

# ***Modular New Residential Design under the Background of Rural Revitalization in Southern Anhui—A Case Study of Liqiao Villagers' Residence in Yi'an District, Tongling City***

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**Abstract:** With the development of economic globalization, the development of traditional housing is inevitably affected, which leads to the serious phenomenon of blind plagiarism and imitation in modern housing construction. Problems existing in rural housing construction, such as blind plagiarism, lack of technical guidance, obvious trend of architectural style and regional differences, lack of communication from planning to farmers' housing construction, and confusion of construction situation, are gradually emerging. At the same time, China has formed a colorful and spectacular architectural culture in thousands of years of history. Most rural areas in China are rich in natural and cultural resources. How to rationally develop and utilize rural resources on the basis of rural culture has become a problem in rural development. Practice has proved that art design intervention is a quite feasible idea. This paper attempts to integrate two key aspects of new rural housing design-modularity and adaptability to landscape-into a study, which not only embodies the characteristics of traditional rural areas, but also has universal guiding significance for the construction of new rural housing. [1] This paper puts forward a modular design method to realize the expansibility of new rural housing design, and an adaptive design method to continue the traditional rural style. Taking Tongling area as an example, this paper first discusses the proposed focus of these two studies and organizes their dialectical relationship.

## **1. Introduction**

Based on the self-built houses widely existing in China today, the new residential houses combine the advantages of traditional houses in China, and create a reasonable and comfortable living environment by analyzing, adjusting and improving their internal functions and considering the needs of other elements. Modularization is a concept borrowed from various disciplines, hoping to deepen and cover housing research from this perspective. As a big agricultural country, the countryside is very important to the development of China. The state attaches great importance to the living environment of farmers and puts forward a series of improvement measures. However, how to

coordinate traditional culture with modern needs is a complex problem.

This problem is solved by introducing modular housing. Modularization of housing is a supplement to its local adaptability and cannot be discussed in isolation. Taking Tongling area as a case, according to the spatial characteristics of traditional settlements and houses in Tongling area, this paper discusses how to apply modularity and adaptability in detail, so as to deepen the research. It is hoped that through the application of modular and adaptive design in rural construction, a new way of thinking can be provided to solve the dilemma of lack of design intervention in rural construction. [2] It is also hoped that its application can lay a foundation for the further implementation of prefabricated buildings and provide a catalyst for the industrialization of rural buildings.

## **2. Research background of rural revitalization in southern Anhui**

China is a big agricultural country, and thousands of years of farming civilization have shaped profound rural culture. However, in recent years, the gradual acceleration of urbanization has led to a serious imbalance between urban and rural development, which has attracted the attention of the central government, the public and academic circles. For example, in 2022, the People's Government of Xilian town, Yi'an District, Tongling City also issued the Village Planning of Liqiao Village, Xilian town, Yi'an District, Tongling City (2020-2035).

### **2.1. Faced with difficulties**

At the same time, the objective situation is that with the improvement of living standards and the change of farmers' living habits, the layout of old houses can no longer meet the needs of modern life, and villagers have an urgent need for building houses and spontaneously start building new houses. Due to the lack of systematic control and the influence of western neoclassicism, ancient Rome and other styles, a variety of small foreign buildings have been built, which are not only uncoordinated in overall style, but also lose local characteristics. [3]

With such great development efforts, such rapid development speed and such high development requirements, the current village development is in trouble, and the village characteristics so carefully inherited can only win the success of the pilot project, because the designer's energy is limited, the design and construction costs are high and wide, and it is difficult to popularize it in a large area. However, if the price is excessively considered, it will not only appear in the urban area of the military camp-style single-management project, but also seriously damage the taste of the village.

### **2.2. Cases of rural revitalization in southern Anhui**

#### **2.2.1. Zuyuan Village, Xikou Town, Xiuning County**

Zuyuan Village, Xikou Town, Xiuning County is located in Anhui Province. In March 2016, Zuyuan Village entrusted Shanghai Hongxian Investment Development Co., Ltd. to invest more than 40 million yuan to develop the "Dream Village" homestay project on the basis of the traditional village brand, and it opened in November, becoming the largest rural resident group in southern Anhui. Since the completion of the "Dream Village" residential group, it has attracted more than 10,000 tourists every year, earning nearly 2 million yuan, and the villagers have built 16 homestays.

The development of villagers' lodging industry in Zuyuan helps villagers to absorb local employment and start businesses, sell local agricultural and sideline products, and promote the development of the tertiary industry; In 2020, the per capita net income of residents in Ruiyuan Village reached 17,600 yuan, three times that of 2016, and the resident population increased by 110

compared with 2016. Zuyuan Village was awarded the titles of "National Key Village of Rural Tourism" and "National Village of Cultural Civilization". "Use in protection and protect in use", the traditional villages in Huizhou have changed from a static shelter to a living heritage, becoming a "treasure house" for rural revitalization and a "golden tree" for farmers to increase their income.

### **2.2.2. Xidihong Village, Huangshan City**

Xidihong Village, located in Huangshan City, Anhui Province, is an ancient village representing Huizhou culture and a regional culture in southern Anhui Province. Its Huizhou culture reached its peak in Ming and Qing Dynasties. The village is densely populated and has exquisite houses with typical Huizhou style. The layout, ancient buildings and decorations in the village are unique cultural heritage.

Many photographers devote themselves to capturing and publicizing the cultural heritages of West Village and Hongcun Village, which are still alive after thousands of years. They photographed rural scenery, preserved villages, exquisite Hui-style houses and various historical and cultural backgrounds from a unique perspective. They perfectly reproduce the "living" ancient villages, highlight the "living" tradition, heritage, culture and history, and describe the development and changes of "living". They attract a large number of tourists, including students from the Academy of Fine Arts, and contribute to local tourism.

## **3. Modular research on residential design**

The difficulty of building new houses on a large scale in rural areas of China and the fact that participating in planning cannot reach every farmer in every village lead to the concept of modular design. The original intention of the concept of modular architecture is to solve an existing dilemma in the planning of new housing in rural areas. At present, the research in the field of architecture can be divided into two categories: research related to modular industrial products and research related to modular architecture. [4] With regard to modular architecture and design, in order to understand its characteristics in detail, we first need to understand the theory of modular architecture and design. Therefore, this paper first introduces the relevant theories, and then introduces the modular method of architecture.

### **3.1. Module and modularization**

Modules and modularity are a part of extensive theoretical research applied in various industries. Moreover, a module is a very broad concept, and the following elements are related to the theme of this study: 1. A module, also called a component, is a set of program operators (a collection of program codes and data structures), which are named separately and can independently perform specific functions. The module has two main features: external function and internal function. External function refers to the interface between the module and the external environment and the function of the module, while internal function refers to the function of the internal environment of the module. 2. In Webster's English Dictionary, the word "module" in Article 1 is interpreted as "a reusable standard furniture unit or component".

Modules are components of typical and universal systems, which means that they have standardized characteristics. After the module is separated from the system, it loses its practical value, but each module has a specific function, which is relatively independent of other functions and does not interfere with other functions. [5]

Modularization is a strategy to solve problems by decomposing complex systems into more manageable modules. It involves the whole process of looking at the composition of a product (or

system) from a system perspective, applying decomposition and integration technology to create a modular system, and combining these modules to create a product (or system) that can provide the greatest value.

### 3.2. Modular design of buildings

In the modular design of architecture, the combination between modules can be roughly divided into four ways: module adjacency, module inclusion, module insertion and connection in public space. [6]

#### 3.2.1. Module adjacency

Module adjacency is the most common type. It is called direct connection to place modules with similar functions and adjacent paths close to each other to realize space transfer. For example, in a hospital building, different nursing units can be directly juxtaposed to form a large comprehensive module group such as nursing units, because they are repetitive and similar in function, size and load. (as shown in figure 2-1-a)

#### 3.2.2. The module includes

According to different functional requirements, some functional modules are included in other modules to form a complete module, which affects the shape, size and interface of the module. For example, a building consists of an independent square box, but there are partitions for bedrooms, restaurants, kitchens and bathrooms in the box. These functional modules are grouped into blocks and stacked in a building envelope, which together constitute the whole building. (as shown in figure 2-1-b)

In buildings with complex functions, modules with the same function are first grouped into module combinations, and then combined.

#### 3.2.3. Interpolation of modules

Interpolation is a spatial relationship. Two spatial areas overlap to form the same spatial area, but each area retains its own spatial characteristics. For example, the horizontal and vertical transport modules are sandwiched between other modules to form a whole. Hallways and stairs are usually scattered and adjacent to other modules in the building. (as shown in figure 1-)

#### 3.2.4. Connect in public space

Two space units separated by a certain distance can be connected by a third transitional space with certain commonality, and its existence can connect and relatively separate the main house and the secondary house (such as the quadrangle in Beijing). (as shown in figure 1)

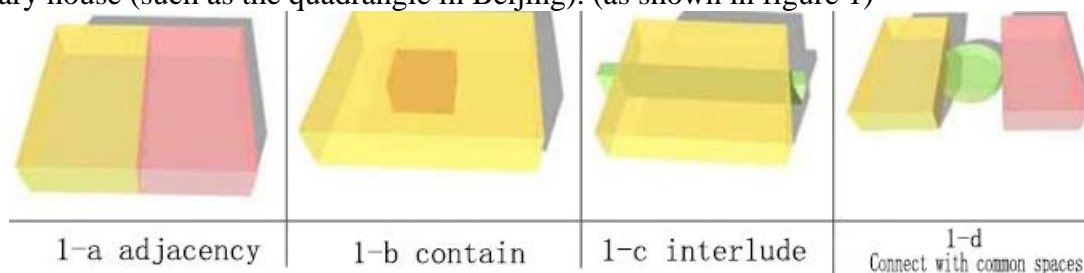


Figure 1: Spatial connectivity

## 4. Modular cases of residential design

The case of Belabre is discussed separately, because it is very consistent with the above-mentioned modular housing principles and has guiding significance. Belabre District in Mumbai is a low-rise, high-density community led by architect Charles Correa, with a large number of low-income people. It has a total area of 5.4 hectares and can accommodate 500 people (about 100 households) or 550 households per hectare. The architect is responsible for the overall planning, but every resident can adjust the building according to his own needs. Each house is unique, and the whole community is very active, so it is called "art village".

### 4.1. Residential design model

The architect divided the design into rooms, units, groups and residential areas.

Type A: The simplest type, including the main living space and a separate toilet.

Type B: It is a functional improvement of Type A, adding an independent kitchen and a bathroom.

Type C: The expansion of type B increases the number of bedrooms.

D-type: The vertical extension of B-type increases the number of bedrooms on the ground floor.

E-type: it is a vertical supplement to C-type, with functional ground floor and more bedrooms.

These residential groups are grouped in a similar pattern, but after development and transformation, the personality of each family is emphasized. Starting from Type A, the other four types have been expanded not only in the vertical direction, but also in the horizontal direction to increase the required functional space. (as shown in figure2)

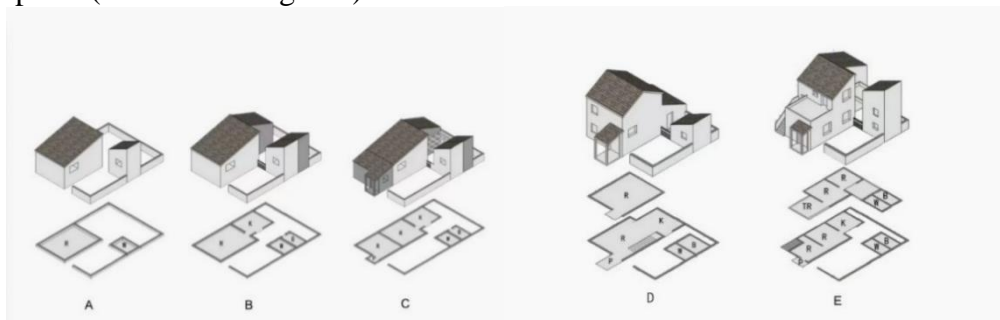


Figure 2: Different Types of Residential Buildings

### 4.2. From monomer to group development

Architects skillfully combine these independent units to form a basic unit group. In this project, Correa first divided the group into eight units, one of which was demolished to form the entrance unit of the whole block, while the other seven units were residential. Each basic unit shares a yard, three of which form a group, while other groups form a big square around the yard, and community services (schools, shops, etc.) are located in a closed space.

## 5. Research on the Integration of Modularity and Adaptability of New Rural Dwellings in Si Tongling

The above case of India deserves our careful study, but as the saying goes, "One side of the soil and water can support one side of the people, and the other side of the landscape can form one side of the building". Specifically, each region has different geographical location, cultural customs, climate and environment ... such as China and India, so the above case is for reference only. This paper takes Tongling as an example to carry out modular application. Most of Tongling's buildings

are mainly Huizhou-style, bearing the history, culture and local customs of China for thousands of years.

## 5.1. To adapt to the Tongling rural new residential hierarchy division

### 5.1.1. The smallest unit space-room

Since ancient times, architecture has thought that a room is a basic space unit, and its "opening" is mainly determined according to the horizontal spacing of columns. Here, the definition of module (a typical independent unit with specific functions and interfaces, which can be configured as a system) is introduced, and the "room" can be regarded as the basic component of the house, that is, the new rural house. The wall between two adjacent rooms and the circulation space connecting them are so-called "interface structure", but a house may have several rooms with the same function. This module that can no longer be divided is called "basic module".

### 5.1.2. Independent function module-room

"Room" is just a general term. In traditional northern houses, it includes main room and secondary room. Most rooms consist of three compartments, although some rooms have five or seven compartments. Rooms are composed of relatively independent standard functional units and "rooms". Functional units composed of these main units are called group units.

### 5.1.3. The basic living unit-house

In a complete yard, these modules can be combined into a main room, an east-west room or a rest room according to their positions. Individual functional modules that people need, such as bedrooms or kitchens, are collected according to specific rules and connected through the center of the courtyard.

## 5.2. To adapt to Tongling rural new residential settlement planning

### 5.2.1. Plane layout

The traditional one-line graphic design is too monotonous, so the L-shaped graphic design is chosen in the ongoing research. L-shaped graphic design mainly refers to two middle blocks with different shapes in actual design. The L-shaped layout can be extended in two directions, and new architectural forms appear through rotation, mirror image and rotation+mirror image conversion. In addition, the yard and main space always maintain good directionality. Therefore, the prototype can have four manifestations. (as shown in figure 3)

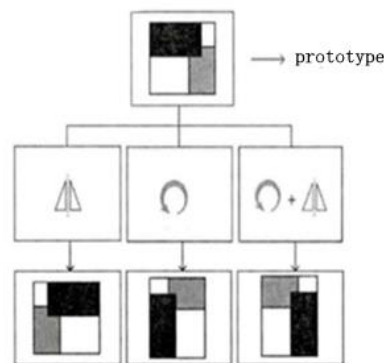


Figure 3: L-shaped unit change mode



On this basis, we can find some new peasant prototypes from the projection of single blocks. According to the above models, we can create three prototypes of single blocks, and then we can create 12 different shapes by rotating and mirroring. (as shown in figure 4)

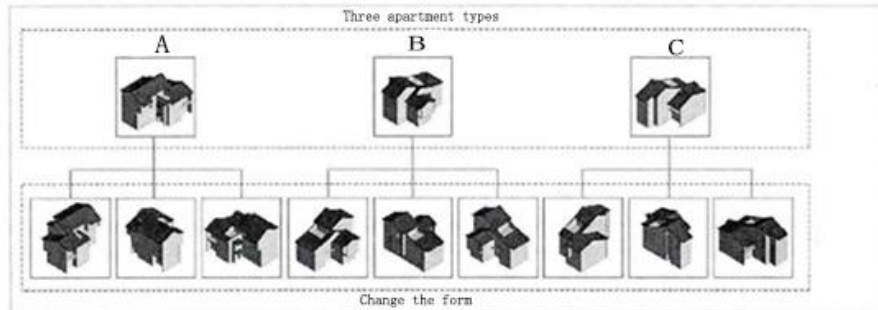


Figure 4: Three types change into twelve types.

### 5.2.2. Vertical layout

First of all, the balance of roof height: there is a combination of high and low roofs, including the combination of two floors and three floors, which realizes the natural transition from three-story to two-story inclined roof, forming the basis for the formation of deliberate stepped eaves. (Figure 4-3) Secondly, the combination of long and short roofs breaks the symmetrical shape of the traditional single roof and forms an asymmetrical form, which contributes to the diversity of the single curve and mirror image of the house and enriches the appearance of the settlement. (as shown in figure 5)

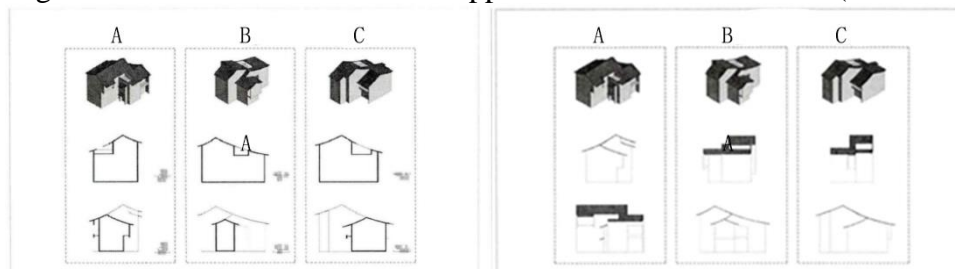


Figure 5: Schematic Diagram of Roof Height Change

## 6. Take the modular new residential design of Liqiao Village, Yi 'an District, Tongling City as an example

Liqiao Village, with 99 clear lakes and the advantage of being surrounded by water on all sides, is a "water tower in a dream, a bridge with ancient rhyme", and its construction must be planned first. The village's tourism industry is booming due to the use of local water resources. Liqiao Village is a village rooted in Ming 'an's art and culture. There are classic tourist attractions such as Anhui Wandering Garden, century-old bridge and artificial river, and it advocates the integration of public art into village life. [7] The ongoing "Tongling Pastoral China Art Season" invites artists and architects to create works of art while living in the village. Murals, paintings and installations can be seen everywhere. According to statistics, the village receives an average of 100,000 tourists every year in public art spaces, such as hotels, online red houses, cafes, rice fields and rice field theaters.

### 6.1. Analysis of the current situation of the village residence in Liqiao

#### (1) Geographical location

Liqiao Village is located in xilian town, Yi 'an District, Tongling City, Anhui Province. It is located

in the center of xilian town, with a population of less than 2,000. It is a combination of the former Ming Dynasty and Doumen Village. It is located in the seat of the former heping town government. The village covers a total area of 5 square kilometers, with 19 villagers' groups, 3,650 mu of cultivated land, 650 mu of wetlands and 4 agricultural professional cooperatives.

#### (2) Climate and environment

Tongling City is located in the south of Anhui Province, on the south bank of the Yangtze River, with a humid monsoon climate in the north subtropical zone. Tongling has a hot and humid climate, with hot summer, dry autumn, mild winter, long frost-free period and four distinct seasons at the turn of spring and summer. In spring, the temperature is moderate and the rainfall is suitable; Summer weather is hot, rain and heat are the same season, and there are often thunderstorms; Autumn climate is suitable for travel, with less rainfall and fresh air; It is warmer in winter than in northern cities, with an average temperature of about 5 C.

## 6.2. Site and layout

### 6.2.1. Site design

The design of the site retains the historical courtyard layout and the original topography, vegetation and trees. The courtyard retains its original closed form, and the main area is divided into two parts: a residential courtyard and an orchard. The terrain of the plot is fully utilized to create a sense of architectural hierarchy.

The sustainable design of the residential part continues the original layout of the courtyard, better reflects the daily life and work habits of the owners, and inherits the design and layout of the ecological environment and traditional building culture. The original architectural design can make better use of the site, avoid the damage to the original landscape and environment, and make more effective use of the space. [8] The design respects the original appearance of the whole ecological environment, adheres to the architectural standards of beautiful landscapes, makes the house perfectly integrated with the surrounding natural environment, and creates harmony between man and nature.

### 6.2.2. Architectural layout and landscape design

The project will take into account the design of historic houses. The design of the building is very simple, providing a closed form. In this form, the building is not enclosed in a traditional yard, but reflected in the surrounding environment and vegetation. [9] In the center of the building is an empty space designed to serve the daily life of the owner and the landscape design of the yard. Nearby, a planting area was created to meet the requirements of daily production and bring natural colors to the environment around the building.

### 6.2.3. Architecture and Interior Design

(1) Architectural modeling design. The main task of new houses is not to update the design, but to properly solve the functional problems. The design of new houses should follow the simplicity of traditional houses and the basic principles and rules of house decoration. As the new residential houses are both private houses and a part of the village, the styles of each residential house should not be inconsistent or disproportionate to the whole.

(2) The form of each new residence should be combined. While considering the design of new residence, we should also consider the requirements of the functional layout of internal space. Its independent architectural form can be interpreted as: the design of new residence is not positioned as pure "aesthetics", but as "comfort".

(3) Based on the concept of modularization, although the overall style of the village is similar, the



specific details and internal layout of each building are not the same. New residential buildings can integrate more effective use space through spatial reorganization, thus improving the living environment quality of new residential buildings. [10] The patchwork combination of new houses is related to architecture. In order not to destroy the plants around the building, the building has been designed in a staggered way, so in order to echo the building, the form of the building has been adjusted [11].

## 7. Conclusion

The high demand for new houses in rural areas and the lack of professional designers caused confusion [12], and villagers built their own houses, which led the government to promote rural design. When design began to intervene in new housing construction in rural areas, it encountered two problems [13]. First of all, the successful design pilot in rural areas absorbs the energy of designers, needs public, social and financial support, and is costly and unrepeatable; Secondly, the urbanization of production efficiency and value design is forced, which leads to the simplified design of villas and cottages and seriously affects the original appearance of rural areas. In this case, starting from the two key points of modularity and adaptability, the above two issues are integrated. In order to explore the new rural design, this paper discusses the following topics [14]:

(1) Organize the development and research of new rural housing at home and abroad, establish a modular theory useful for research, explain the huge demand of new rural housing in China and its reasons, and analyze the difficulties faced by participatory planning at present.

(2) Solve the problems faced by planning participation in the new rural housing design at present, put forward two conflicting theories-modularity as a method and adaptability as a foundation, and explain how to combine them and coordinate them through specific design strategies[15].

(3) Taking Tongling landform as an example, the combination of modularity and adaptability in the design of new houses in Tongling landform is studied. In this paper, the adaptability level of modularity in Tongling landscape is studied, and the cluster planning and design strategy is studied from the physical point of view, and then the spatial modules are combined into a single module, and the single module is combined into a module cluster, and the cluster design strategy is further studied. Then the cluster design strategy is analyzed. In this process, the modular design method ensures adaptability and intelligent village design.

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