Review on Seismic Performance of Assembled Building Joints

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Abstract

The connection between the joints of assembly building components is related to the seismic performance and collapse resistance of the whole structure, and plays an important role in the whole assembly structure. But there are still some imperfections in the existing installation and connection technology of assembled components, which makes the joint of assembled components cannot meet the better seismic requirements, and there are great potential safety hazards. On this basis, this paper discusses the seismic performance of the joints of the assembled building components, and summarizes the previous research on the strengthening of the joints of the assembled building. By comparing and analyzing different connection modes at different nodes, the existing problems and future research directions of assembly joint connection are finally clarified.

Keywords

Prefabricated construction, Seismic resistance of joints.

1. Introduction

With the advantages of short construction period, environmental protection and energy saving, assembled buildings are gradually appearing in people's vision. However, due to the late start of assembled buildings and immature technical conditions in China, there are still major problems in existing assembled buildings. Among them, the connection between components is still the weak link of the whole building framework. Therefore, it is of great significance for the development of assembly building and the adjustment and transformation of construction industry to optimize and deepen the processing of assembly building nodes in existing technology.

2. Connection modes of assembly building joints and their current status

2.1 Connection modes of fabricated building joints

In the assembly building structure, the joint determines the mechanical performance of the structure. According to the different construction methods, the connection methods are mainly divided into dry connection and wet connection. After the prefabricated components are hoisted in place, the connection between components is realized by pouring concrete or grouting, which is called wet connection. Components overlap with each other or connect with each other through embedded components. There is no need to pour concrete on site. This method is called dry connection [1]. Dry connection and wet connection are essentially different in construction method and technology. The main prefabricated components and the main structure have the following connection forms：

(1)Beam-column: Dry connection includes bracket connection, steel plate connection, bolt connection, welding connection, entrance connection, mechanical sleeve connection, etc. Wet connection includes cast-in-place connection, grouting-anchor connection, pre-stressed integral connection, post-pouring integral connection, grouting assembly, etc.

(2)Prefabricated wallboard and main structure: external hanging type is prefabricated external wall upper and beam connection, side and bottom only for limited connection; side connecting type is prefabricated external wall upper and beam connection, wall side and column or shear wall connection, wall bottom and beam only for limited connection.

(3)Composite Floor - Composite Floor: The dry connection is the adjustment joint between prefabricated floor and prefabricated floor; the wet connection is the post-pouring belt between prefabricated floor and prefabricated floor.

(4)Composite Floor-Beam (or Composite Beam): The end of the slab is overlapped with the edge of the beam, steel bars are reserved at the edge of the slab, and the composite layer is poured as a whole.

2.2 Current Research Situation Abroad.

Restrepo [2] repeated experiments on the changes of post-cast precast concrete frame joints under certain loads by referring to the most commonly used connection modes of assembled frame joints in high-strength areas of New Zealand. The results show that the stress and energy dissipation of the specimens will not have a significant impact on the whole structure, and the seismic performance is almost the same as that of the cast-in-place structure.

Erosy [3] conducted a comparative test between the welded joint and the cast-in-situ joint. The results show that the seismic performance and energy dissipation capacity of the welded joint are approximately equal to that of the cast-in-situ joint, and the side plate plays a role in strengthening the bearing capacity of the joint and consuming the shear force.

2.3 Research on Assembled Joints in China

Lin Zongfan [4] carried out experiments on friction slip joints and non-linear elastic joints of assembled frame structures. The results show that the bracket-beam joint in the friction-slip mechanism has direct force transfer, and the performance has not deteriorated during the process. When the displacement angle of the layer is low, the flexibility of the joint increases due to the relay force, which affects the strength and performance of the joint.

Li Zhenbao and Dong Tingfeng [5] carried out loading tests on concrete frame joints with hybrid connections under low cyclic repeated loads. The damage morphology, hysteretic property, denaturation recovery ability and displacement ductility of the joints were studied in detail. The results show that the energy dissipation capacity of the joints is almost the same as that of the cast-in-place joints, and the ductility, deformation recovery and seismic performance of the joints are better than those of the cast-in-place joints.

3. Seismic resistance of assembled beam-column joints

3.1 Seismic Behavior of Beam-column Joints in Frame Structures

Frame structure is composed of beams and columns connected by rigid joints or articulated joints. There are many connection modes of frame structure joints, which can be divided into dry connection and wet connection. The difference between the two connection methods is that the plastic deformation of the wet connection frame occurs outside the joint area and the joint area remains elastic, while the plastic deformation of the dry connection frame usually occurs in the joint area itself.

3.1.1 Prestressed connection

Before the wall structure is subjected to external loads, pre-stress is generated, which is called pre-stress. Prefabricated frame structure generates prestressing force by stretching prestressing tendons, and connects beams and columns as a whole, which is called prestressing connection. It reserved the precast beam and the hole in the column, and used the prestressing tendon to connect the beam and the column along the direction of the channel, and grouted the joint treatment. Geraldine S. Cheok [6] of the United States and Minhiro Nishiyama [7] of Japan experimented with this connection and obtained the following results:

（1）The shear strength of the connection zone is high and the damage of the components is small.

(2) It has good ductility, strong resilience and small residual deformation.

(3) The stiffness degradation of unbonded prestressing joints is smaller than that of bonded prestressing joints.

3.1.2 Hybrid connection

In order to improve the disadvantage of prestressing connection ability, ordinary reinforcement bar is added on the basis of prestressing connection to form mixed reinforcement bar between prestressing reinforcement bar and ordinary reinforcement bar. This connection method is called mixed connection. The beams and columns are joined by common grouting and post-tensioned prestressing tendons, and the prestressing tendons are not bonded or partially bonded in the beam span. Its seismic performance is as follows:

(1) The strength is approximately the same as that of cast-in-place structure.

(2) Strong recovery ability and small residual deformation.

(3) Good energy dissipation performance.

(4) The shear strength of the joint zone is better than that of the cast-in-place structure

4. Conclusion

As the core area of construction industry transformation, the development of assembly building plays an important role. Since the sixties and seventies of last century, people have made numerous discussions and studies on assembly architecture, and have made certain progress and achievements. However, there are still some problems. For example, most of the research on fabricated buildings are focused on the beam-column joints of frames, and less on the prefabricated fabricated walls. There is a lack of a complete set of planning criteria to classify the connection modes of joints as a whole, which does not form a sufficiently mature and feasible connection mode and technology. To solve these problems, we need to continue to carry out in-depth research, such as strengthening the development of new joints, optimizing the structure of joints, and as soon as possible to issue a set of mature and complete construction industry specifications for the connection of assembly building joints.

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