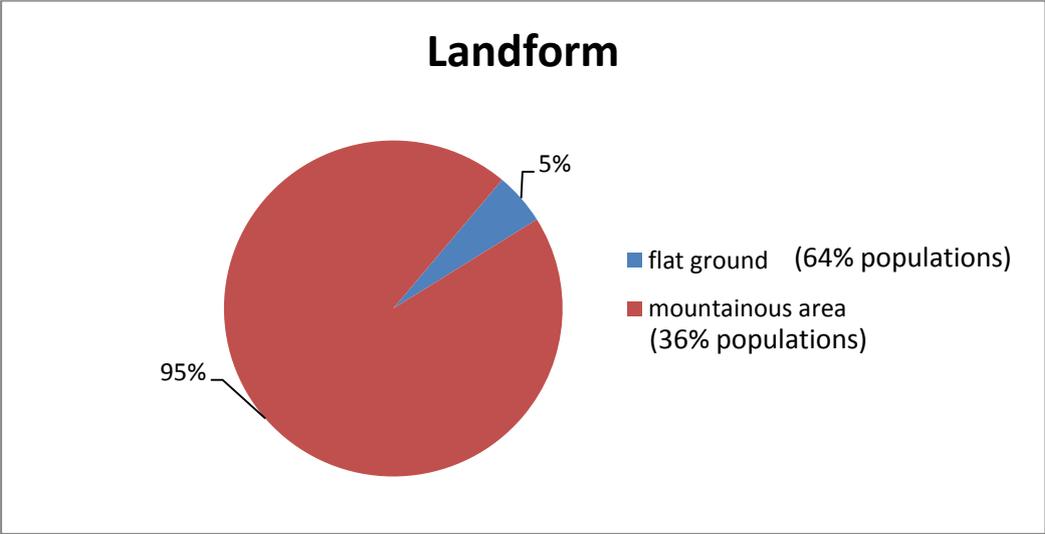


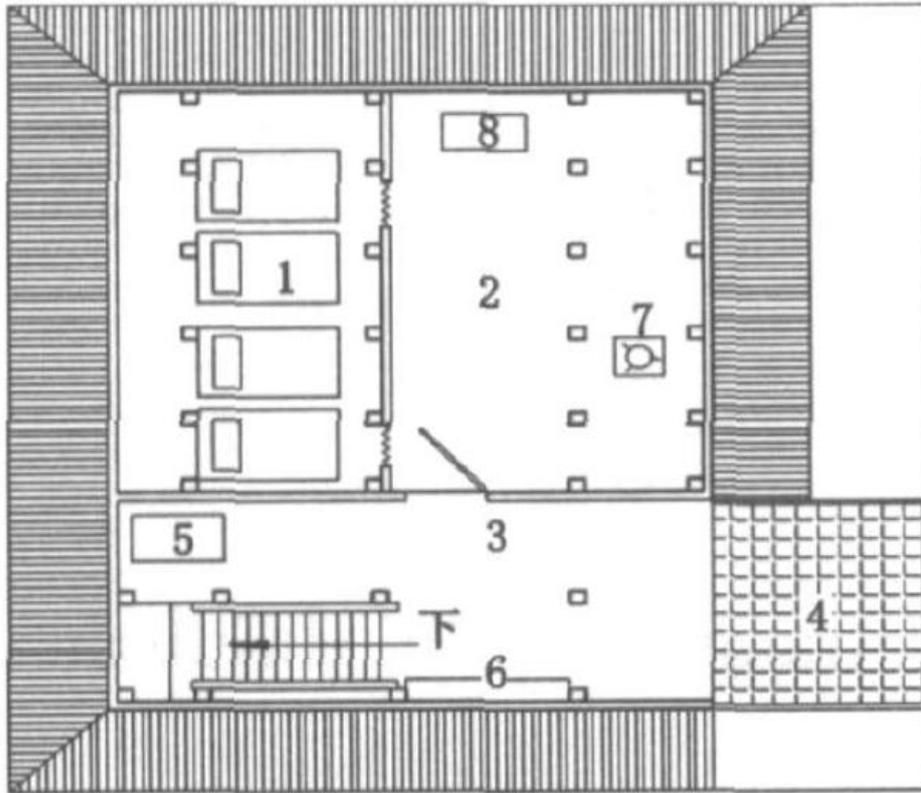
Figure 3 – Landform distribution in Xishuangbanna.

2. Study of Dai dwellings

The traditional dwelling of “Dai” minority is the typical stilt housing in China. Dai is the largest ethnic minority in Xishuangbanna. “Zhulou” is the name of their traditional dwellings. In old time this type of housing was made all by bamboo and timber. Usually the house consists of two floors; the ground floor and upper floor. The ground floor which does not have walls is for goods and animals, while residents normally live in the upper floor.

2.1 Traditional rural house

The traditional design of “Zhulou” has a simple layout. All the family numbers are living in one bedroom with separated curtains or partitions (note: usually curtains). And they have a fire place in the living room as a heating source during the cooler months of winter. No bathroom was allocated within the indoor spaces of the houses.



Legend: 1 bedroom / 2 living room / 3 porch/ 4 balcony / 5 storage / 6 chairs / 7 fire place / 8 owner's seat

Figure 4 - The plan of traditional Dai dwellings^[4].



Figure 5 - The timber-constructed building of a traditional Dai dwelling^[4].

2.2 Modern rural house

Several improvements are made in the new dwellings:

- Change of layout: increase the room functions. Add separated bedrooms, kitchen and toilet;
- Change of façade: change the original bamboo and timber wall in to brick wall. Increase floor height from 1.8m~2.5m to 2.6m~3m. Increase the size of windows;
- Change of flooring and roofing materials;
- New structure technology: IMS system;
- Ventilation and humidity comparison: new dwelling increase the ratio of window/wall; Increase the indoor daylight amount; new dwelling's insulation and dehumidification ability is not as good as the traditional.

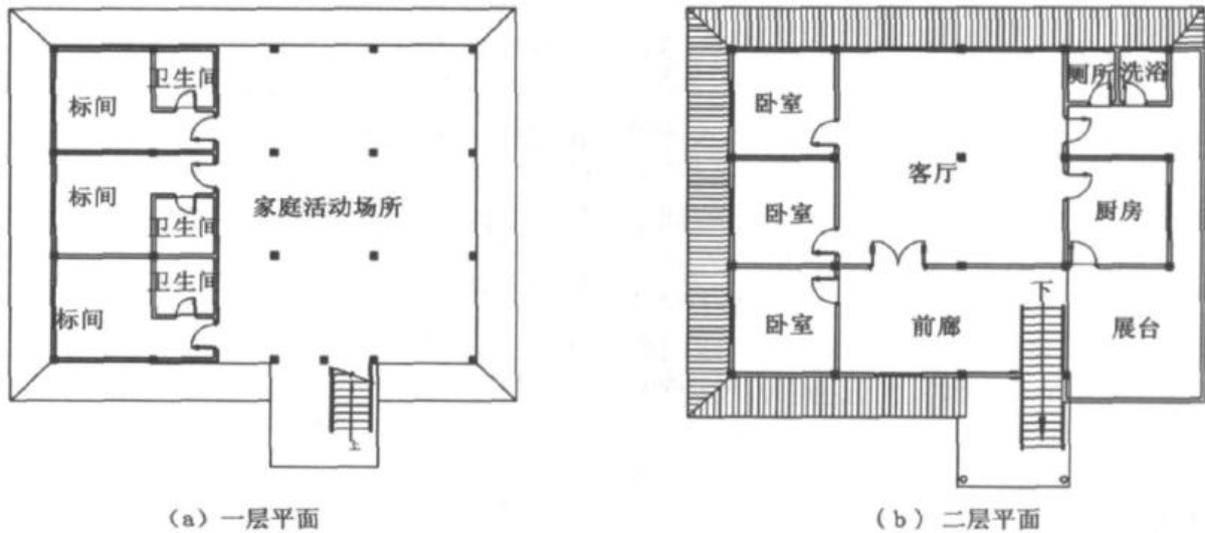


图3 西双版纳傣族新民居平面
Fig.3 The plan of new Dai dwellings

Figure 6 - The plan of a new Dai dwelling [4].

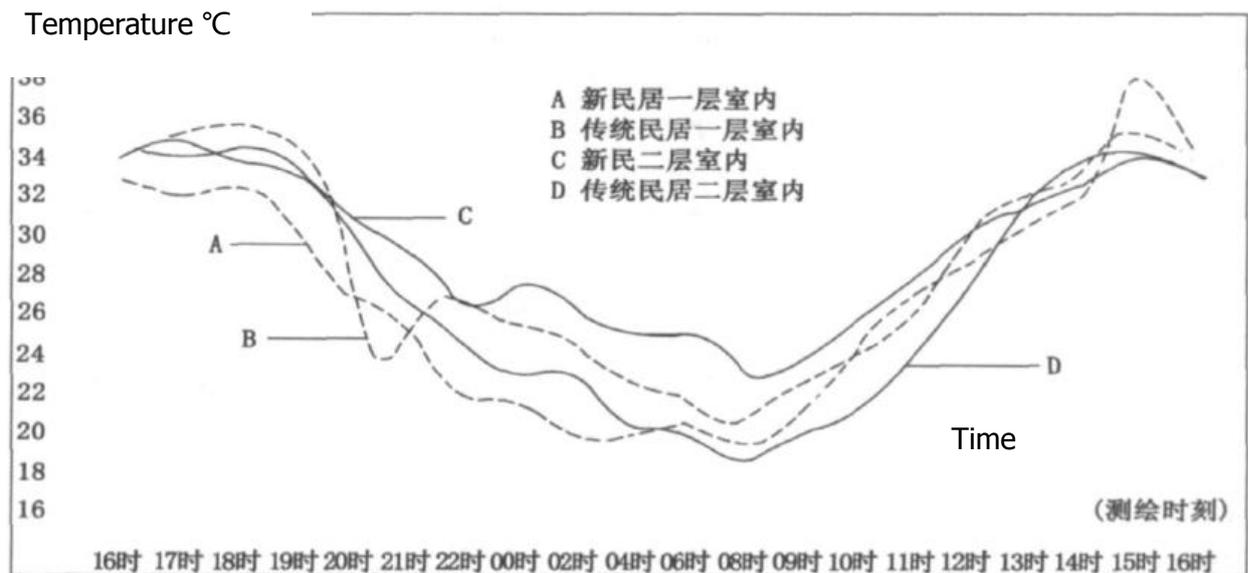


Figure 7 - the comparison of indoor temperature curve in the new dwelling and the traditional dwelling [4].

- (A) New dwelling ground floor
- (B) Traditional dwelling ground floor
- (C) New dwelling upper floor
- (D) Traditional dwelling upper floor

According to figure 7 the temperature range in the new dwelling is less than the traditional one. The new dwelling keeps more heat in at night, which challenges the effectiveness of passive cooling.

3 Design feature for passive cooling

Traditionally, the bamboo wall can provide enough leakage to realize the stack ventilation.

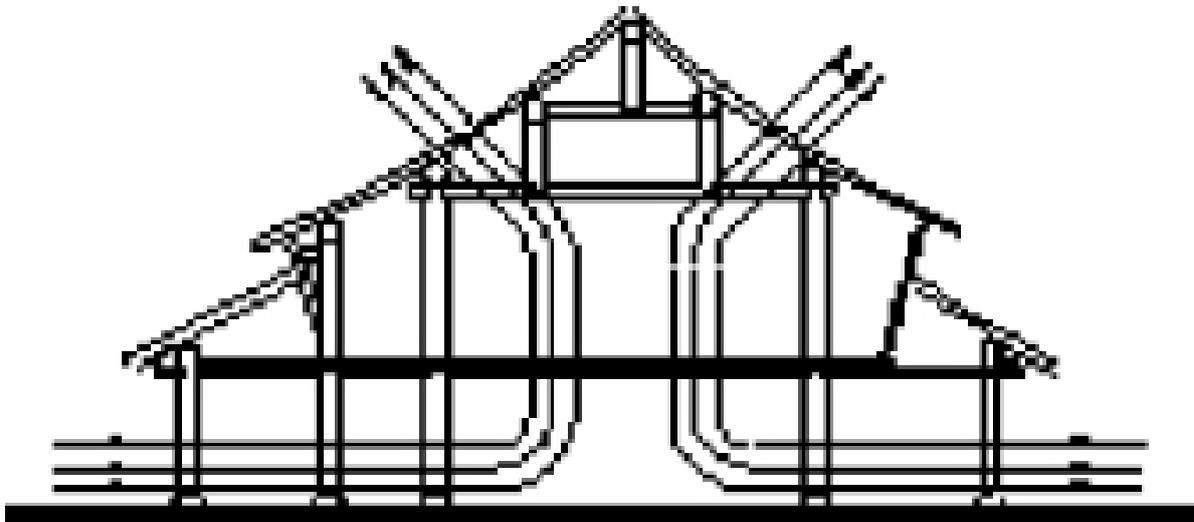


Figure 8 - Traditional Dai “Zhulou” ventilation ^[5]

“Zhulou” uses a traditional Chinese roof type called Jehiel mountain roof. Normally the whole roof will contain 3 or 2 Jehiel mountain roofs with a roof pitch degree of 35 to 45.

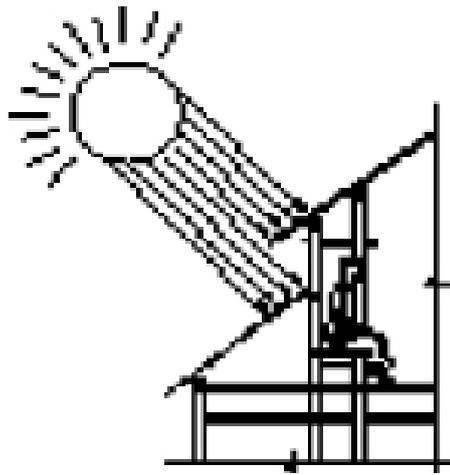


Figure 9 - Roof shading of traditional “Zhulou”^[5]

High roof angle can effectively reduce heat gain from direct radiation. This can also diminish indoor heat gain from the roof structure.

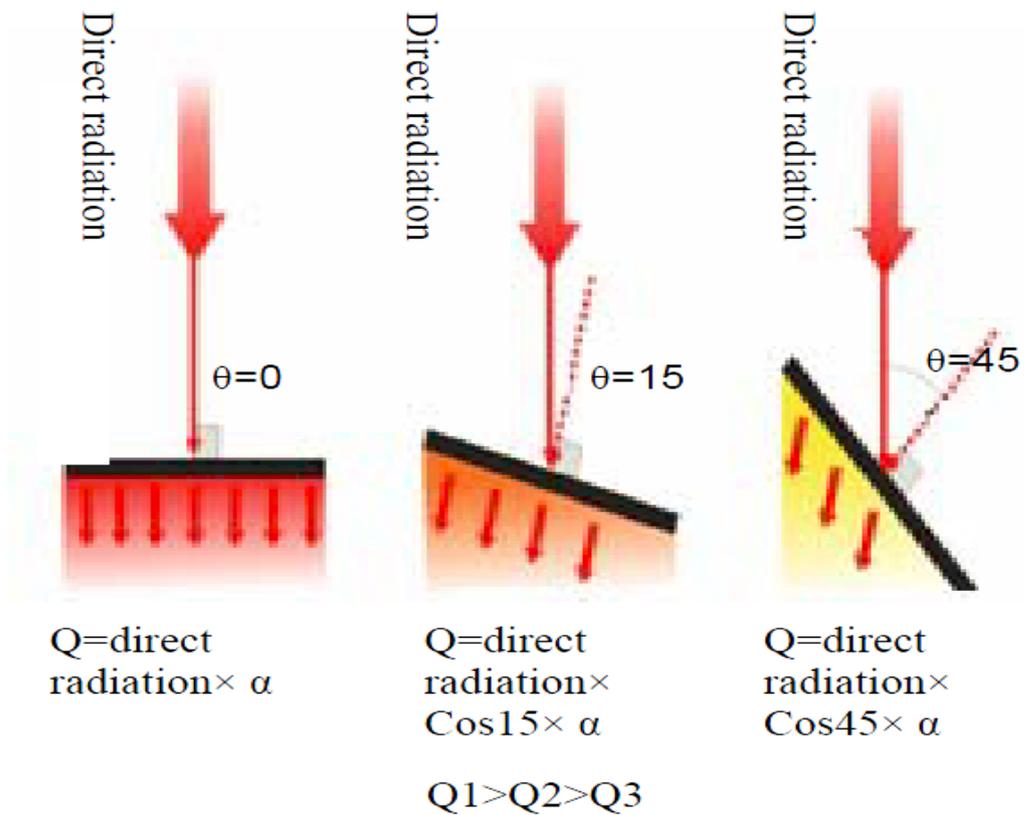


Figure 10 - The impact of roof angle^[6].

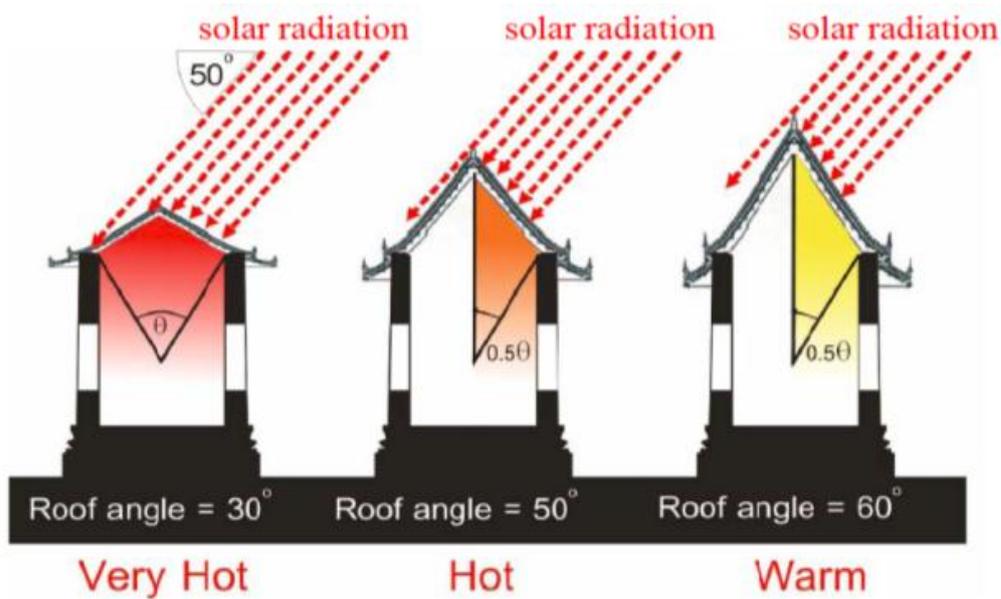


Figure 11 - The impact of roof angle^[6].

3.1 Structure, material and price

There are basically four type of loading structure: load bearing by wooden pillar, brick pillar, ground brick wall and reinforced concrete^[7].

For the first loading type, the wooden poles from old house can be reused as the beams of the new house. However, the quality of wooden poles cannot guarantee supporting the new load. This loading strategy also cannot solve the problems, such as a separated kitchen and lack of indoor daylight.

Loading carrying by brick pillar is the most popular solution. Within this structure type, the external wall material can be either timber or brick. 97% of the newly built dwellings after 1990s are using this structural type.

As the timber uses for external walls often comes from old houses/dwellings, the cost is not as high as initially expected. To build a 150m² timber external wall brick pillar dwelling, the construction fee is approximately 20,000RMB (2,000 GBP), which is acceptable for most residents in the region.

The disadvantage of such load-carrying type is the low earthquake resistance. Reinforced concrete and brick walls structure can solve this problem (partially), but costs are both relatively higher.

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