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Overview of overseas prefabricated structure development

Xingda Chen

North China University of Science and Technology, Hebei, Tangshan, 063210, China.

Abstract

Prefabricated concrete structure has many advantages, such as saving labor costs, reduce noise and dust pollution of the construction site, better product quality control in the production of high efficiency under the premise of shortening the time limit for a project, high material utilization, and easy to make factory production waste water and solid wastes recycling [1], some structures can use [2] again. Foreign precast concrete components and reinforced concrete started roughly the same, precast prefabricated concrete structure is an important way of building industrialization, industrial precast concrete really began to develop after the second world war.

Keywords

overseas; prefabricated structure; development.

1. Development and application of precast concrete structures in Europe

The development of precast concrete in Europe was made possible by the massive displacement of refugees after the second world war, which led to an extreme shortage of housing in Europe. The development of precast concrete was further accelerated by the climatic factors in cold regions. The first patent was obtained by a Frenchman, menier, who obtained a patent for prefabrication in 1840 [3]. This stage, France, Germany, Switzerland, Denmark and other European countries appeared a large plate structure system (figure 1-1). Architect Joan pruvey developed a series of industrial-scale housing structures that led to the creation of a large number of fully assembled panels and tool-like formwork. Subsequently, Russell, a Briton, obtained patent no. 2151 in June 1875. His patent "improvement of building structure" indicated that precast concrete wallboard could be installed on load-bearing structure parts, which morris considered to be a pioneering event in precast concrete structure technology [4]. This structural technique can be used for both low-rise villa buildings and one-story bungalows. After the further development of precast concrete structure, Lascell began to focus on the practical application of precast concrete in engineering. Finally in 1878, in the British exhibition area of the Paris exposition, Lascell showed a temporary villa with wood structure as load-bearing skeleton and precast concrete wall board as wall, which was the first building built with precast concrete technology in the world. Until now, the earliest precast concrete buildings in relatively good condition are the two villas built in 1882, which are located in Croydon, England. The architecture of these two villas is a practical result of the temporary villa exhibited at the Paris expo. They are constructed in the same way as the temporary villa of the exhibition, while the wooden structure is connected by bolts with the prefabricated wallboard.

Around 1950, some factories in Denmark and Sweden began to produce concrete wallboard parts. Small slab structure and large slab structure are the initial structural forms of precast concrete structure. In 1969, Swiss kantz [5] compared the advantages and disadvantages of small slab structure system, large slab structure system and spatial unit structure system, indicating that large slab structure system has huge economic advantages and is suitable for mass production. There is a difference between the prefabricated wallboard and the current shear wallboard in the large plate structure. The prefabricated wallboard in the large plate structure mainly bears the vertical load, while

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the current shear wall bears the vertical and horizontal load. In Europe, various large plate structure systems have emerged, such as Cauus system, larsen system and nelson system [6]. In the early stage of the development of precast concrete, the connection modes of precast concrete mainly include wet joints [7], friction-type joints [8] and mechanical connections [9]. Now precast concrete connection appeared new development, New Zealand precast concrete structure design code "standard of concrete structures" (NZS3101) [10] provides mixed node precast concrete structure based on force and the design method based on displacement, the design method based on displacement between layers of the structural displacement and mixed node since the recovery center capacity and energy dissipation capacity for consideration.

In the 1970s, the commission of the European communities established a series of norms to replace national norms, so as to coordinate national technical norms and solve the problem of technical barriers to trade. Finally, the collated and coordinated European codes will be submitted to the European standardization committee to form a series of structural rules and precast concrete design codes with the same status as European standards [11]. Then, due to the rapid development and production of European prefabricated buildings, a series of problems began to be exposed, and prefabricated buildings entered a slow stage of development.

At present, European prefabricated buildings are relatively mature. The German prefabricated building, which is famous for its energy saving, is the most energy saving country in the world. This passive building USES solar energy to provide indoor heat energy through conduction and convection of natural heat transfer [12]. By storing excessive heat energy in summer, it achieves a building with zero energy consumption that is warm in winter and cool in summer [13]. These passive buildings are integrated with prefabricated buildings in Germany, making them more energy efficient and environmentally friendly.

In contrast, Denmark and Sweden have a rich diversity in the development of prefabricated buildings and a good development in the modular prefabricated buildings. The country has unified the standards of prefabricated concrete components produced in industrialization, which has achieved the unification of diversification and standardization of prefabricated buildings. Prefabricated components in prefabricated buildings reach 80%, and the energy saving rate is over 50%.

2. Development and application of precast concrete structures in North America

After the beginning of prefabricated construction in Europe, during the same period when prefabricated buildings were developed in Europe, prefabricated prestressed concrete structures began to be widely developed and prefabricated box structures appeared in North America in the 1940s and 1950s. Box structure is only one assembly, pipe line circuit, such as construction at the scene, the remaining two-thirds of the construction process to finish in the factory, when installation, trailer and dragged the unit of each box to the scene, and then to assemble the parts into a whole, the box structure is suitable for mass production to finalize the design, but also give the public a cheap low-end impression.

Fig.1-1 The first precast concrete building in Germany- the plemann residence in Berlin

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In 1962, there were 1.53 million cubic meters of precast prestressed concrete products, part of which were used for structural construction on Bridges and part for structural construction on buildings. In 1970, the energy crisis broke out in the United States, which became the opportunity for the United States to develop construction construction and mechanized production. Then, the United States formulated strict industrial standards and standards and formed a system. This series of codes was compiled by PCI (precast and prestressed concrete association), known as the PCI design manual, and the system has been continuously developed and improved into the American architectural system still in use today. According to the United States building code issued in 1997, precast concrete structures are allowed to be used in seismic areas with high intensity of multiple earthquakes if tests and analysis can prove that the performance of precast structures in bearing capacity and stiffness can meet or even exceed the performance of cast-in-place concrete structures on the structure [14]. At the end of 20th century, precast concrete structure has been used in engineering, civil architecture, bridge structure, hydraulic structure and other engineering structures. In accordance with the United States in 2000 the national earthquake disaster mitigation planning, "[15] (NEHRP) specification, prefabricated concrete structure framework mainly equivalent cast-in-situ connections and fabricated connection, connection of precast structure and the connection of the mechanical properties of cast-in-situ concrete structure is different, the equivalent cast-in-place connection needs and cast-in-situ concrete connection has the similar seismic ability, so the national earthquake disaster mitigation planning seismic provisions shall be given. The design manual of prestressed concrete published by the American PCI society [16] summarizes the design method of prefabricated structure, the connection form of each node and the analysis method of structure, which represents the mature structural system of assembled concrete structure in the United States. These developments make the buildings constructed by precast concrete structures in the United States diverse and beautiful (figure 1-2), with good quality and far-reaching influence. At present, the proportion of precast concrete structures in the United States is about 35%[17].

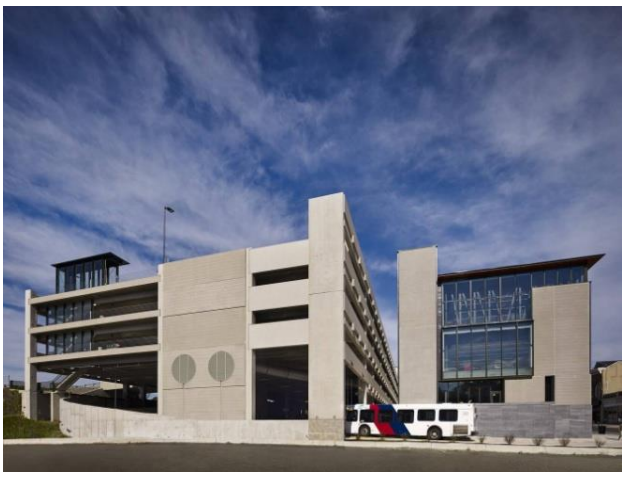

Fig.1-2 Easton city hall, USA

Fig.1-3 Zhongyin capsule tower, Japan

3. Development and application of precast concrete in Japan

Japan is a country with fast development speed of housing industrialization and high quality and level of development. Japan learned the European PC construction method and developed the plate reinforced concrete construction method. In the three years after 1960, a total of 120,000 collective houses were built [18]. In 1966, Japan's ministry of construction put forward the concept of industrialization of housing construction, saying that "industrialization of housing construction must be vigorously promoted". In 1969, the industrial technology research institute of the ministry of construction of Japan issued the five-year plan on promoting the standardization of the housing industry, which stipulated the base size and modulus of the housing. Due to the large number of Japanese people and small land area, the target of Japanese prefabricated buildings is high-rise buildings (figure 1-3). The introduction of this series of policies and regulations improves production

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efficiency and quality [19]. Through legislation, the quality of components is guaranteed and the standardization of components is realized.

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