Climate Adaptive Pattern Languages Implied in the Traditional Rural Houses in the South Shaanxi Province of China

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Abstract. This paper introduces part of the results of a research that was mainly focused in the area of south Shaanxi province of China. The main features of climate conditions in the researched region is introduced, based on which four main climate adaptive pattern languages implied in the traditional rural houses are identified, their applications in the contemporary rural houses are discussed. A summary of the research is provided and further researches are recommended.

1. Introduction

China is a large country with huge population living in the vast rural areas. In the recent years, the China government has put great efforts in promoting the construction of green buildings both in the city and rural areas [1]. Considering that local climate has great influences on the energy consumption and environmental performance of buildings, especially on the self-constructed rural houses, climate adaptive performance has been identified as an important perspective of green rural houses. A large number of relevant researches and practices have been explored in different regions of China. This paper introduces one of such explications in the south of Shaanxi province of the country.

2. Climate Conditions

The south of Shaanxi province belongs to the Hot summer & Cold Winter climate zone for building thermal design and the low solar radiation zone in China. The precipitation in this area is between 750-1000mm. Its rainfall mostly concentrates in the summertime. In the recent 40-50 years, the average annual temperature is observed to be increasing in this region. The total amount of annual precipitation and the frequency of storms are also increasing [2,3]. The hot period in this region is the same as its humid period.
3. Climate Adaptive Pattern Languages in the Traditional Rural Houses

Literature review and field investigations had been conducted in the researched region, based on which some climate adaptive pattern languages implied in the traditional rural houses have been identified, their relevant changes in the contemporary rural houses are introduced.

3.1 Slope Roof

With obvious advantages in quick drainage of rainwater, slope roofs had been applied in all of the traditional rural houses in the researched region (Fig. 1). It was interesting to find out that, in the contemporary concrete-brick structure rural houses, such roofs were first abandoned and replaced by the flat roofs, but added on top of the existing flat roofs later, in order to prevent rainwater leakage, to achieve better thermal insulation in the summer time, and to get more storage spaces.

![Figure 1. A typical traditional rural house with double slop roof.](image)

3.2 Deep Eave and Under-eave Space

To protect the exterior walls & windows against rainwater and solar radiation, deep eaves had been widely applied in the traditional rural houses, usually along the building envelopes and especially at the front and back entrance areas, which are connected to the front and back yards (Fig.2). The upper parts of the under-eave spaces were usually used as semi-open storage rooms for wind dry agriculture produces; while the lower parts of the under-eave cool & shading spaces were mostly used as the second living rooms where a variety of family activities were hosted.
In the contemporary rural houses, the depth of eaves are much smaller and the under-eave spaces are much less used, since in the more recent time, family activities become more concentrated in the indoor spaces and backyards, rather than in the under-eave spaces, especially those connected to the front yards.

3.3 Water Resistant Material in the Lower Part of External Walls

To protect walls against damages from rainwater or storm-water in the summertime, local stones, as a kind of water resistant material, had been widely used at the lower parts of external walls of traditional rural houses (Fig. 3 lower part). In the contemporary rural houses, concrete and bricks, which possess similar water resistant features, are used instead of stones.
3.4 Thick Clay Walls

To keep warm indoor environment in the winter time, clay together with straw sticks were used as wall materials (Fig. 3 upper part). The walls, especially the external walls, were built with big thickness, usually between 600-800mm. Such walls performed as thermal insulation and thermal storage element, which could help saving heating and cooling energy and maintaining comfortable indoor environment both in the winter and summer time. In the contemporary rural houses, single layer (240mm thick) brick walls are widely used instead of the traditional thick clay walls, although the later have been proved to possess better thermal performance.

4. Summary and Further Researches

This paper briefly introduces the major climate conditions of south Shaanxi province of China and identified four climate adaptive pattern languages implied in the traditional rural houses in the researched region. In the contemporary rural houses, all the four identified pattern languages have been changed to some extent (mainly because of the change of building materials and life styles); while one of them was abandoned first, but re-used later, because it appeared to be more climate adaptive comparing to the relevant contemporary methods.

Further researches are recommended to clarify the necessities and possibilities (including the potential advantages and problems) for the application or revision of traditional climate adaptive pattern languages in the design of contemporary rural houses in the researched region, as well as in other regions with similar climate conditions.

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