

Research on the Current Situation of Temporary Assembly Construction Industry based on Public Health Emergencies

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Abstract

The prevention and control of the new coronavirus pneumonia outbreak poses an unprecedented and urgent need and challenge to the construction industry. The development of on-site rapid assembly steel buildings for epidemic prevention and disaster relief that can promptly resolve post-disaster risks and enhance the safety and security of people's lives is the inevitable choice, or even its only choice, in the event of a public health emergency. The development and application of assembled buildings is of strategic importance to enhance China's independent innovation and core competitiveness in the construction industry and to achieve sustainable economic and social development in the future. This paper analyzes the application and development of assembled buildings under public health emergencies by combing the history of the development of assembled buildings, combined with the current market situation research, to provide some reference for the practical application of assembled buildings under emergency events.

Keywords

Public health Emergencies; Assembled Buildings; Steel Structures.

1. Introduction

As China's socio-economic development continues to accelerate in the 21st century, especially in the last five years, China's urbanization and urbanization process continues to speed up, the demand for energy conservation and environmental protection continues to increase, and labor costs continue to grow with social development. This series of factors led to China's precast concrete assembly construction technology and prefabricated steel structure assembly building research and application of rising heat. The promotion of building assembly has been the consensus of the construction industry. This trend is mainly dominated by three factors:

1.1 As determined by the stage of economic development

In just a few decades of reform and opening up, China has brought a large agricultural country with the world's largest population into a "moderately prosperous society". This feat is unprecedented in the history of economic development in the human world. As China's economic development enters the "new normal", the central government has proposed a new type of industrialization, informatization, urbanization, agricultural modernization and green development requirements. As an important constituent role in economic development, the construction industry must also transform its mode of development and production in the new situation. Therefore, building assembly reflects the requirements of new industrialization, informationization and greening, which is the inherent demand of China's economic development.

1.2 The need for the development of new types of urbanization

According to relevant statistics, it is expected that by 2030 China's urbanization rate will reach the level of developed countries is about 70%. Nearly 390 million rural people will be converted into an urban population. This massive population shift presupposes a huge scale of construction to underpin it. And only the construction technology of architectural assembly can be adapted to the construction of such a large number of homes. Therefore the development of assembled buildings is a real need of the urbanization process.

1.3 The need for transformation and upgrading of the construction industry

China's construction industry is currently a traditionally labour-intensive industry. Judging from the current development trend, the transformation and upgrading of the construction industry from traditional industries to industrialized production of assembled construction can greatly improve the energy efficiency of construction projects, and is an important means for the construction industry to achieve industrial upgrading.

2. Background to the research

The new coronavirus epidemic of 20 years is raging, in order to alleviate the shortage of hospital beds in Wuhan, Wuhan started construction of Wuhan Huoshen Mountain and Leishen Mountain two hospitals modeled after Beijing Xiaotangshan Hospital. In two key projects to combat the epidemic, the advantages of traditional and assembled construction were fully utilized. Adopting the concept of modernization of the construction industry, such as standardized design, factory production, assembly construction, intelligent coordination and system integration, the Huoshen Mountain, covering an area of 33,900 square meters with 1,000 beds, was built and delivered within 10 days. Supported the fight against the epidemic in Wuhan.

Xi Jinping, General Secretary of the Central Committee of the Communist Party of China (CPC), stressed at the 12th meeting of the Central Committee for Comprehensively Deepening Reform held on February 14, 2020, the need to improve institutional mechanisms for the prevention and control of major epidemics and improve the national public health emergency management system. Therefore, it is necessary to conduct a detailed investigation and analysis of the application of the assembly construction industry under public health emergencies, in order to provide reference for the application and practice of assembly construction in emergency situations.

3. Application status of assembled building at home and abroad

3.1 Current situation of foreign

3.1.1 Status of foreign development

Assembled buildings have a long history of development. In the 1950s, the effects of World War II devastated European city building and left a large number of buildings in need of reconstruction, the vast majority of which were residential. In order to solve this problem of post-disaster reconstruction, Europe began to adopt the assembly building for residential construction. And on this basis, a complete system of assembled residential construction was developed [1].

For example, French assembled buildings are mainly based on reinforced concrete structural systems, mostly using frame structures or plate and column structural systems. And gradually to the development of large-span structure; Germany, on the other hand, has mainly developed a reinforced concrete frame shear wall assembly structure, which is industrially produced by means of factory prefabrication; The Nordic countries such as Denmark and Sweden have mainly studied the construction for concrete structural assemblies and have used it extensively in engineering practice. The use of general-purpose components has now reached 80%, reducing building energy consumption by 50% and forming an industry standard; In Australia, it was only in the 1980s that the development of assembled buildings began, with a focus on light steel building systems. Developed

a dry construction process with industrialized production and assembly construction technology as the core [2].

The U.S. was late in the development of assembly construction, with industrial production of fittings only beginning in the 1970s with energy crisis practices. In order to promote the development of assembled buildings in the United States, the relevant regulatory authorities issued a series of industry norms, which are still in use today. American assemblies are primarily concrete and steel structures. The PCI Design Manual produced by the Precast and Prestressed Concrete Association includes a section on assembled structures, which has had a profound impact on the development of assembled buildings worldwide. [3,4]

Japan was one of the first countries in the world to practice industrial production of assembled buildings. In the early days, Japan mainly used wooden structures as the main material for assembled buildings, which gradually developed into concrete and steel structures. But after many years of practice steel structures dominate the assembled building. At the same time, the conflict between standardization, mass production and diversified needs has been resolved through legislation and other means to ensure the quality of assembled buildings in Japan. [5]

3.1.2 Status of foreign applications

The application of engineering practices for modular construction varies from country to country. France is one of the first countries in the world to promote modular construction. The high level of production quality and construction quality of French assemblies through the dry construction process. At present, France mainly uses pre-stressed concrete assembled frame structures, which have a market share of nearly 80%. The U.S., on the other hand, mainly focuses on ground-floor steel and wood-frame assemblies, with more emphasis on residential comfort and diversity. An emphasis on green building in the UK, promoting green and energy efficient buildings, with steel and timber structures dominating engineering practice as a whole. The development of affordable housing in Japan in the 1950s was an opportunity to promote the development of modular construction. Data through 2015 shows that 55.5% of new homes are wood-framed, 18.1% are steel-framed, and 26.3% are reinforced concrete-framed. [6,7]

3.1.3 Current status of foreign applications in sudden-onset emergency situations

In addition to the vigorous development of assembled buildings in general civil construction, some countries have also done some research on the application of assembled buildings in post-disaster emergency response due to geographical factors. Canada and Japan are both in earthquake-prone areas, so there is a considerable need for post-earthquake reconstruction and response. The Canadian Wood Industry Association (CWA) has primarily developed a lightweight wood construction system that is lightweight and earthquake resistant. And in Japan by Master Itamo Architect came up with the paper tube construction system. This structure is made of paper tube as the main construction material, with wooden nodes or metal members as connectors. It is light in weight, fast in construction and strong in strength, and is widely used in public service activities without borders after disasters.

3.1.4 Summary

In summary, foreign countries in the field of assembled construction mainly concentrated on concrete components, wooden structures, light steel structures and other three categories. In the course of practice, a set of standardized construction technology and technical standards have been formed with a high degree of industrialization. However, the application practice and research in emergency situations are relatively weak, and a unified construction technology standard and standardized structure system have not been formed.

3.2 National situation

3.2.1 Current status of development

At the beginning of the founding of the new China, China is actively promoting the development of assembled buildings and the industrialization of building components. Objectively speaking, the development of China's assembled construction basically started at the same time as foreign countries.

However, due to a variety of reasons, the development of China's assembly building has gone through a start-up period, a downturn, and a restart of the three stages of development.

Phase I: Initiation of the development phase, 1950-1980.

At the very beginning of the founding of New China, the State Council issued the Decision on Strengthening and Developing the Construction Industry, which began to promote standardization, factoryization and mechanization in the national construction industry, and vigorously developed prefabricated components, assembly-based construction techniques and prefabricated assembly buildings. It is jointly promoted by the State Construction Commission and various industrial ministries, covering the construction, railway and transportation sectors. Thousands of prefabricated concrete assembly plants were built across the country, and at one time almost all buildings had "prefabricated assembly elements" and almost all horizontal members were produced using the "prefabricated assembly method".

Phase 2: Low tide, 1980 to 2008.

After the Tangshan earthquake, earthquake damage investigations showed that prefabricated buildings built according to China's regulations at the time had poor seismic performance and collapsed severely, leading to the near extinction of prefabricated buildings between 1980 and 2008. Cast-in-place concrete structures have become popular, and cast-in-place technology has developed considerably.

Phase 3: Restart phase, 2008-present.

Despite repeated decrees issued by the construction department to promote the relaunch of assembled buildings, there have been few new assembled systems and buildings until 2008. After 2008, governments around the world to promote mandatory assembly building measures have been introduced, assembly building into the restart stage.

3.2.2 Application Status

China's research in the field of assembled steel housing started relatively late, and the concept of housing industrialization was first proposed in 1994. After nearly 20 years of industry development, China's assembled steel housing system is currently divided into two main categories of low-rise assembled housing and multi-high-rise assembled housing.

(1) Low-rise light steel assembled houses

In 2002, Beixin Group set up Beixin Housing together with Japanese enterprises, and through an in-depth study of the housing manufacturing technology in Japan, Europe and the United States, the Beixin Thin Plate Steel Bone Housing System was launched on the basis of cooperation with Japanese housing manufacturing companies. The system adopts cold-formed thin-walled steel as raw material for the production of industrialized components, without welding or painting during on-site construction, and is a new type of assembled light steel structure residential system with wall plate load-bearing.

(2) Multi- and high-rise light steel assembled houses

In 1996, the Yuanda Group began to research new industrialized housing systems and established the first comprehensive "National Housing Industrialization Base" in China. In 1999, Yuanda built the No. 1 Experimental Building of China's first-generation steel-framed assembled houses in only 97 days. Ltd. was formally established by the Yuanda Group in 2009, focusing on the research and development of assembled building structures and proposing a nodal diagonal braced reinforced steel frame structure system, which adopts the "building block" construction method and greatly improves the construction speed on site.

Although China has the advantages of abundant steel types and sufficient output in the field of assembled construction, the imperfection of steel structure residential design specifications and the lack of uniform technical standards have led to the slow industrialization of China's assembled

construction industry, which is still relatively low. Therefore, the development of assembled buildings in China still has a long way to go.

3.2.3 Application in sudden-onset emergency situations

Thanks to its unique features of standardization, easy transportation, quick installation, adaptability to the site, labor saving, energy conservation and environmental protection, as well as its modular design, assembly building is widely used in post-disaster reconstruction and resettlement.

For example, during the 2003 SARS epidemic, Beijing built the Xiaotangshan Hospital using an assembled slab structure with an overall construction cycle of seven days, which provided strong support for the SARS protests; In the 2008 Wenchuan earthquake in Sichuan province, the local government used modular temporary buildings to properly relocate the victims, which was well received; In 2020, in order to combat the neo-crown epidemic, the Wuhan municipal government built Vulcan Hill and Thorshan Hospital using assembled buildings, delivering the Vulcan Hill Hospital with 33,900m² of floor space in 10 days and the Thorshan Hospital with 79,900m² of floor space in 12 days, providing strong basic support for the control of the neo-crown epidemic. These application examples prove that assembly building has great potential in emergency situations, and in the pursuit of time-sensitive disaster disposal in the assembly building will have broad prospects for future development, or even its only choice.

3.2.4 Summary

In summary, the development of China's assembly building, despite its early start, but its development course is more tortuous, more single application areas. But with the objective needs of China's economic development, in the next 5-10 years assembly building is bound to its unique advantages of substantial development and practice. At the same time, the development of China's assembly building in emergency situations has a lot of experience in the application of practice, especially the Wuhan Thor Mountain Hospital and Vulcan Mountain Hospital engineering practice shows that the application of assembly building in specific conditions will have a very broad space.

4. Research on the Current Situation of Assembled Buildings

4.1 Current state of technology

At present, the assembly building in Hunan Province is mainly based on concrete assembly components and heavy steel assembly building structure, and is mainly used in residential and industrial plants and other fields, and the reserve of application technology in disaster disposal is relatively small. In terms of light steel assembled building structures, there is basically no large-scale large-scale production enterprise in Hunan Province, mainly acting as a distributor, the main product type is light steel villas, and a small amount is used for earthquake prevention and disaster mitigation.

4.2 Application Status

In recent years, Hunan construction enterprises based on accelerating green development and promoting the transformation and upgrading of the construction industry, in 2018, the province's construction enterprises completed a total output value of 958.144 billion yuan, an increase of 13.8% year-on-year, about to upgrade to a trillion-dollar industry. National leading enterprises of assembled construction such as Yuanda Sumitomo, Zhuyou Zhizao, and Sany Group have emerged. In order to make the assembly building industry chain better and stronger, Hunan actively promotes the transformation and upgrading of assembly building by large residential construction enterprises such as Hunan Orient Red Construction Group, Hunan Shaping Construction Company, Hunan Construction Group, China Construction Bureau 5, Hydropower Bureau 8, Minmetals 23ye, etc., which have become national or provincial assembly building industry bases. At the same time, promote Sany Group and other construction machinery manufacturing enterprises, to expand assembly building factory automation, automation of a full set of PC component machinery and equipment business, the current market share has more than 50% of national sales, Hunan has become

the country's fastest-growing assembly building, the strongest comprehensive strength, the largest production capacity of the province.

At the same time, the construction industry in Hunan province, such as assembly building, green building, building energy efficiency, BIM technology, green construction, construction engineering technology, etc., is developing rapidly and has become an advantageous strategic industry in Hunan province, especially the comprehensive strength of assembly building ranks the forefront in China. By the end of 2019, Hunan Province had implemented a total of 56.04 million m² of assembled buildings and had achieved excellent results in the construction of industrial bases and platforms (Table 1):

Table 1: Results of construction of industrial bases and platforms for assembled buildings in Hunan Province

Platform name	rank	quantities
National Demonstration City for Assembled Buildings	national	1
National Pilot City for the Construction of Assembled Steel Structure Houses	national	5
National Assembly Building Industry Base	national	9
Provincial Demonstration Cities for Assembled Buildings	provincial	6
Provincial Assembly Building Industry Base	provincial	41

In terms of technology development, Hunan Province has steel-framed and wood-framed assembled buildings as its main development direction. It is planned to adopt a pilot program for the construction of steel-frame assembled houses in 2022, initially establish a mature technical standard system for steel-frame assembled houses that suits the reality of Hunan Province, and cultivate more than five large steel-frame assembled house project general contracting enterprises. Completing more than 10 pilot demonstration projects of steel structure assembled houses to form a green steel structure assembled building industry cluster in Hunan Province. In Hunan Province, the General Office of the People's Government of the People's Republic of China on accelerating the development of assembled buildings in the implementation of the views put forward in Hunan Province, localities should be combined with new rural construction, especially in the province's relocation of poverty alleviation, reconstruction of dilapidated buildings, centralized resettlement and other construction projects to vigorously promote the application of assembled buildings, vigorously promote the development of light steel structure-based rural assembled buildings, scenic tourist areas and minority areas to develop modern wood-framed assembled buildings.

4.3 Application in sudden-onset emergency situations

Although Hunan Province has a large scale, strong technology and new equipment for assembled building structures, it is mainly concentrated in the residential sector, with little investment in public health in sudden emergency situations, and insufficient technical reserves to form an industrial cluster. In order to solve this problem, in the Hunan Provincial People's Government on the issuance of the "Hunan Province public health prevention, control and treatment capacity of key construction action plan (2020-2023)" has been proposed in the notice relying on the provincial assembly building production enterprises, research and production of mobile, modular cubicle hospital, so it can be predicted that in the next 3-5 years of development, Hunan Province in emergency situations in the assembly building research and development and application will make great progress.

5. Developments and prospects

5.1 Technology Trends

According to the accumulation of existing assembly technology, there is no effective solution to corrosion and fire protection in assembled buildings, and corrosion and fire are still the biggest risks facing assembled buildings. Secondly, the current fragmentation of the assembly building enterprises,

the components of the general poor between the various enterprises, the structure of the system varies greatly, the failure to form a unified production and manufacturing standards, which greatly restricts the unified development of China's assembly building. In addition, the current assembly building in the cost of poor economy, can not guarantee the competitiveness of the structural system and vitality. Therefore, the future development of China's assembly building will inevitably focus on the technical force to focus on the above breakthroughs.

At the same time, the application and practical research of post-disaster assembled building structures will also begin, and China will invest more technical strength in the application of post-disaster assembled building structures in the future. This will enable more people to know more about the assembly building structure, understanding of the application of the assembly building structure in the post-disaster reconstruction, will be carried forward, the significance is not limited to post-earthquake reconstruction, for China's new rural construction and urbanization will also have a long-term role and significance.

5.2 Application Trends

In the application of assembled building structure, China is actively promoting the development of assembled building structure. But the current development, China's assembled building is still at the primary development stage, but also faces a number of problems to be solved. Including how to solve the recognition of assembled buildings is the primary problem. The future development of China's assembled buildings should learn from foreign development experience, combined with China's national conditions and industry characteristics to explore the technology and management system suitable for China. Assembly building is China's futuristic realization of the main means of industrial transformation of construction, is an important direction for the development of China's construction industry, China's future application of assembled buildings is bound to achieve refinement, industrialization and popularization.

5.3 Trends in application in sudden-onset emergencies

The application of assembled building structures in emergency situations has enormous advantages, and the future development in this field will be more extensive, and will gradually form a proprietary technology and standards in the field. At present, it is possible to build an emergency medical facility system from the perspective of the whole industry chain, the whole life cycle and globalization, in order to better cope with future medical emergencies. The construction system of emergency medical facilities is established from the perspective of the whole industry chain, and the modular emergency medical facilities adopt an integrated system design and an integrated standard system. Focus on post-treatment of emergency medical facilities from a full life-cycle perspective. Transforming patient transport facilities across regions with a global perspective.

6. Conclusion

The assembly technology originated in Europe, but different countries have developed many different structural forms according to local conditions, and the assembly building in many developed countries has been well developed. Although our country did not start too late in this field, its initial development was slow or even extinct. But after nearly two decades of rapid development, in the field of assembled construction has gradually matured, has its own classification, especially during this year's epidemic 10 days Vulcan Hill Hospital, 12 days Thunder Mountain Hospital delivery and perfect application of the feat in the show assembly building huge efficiency advantage at the same time shows the maturity of the development of China's assembly and China's fight against the epidemic and a firm determination to win.

Hunan province is also following the national development in the field of assembled construction, and has gained some experience and advantages in the field of residential use, but the investment in the field of public health emergencies and various technical reserves will still be slightly insufficient. The new crown epidemic of 2020 has clearly shown us that the development of temporary assemblies

under public health events can no longer be stopped, and that we must invest more in making their role more visible.

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