



# Research on the Architectural Renovation of Caoyang Community

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**Abstract.** Caoyang Community is the first new worker village built in China after the liberation, carrying a long historical significance. However, its energy-saving renovation started relatively late and requires more attention. Based on the historical style and characteristics of Caoyang Community, this article updates and renovates the residential space, housing structure, building energy-saving strategies, and public space from four aspects. While retaining the symbolic features of the community, it expands social spaces, improves the quality of the community, and preliminarily proposes research methods and frameworks for building energy efficiency.

**Keywords:** building construction, building energy efficiency, structural renovation

## 1 Introduction

Shanghai Caoyang New Village was founded in 1951 and is the first worker's new village built throughout China after liberation, carrying a long historical significance [1]. After more than 60 years of construction, Caoyang New Village has developed into a large mature community with high-quality education, medical treatment, culture, technology, environment, transportation and other resources, with a superior living environment [2]. However, due to historical limitations, the residential functions of several communities such as Caoyang Village, which was first established, are far from meeting the current living requirements [3]. To this end, the Putuo District Government launched the renovation and upgrading project of Caoyangyi Village in December 2019.

Statistics show that over 2000  $\times$  104 m<sup>2</sup> residential buildings in the worker's new village have reached the "advanced age" of over 50 years [4]. Most of these houses have good main structures, but there is a considerable gap between the layout, area distribution, equipment configuration, and physical properties of the buildings and the standard of comfortable living.

The "four in one" public housing form is a typical unit type in Workers' New Village, where the living room is used alone and the kitchen and bathroom are shared by four

households [5]. Generally, the building area of each household is less than 30 m<sup>2</sup>. Therefore, the complete renovation of the unit type is currently the focus of the residential renovation in the workers' new village. However, the layout, shape, orientation, and structure of existing residential buildings are all established facts, so renovation is far more complex than new construction due to limitations, but it is not impossible. For example, in the renovation of Anshan New Village, measures were taken according to local conditions, while meeting building standards such as spacing and sunlight. Local additions and expansions, internal changes in layout, and adding floors to some buildings were comprehensively utilized to achieve local adjustments to the house plan and spatial layout, reinforcement of the structure, and addition of kitchen and bathroom equipment. While achieving the goals of kitchen and bathroom independence and complete residential units, the balance of the total number of households was also met. However, the current renovation focuses on solving the problem of indoor usage space not meeting the requirements of residents, but there is little consideration given to how to improve indoor thermal comfort, especially in the consideration of building energy efficiency, which lacks foresight.

## **2 The Problems Faced by the Renovation of Caoyang Village**

The original design feature of Caoyangyi Village was that the public space was relatively large, while the private space was relatively small, with an average living area of less than 4 square meters per person [6]. With the growth of population, illegal constructions such as adding floors without authorization and opening tiger windows are everywhere, seriously damaging the original style and load-bearing structure of the community, and posing safety hazards.

Fig.1 shows the scope of renovation and upgrading of Caoyang Village. From the perspective of the internal structure of the building, due to the limitations of the design at that time, the matching rate of each household was low, the coal and bathroom were not complete, and the situation of three or four households sharing a common kitchen and bathroom was very common, which was far from meeting the living needs of modern urban residents [7].

As the fourth batch of excellent historical buildings in Shanghai, many of their exterior features have historical significance and iconic features, which must be refined and preserved during the renovation process.



Fig. 1. The scope of renovation and upgrading of Caoyang Village.

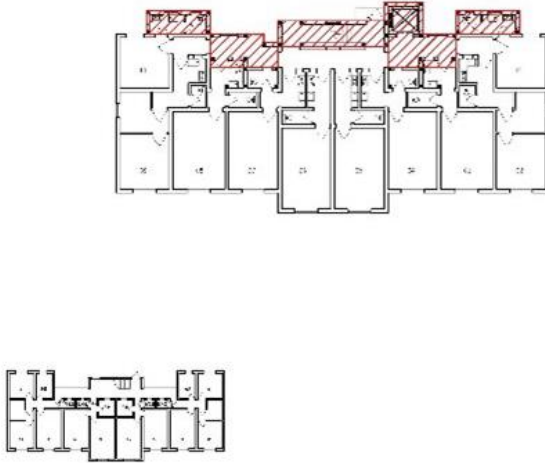
### 3 Renovation of Caoyang Village

Based on extensive research and visits, a comprehensive solution has been gradually formed through repeated comparisons.

#### 3.1 Expansion of residential space for each household

Based on the overall living conditions, in the renovation, the first step is to carry out the renovation of independent kitchen and bathroom facilities for each household, greatly improving the privacy of the residence [8]. At the same time, three households share an external kitchen, and due to area limitations, many tableware and seasonings are placed in the bedroom. Fig.2 shows Unique kitchen and bathroom drawings for each renovation. Through the complete renovation, some of the functions of the kitchen and bathroom that were previously compressed in the bedroom are also released, indirectly increasing the actual living area.

Due to significant changes in current living conditions and housing design, each household has some personalized needs to some extent, such as the placement of toilets and the location of entrance doors, which have been personalized in design. Thus, the overall design can basically keep up with the current quality status of mainstream independent residential buildings.



**Fig. 2.** Unique kitchen and bathroom drawings for each renovation.

As mentioned earlier, Caoyangyi Village is the fourth batch of excellent historical buildings in Shanghai. According to the specific requirements of the protected area [9], the main facade of such buildings should not be changed, and key protected areas should be strictly repaired and renovated according to the original style, raw materials, and original technology.

This requirement has certain limitations on improving the living environment. Therefore, in the design, considering the requirement that the main facade of such buildings should not be changed, renovation should be carried out on non main facades. Each building in Caoyang Village resembles a "concave" character, and this renovation has "gouged" 2.65 meters above the "concave" character [10]. For the south facade of the main facade, the original appearance will be preserved. For the concave area in the north, it will be appropriately reduced by 2.65 meters. The expanded area will be used as a shared area for residents to establish independent kitchens and bathrooms. After counting and calculating the existing number of households, it can reach 8 square meters per household, which can meet the needs of new kitchens and toilets. Through the comparison of CAD effects, the residential area remains basically unchanged, and the expansion of the north facade has a relatively limited impact on the overall style. Fig.3 shows the iconic features of a village in Caoyang Village. At the same time, the most iconic decorative shapes of the east-west gables, such as the looped hollow design and the bright red sloping roof of the residential area, have been fully preserved.

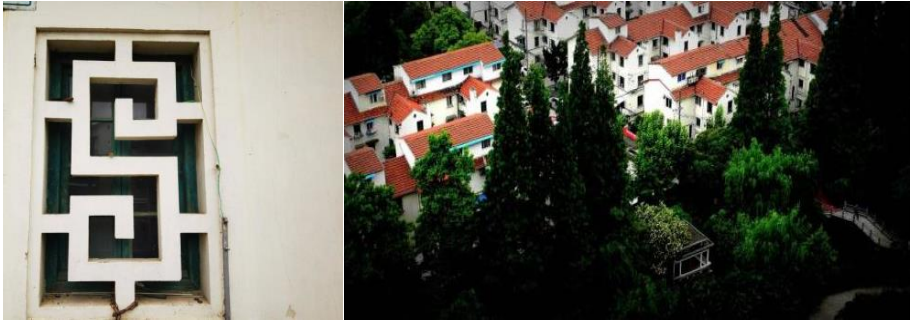


Fig. 3. The iconic features of a village in Caoyang.

Due to the expansion of living space, all exterior doors and windows that were built without authorization in the past to expand space and did not conform to the building have been blocked, and the courtyard and roof construction, roof dormer windows, air conditioning frames, etc. have been dismantled. The appearance of the community has been greatly improved.

### 3.2 Reinforcement and renewal of building structures

Caoyangyi Village was first built in 1952. At that time, it was a brick and wood structure. After nearly 70 years of use, the buildings tended to age, and problems such as ant infestation and wood structure decay were common. At the same time, the original design of Caoyang Yicun only had two floors, but in 1962, a third layer of cover was added [11]. The load-bearing wall of this layer was built with fly ash blocks and mixed mortar, and the material was soft. After 60 years of use, this part has become an embarrassing burden.

Based on this, in terms of structural renovation and renovation, the original coal ash wall was demolished and rebuilt with concrete solid brick walls. The roof was also rebuilt as a whole. At the same time, to maintain the original style of the wooden roof of the residential building, other old tiles from the old renovated residential area were collected and re laid on the roof, achieving a unity of structural improvement and unchanged effect.

Wooden stairs and wooden flooring were the basic configurations of buildings in the 1950s. With the passage of time, wear and tear, and the increasing age of residents, narrow and steep public wooden stairs have become obstacles for residents to travel. This renovation has rearranged and rebuilt the staircase passages, increasing their width and slowing down their steps, while reducing the impact of noise on residents when going up and down stairs.

The construction of wooden flooring in the 1950s was relatively simple, with problems such as mutual interference of walking sounds and easy leakage. In this renovation, the wooden grid on the second floor and the prefabricated slab on the third floor of the building are both reinforced concrete floors, which not only strengthens the overall structure of the house but also completely solves the problems existing in the original floor.

### 3.3 Building energy conservation strategy

Buildings need to comprehensively apply various energy-saving technologies that are suitable for climate and region, such as external enclosure insulation, solar energy utilization, etc., to improve the building's own performance, reduce building energy consumption, and promote ecological environment optimization. Shanghai is located in a hot summer and cold winter area, with high relative humidity throughout the year. Therefore, residential buildings should not only meet the requirements of summer insulation and cooling, but also take into account the needs of winter insulation.

The external enclosure structure of buildings is mainly divided into three forms: walls, doors and windows, and roofs. The thermal performance of the external walls of existing residential areas is poor, and about 40% of air conditioning losses are caused by building envelope materials. The method of adding an external insulation layer can be adopted to enhance the thermal insulation performance of the external walls.

The doors and windows of many old residential areas are made of single-layer white glass, aluminum alloy window frames, and even iron or wooden windows. These doors and windows have poor thermal insulation performance, which is the main way for cold and heat losses. Therefore, strengthening the sealing and thermal insulation of doors and windows plays an important role in improving the building's exterior envelope structure. At present, a more mature approach is to use double-layer insulated glass plastic steel windows. It has been proven that although double-layer insulated glass has a higher cost than ordinary single-layer glass windows, the improved insulation performance of windows reduces air conditioning energy consumption and reduces residents' daily energy consumption expenses.

The insulation of the roof and other insulation measures have a significant impact on the energy consumption of the top rooms of low and multi-story buildings. According to the principle of regional differences, the renovation of the roof should be combined with the climate. For example, the measures required to reduce roof heat dissipation in hot areas aimed at reducing solar heat gain in summer are completely different from those in winter. Inverted roofs, ventilated roofs, water storage roofs, and green roofs are all effective forms of improving the thermal insulation performance of the fifth facade, and the renovation technology requirements are not high, making them suitable for flat roofs in urban residential areas.

### 3.4 Reinforcement and renewal of building structures

Caoyang Village was designed for occupancy in the 1950s, and due to the use of public kitchens and bathrooms, the social space of residents is mainly concentrated in the building [12]. Through this transformation, the privacy of each household has been fundamentally improved, but it also increases social distance.

Therefore, in this renovation process, the design concept of transforming the social interaction inside the building into outdoor social interaction was adopted. At the beginning, the public space in Caoyang Village was mainly a square. With the increase of population and the decrease of average living space, it even developed into a laundry yard for residents.

Through this renovation, three new landscapes will showcase the spirit of model workers with the theme of "source, memory, and harmony". For example, the central green space in a construction area will also form a green belt with abstract cotton elements, which is closely related to the cotton textile industry that the residents of this community once engaged in. With the construction of such a public green space, it can become a new social venue for the residents of the community.

## 4 Conclusion

As the first new worker village in China, it is not only a new worker village, but also a glorious memory for a generation. This study focuses on the renovation of residential space, housing structure, building energy-saving strategies, and public spaces in Caoyang Village. Combined with the current energy crisis, a preliminary research method and framework for energy-saving renovation of residential buildings in Workers' New Village are proposed.

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