Research on the layout of low energy consumption ecological housing for farmers and herdsmen in cold regions based on climate adaptability

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Abstract. This research combined the demand of settling down of farmers and herdsmen living in cold region, and traditional ecological residential experience. Considering the climate conditions of cold region, and taking full advantages of solar energy and other renewable energy technologies, new planning forms of dwellings which based on low cost, high performance, low carbon, green and healthy are explored from the perspective of architecture space organizing design. Comparing their energy saving mode through different village layouts and forms of single architecture spaces, such kinds of building forms of dwellings which reflected their local architectural style are worked out, and also adapted to the local lifestyle of residents.

1. Introduction

In the increasingly severe global energy crisis, housing in severe cold areas has a huge energy consumption to meet the needs of heat preservation and cold prevention [1]. Energy consumption and environmental pollution have become hot issues of increasing concern [2]. While the energy required for farmers and herdsmen livestock production activities is restricted, the renewable energy generated by them is not fully utilized.

This paper combines the housing of farmers and herdsmen with the local climate. The building should be designed to cope with the climate. It should try not to rely on the consumption of conventional energy, and should try to improve and create a comfortable living environment by means of planning, design and environmental configuration [3]. Therefore, this paper studies the spatial layout of the village planning and the layout of the courtyard space in different ways, and compares its energy-saving characteristics. It is of great significance to the design of housing for farmers and herdsmen in the severe cold regions represented by the Sun and moon Tibetan Township.
2. Climate analysis in Qinghai

Qinghai Sun and moon Township is a severely cold area, with northwest winds prevailing all the year round, and strong solar radiation and sufficient sunshine. The rabbit village is located at 36°32′ north latitude and 101°08′ east longitude. It is inland and belongs to the continental monsoon climate, which has the characteristics of long sunshine time and strong solar radiation, and which is mainly northwest wind all the year, with the annual average temperature 3.0℃, the highest temperature in summer is 28.3°C, and the lowest temperature in winter can reach -23.5°C [4]. From the perspective of using renewable energy, the region has abundant solar energy resources, which has the necessity and advantages of developing solar energy buildings.

3. Rural and herd village planning space layout

The overall layout of the village often needs to consider the local climate characteristics and topographical features. The climate is mainly based on sunshine and temperature. At the same time, it is necessary to consider local cultural characteristics, forms of building materials, farming habits, daily communication habits and daily activities.

Combined with local climatic conditions, the key points of village planning and design are winter insulation and wind protection, followed by summer heat dissipation and ventilation, and passive control of solar radiation, organized natural ventilation, etc. to control the effective use of sunlight, heat and air in buildings [5].

3.1 Multi-storey layout

There are two types of multi-storey layouts, one is the traditional horizontal barracks-style layout, that is, several houses are horizontally connected together, the houses of farmers and herdsmen are arranged in a row according to a certain orientation and reasonable spacing, which can be based on design requirements of topography or village group space, resulting in some positional changes, breaking the monotonous and rigid layout of the neat determinant layout, making the majority of farmers and herdsmen’s residential buildings get adequate sunlight and ventilation through the staggering of the gables, the staggering of the units, and the separation of the low walls. At the same time, it can form the planning characteristics of the whole village (Fig. 1). On the basis of the horizontal layout, each group of buildings is staggered to adapt to the elevation of the base terrain, forming a zigzag lateral joint space, which evolves based on this layout(Fig. 2).

The other is the vertical multi-storey layout, which is designed to lay a reasonable orientation based on the sunshine and the base contours, and then concentrate the vertical layout to plan the concentrated building volume. The farmers and herdsmen's houses can not only get good sunshine conditions, make full use of solar energy, and also reduce the body shape coefficient of the village's overall building community, which can reduce the energy loss of the building and benefit the energy saving of the whole building community (Fig. 3). This longitudinal row of buildings forms a barrier against the harsh environment, while enclosing the public space of the village in the center of the village, enriching the spatial system of the village.

The multi-storey layout should be perpendicular to the local winter dominant wind direction, which can maximize the building group's resistance to the cold wind, reduce the heat loss of the entire building community, reduce the building energy consumption, and reduce the loss of wind energy to the building. The two-storey buildings in the north and the south can increase the traffic space, connect the entire community, and create a concentrated interior space, which can be cultivated or carried out in public activities in this complete outdoor space. It is also conducive to the daily communication activities of the villagers. The problem of this layout is that the single arrangement is too neat and rigid, lacking the necessary aesthetics and fun, the spatial experience is easy to make people nervous, and the overall streamline is too single. In each group of buildings, while ensuring the energy saving of the body shape coefficient, it should be staggered according to the boundary line of the land, which will make the space more abundant and increase the interest.
3.2 Cluster layout
The cluster type, also known as the unit type, is a combination of several households and herdsman's single housings to form a cluster-like unit layout pattern. There is a common unit space, and each unit can adopt the same layout method. It is connected with other units, thus forming a public-semi public-private, progressive space layout, which can create different scales of neighborhood communication space. The overall village planning layout is flexible and variable through different combinations of units.

Some unit layouts can fully reflect the regional characteristics of the Sun and Moon Tibetan townships. For example, the simplified image of Tibetan auspicious knots is used as a starting point for design, combining the climate characteristics of the Sun and Moon Tibetan towns, the residential architecture of the Tibetan area, and the local Farmers' habits, adjust the layout of the two groups of residential groups, and create areas of exchange between households of different scales (Figure 4).

This combination of auspicious knots as a unit model, one is to represent the image of the Tibetan auspicious knot; the second is that the settlement connects the mountain and the water; the third is the neighborhood's communication space, which is combined by the occlusal house and the diverse communication space together.

3.3 Peripheral layout
Peripheral is a kind of layout that combines a series of single buildings and enclosures. Each group of buildings surrounds the surrounding area to form a cohesive village space. Compared with the multi-storey layout, it is relatively flexible and free. The public space was designed in the enclosed space, which enhanced the communication between the villagers. While ensuring the integrity of the village, it has a good resistance to withstand the cold wind, and at the same time it encloses a more comprehensive and comfortable outdoor public space (Fig. 5).
3.4 Free-style layout
The free-style layout combines the layout of the village with the characteristics of the single body and terrain. The advantage of this layout method is that it creates a building area with varied villages and has fluidity. The building shape presents a traditional architectural style. The disadvantage is that the building group is weak in resisting the cold wind and is easy to generate heat loss.

3.5 Comparative Analysis of Different Village Planning and Layouts
In the cold weather, the multi-storey and cluster layout can effectively resist the winter wind, but the summer ventilation is not as good as the peripheral layout; while in the ventilation, the cluster type is not as good as the multi-storey layout, the latter can flexibly adjust the building spacing of the middle and rear rows to achieve air circulation between the buildings. Peripheral layouts are superior to winter winds and summer ventilation, and free-form organizations are less able to withstand winter winds and are not recommended for use in severe cold areas.

4. Conclusion
Combined with the above research and analysis, the following conclusions are drawn:

In terms of the planning and layout of the villages of farmers and herdsmen in Qinghai Tibetan Sun and Moon village, the multi-storey layout and the cluster layout is more effective in resisting the invasion of the winter monsoon, and the free-type layout resists the winter wind. The ability is weak; in guiding the summer ventilation, the peripheral layout is better, and the cluster type effect is worse when compared with the multi-storey layout.

Through reasonable village layout, the low-energy eco-housing model of farmers and herdsmen in Qinghai Sun and moon Tibetan township is suitable for the cold weather.

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