

Comparative Study on Modular Building and Traditional Prefabricated Building

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Abstract: The structural system of traditional prefabricated building mainly corresponds to direct prefabricated structure system and prefabricated large plate structure system. Modular building system takes each room as a modular unit, and the whole unit is prefabricated in the factory, transported to the site after completion, placed in a suitable position, and assembled into a whole building through reliable connection. The building components of both are prefabricated by the factory and assembled directly on site. Modular architecture can be said to be the inevitable result of the development of traditional prefabricated buildings, the product of the development of the times, and has a good development prospect.

Keywords: Traditional Prefabricated Buildings; Modular Building; Building Industrialization; Prefabricated Assembly Rate

1. Introduction of prefabricated buildings

Prefabricated building refers to a building in which every part of the building is directly assembled on site according to the mode of installation on site, just as factories produce machines in batches and sets.

According to different prefabrication degrees, prefabricated units of prefabricated buildings can generally be divided into bar units, plate units and modular units, and the corresponding building structure systems are: direct prefabricated structure system, prefabricated large plate structure system and modular building structure system^[1].

The advantages of prefabricated buildings are also obvious. On the one hand, the production method of prefabricated components in factories can better control the production conditions of components to ensure the quality of the project, and the operation method of on-site assembly strictly follows the process, improving the quality and production efficiency of the project and reducing the potential safety hazards; On the other hand, in the operation process of assembly-type construction engineering, the air pollution caused by dust can be relatively reduced, and the building materials can be recycled, thus improving the use efficiency of materials and being more energy-saving and environment-friendly.

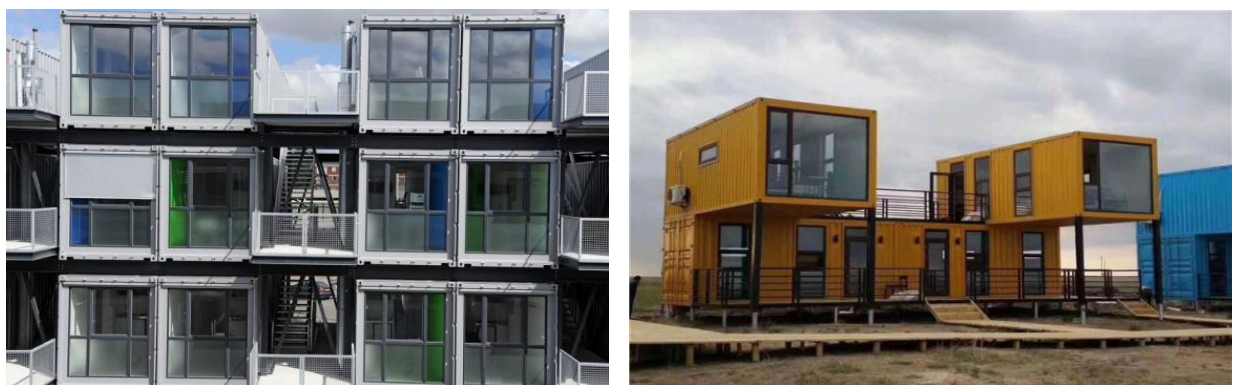


Fig. 1 container building example

2. Comparison between modular building and traditional prefabricated building

Compared with traditional prefabricated buildings, modular buildings are similar in that the building components are prefabricated by factories and have the characteristics of standardization. Next, this paper will compare the similarities and differences between the following three aspects:

2.1 Component fabrication

In the design of prefabricated components in prefabricated buildings, the principles of modularization and standardization should be followed, and the standardization degree of components should be improved as much as possible, and the types of components should be reduced as much as possible, so as to achieve the purpose of reducing the project cost. For the design of the size and weight of parts and components, the ability to transport to the site after production should be fully considered; In the design of prefabricated components, the service performance of components, such as fire resistance, durability, airtightness, insulation, thermal insulation and other factors, should be fully considered. For the design of the main load-bearing components, the strength required by the code should be achieved to ensure the seismic resistance and stability of the whole building. ^[2]

The structural system of traditional prefabricated buildings mainly corresponds to the direct prefabricated structural system and prefabricated large slab structural system. The components that need to be produced in advance in these two structural systems mainly include: composite beams, composite floors, prefabricated columns, prefabricated stairs, prefabricated composite shear wall plates, prefabricated external wall hanging plates, etc. The production processes of prefabricated components include: steel bar processing, binding, welding, assembling dies, mixing and pouring concrete, dense forming, maintenance, etc.

Modular building system takes each room as a modular unit, and the whole unit is prefabricated in the factory. After completion, it is transported to the site, placed in a suitable position and assembled into a whole building by reliable connection. According to the structure and function of building modules, the modules used in modular buildings can be divided into: wall load-bearing module, local opening module, corner pillar support module, stair module and non-load-bearing module; According to the structural forms of modular buildings, the structural systems adopted by them can be generally divided into full modular building structural systems and composite modular building structural systems [3]. The structure of a single modular component unit is simple, and modeling is convenient. At the same time, the reasonable structural system composed of component units is systematic, and becomes a part of the whole building after hoisting. The design difficulty of modular building component units lies in how to meet the design requirements, and at the same time, the structural system composed of modular units is required to meet the overall and connection design requirements.

2.2 Construction arrangement

One of the characteristics of the construction of traditional prefabricated building structure system is to face the problems of transportation, lifting and stacking of components. In the transportation process of components, in order to prevent the components from moving, toppling and deforming, it is necessary to take corresponding fixing measures, and in order to prevent the components from being damaged, it is necessary to take measures such as setting protective pads. When transporting wallboard, special brackets shall be used, and the components and brackets shall be bound firmly. The transport vehicles of prefabricated components shall meet the requirements of component size and load. The wallboard should be placed symmetrically with the exterior facing up, and the upper part of the component should be isolated by wooden cushion block and fixed measures should be taken to support the cushion firmly. When the components are transported in a stacked and flat manner, measures should be taken to prevent cracks in the components.



Figure 2 Assembly of prefabricated buildings

Modular building structure system, according to the concept of modularization, after prefabricated components are completed, they are assembled into large components at the assembly site, and then assembled with modules and transported to the hoisting points in the construction area, and then hoisted in place by large crawler cranes. Because modular construction will form relatively large components and items, on-site hoisting requires larger hoisting machinery and equipment than the traditional prefabricated building structure system. During the whole construction process, the parallel operation of civil construction and equipment installation appears, which can shorten the construction period, but there is still the boundary of the overall stage.



Figure 3 Assembly of modular buildings

2.3 Degree of informatization

The construction drawings of traditional prefabricated buildings are generally delivered in two-dimensional form, and the information in the design stage is also transmitted in the form of two-dimensional construction drawings, which not only consumes a lot of energy for designers, but also requires the builders to grasp the drawings very accurately. In fact, both traditional prefabricated buildings and modular buildings need strict management requirements for the production, transportation, lifting and stacking of prefabricated components, and traditional information management methods are difficult to meet the requirements, so advanced and efficient management methods should be adopted in information management. With the development of modular buildings, the structural system is becoming more and more complex, and the requirements for construction accuracy are becoming more and more stringent. It is difficult to express the complex space and components in detail by traditional CAD lofting of structures. Especially for the construction process of modular building which is different from traditional building, the 3D information model can be established by combining BIM technology in the design stage, which can make the analysis and review process very easy and convenient.

3. Problems in the practical application of prefabricated buildings in China

In recent years, through the continuous efforts of the government and enterprises, prefabricated buildings have made rapid development in China, but there are still many problems in the development stage.

3.1 High project cost

The cost of traditional construction engineering includes direct cost, indirect cost, profit and tax, while the cost of assembly construction engineering includes not only the cost of traditional construction engineering, but also the production cost of prefabricated components, the transportation, lifting and stacking cost of components, and the installation cost of component installation site. From the perspective of building scale, the larger the scale, the more kinds of components, the more complex the process, the more manpower and resources are needed, and the higher the cost.

The prefabricated assembly rate of traditional prefabricated buildings refers to the proportion of prefabricated components in building structures such as walls, beams and columns, floors, stairs, balconies, etc. Generally, it is an important factor affecting the cost of prefabricated buildings. In a certain range, with the increase of assembly rate, the cost decreases [4]. Modular buildings are difficult to assemble, and have high requirements for hoisting and installation, so they have different requirements for hoisting machinery. Different types of hoisting machinery have different costs, so hoisting machinery should be selected according to the size of components. At present, the cost of prefabricated buildings in China has been in a relatively high state, which is also related to the incomplete industrial chain in China. The technology of component design, production and construction is relatively backward, and there is a lack of supporting facilities and modern enterprise management mode.

3.2 Lack of technical support

The development of prefabricated buildings needs the support of professional technology. However, the technicians engaged in assembly at present in our country are lack of professional quality and professional construction team and technical management personnel, which leads to the fact that most of the prefabricated buildings in our country can only achieve the industrial production and assembly construction of some components at present, and the standardized design, integrated decoration, information management and intelligent application can all do very little at present. Standardized design is also the basis of integrated design in assembly-type construction, but the main problem is that there is no unified design template as a standard, which leads to uneven quality of prefabricated components. Different places have different standards for prefabricated production, hoisting transportation and assembling operation of components, which is a major obstacle to the rapid development of prefabricated buildings in China.

Both traditional prefabricated buildings and modular buildings need professional factories to produce prefabricated components, professional technicians to assemble and other operations, professional transportation teams to transport and protect components, and professional hoisting machinery to carry out hoisting work, thus reducing manual intervention and assembly time. In addition, one of the difficulties in construction is the assembly of components, so as to ensure the quality of connection points, so as to ensure the quality of fabricated buildings. In the current situation in China, the bearing capacity and stiffness of joints are well guaranteed, but the ductility cannot meet the requirements.

In a word, every process from design to transportation to site installation, such as measurement, hoisting and connection of components, needs to have high technical level and management level, and technical breakthrough is needed to make prefabricated buildings popular in China.

4. Development strategy and improvement measures

Compared with the developed prefabricated building industry in foreign countries, there is still a big gap between China and it, so we should take corresponding measures to promote the development of prefabricated buildings in China.

4.1 Adopt advanced engineering mode

In recent years, prefabricated buildings have been implemented in many places in China. However, because the management mode still adopts "subcontracting at different levels", the links between various departments are insufficient, resulting in many problems in actual production. In my opinion, EPC mode has more advantages than traditional engineering mode, and it is an effective way to implement EPC mode.

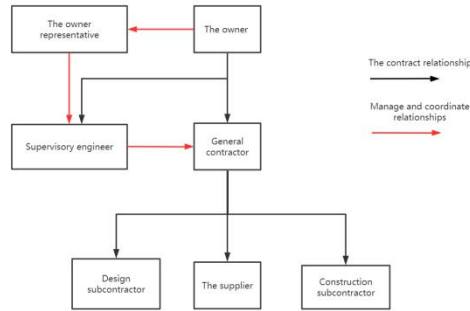


Fig. 4 diagram of EPC mode

EPC mode is the perfect combination of architectural engineering mode and design, the construction unit indicates the investment intention, and the general contractor is responsible for the component design and production, assembly construction, etc. The project mode includes organization management, cost control, schedule control, quality control, contract management, information management and communication management, which realizes the high organization of project management and gives full play to the advantages of prefabricated buildings. Secondly, the engineering model can coordinate the manufacturing of factory components and the installation of field components, effectively shorten the construction period, optimize and integrate the resources of the whole industrial chain, reduce the conflicts among various links, and improve the production efficiency and coordination among various departments. Furthermore, the project mode can be managed globally, the materials to be purchased are determined in the design stage, and the information of all parties is coordinated in the whole process, which greatly reduces the consumption and waste of resources, thus reducing the total cost of the project.

4.2 Increase the development of science and technology

Prefabricated buildings can't develop by going up one flight of stairs without the development of science and technology. With the continuous development of prefabricated buildings in China, there will be a steady stream of social needs, so we should strengthen the research of prefabricated buildings and speed up the construction of construction teams. Technological development needs to improve the quality and precision of prefabricated components, realize modular construction of prefabricated components with the advantages of prefabricated buildings, and realize standardized design, integrated decoration, information management and intelligent application. The construction and implementation of the standard system of prefabricated building design provides more systematic and standardized guidance for the design process of prefabricated building, and achieves the highest quality engineering design and construction ^[5]. In addition, technical innovation is needed for lifting and hoisting equipment. At present, the development of hoisting machinery is not perfect enough, and there are many places where manual intervention is needed. It is necessary to combine the standardized production of prefabricated parts, optimize the original design, effectively match prefabricated parts with hoisting equipment, improve the success rate of hoisting once and reduce the occurrence of safety accidents ^[6].

The most important point in developing science and technology is to increase the supply of talents. With the flourishing state of prefabricated buildings, the demand for talents in prefabricated buildings has increased obviously, so we should strengthen the cultivation of professional talents and the construction of talent team. This requires us to improve the vocational training system, build a complete and mature education mechanism for prefabricated building builders, cultivate professional knowledge and innovative spirit simultaneously, and give a good internship environment. For example, through school-enterprise alliance, colleges and universities set up related majors or courses, so that students can receive the knowledge of specialized prefabricated buildings and enterprises can provide a good internship environment.

5. Conclusion

Compared with the traditional construction mode of prefabricated buildings, modular buildings have higher

industrialization degree and engineering quality, more convenient construction, more flexible design, less pollution and more environmental protection.

The Huoshen Mountain and Thunder God Mountain hospital built in the epidemic stage last year played a very significant role, and they were quickly completed and put into use in a short time. Apart from the concentrated leadership advantages, outstanding architectural experience and the spirit of unity, the modular and prefabricated building technology itself also played a key role.

China is promoting the development of standardized design, which makes the construction industry vigorously develop building industrialization and modular construction. Therefore, modular construction is the inevitable result of the development of traditional prefabricated buildings, the product of the development of the times, and has a good development prospect. However, it is necessary to constantly improve standards and technical specifications, adhere to the concept of industrialization, continue to advance steadily, run through the idea of green buildings, and strengthen the training of talents, so as to further promote the development of prefabricated buildings.

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