Application and Prospects of Prefabricated Buildings in Rural Areas of China

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Abstract. This article analyzes the status and existing problems of rural housing in China. In order to promote the construction of new countryside and improve the quality of rural housing, prefabricated buildings should be preferentially adopted in rural areas. According to the application and promotion status of prefabricated buildings, compared with traditional buildings, the advantages of prefabricated buildings are obvious. However, there are many obstacles in the promotion of prefabricated buildings in rural areas. In order to change the appearance of buildings in rural areas, more policy support should be provided during the construction of new farmers, so that prefabricated buildings can be better promoted.

1. Introduction
The 19th National Congress of the Communist Party of China has clearly established the concept of green development, promoted the development of new industrialization, raised the level of "Made in China and Construction in China", promoted supply-side structural reforms, built a strong country of quality, and built a beautiful China. The specific contents are specific to the construction industry, China should establish a comprehensive promotion of green ecological development. Prefabricated buildings and green buildings have become important carriers, and in the coming decades, they will face great opportunities for sustainable development.

At present, with the promotion of the State Council policy, more than 30 provinces and cities across the country have issued guidance and related supporting measures for the development of prefabricated buildings and building industrialization to vigorously develop prefabricated buildings and promote the transformation and upgrading of the construction industry. On March 27, 2019, the Ministry of Housing and Urban-Rural Development announced the “Key Points for Work in the Construction Market Supervision Department of the Ministry of Housing and Urban-Rural Development in 2019” and launched a pilot construction of prefabricated residential buildings with steel structures. In the pilot areas of affordable housing, prefabricated house construction, rural dilapidated house reconstruction, and ex-situ poverty alleviation, a certain percentage of dwellings were specified to be constructed with steel structures.

2. The Status and Problems of Rural Housing in China

2.1. The Status of Rural Housing
The Fifth Plenary Session of the 16th CPC Central Committee proposed a 20-character policy of "production development, ample living, civilized villages, neat villages, and democratic management" for the construction of a new countryside, drawing a beautiful blueprint for a new countryside. Mainly including the construction of new villages and towns, that is, to improve the rural human settlements environment, so that the development of the countryside is properly planned. Since 2014, the...
completed construction area of rural housing nationwide was 8.38 million square meters, while the completed area of commercial residential buildings nationwide was 0.89 million square meters. That is to say, compared to urban commercial residential housing construction, the scale of rural housing construction is also large\[1\].

2.2. Problems in Rural Housing

Rural houses in China are generally self-built by villagers, and most of them are brick-concrete structures. Brick-concrete structures usually use brick masonry for walls and reinforced concrete structures for roofs and floors. The seismic performance of brick-concrete structures is poor. Houses are generally below 6 floors, and other civil buildings are below 3 floors. The following problems are common in rural housing in China.

First, no design drawings, construction is arbitrary. Farmers' houses are mainly brick-wood and brick-concrete structures, accounting for 76% and 20%, respectively. At present, the overall planning of self-built houses in rural areas does not consider the overall plan of the village. In recent years, with the economic development and population increase, the number of new houses in rural areas has increased, the appearance of villages and villages has not changed significantly, and housing sites have expanded significantly. Rural housing construction generally has no design drawings and presents strong regional characteristics. Rural houses have poor energy saving, land and material saving effects, and are not environmentally friendly, and uneconomical. For the construction of a new socialist countryside in our country, it is more important to form a style, create characteristics, and inherit culture.

Second, the quality of rural houses and the energy-saving effect are poor. Rural houses generally suffer from poor waterproofing and thermal insulation. There is no structural drawing for the construction of rural dwellings, only the amount of various materials is calculated based on the experience of the contractor. Geological surveys are not carried out in the construction of rural houses, which leads to irrational foundation designs, too shallow foundations, and insufficient reinforcement measures. Easy to cause unsafe accidents. The arrangement of some other important components is unreasonable, resulting in uneven construction and damage to the building.

Third, traditional construction methods are used during construction, and the seismic performance is poor. Rural construction workers have not undergone formal vocational training and lack basic building construction knowledge. When preparing the mortar and concrete, the workers do not weigh the coarse and fine aggregates according to the requirements of the mix ratio, and mix them at will regardless of experience, regardless of whether the concrete meets the strength requirements. The masonry structure is generally of poor quality. There are not full gray joints, and the embedded tie bars are randomly placed. The length, direction, and spacing are not standard, which causes the vertical and horizontal walls to be insecure. The dry bricks on the wall are seriously dehydrated by mortar As a result, the strength of the masonry structure is reduced. All the above practices reduce the safety and reliability of the house structure, and the quality cannot be guaranteed.

Fourth, the peasant's legal concept is weak, which has hidden dangers for the quality of housing construction. Most rural houses are built on a contract basis, and villagers and construction teams do not sign construction contracts. There is a quality problem in the house, and it is difficult to define responsibilities, which makes it difficult to hold accountability later.

Fifth, the energy problem is prominent. Most of the winter heating in rural areas in northern China uses coal combustion, which causes severe environmental pollution and high energy consumption.

In summary, at present, the construction of rural dwellings in our country is large, mainly belonging to low-rise buildings with three or less floors. In order to respond to the national call and promote the construction of new countryside, the new technology-prefabricated building is given priority to protect the beautiful rural construction in China.

3. Prefabricated Buildings

Prefabricated building refers to the building formed by transporting the main structural components produced by the factory to the construction site for lifting. Such a building has high efficiency, excellent performance, good quality, energy saving and environmental protection\[^2\].
3.1. Classification of Prefabricated Buildings
Prefabricated buildings include prefabricated concrete buildings, prefabricated steel structures, and prefabricated decoration.

3.1.1. Prefabricated concrete building. Prefabricated concrete building refers to the concrete structure-type house building which is mainly produced by factory-made concrete prefabricated components and designed and constructed through on-site assembly. The assembly methods of components generally include on-site post-laminated laminated concrete, reinforced anchor post-concrete concrete connection, etc. Reinforced connections can be made by sleeve grouting, welding, mechanical connection, and hole-overlap connection[3]. Prefabricated concrete buildings can be divided into fully prefabricated prefabricated concrete structural systems and prefabricated monolithic concrete structural systems according to the prefabricated parts of prefabricated components.

3.1.2. Fabricated steel structure building. The prefabricated steel structure is suitable for the factory production of components, which can integrate design, production, construction and installation. Light weight, low foundation cost, suitable for weak foundation, easy installation, fast construction, less pollution to the environment, good seismic performance, recyclable, economic and environmental protection, etc[3].The prefabricated steel structure building mainly includes the main structure system, the envelope structure system, and the building and roof structure system.

3.1.3. Prefabricated Decoration. Assembly type decoration is to produce most of the indoor and outdoor decoration work in the factory through assembly line operations, such as room doors, door covers, window covers, baseboards, beds, cabinets, etc., and then assembled on site. Through batch purchasing, modular design, industrialized production, and integrated installation, standardization, and energy efficiency of decoration are achieved[3].

3.2. Status of Prefabricated Buildings
Since the "Thirteenth Five-Year Plan", the State Council has issued "Several Opinions on Further Strengthening the Management of Urban Planning and Construction". The scale of the prefabricated building market is showing a rapid development trend, and China's construction industrialization has officially entered a period of rapid development. According to statistics, as of the end of 2018, the market size of China's fabricated construction industry reached 523.4 billion yuan, a year-on-year increase of 47.2%.The market size and growth ratio of China's prefabricated construction industry from 2012 to 2018 as shown in Figure 1.According to statistics, as of the end of 2018, China's newly built prefabricated building area accounted for less than 9% of all newly built buildings, which is still far below the average level of developed countries. The proportion of prefabricated buildings in major economies in 2018 as shown in Figure 2.

Judging from the latest “Consumable Construction Consumption Quota” released by the Ministry of Housing and Construction, the construction cost of prefabricated concrete structure low-rise residential buildings is about 2150RMB/m²;and high-rise residential buildings are 2420RMB/m²;The construction unit price of prefabricated steel structure high-rise residence is about 2776RMB/m².According to calculations, the construction cost of cast-in-situ concrete houses is about 2000RMB/m², and the prefabricated building has a premium of 7.5% -38% compared to the cast-in-place model. From the perspective of construction cost, the cost of prefabricated building is close to that of traditional buildings.

3.3. Significance of Promoting Prefabricated Buildings in Rural Areas
Compared with traditional rural buildings, prefabricated buildings are mainly changes in construction methods, and their advantages are mainly reflected in the following five aspects.
First, improve residential quality. Fabricated building components are produced in prefabricated factories. Conditions such as temperature and humidity can be controlled during the production process, and the quality of the components is more easily guaranteed[4].

Second, save energy and reduce emissions, and reduce pollution. Prefabricated buildings are constructed using prefabricated plants and assembled on-site, with a high degree of mechanization, reducing the number of on-site construction personnel[5].

Third, shorten the construction period, improve efficiency, and reduce labor costs.

Fourth, improve the appearance of the village and the quality of the house.

Fifth, drive economic growth and ease employment problems.

3.4. Problems Facing Prefabricated Buildings in New Rural Construction

Aiming at the problems facing China's rural dwellings, the use of new technology-prefabricated
buildings to solve rural housing problems is a new trend in new rural construction. However, in the whole process of promotion and implementation, there has not been a large-scale promotion at present, and most rural villages still adopt the traditional way to build houses during the process of house renovation.

First, the cost is relatively high. Fabricated concrete buildings are more expensive than traditional brick-concrete houses. Since the reform and opening up, although the living standards of Chinese farmers have improved significantly, their economic income has been relatively low[6]. Therefore, most farmers will choose a low-cost brick-concrete structure.

Second, the infrastructure is incomplete in rural areas. Prefabricated buildings have a lot of advantages, but in the specific implementation process, they must be combined with the actual situation. Rural roads are partly hardened and partly dirt roads[7]. The construction of prefabricated buildings requires mechanization. This is the limiting factors. In addition, natural gas is not available in most rural areas. Even if prefabricated concrete houses are built, heating in the north in winter is a serious problem. If you rely on air-conditioning for heating, which costs more electricity, villagers will think the cost is too high. Most of the rural areas do not have a system of domestic sewage and rainwater drainage. Each household is almost an aqua latrine. In the kitchens and bathrooms of prefabricated concrete houses, sewage discharge is also an issue to be considered.

Third, the villagers' concept. In the countryside, most of them live in the same house. In the process of housing reconstruction, the feelings of the elderly must be considered. The old man's thinking is solidified and he is unwilling to accept new things.

Fourth, the prefabricated construction market has not been market-oriented. Due to various reasons such as construction cost and performance, China's prefabricated building structure system will still be prefabricated prefabricated concrete structures. No unified norms and technical standards have been formed to restrict promotion.

4. Conclusion and Prospect

By understanding the current status of rural housing in China, and encouraging national policies, the development of rural prefabricated buildings can improve project quality, shorten construction periods, and save energy and reduce emissions. However, in the process of applying prefabricated buildings to rural houses, there are problems such as high cost, incomplete infrastructure, and conservative villagers' thinking. At present, China's prefabricated buildings are still in the early stage of promotion, and industry standards suitable for different regions need to be revised urgently.

Prefabricated buildings have many advantages and can play a greater role in the construction of new rural areas in China in the future. In order to overcome the resistance of promotion, the following aspects can be done well.

In the production process of prefabricated building components, new environmentally friendly materials can be used to reduce the cost of prefabricated buildings and better improve the energy-saving effect of prefabricated buildings.

The pilot construction of prefabricated buildings in rural areas will better demonstrate the advantages of prefabricated buildings and make people accept such prefabricated buildings more quickly.

From a long-term perspective, the Ministry of Agriculture and Rural Affairs and the Ministry of Finance can appropriately subsidize the construction of prefabricated buildings in remote and impoverished areas, making it easier for villagers to accept this new type of housing.

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