Analysis of the Development and Trend of China's Prefabricated Buildings

XiongLin¹, ShenJie²

¹Institute of civil engineering, Quzhou University, Quzhou, Zhejiang province, 324000, China
²Institute of civil engineering, Quzhou University, Quzhou, Zhejiang province, 324000, China

Corresponding author’s e-mail: 781723057@qq.com

Abstract: This paper analyzes the policy and scale of China's prefabricated buildings, expounds the current project management model EPC of prefabricated buildings, and further analyzes the changes in job requirements and cost trends.

1. Overview of Chinese Assembly Architecture

1.1. Market size
Prefabricated buildings refer to prefabricated components such as walls, beams, columns, and plates required for the building. In the workshop, the production is carried out according to the standard, and the prefabricated parts are transported to the construction site for assembly. The popular understanding is the “building block” type of building, which is mainly classified into prefabricated concrete structure (PC building), steel structure, modern Wood structure, etc. Driven by the promotion of national policies and the industrialization and intelligentization of construction, the scale of China's prefabricated construction market has gradually expanded, and the future market of trillions of dollars is vast. [2]

Newly-built building area is expanding year by year. See Fig 1 and Fig 2

In recent years, with the rapid development of the economy, the rising labor costs, the precision and quality of prefabricated components, the improvement of the construction technology and management level of the prefabricated buildings, and the promotion of national policy factors, the prefabricated buildings have warmed up and developed rapidly.

According to statistics from the Ministry of Housing and Urban-Rural Development,
In 2015, the newly built assembled building area in the country was 72.6 million square meters;
In 2016, the newly built prefabricated building area in the country was 114 million square meters, a year-on-year increase of 57%;
In 2017, the newly built assembly area of the country was approximately 152 million square meters, an increase of 33.68% over the same period of last year;
In 2018, the newly built prefabricated building area in the country was about 190 million square meters, an increase of 24.67% year-on-year.
1.2. Current areas and targets
Three major promotion areas [1]

1.2.1. Key promotion area:
Beijing-Tianjin-Hebei City Group, Yangtze River Delta City Group, Pearl River Delta City Group, Xiong'an New District.
By 2020, prefabricated buildings will account for 20% of new buildings.

1.2.2. Actively promote the region
By 2020, prefabricated buildings will account for 15% of new buildings.

1.2.3. Encourage the promotion of areas:
By 2020, the proportion of prefabricated buildings to new buildings must reach 10%. [1]
2. Project Management Model-EPC

2.1. EPC mode
In the EPC mode, different aspects of design, manufacturing, assembly, and procurement form reasonable interspersed and deep integration, and the linear work sequence of starting the procurement plan, manufacturing plan, and assembly plan is changed to superimposed and integrated after the original design is determined. After the overall planning, the procurement plan, production plan and assembly plan will be formulated at the design stage, so that the follow-up work will be blended and the construction period will be greatly saved.\[3\]

2.2. The feature of prefabricated construction
The feature of prefabricated construction is to divide the original traditional site construction into two sections, the factory and the site. The EPC project general contract management mode can adapt to the requirements of this feature, realize the organic combination of factory manufacturing and on-site assembly, and manufacture and assemble in different spaces to form an orderly whole system, which fully guarantees the factory manufacturing and on-site. The technical synergy of the assembly, as well as the output of the factory product, is consistent with the on-site assembly requirements. see Fig 3 \[4\]

2.3. Prefabricated building core competence
Compared with traditional engineering construction, according to the whole process construction characteristics of the prefabricated building, new capacity requirements are put forward for some positions, and even some new positions and skill requirements are derived, and the core competence of the assembled building is formed.\[4\]

2.4. Missing assembly management talent
The State Council pointed out in the "Guiding Opinions of the General Office of the State Council on the Development of Prefabricated Buildings" that the important task of developing prefabricated buildings is to "promote general contracting of projects." The assembly-type construction project has undergone great changes from design and construction to project delivery and operation. Traditional engineering project management personnel lack industrial management thinking and lack systematic understanding of the entire assembly-type building design, production and construction process. In particular, EPC project management personnel, information management, component quality administrators, operation and maintenance personnel.\[9\] see Fig 4

Under the EPC mode, both construction companies and design companies face considerable transformation challenges: the design institute needs to improve the control and control capabilities of the P&C link, and the construction unit needs to master the experience of assembly-type construction quality management. Information management personnel engaged in prefabricated construction information must have two aspects of technology: assembly construction information technology and assembly building integration management technology.

There are serious shortages of talents who master the construction of BIM information technology.
2.5. Missing assembly technicians

The assembly design process, industrial production, and assembly-type construction process have also brought new technical challenges to design and construction. The talents who master the design, production and construction technology under the assembly-type building are seriously inadequate. In particular, standardized designers, deep designers, special technology developers, component craftsmen, etc.

2.5.1. Missing Deepen the designer

The deep design of prefabricated components should be actively coordinated with the construction unit in the design stage of the project. According to the professional design requirements of construction, structure, equipment, decoration, etc., combined with the production and construction and installation conditions of the components, the standardization and shaping technology is used to separate the components and design the nodes. The output component is assembled with the construction drawing and the component processing drawing. See Fig 5

Emerging technologies will play an increasingly important role in the development of fabricated buildings. BIM, 3D printing, VR technology, Internet of Things, construction robots and other technologies require the value of these technologies and technologies in the industry. Have a certain understanding.[5]

The industrial work of the construction industry usually includes woodworking, mason, plumber, welder, steel bar, shelf worker, plasterer, putty worker, curtain wall worker, plumber, concrete worker and so on. After the prefabricated building, some components such as walls, stairs, balconies, etc. have been made in the factory. The on-site operation of the workers is only the steps of positioning, seating, installation and necessary small amount of on-site filling structure. The demand for carpentry, masonry, concrete workers and other jobs will be greatly reduced. Component assembly workers, grouting workers, pre-buried workers, component makers and other types of work are increasingly demanding.

2.5.2. National strategy and top design

In the intensive assembly development policy document issued by the state, the project general contracting model is emphasized. The seventh key task in the "Guiding Opinions on Vigorously Developing Prefabricated Buildings" issued by the State Council on September 30, 2016 is to implement general contracting of the project. See Fig 6
Local governments such as Beijing, Shanghai, Zhejiang, Jiangsu, and Chongqing have introduced policies related to the general contracting of prefabricated buildings. On May 10, 2019, the Ministry of Housing and Urban-Rural Development and the National Development and Reform Commission jointly issued the "Regulations on the General Contracting of Buildings and Municipal Infrastructure Projects (Draft for Comment)", and in principle, the general contracting method of the assembly-type building is adopted.

3. Assembly-based construction cost trend analysis

3.1. Current cost analysis
At this stage, the cast-in-place concrete and masonry of cast-in-place buildings in China have a large workload and high cost, while the use of fabricated buildings greatly reduces the engineering costs of masonry and plastering, but comprehensively considers the production of PC components. Transportation and hoisting costs ultimately result in a much higher unit price for prefabricated buildings than cast-in-place buildings.\[9\]

On the basis of neglecting transportation and hoisting costs, the production cost of fabricated building PC components is much higher than that of cast-in-place buildings.\[8\]The main reason is that due to the maturity of component production of fabricated buildings in China at present, PC component production costs and amortization costs Higher, workers' production and construction assembly capabilities are lower.\[7\]

3.2. Cost Trends
The implementation of the EPC model can reduce the cost of prefabricated buildings because it can achieve a certain "scope economy", effectively avoid communication and coordination barriers between the various entities, the intentions of all parties can be clearly communicated, and resources can be realized more effectively. Configuration, etc.\[6\]

4. Summary
The development of prefabricated buildings is a major change in the way of construction, as well as a revolution in the way construction organizations are managed, and an inevitable trend in promoting the transformation and upgrading of the construction industry.
Figure 6 Construction scene of the fitted building

Reference
[1] Guo guan wen. (2019) Assembly-related building policy information. Gezhouba Group Technology, 129:79-80.
[2] Liu zhe. (2019) 2018 National Assembly Building Market Research. China Building Metal Structure, 230:41-48.
[3] Xu Meng yu. (2014.02) Talk about assembly-type construction project management Residential and real estate, 140-141.
[4] Fan Yu, Zhou Xuan. (2018.05) Assembly Building Implementation Matters and Problems Analysis, HOUSING AND REAL ESTATE, 51-53.
[5] Wang Shuzhen, Tang Jia, Yan Yifan, Zou Yiquan. (2018.09) Risk Research in Deepening the Design Stage of PC Components——Based on Fuzzy Level Comprehensive Evaluation Method, CONSTRUCTION ECONOMY, 37-39.
[6] Li Jinhua, Li Xueqiang, Ma Hui. (2018) Research on Model Selection of Assembly Building Projects Based on Cost Optimization, 39:34-36.
[7] Zhang Xinliu. (2019.04) Analysis of the reasons for the high cost of fabricated building, INTELLIGENT CITY, 25-26.
[8] Zhao Liang, Han Quqiang. (2018) Evaluation of Factors Affecting the Cost of Prefabricated Buildings CONSTRUCTION ECONOMY, 35:25-29.
[9] Kang Xiaohui, Sun Jinying, Jin Zhanyong, Wang Ying. (2019) Analysis of factors affecting the development efficiency of fabricated buildings, 40: 20-22.