



# Discussion on Construction Technology of Formwork and Scaffold Engineering

Xudong Yang<sup>1\*</sup>, Kangxian Sun<sup>2</sup>

<sup>1</sup>Construction Fangda (Zhejiang) Construction Technology Co., Ltd., 310000, China.

<sup>2</sup>Zhejiang Petroleum Integrated Energy Sales Co., Ltd., 310012, China.

**How to cite this paper:** Xudong Yang, Kangxian Sun. (2022) Discussion on Construction Technology of Formwork and Scaffold Engineering. *Engineering Advances*, 2(2), 220-224.

DOI: 10.26855/ea.2022.12.015

**Received:** November 20, 2022

**Accepted:** December 18, 2022

**Published:** December 30, 2022

\***Corresponding author:** Xudong Yang, Construction Fangda (Zhejiang) Construction Technology Co., Ltd., 310000, China.

## Abstract

Construction technology of building formwork and scaffold refers to the enclosure structure in the process of engineering construction. In order to ensure the engineering quality and avoid unnecessary losses caused by mistakes in construction, various technological measures are adopted to minimize the influence of construction on the progress of the project on the premise of ensuring the engineering quality, and correct technical measures and operation methods are adopted. It can play a great role in construction. Traditional scaffolding is mainly made of wood and bamboo, but nowadays, most of them are made of metal or steel, which not only improves the construction safety of scaffolding, but also has certain characteristics of energy saving and environmental protection. Therefore, this paper mainly discusses the construction technology of new formwork scaffold, hoping to provide corresponding reference for related construction workers.

## Keywords

Building template, Scaffolding, construction technique

## Introduction

Formwork is widely used in concrete building construction in China, and its main characteristics are short production cycle, convenient operation and easy formwork removal. Generally, the construction site is on the construction site, but the scaffolding in the construction work is often used and must be replaced regularly. Due to the large scale of China's template market, few production enterprises, lax requirements for quality standards and fierce market competition; Coupled with the high complexity of template production process and the difficulty of installation and debugging technology, the development of China's template industry is unbalanced. Therefore, only by strengthening technical training and technical exchange can we better promote the rapid and healthy development of this industry. Therefore, this paper analyzes and discusses the construction quality control technology of building formwork engineering in China.

## 1. Overview

At present, formwork and scaffold are widely used in China's construction projects, which have the characteristics of low cost and simple operation, and are widely used in concrete construction projects. At present, the supporting frame structure of steel-wood concrete supporting system is widely used in building formwork engineering in China. Generally, there are two forms of formwork structures. One is a concrete support structure composed of two concrete slabs; The other is a reinforced concrete support system composed of a layer of steel-wood support system. For the concrete support system with simple structure but high cost, the steel-wood concrete support system can be considered to replace the traditional steel-wood structure support frame; [1] For the concrete support system with complex structure, low cost and less construction difficulty, steel-wood concrete support system can be considered to replace the traditional concrete support system. With the increasingly tight construction period and the development of urban planning, the construction formwork industry is facing great challenges. Adopting high-strength steel formwork system in the construction process can effectively reduce the harm caused by concrete construction to the environment and workers' health; In addition,

steel molding can also reduce the construction cost, labor loss and labor loss and other advantages [2]. Therefore, the traditional steel-wood concrete support system should be replaced by the steel support system with reliable quality and easy disassembly. In recent years, due to the sustained and rapid development of China's economy and the increasing emphasis on ecological environment protection, the whole building formwork industry has developed rapidly [3], which has accelerated the research, popularization and application level of building formwork and scaffold engineering construction technology in China, and greatly improved the technical level and economic benefits of the whole industry.

## 2. The new mold base application advantages

In recent years, China's formwork technology has developed rapidly, which not only has many varieties and advanced technology, but also provides more choices. In 2017, there are 11 sub-items of formwork and scaffold technology listed in "10 New Technologies of Construction Industry". Popularizing these new technologies will create favorable conditions for green construction. The main contents are as follows. (1) The composite aluminum alloy formwork is a new type of formwork with light weight, high strength, high processing precision, [4] large single-piece width, less flat-fell seam, convenient construction, many times of formwork turnover, [5] high recycling value and good comprehensive economic benefits. It has a wide application range and meets the requirements of national environmental protection and energy conservation. One layer of composite aluminum alloy formwork and three layers of independent support are arranged, so the amount of formwork arrangement is reduced, and the construction cost is correspondingly reduced. (2) The combined ribbed plastic formwork has the advantages of smooth surface, easy demoulding, light weight, good corrosion resistance, multiple formwork turnover times, recyclability, etc., which is conducive to environmental protection and meets the national requirements of energy conservation and environmental protection. Plastic formwork can be divided into sandwich plastic formwork, hollow plastic formwork and ribbed plastic formwork, among which ribbed plastic formwork has good indexes such as static bending strength and elastic modulus, and horizontal formwork can be dismantled early. (3) The formwork climbing device of the intelligent hydraulic climbing formwork is attached to the concrete structure through the bearing body. When the newly poured concrete is demoulded, the hydraulic oil cylinder is used as the power and the guide rail is used as the climbing track, and the formwork climbing device climbs up one floor, and the operation is repeated. At present, the formwork climbing technology in China has achieved good results in engineering quality, safe production, construction progress, cost reduction, work efficiency improvement and economic benefits. (4) The intelligent integral jacking platform is a set of integral steel platform, which adopts long-stroke oil cylinder and intelligent control system. The jacking template and the whole operating platform device have the characteristics that the operating platform is in the high position and the supporting system is in the low position. It can adapt to the complex and changeable core tube structure construction, and meet the construction period requirements of the average 3d1 floor, thus ensuring the construction safety and quality of the whole process. (5) The integrated attached lifting scaffold refers to the external scaffold which is erected at a certain height and attached to the engineering structure, can climb or descend layer by layer with the engineering structure by its own lifting equipment and devices, and has anti-overturning and anti-falling devices; It is suitable for structural construction and decoration of high-rise or super-high-rise buildings.

## 3. The improvement direction of building formwork construction technology

At present, aiming at the existing concrete formwork system, the following aspects should be improved: First, the quality of concrete production should be improved. As most steel formwork materials are processed by mechanical equipment in a certain range, it is necessary to increase the indexes of mechanical strength, bending strength and tensile strength during manufacturing. This can better adapt to the concrete strength index and quality requirements required by the current construction conditions in China, so as to achieve better quality control. The second is to optimize the concrete pouring method. Although some construction methods can effectively improve the quality of concrete pouring, there are many unreasonable places, such as affecting the construction speed and workers' working mood. Therefore, it is necessary to further study and fully embody the optimization method, so as to improve the quality and efficiency of concrete pouring and reduce waste, thus fully meeting the current market needs and development direction in China. The third is to adopt a standardized template system. In practice, the standardized formwork system has some drawbacks, but as long as it is installed strictly according to the technical requirements of standardized formwork system in the construction process, it can achieve good and economic results. Therefore, it is necessary to operate in combination with the actual work, and it is impossible to implement the design and construction activities completely according to the operation mode of standardized templates.

## 4. Template engineering construction technology

The construction stage mainly includes installation, formwork installation and disassembly. First, in the basic work stage, the basement and surrounding environment should be cleaned first to ensure that the basement is clean and meet

the subsequent construction requirements; Secondly, in the formwork erection stage, the size of the formwork should be selected, assembled and disassembled according to the construction requirements and drawings; Thirdly, the corresponding cranes are used to fix the whole building. Finally, after the template is assembled, it is installed after ensuring the quality of the template is qualified. At present, there are many concrete construction projects in China, and the types of building formwork used in different projects are not the same. Generally, steel mold and wood mold are used to make it. Generally speaking, the steel (wood) mold is hard and its surface is smooth and beautiful, while the wood mold is easy to deform and break. Therefore, we should choose the wood mold with high strength and strong compression resistance, or make the wood (grass) mold into various complex shapes and process combinations.

#### **4.1 The main structure construction stage of the template installation**

(1) Foundation work: It is mainly used to reinforce the foundation of buildings with high underground water level. Generally, steel formwork or wooden formwork is used. Generally, it is necessary to set the formwork support. The height of the upper formwork should ensure that the height of the building foundation is more than 3 m. The distance between the formwork support and the wall should not be less than 50 cm, and the distance should not be greater than 200 cm.

(2) Formwork erection: Generally, it is carried out at 1 m~1.5 m below the structural plane, mainly including longitudinal shear wall, column support frame, frame shear wall, steel support frame, connecting column, floor hanging basket, steel pipe fixing frame, steel-wood formwork, etc. At least one supporting arm or connecting column should be set under each frame. When the main structure of the building has been completed, the installation position of the formwork and support frame should be checked and accepted, and the next construction operation can be carried out only after it is qualified.

(3) Installation of steel formwork and wood formwork: it is mainly used in the construction of the main structure. In general, steel formwork and grass formwork are fixed with steel bars. If there are special requirements, the formwork installation drawings can be drawn on the formwork before installation. After the formwork installation is completed, the wood formwork will be tightened, and the bolts connected with it will be checked for fastening. The formwork with special requirements must be reinforced. When there are no special requirements, the steel formwork and grass formwork can be fixed on the formwork respectively, and the steel formwork and wood formwork can be connected by anchor bolts to ensure that there is no displacement between the two formworks. When there are special requirements, reinforcing ribs or bolts can also be added to the steel frame to ensure that the steel bars are installed firmly and prolong the life of steel-wood formwork and supports.

(4) Scaffolding and steel (rattan) formwork installation: Scaffolding is generally composed of prefabricated components or temporary facilities, which is one of the important links in building construction. Scaffolding installation at the construction site must be checked and accepted, and it can be put into use only after it is qualified. Generally, the wire drawing process can be used for acceptance and re-inspection.

(5) Installation and disassembly of steel (rattan) formwork: the formwork engineering should adopt the correct installation technology to ensure safe, civilized and orderly operation.

#### **4.2 Template work in wall decoration engineering**

The formwork engineering of wall decoration is generally made of wood pattern, and then pasted and decorated. At the same time, other special process combinations can be carried out according to the needs, such as wallpaper pasting and cloth pasting. Template installation, need to be carried out in strict accordance with the design drawings, and to ensure the smooth surface, avoid deformation and damage. Ensure that the bottom of the template is close to the wall. After the installation of the template, the surface should be maintained and dried, and the overall acceptance of the wall should be made. If the template is demoulded, it should be removed to ensure that the wall will not be deformed and fall off. Template splicing, fixing and installation shall be carried out in strict accordance with the design drawings and relevant regulations to ensure that the gaps meet the requirements; According to the construction requirements and the actual construction situation, it should be assembled by blocks, which should be fixed during installation, protected and treated with anti-corrosion. In the process of formwork installation, advanced cranes should be adopted, and the operation time of cranes should be strictly controlled to ensure safe production. There are some problems in the safety of scaffolding engineering, such as improper erection and untimely dismantling, which can't fully meet the requirements in this respect, and corresponding measures should be taken to improve and maintain it.

### **5. New progress of formwork and scaffolding engineering construction technology in China**

#### **5.1 Assembled all-steel formwork technology**

The technology mainly includes plane formwork, cylindrical formwork, adjustable arc formwork, internal and exter-

nal angle formwork, door and window opening formwork, elevator shaft formwork, square column formwork, special-shaped assembled all-steel formwork, stair formwork, various connectors and supports, etc. Its construction features include: (1) systematic research on the working platform, connectors and supports of the formwork; (2) Serialized and standardized all-steel large plane formwork system with framework modulus of 300mm; (3) The door and window openings, elevator shafts, various column templates, stair templates and special-shaped assembling templates are systematically studied. Assembled all-steel formwork technology has been widely used in the construction of reinforced concrete structures, especially in fair-faced concrete projects.

Under the action of lateral pressure of 60kN/m, the strength and stiffness deformation of assembled all-steel formwork technology are all lower than 1.8mm, and the overall flat-fell seam is less than 0.5mm, and the flatness deviation is less than 2mm. It has the advantages of tight joint, no slurry leakage, high flatness, good rigidity, high strength, no error, light weight, easy disassembly, low cost and strong interchangeability, and can better meet the requirements of fair-faced concrete construction. At present, the assembled all-steel large formwork technology is in a leading position among various technologies in China, creating greater economic and social benefits for building construction.

## 5.2 Climbing formwork technology

### (1) Hydraulic self-climbing formwork technology

It mainly uses hydraulic system to provide climbing power, and achieves the purpose of climbing with the help of columns or walls attached to buildings. It is widely used on the external walls of high-rise and super-high-rise buildings. Because of its self-climbing characteristics, it can effectively reduce the hoisting times of hoisting equipment, and can effectively adjust the angle and height of formwork, which is not only convenient to install, but also can effectively save human capital. Although this technology has not been widely popularized in the whole country at present, it is the trend of future development.

### (2) Full-automatic hydraulic climbing formwork and scaffold construction technology

This technology belongs to a new type of practical technology in the current construction industry. It can solve the problems encountered in the construction stage of high-rise and super-high-rise buildings, effectively shorten the construction period, save a lot of manpower, financial resources and material resources, and achieve the effect of energy saving and emission reduction. At present, JFYM100 hydraulic climbing frame material platform, JFYM75/100 hydraulic climbing frame, JFYM75-T hydraulic climbing frame, JFY50/100 hydraulic climbing frame, etc. are all fully automatic hydraulic climbing frames that are often used in the construction industry.

### (3) The whole intelligent formwork climbing platform system

It is widely used in the construction of high-rise and super-high-rise buildings, especially in the vertical structure construction of cast-in-place reinforced concrete. The platform not only has its own template, but also has high safety. In the process of platform climbing, the main template can climb together with the operating platform, which has the characteristics of high quality, low energy consumption and high speed, and effectively improves the overall level of construction.

## 5.3 Attached hydraulic lifting scaffold

Attached hydraulic lifting scaffold has the following characteristics: synchronous function, preventing the frame from being deformed and broken; Overload protection function, to prevent over-limit breaking and falling. The lifting equipment does not need to be disassembled and transported every time, the lifting equipment itself is not easy to be damaged, and the labor intensity of workers is low; The lifting equipment has large bearing capacity and self-locking protection function; It has higher safety performance, comprehensive economic performance and social benefits.

Attached hydraulic lifting scaffold is a kind of material-saving, labor-saving, fast and safe operation protective scaffold used in the construction of outer wall and inner tube of high-rise building and tower building. It is also suitable for the construction of shear walls, frame shear walls and frame structures, can meet the different operation requirements of main structure construction and exterior wall decoration construction, and can be arranged into single pieces, sections and whole lifting according to the construction requirements; It is suitable for the construction of various parts such as floor height change, shape change, step shrinkage, etc.

## 5.4 Integral climbing steel platform technology

Integral climbing steel platform technology is a kind of technology that adopts an integrated formwork scaffold system composed of integral climbing totally enclosed steel platform and scaffold to construct high-altitude steel formwork engineering. This technology transfers the load to the concrete structure through the support system or climbing system, which is driven by power equipment, and uses the alternate support of the support system and climbing system to climb the formwork scaffold system, so as to realize the efficient and safe operation of formwork engineering, ensure the construction quality of the structure, and meet the requirements of complex and changeable concrete structure engineering

construction.

## 6. Concluding remarks

Formwork plays an important role in concrete construction in China, which is directly related to the quality and progress of the project. However, at present, the development of China's urban construction formwork industry is unbalanced, and some large-scale construction enterprises have relatively strong strength and high technical level. Therefore, it is necessary to constantly improve the building formwork industry standards and technical training mechanism. To strengthen the training of technical personnel in the field of engineering construction, improve the technical level of building formwork, and improve the construction of exchange learning and technical exchange platform between building formwork enterprises. With the aim of improving the technical level and comprehensive quality of technicians in the engineering construction industry, the overall strength of building formwork enterprises will be gradually improved.

## References

- [1] Yu Baoming, Xu Hankui, Chen Maosheng, Application of new assembled formwork support system in building construction [J]. *Journal of Qingdao University of Technology*, 2012(02).
- [2] Liang Jinde. Discussion on safety technology of steel pipe formwork support project [J]. *Construction Supervision and Inspection and Cost*, 2010, (07).
- [3] Xie Changlin. Discussion on construction technology of new formwork scaffold [J]. *Construction Science and Technology*, 2014, 9(7):90-91.
- [4] Zhu Lin. Innovation of construction technology of utility model formwork scaffold [J]. *Low Carbon Real Estate*, 2016, 3(16):114-115.
- [5] Wang Yongsheng, Zhang Zhiyue, Li Xiaobin. Application analysis of new formwork and scaffold technology in housing construction [J]. *Commodity and Quality*, 2017, 9(13):77-78.