

Discussion on Quality Control and Supervision Countermeasures of Precast Concrete Structure

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Abstract: The precast concrete structure is made up of precast concrete components that are connected in a reliable way and form a whole with on-site post-pouring concrete and cement-based grouting. It has a high degree of industrialization and standardization, and is also fast, efficient, energy saving and consumption reduction. Nowadays, it has become an important direction for the transformation and upgrading of construction industry in China. This study started from the form and classification of precast concrete structures. On the basis of design, production and installation, this study analyzed the points for attention in quality control of key links, such as component splitting and node connection design, detailed design of component production, quality inspection of component manufacturing process, component hoisting and temporary fixation. According to the specific problems in the construction of precast concrete structure, the corresponding entity quality supervision standard was formulated, which would be expected to improve the construction effect of precast concrete structure to a certain extent.

1. Introduction

Precast concrete structure is a crucial way of construction industrialization, which sprouted in the 1920s and 1930s and rose after the World War II. At that time, Europe was faced with two difficulties: housing shortage and labor shortage, which contributed to the rapid development of precast structures [1]. After decades of development, European countries, the United States, Japan, New Zealand, etc. have established a more mature precast concrete structure system. Since the 1990s, extensive attention has been paid to the construction industrialization represented by precast concrete structure system. Several components of the building structure can be reused, which can save project cost and shorten construction period, and has become the top priority of construction in the new period [2]. However, due to the lack of quality control and supervision control, the safety, reliability and stability of precast concrete structures in China are not ideal, which need further adjustment and improvement.

2. Main Forms of Precast Concrete Structure

According to the structure system, precast concrete structure is divided into frame structure and shear wall structure according to the current code Technical Specification for Precast Concrete Structure (JGJ1-2014).

1) Precast concrete frame structure is generally composed of precast columns, precast beams, precast floors and Non-load-bearing wallboard, and then the equivalent cast-in-place joints or fabricated joints are used for combination. At present, the common structural systems include cast-in-place column structure system, cast-in-place joint structure system, precast prestressed structure system, self-integrated world structure system, etc.

2) Precast shear wall includes external composite cast-in-place wall and internal cast-in-place shear wall, external hanging plate and light-weight infilled wall system, fully precast or most precast shear wall structure system, simplified connection multi-layer precast large plate structure system, etc. In the early stage, it was mainly fabricated large plate structure, and then gradually developed

into post tensioned unbonded prestressed precast shear wall structure. After process optimization, four kinds of shear wall structures with high reliability and strong safety were formed.

3. Quality Control Points of Precast Concrete Structure

3.1 Structural design stage

1) The basic parameters and structural performance of precast concrete structure must meet the requirements of Technical Specification for Precast Concrete Structure (JGJ1-2014) and be consistent with the construction standards [3].

2) Construction requirements:

Ensure the joint work between components and between components and post-cast concrete; check and calculate the construction of demoulding, lifting, transportation and installation of components;

Consider the convenience of precast, hoisting, positioning and correction. The reinforcement and embedded parts in the joint part should not be too much, and the connection part should be able to bear the load earlier;

The precast exterior wall panel and its joint structure should meet the requirements of structure, thermal engineering, waterproof, fireproof and architectural decoration.

3) Connection requirements:

Mechanical connection, sleeve grouting connection and welding connection should be adopted for steel bar connection at joints, and shear connection is supposed to be set at concrete joint surface;

At the vertical joint of the shear wall, the reinforcement is expected to be anchored into the cast-in-place concrete; the reinforcement should be connected by sleeve grouting in the horizontal joints and frame column joints of the shear wall edge components;

At the joint of frame beam and frame beam column, the horizontal reinforcement should be connected by mechanical connection or welding.

3.2 Component manufacturing stage

3.2.1 Material control

Raw materials entering the site shall be inspected for qualification data and stored separately to avoid mixing and misuse. Especially the material parameters, material properties, etc., should be checked one by one and rechecked.

3.2.2 Component manufacturing

The formed steel bar and steel bar welding mesh should be produced professionally. After the steel bar is put into the mold, the variety, grade, specification, quantity and installation location of the steel bar should be checked. Before concrete pouring, the mould, cushion block, external decoration material, support, joint bar, connecting sleeve, connector, embedded part, lifting ring, reserved hole, etc. are expected to be inspected and accepted item by item, and records of concealed works should be made. The precast components with thermal insulation materials should be formed by horizontal cast-in-place method. For the precast components with sandwich insulation, connectors should be used to connect the inner and outer layers of concrete. The precast concrete components with external decoration should be made by reverse striking process to achieve smooth surface, straight joints, and the width and depth of joints meet the design requirements. The methods of natural curing, chemical protective film curing and steam curing can be adopted for concrete curing. Steam curing of precast concrete components is supposed to strictly control the rate of temperature rise and fall and the maximum temperature.

3.2.3 Demoulding inspection

When demoulding, the floor should be lifted by multi-point hanger, and the complex components are expected to be lifted by special hanger. In case of local damage or cracks, repair paste is expected

to be used for surface repair. It can leave the factory only after the inspection and evaluation are correct in batches according to regulations.

3.3 On-site installation phase

3.3.1 On-site inspections

It is essential to check whether the axis, elevation, section and concrete strength of cast-in-place concrete components meet the design requirements, and whether the embedding, exposed length and anchoring method of connecting reinforcement meet the design requirements, etc.

3.3.2 Component hoisting

The components are supposed to be transported by special brackets and low flat cars, and the components and brackets should be bound firmly. After arriving at the site, they are expected to be classified and stored according to the model, the location of components and the sequence of construction and hoisting, and cannot be damaged. Hoisting should adopt the operation mode of "lifting → positioning → preliminary correction → fine adjustment", with slow lifting, fast lifting and slow release [4]. Wall panels and columns should be installed by inserting from top to bottom, and temporary supports and fixing measures should be set in time after being in place.

3.3.3 Joint connection

Joint connection can be made by pouring or welding. When pouring, it is necessary to ensure that the strength of the concrete or grouting material reaches the specified strength before removing the support. When welding or bolt connection is adopted, anti-corrosion measures should be taken for exposed iron parts, and cracking of components and connection parts caused by continuous welding should be avoided.

3.3.4 Floor slabs assembly

The temporary support for the construction of composite floor slabs should be set according to the design requirements or construction scheme. The temporary support is supposed to conform to the design elevation and meet the deformation of the support system under load. Before the construction of the post cast concrete layer, the roughness of the joint surface should be checked and the exposed shear reinforcement of the components should be righted. After the strength of the post cast concrete meets the design requirements, the temporary support can be removed or the load can be borne.

3.3.5 External wall hanging slabs assembly

In order to avoid the change of the stress mode of the external wall hanging slabs, the elastic waterproof structure should be ensured in the slab joint cavity during the installation. It is strictly prohibited to place rigid cushion blocks in the joints around the wallboard.

4. Points for Attention in Construction Supervision of Precast Concrete Structure

The supervision and acceptance of precast concrete structure must be emphasized when supervision work is carried out. It is crucial to form systematic and comprehensive quality control on the basis of quality supervision and component acceptance to minimize the impact of hidden risk on structural performance. The details are presented as follows.

4.1 Organize the acceptance of the first piece

To avoid that the precast components produced by the precast component manufacturers cannot meet the requirements of design and related construction quality acceptance specifications due to various factors, resulting in construction delay and cost waste, the construction unit ought to organize the design, precast component production enterprises, construction, supervision and other relevant units to conduct the acceptance tests on the first precast component of the same type in the

same project at the precast component production site and form the first piece acceptance record. The precast components can be produced in batch only after passing the acceptance.

4.2 Organize the acceptance of the first section

In order to check whether the installation and construction meet the design requirements and the feasibility of the construction process, and to provide a model guide for large-scale construction, the construction unit is expected to organize the design, construction, acceptance and other relevant units to carry out the supervision and inspection of the first section after the installation of precast components in the first construction section and the installation of reinforcement and formwork of cast-in-place concrete. Only site supervision data show that all construction operation and construction technology are correct, the subsequent construction can be carried out [5].

4.3 Carry out subsection supervision

The engineering quality acceptance of precast monolithic reinforced concrete structure ought to be supervised and accepted according to the sub-engineering projects in sub-division projects of concrete structure. The inspection contents of integrated precast structure include precast components, installation and connection. The reinforcement binding, concrete pouring and other contents involved in the on-site construction of are separately included in the sub project of reinforcement and concrete for supervision. The integrated precast structure can be divided by floor, structural joint or construction section. In the process of acceptance, the following inspection should be focused on:

Pay attention to the quality behavior of construction, design, construction, supervision units and precast component production enterprises;

Attach importance to the raw materials and concrete used for the fabrication of prefabricated components, the forming process of component manufacturing, the physical quality of finished components and relevant quality control data;

Place importance to the operation in the process of precast component installation and post-pouring concrete construction.

5. Summary

Nowadays, there are still several problems in precast concrete structures in China, such as inadequate quality control of key links and imperfect quality supervision and acceptance, but with the development and improvement of quality management system, the above issues will be well solved in research and development and engineering practice. As far as the content of this study is concerned, when carrying out the management work of precast concrete structure in China, it is necessary to start from the component design, production to the construction of the site installation, work well in the analysis and research of the key points of quality control of precast concrete structure, and determine the quality control scheme and supervision measures. Only in this way can the safety and quality of precast concrete construction be effectively controlled, and its development and application prospects can be fully expanded.

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