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Suitability Transformation of Rural Dwellings —An Example of Rural Dwellings in Northern Henan

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Abstract: *Today, we are focusing more and more of our efforts on enhancing the rural living environment. Some rural dwellings in northern Henan Province have problems such as poor ventilation, poor lighting and poor insulation, and the living environment of villagers needs to be improved. In this paper, from the current situation of rural dwellings in northern Henan, through field research and data collection, some problems of rural dwellings, as well as the necessity and urgency of suitable renovation are explained, and the current situation is analysed, and finally suggestions and measures for suitable renovation using building technology are put forward.*

Keywords: *Rural dwellings; Technical means; Suitability modification*

1. Introduction

For many years, rural dwellings in China have been built using locally available technical materials and with the participation of local craftsmen using the technical means available at the time. With the development of the times, people's pursuit of quality of life has become higher and higher, and they have higher requirements for the comfort of residential buildings. Rural dwellings in some areas are no longer adapted to the needs of contemporary people, and there are problems such as poor ventilation, poor lighting and poor heat insulation. At present, the cost of new construction is too high, and it is particularly important to improve the comfort of the houses by adapting them to suit the needs of the people. As a place for villagers to live, the renovation of rural dwellings to meet the needs of the times is of great positive significance in improving the living environment of the countryside and creating an ecologically livable countryside.

2. Significance of the study

2.1. Purpose of the study

A country house is a house in the countryside where people who work and produce live. Since ancient times, rural dwellings in China have been built with the participation of local craftsmen, according to the habits of the inhabitants of the region, taking into account the climate and the local conditions, using local materials and the construction techniques of the time. The traditional dwellings contain the cultural perceptions of people from various eras regarding the form of architecture, and the construction elements of the buildings are closely related to people's production and life, and have certain characteristics of the time and place[1].

Rural dwellings in northern Henan are mainly of the courtyard type, consisting mainly of living rooms for people, living rooms (halls), kitchens, toilets, animal sheds and storage places for agricultural machinery. The structure, construction and spatial layout of these houses were created by the social needs of the time. Today, many rural dwellings are no longer suitable, with problems such as cold winters and hot summers, poor ventilation, poor lighting and poor hygiene (Figure 1).

In some areas of northern Henan, rural dwellings are no longer suitable, resulting in a poor living environment in the countryside, and many people want to flee the countryside and do not want to return to live there. The existence of problems such as poor lighting and ventilation and poor insulation in rural dwellings has resulted in the prevalence of a number of diseases. The plastering of the external walls of traditional dwellings made of rammed earth is not aesthetically pleasing nor safe, and the

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non-structural construction of the buildings is aging and loosening, causing a certain risk to the health and safety of the villagers[2].

Any historical dwelling pattern is an active choice made by the villagers in response to the objective climatic environment, economic and technological level, traditional living customs and other constraints. Therefore, any residential model is set in its specific time and space, and is bound to change with the development of the times, rather than remain unchanged[3]. Rural dwellings also need to make changes in the new era. By studying the existing problems of rural dwellings in northern Henan, and proposing solution strategies based on technical means, this paper aims to make suitable changes to the existing rural dwellings in northern Henan, improve the living environment of villagers, and help revitalise the countryside.

Figure 1: Traditional houses in Beixishang Village

2.2. Problems to be solved

Architecture is an important means by which humans adapt to their environment, and the formal characteristics of architecture are derived from and constrained by the natural environment[4]. At present, rural dwellings are of various types and of varying quality, but the fundamental problem of poor living conditions has not been solved. Many of the current rural dwellings are not adapted to modern rural production and lifestyle. There is a need to understand rural dwellings and to propose targeted renovations, using building technology to transform them. The main solution is to solve their problems of light and ventilation, heat insulation and other aspects.

3. Problems with the current situation of rural dwellings in northern Henan

3.1. Poor lighting

3.1.1. Poor orientation of houses

Many rural dwellings in northern Henan do not face north or south, resulting in poor lighting[5].On the one hand, many rural dwellings are not planned and designed by professionals at the beginning of construction, but are built by local workers or householders according to their own experience. On the other hand, for historical and cultural reasons, rural houses are mostly courtyard houses, with the main house of the elders occupying the best position and the rooms of the younger generations occupying the east-west position. As a result, many houses do not face north or south, and because there are few windows in traditional rural buildings, the interior is not well lit (Figure 2).

Figure 2: Building orientation, south facing north

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3.1.2. Small window-to-wall ratio

As most of the rural dwellings in northern Henan are of brick and concrete construction, and some of the mountainous areas are masonry dwellings, their structure limits the size of the windows in rural dwellings. For some historical and cultural reasons, the courtyard houses in northern Henan are generally inward-facing, with only one inward-facing side of the building having windows on all four sides, and too few windows are not conducive to light and ventilation, resulting in a dark and damp interior (Figure 3).

Figure 3: Rural dwellings with introversion

3.1.3. Excessive length of building eaves

In the early days, dwellings were generally built of raw earth, and to ensure that adobe walls were protected from rainfall, they were often protected by very deep eaves, a form that has continued, the deeper eaves facilitating drainage and protecting the walls, but also blocking sunlight and making the interior dark (Figure.4).

Figure 4: Residential houses with too long eaves

3.1.4. The building is constructed in an unreasonable manner

The inward-looking nature of rural houses and the influence of the psychology of the built environment, the idea of 'hiding the wind and gathering the air', led to small bedrooms in both early landowners' houses and ordinary dwellings, and the small openings and large depths of the bedrooms made for extremely poor indoor lighting. In the middle of the house is the hall, which is used for meeting guests and living. The bed is placed in the most northerly position against the wall, which is the most humid and dark position and is prone to bacteria and illness (Figure.5).

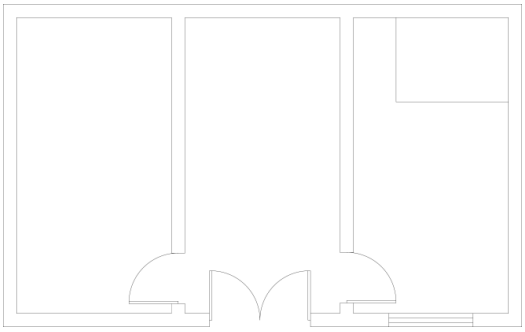

Figure 5: Jiaozuo city rural residential house common shape system

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3.2. Poor thermal insulation

When the houses were built, they were generally built by the householders according to their experience and, due to the poor technical conditions of the time, little thought was given to the insulation of the houses. The building materials were mostly masonry or adobe, with no additional insulation inside, outside or in between. The frames of the windows and doors were mostly timber, the windows were single glazed and not well sealed, and the heat transfer from timber was strong. This leads to a relatively intense heat exchange between inside and outside, and the indoor thermal environment does not meet the basic requirements of people for thermal comfort (Figure 6). Traditional stone masonry dwellings in the mountains of the northern Henan region are all made from local materials, with stone as the main building material, and the walls of almost all buildings are built with stone, which is one of the characteristics of traditional villages in the South Taihang Mountains[6].

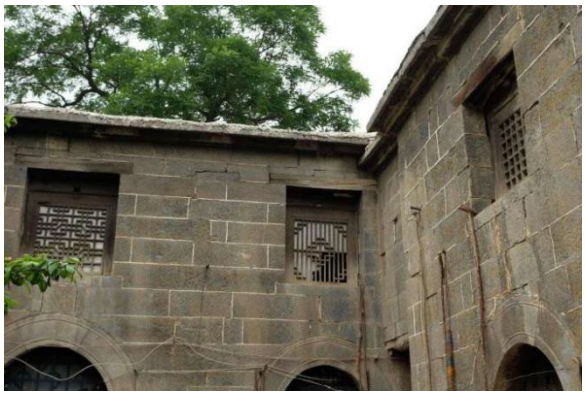

Figure 6: Lijing village stone folk houses

3.3. Poor ventilation of the house

Traditional courtyards in the northern part of Henan Province are inward-looking enclosed spaces enclosed by buildings and walls[7]. Rural dwellings are inward-looking, with the building form generally consisting of houses on the east, west and north sides, and walls on the south side, with the houses and walls forming a courtyard with privacy, and with the buildings only facing inward with windows, which are not permeable and have poor ventilation (Figure 7).

Figure 7: Zhaibuchang villagers residence

4. Recommendations and measures for rural dwellings

There are two main ways to improve the living environment of villagers, one is to build new houses and the other is to renovate old homes in a suitable way. The cost of major demolition and construction is too high and can easily lead to a series of problems, so it is imperative to renovate old dwellings. It is important to understand the climatic factors in the design process and to establish a good relationship between the building and the climate in order to save energy and preserve the regional characteristics of the building[8].

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4.1. Retrofit design of the walls

4.1.1. Adding insulation

There are generally three ways to insulate building walls: external wall insulation, external wall insulation and external wall sandwich insulation technology. As the energy-saving renovation of existing buildings is carried out on the basis of the original building, so the energy-saving renovation of external walls can only be carried out in two ways: internal insulation or external insulation[9].

4.1.2. Light-coloured finishes for external walls

As different colours have different effects on the absorption of solar heat, light-coloured finishes can reduce the absorption of solar energy by the walls, so light-coloured finishes such as white can be used as far as possible when renovating existing building walls.

4.1.3. Greening of external walls

If the walls of a building are exposed to direct sunlight, they will absorb the sun's energy and cause the indoor temperature to rise. Therefore a layer of covering can be added to the outer surface of the wall. For example, vine plants can be planted and attached to the external walls of the building to shade them from the sun, both to beautify the environment and to reduce the absorption of sunlight by the walls through photosynthesis and transpiration of the plants.

4.2. Retrofitting of the roof

4.2.1. Adding thermal insulation and waterproofing

Rural dwellings are rarely built with a thermal insulation and waterproofing layer on the roof. For technical reasons, years ago, rural dwellings were not waterproof and rainwater leakage was very serious. In the renovation of rural dwellings, the roof needs to be treated to improve its thermal insulation and increase its waterproofing capacity, and an inverted form of roof construction can be used in the renovation.

4.2.2. Changing flat roofs to sloping roofs

Many rural dwellings have been rebuilt with flat roofs after knocking down old brick and tile houses with sloping roofs. However, flat roofs absorb extremely high levels of heat in summer, resulting in higher indoor temperatures, and this type of roofing is not really practical. In this case, the flat roof can be rebuilt as a pitched roof, which will form an insulating layer in the middle, reducing the absorption of heat in summer and the dissipation of heat in winter.

4.2.3. Conversion to planted roofs

Planted roofs are roof coverings with plants, which greatly improve the insulation performance of the roof and reduce the heat transfer from the roof. Plants have a shielding effect on solar radiation and can effectively reduce the temperature near the roof. At the same time, green roofs can also increase the waterproofing effect of the roof. Planted roofs have the effect of improving the ecological environment, improving the indoor and outdoor thermal environment and heat insulation.

4.3. Retrofit design of external windows

The energy consumption of traditional residential houses mainly includes energy consumption for cooling and heating, energy consumption for cooking and energy consumption for home appliances, of which energy consumption for heating in winter is much higher than that required for cooling in summer [10]. Compared to other parts of the building, windows and doors have the worst airtightness and thermal insulation properties [11]. External doors and windows have many gaps and the materials used have a small thermal resistance, making them the weak link in the thermal insulation of the external envelope. Studies have shown that the heat loss caused by air infiltration through doors and windows accounts for 25%-50% of the building's heat load in rural houses in North China with three enclosing walls and a southern frame [12]. As traditional rural homes are single-glazed with wooden frames, they are extremely poorly sealed and have poor thermal insulation properties. For the retrofit design of external windows, double glazing can be used, and double glazing provides better insulation. In addition, better airtight window frame materials can be used to reduce heat loss and blinds can be used to control interior lighting.

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4.4. Retrofitting of floors

In addition to walls, windows and roofs, the ground is also a means of heat dissipation. For the renovation of the floor, the original ground floor can be paved with gravel and grey earth insulation, which is easy to construct and inexpensive. Alternatively, it can be possible to combine the treatment with interior decoration by laying a wooden floor or a perlite mortar topping.

5. Conclusion

Rural dwellings are the most numerous and widely distributed type of building on the Chinese land, and they are also a place for people to carry family customs and accumulate culture. As rural dwellings carry local history and culture and reflect regional characteristics, their importance to rural revitalization is becoming more and more prominent. While improving the living environment and upgrading the living environment of rural dwellings by using appropriate technical means, the innovative application of vernacular materials should also be explored in depth and integrated into the development of modern society.

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