Summary of seismic performance of fabricated frame joints

Huanluan Zhang

College of Architectural Engineering, North China University of Technology

Abstract

The assembled structure is a trend in the development of China's construction industry. As a common structural form, the frame structure ensures that the joint area of the beam-column joints has better seismic performance and makes it not damage before other earthquakes in the earthquake, which is of great significance to the safety of the whole structure. By analyzing the experimental results of researchers at home and abroad, it is found that the fabricated structure has its own structural strengths and good development prospects. In the future study, it is necessary to conduct in-depth research on the fabricated frame structure, and constantly improve relevant theories and supporting technologies. The development of the construction industry contributes.

Keywords

Prefabricated structure; joint connection; seismic performance: reinforced concrete prefabricated component assembly and connection technology

1. Summary

The frame structure is one of the most common structural systems, and it can be combined with the shear wall structure and the simplified structure to form a frame shear wall system and a frame cylinder system. Therefore, it is necessary to promote the assembly structure system and study the connection method of prefabricated frame beams and columns. It is well known that the reliable connection between the frame column and the frame beam is critical because the frame structure works as a whole. The traditional coagulation structure is continuously arranged due to coagulation and co-casting, and the joints are strongly arranged in the joint area. As long as the reasonable steel bars are arranged, the connection failure between the components generally does not occur. However, the nodes of the fabricated structure are the weak parts of the structure. How to ensure the good seismic performance of the node area and make it not damage before other earthquakes in the earthquake is of great significance to the safety of the integrated structure. Therefore, the key to the fabricated frame structure is its connection technology, ensuring that the node has sufficient bearing capacity and does not cause construction difficulties is the focus of component design [1].

The prefabricated structure is a fabricated frame structure system which is connected by prefabricated members such as beams, plates and columns. It is the most widely used structural system in the assembled structure. It has higher prefabrication rate than other structural systems and flexible application space. Reliable connection allows the load-bearing components to fully function against earthquake disasters. The reliability of the connection between the fabricated components and the overall performance of the fabricated structure have a great influence on the earthquake resistance. The effective and reliable connection method is convenient for the safe and normal operation of the assembled structure. Therefore, many countries have different The connection method is designed with different prefabricated components to meet the requirements of seismic action.

2. Significance

In recent years, with the rapid development of domestic industrialization, the assembly-integrated structure is highly industrialized due to its construction.The advantages of fast speed, good overall performance of the building, high quality of construction products, environmental protection and high social benefits.It has been rapidly promoted and used in China. The structural form can effectively

solve the deficiencies in the traditional cast-in-place operation, The development trend of China's construction industry.

Prefabricated structure is one of the effective ways to achieve industrialization of buildings and energy saving in buildings. For a long time, coagulation.The earth building mainly adopts the traditional operation mode of on-site construction, the degree of industrialization is low, and the water consumption and energy consumption of artificial garbage is discharged. Large, not in line with national sustainable policies for energy conservation and environmental protection. With prefabricated structures, factory-prepared on-site assembly is possible.Realize the industrialization of buildings, and at the same time effectively improve the efficiency of materials in building energy conservation and structural performance, saving energy and resources,Reduce the adverse effects of construction waste and the environment, etc. [1]. Compared with the traditional cast-in-place construction method, the main difference between the fabricated structural system and the cast-in-place construction method is that the stressed components and components are produced by factory production and formed by on-site assembly and connection, which has the advantages of high construction quality, short construction period and low building energy consumption. , is an internationally recognized sustainable development technology [2].

In recent years, with the continuous advancement of "green buildings" and "building industrialization and housing industrialization" in China, we have begun to promote the promotion of "industrialization mode" in construction, and some developed regional governments have adopted incentives or compulsory means and measures. Precast concrete assembly technology is required for residential construction. Some domestic enterprises such as Vanke, Zhongnan Group, Anhui Xiweide, Changsha Yuanda, and Harbin Yuhui Group have begun to explore and practice assembly technology, build research bases, and develop experimental buildings. At the same time, the promulgation and implementation of the national industry standard "Technical Regulations for Prefabricated Concrete Structures" in 2014 [3] made the standardized assembly technology begin to be based on evidence.

In the past, the assembly structure was not reasonable and perfect due to the node connection design, and the overall performance was poor, which failed to show good seismic performance. For example, in the 1964 Alaska earthquake in the United States [4], the Tangshan earthquake in 1976 [5], and the 2008 Wenchuan earthquake, a large number of personal injuries and huge economic losses were caused [6-8]. These have greatly hindered the development of fabricated structures. The overall performance and seismic performance of the fabricated structure are mainly determined by the reliability of the connection. Therefore, it is important to study the joint technology with good seismic performance to promote the development of the fabricated structure [9].

3. Research Status of Assembly and Connection Technology of Precast Concrete Members at Home and Abroad

Reinforcing bar joining technology is one of the key technologies for prefabricated reinforced concrete component assembly. Reliable connection is the key to ensure structural integrity and seismic capacity. By collecting and reviewing a large number of relevant references, it is possible to sort out the main ways of connecting steel bars in a prefabricated concrete structure, namely sleeve connection, slurry anchor connection and mechanical connection.

3.1 Sleeve connection

The sleeve connection technology inserts the connecting steel bar into the high-strength sleeve with the concave-convex groove, and then injects the high-strength grout. After hardening, the steel bar and the sleeve are firmly combined to form a whole. The force-carrying sleeve connection technique is widely used in the United States and Japan through the grouting between the concave-convex groove on the inner side of the sleeve and the embossed grain of the deformed steel bar. The latest sleeve connection is to mechanically connect the connecting bar at one end of the sleeve to the prefabricated factory by threading [10], and the other end of the bar is connected by grouting in the field. The experimental research on the connection of the sleeve includes the stress-strain relationship

of the sleeve, the fatigue performance of the cyclic tension, and the influence of the misalignment grouting of the steel bar on the joint performance. Qian Jiaru et al [11] used the D-16 sleeve produced by Nitto Industrial to connect the vertical steel bars of the prefabricated shear wall and compare the seismic performance test with the cast-in-place shear wall. The results show that the shear wall connected by this sleeve can effectively transmit the vertical steel bar stress, and the failure mode is the same as that of the cast-in-place test piece.

3.2 Slurry anchor connection

The slurry anchor connection technology, also known as indirect anchoring or indirect lap joint, is a method of lap joints after the lap joints are pulled apart by a certain distance. The tensile force of the connected steel bars is transmitted to the grout through the shear force, and then transmitted to the grout through the shear force. Go to the interface between the concrete and the surrounding concrete. Jiang Hongbin [12] proposed a plug-in reserved hole grouting steel lap joint connection method, as shown in Fig. 2(a), and obtained a patent. The method is simple to construct, eliminating the complicated connection of steel bar welding or foreign sleeve connection. In this way, the bearing capacity and influencing factors were studied by 108 steel reinforced joint specimens of 81 steel anchor specimens. The test and discussion results show that the insert-type reserved hole grouting steel lap joint connection method is a rebar connection method suitable for precast concrete structures with reliable connection, convenient construction and low price. Zhao Pei [13] conducted an experimental study on the influence of different hoop ratios on the length of steel bars in this method. The diameter of the steel bars was 12mm16mm20mm. A total of 123 test pieces showed that the spiral stirrups were restrained on the lap joints. Can effectively reduce the length of the lap. Qian Jiaru et al. [14] conducted a seismic performance test of four prefabricated shear walls, in which the vertical steel bars were connected by indirect overlapping of the slurry anchors. The test results show that the lap joint can effectively transfer the steel bar stress, the steel bar is yielded, the concrete is damaged by pressure, and the hysteresis curve is full.

3.3 Mechanical connection

The mechanical joining technique is a method of connecting the force in one reinforcing bar to the other reinforcing bar by the mechanical bite of the reinforcing bar and the connecting piece or the bearing action of the end face of the reinforcing bar. According to the survey of the Japan Welding Society, there are currently 64 types of steel connection methods, 60% of which are mechanical connection methods. From the 1980s, China began to study the mechanical connection of steel bars. The commonly used steel mechanical joints have sleeve extrusion joint taper thread joints. Current straight threaded joints, molten metal filling joints, etc., in China's latest specification "Technical Regulations for Reinforcing Steel Connections" (JGJ107-2010) [15] have provisions for relevant connection methods and parameters. United States.ERICO is a world-class steel connection and production company whose steel joining methods are widely used in building structures.

4. Development trend of reinforced concrete assembled structure in China.

A large number of experimental theoretical studies and practical engineering prove that the load-bearing capacity and seismic energy-consuming capacity of the fabricated structural system are comparable to those of the cast-in-place structural system, which can meet the engineering needs, improve the construction efficiency, reduce the on-site workload, and reduce the quality defects. Reduce the loss of raw materials and turnover materials. At the same time, it has the characteristics of reducing construction noise, reducing environmental pollution, clean transportation, civilized construction, etc., meeting the requirements of national energy conservation, water conservation, material saving and environmental protection, in line with the development direction of national industrialization and housing industrialization, and promoting the green building of China. Green construction has an important demonstration role, so it has been rapidly developed and applied at home and abroad.

Vanke Group started the exploration and pilot of industrial residential construction technology earlier. It has studied in Hong Kong and Japan. At present, it has formed two major technologies: 1PC (precast concrete) technology, which is mainly used for prefabricated concrete components such as balconies and stairs. 2PCF (precast concrete form) technology, namely precast concrete formwork technology, mainly used for prefabricated concrete shear wall exterior wall moulds and prefabricated panels of laminated floor slabs.

Based on the experience of Australia, Zhongnan Group has formed a full prefabrication of the vertical components of the NPC (new precast concrete) technical system with its own characteristics. The horizontal members adopt a superimposed form, and the vertical direction is set by the inserted reinforced mortar anchor connection and the horizontal direction is set. The pouring joints are connected, and the vertical members and the horizontal members are connected by a steel bar anchor joint, a cast-in-place joint belt, a superposed cast-in-place, etc. to form an integral structure.

5. Conclusion

The fabricated frame structure can effectively improve environmental problems, save resources, and create a good living environment for the people, and thus has a good development prospect. However, the development in China is still relatively backward, due to the low level of construction, low social awareness, imperfect related education systems and complex supporting production technologies. In recent years, China has made more research on the seismic performance of fabricated concrete frame joints, and further research on the fabricated frame structure is needed in future study and work. As a result of its good economic, quality, environmental and social benefits, the fabricated structural building is one of the most important structural forms of modern architecture and an inevitable outcome of the development of “green buildings” and “building industrialization” in China.

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