Research on Design and Construction Technology of Laminated Prefabricated Beam-column Joins

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Abstract. In recent years, with the rapid development of China's economy, the construction industrialization has been continuously developed and the prefabricated structure has been widely used due to its characteristics of simple construction and short construction period. However, in engineering applications, the connection of fabricated structural nodes is often the key to the problem. In this paper, a laminated prefabricated beam-column joint is proposed for the prefabricated concrete beam-column joints, and the structural characteristics, construction control points and technological principles of the joint are studied and analyzed.

1. Introduction

Compared with the cast-in-place structure, the prefabricated frame structure has the advantages of fast construction, low on-site pollution, low labor cost and green environmental protection. Thus, it is widely used in the construction industry of China. However, the connection among the prefabricated components has a great influence on the integrity of the structure. Unreasonable connection will lead to the failure of joints and collapse of structures in the frame structure and other engineering problems. For the further development of prefabricated buildings, it is necessary to solve the connection mode of prefabricated components in the prefabricated structures, in which beam and column joints are the key points of the entire prefabricated framework structure.

At present, many scholars have done a lot of research on the connection of beam and column nodes of the fabricated frame structure. Huang Xianghai et al. [1-4] expounded the common design of beam-column joints and designs methods of some new beam-column joints, analyzed their structure characteristics, working mechanism and seismic performance, which have the reference value for engineering construction and scientific research. Elrtem et al. [5-8] studied the failure modes of beam and column joints through the combination of test and finite element model, and proposed reasonable parameters to enhance the bearing capacity and seismic capacity of joints. Park et al. [9-10] used finite element software to design new beam and column joints with different connection forms, and proposed the beam and column connection forms suitable for engineering construction.

The analysis shows that the existing research is of positive significance to reveal the joint performance of concrete beam and column joints. However, the existing researches mainly focus on wet connection, and there are still some improvements in the aspects of quick connection, accurate positioning, improving of nodes stress performance and preventing local cracking. In view of this, the author proposes a composite beam and column joint connection structure on the existing basis. And studies the structure in this paper.
2. Design of composite beam and column joint

2.1. Node design
The structure of cast-in-place beam and column joints is shown in figure 2-1. This paper presents a composite beam - column structure connection method. The design sketch is shown in figure 2-2.

3. Analysis of joint construction technology and construction quality control

3.1. Construction technology process
Figure 3-1 shows that the construction process flow diagram of the superimposed assembly beam and column joints.
3.2. Construction quality control points

In the analysis of technical points, it is mainly based on the existing normative structure, combined with the structural characteristics proposed in this paper, and is not described the conventional construction techniques.

1) Preparation of prefabricated components: The connecting bar insertion slot is placed in the lower mounting post. The connecting steel body is placed in the upper assembly column. The beam bottom reinforcement plate is placed on the assembly beam. The schematic diagram of prefabricated components is shown in figure 3-1.
2) Column top reinforcement plate setting: The top reinforcement plate is placed on the top of the lower assembly column to weld it to the column. And a seam damping layer is pasted on the upper surface of the column top reinforcement plate. Making sure its size is consistent with beam bottom reinforcing plate, the rubber sheet is uniformly and compactly glued to the reinforcing plate with adhesive.

3) Assembly beam hoisting: Hoisting the assembly beam to the top of the lower assembly column using lifting equipment. Support is provided at the bottom of the beam to ensure the height of the beam and to strictly control the horizontal position of the two beams to keep them horizontal.

4) Connect steel plate and vertical hoop plate setting: The connection plate is set between the two assembly beams. Connection plate and the assembly beam are firmly connected through the steel plate connecting bolt. The reinforced bar of the connecting beam is then firmly connected through the steel plate connecting bolt.
bar connecting bolts, and the vertical stirrup plate is arranged on the outside of the stressed steel bar of the beam.

(5) Upper assembly column hoisting: The upper assembly column is hoisted by lifting equipment so that the connecting steel body of the upper assembly column is inserted into the insert slot of the lower assembly column, which ensure that the groove is not blocked before insertion, so that the connecting steel body is pasted tightly to the lower assembly column.

(6) The setting of the transverse hoop plate: After the reinforcing bar of the upper and lower columns is firmly connected by the reinforcing bolts of the steel bars, a transverse hoop plate is arranged on the outer side of the reinforcing bar of the column, and the transverse hoop plate is welded with the steel bars of the column.

(7) Reinforcement gusset setting: The reinforcing angle plate is set in the setting slot of the reinforcing body, and the reinforced gusset is welded to the beam and column reinforcement to ensure its fastness.

(8) Post-concrete concrete construction: The template is supported on the outside of the reinforcing gusset for post-concrete concrete pouring and maintenance construction. The post-concrete concrete strength grade is one level higher than the first poured concrete strength grade, and the surface of the two pouring junctions is flush.

(9) Construction of mortar protective layer: The construction of the mortar protective layer must be removed from the surface of the reinforcing gusset after the concrete is poured to a certain strength. Finally, the waterproof rubber band is set up on the bonding layer on the outside of the reinforcing corner plate to ensure its waterproof performance.

4. Structural process principle analysis
(1) The connecting steel body and the connecting steel plate respectively set up in the column and the beam can play the role of shear bond and quick positioning.

  1) The transverse shear strength of the column and the vertical compressive strength of the beam can be improved by setting steel body and connecting steel plate.
  2) The setting of upper assembly column connection steel body and lower assembly column insertion slot, which can make the upper and lower prefabricated columns quickly and accurately positioned and improve the construction efficiency.

(2) Reinforcing Angle steel is provided on the outside of the upper assembly column and in the post-casting area of the beam, it can strengthen the joint connection, expand the range of forces and prevent the concentration of forces.

  1) Setting of reinforcing Angle steel: The connection between the precast beam and the precast column can be strengthened and the range of forces can be extended.
  2) The reinforcement Angle steel is set in the post-pouring area of beam and column, which can bear part of the load to prevent the stress concentration.

(3) The seismic performance of the joints can be improved by setting the column top reinforcing plate, joint damping layer at the top of the column and beam bottom reinforcing plate at the beam bottom.

  1) The setting of the column top reinforcing plate and the beam bottom reinforcing plate can improve the seismic capacity of the joints, and enhance the joint strength and stiffness of the joints.
  2) The setting of joint damping layer can play a role of energy consumption for seismic action, so as to ensure the structure is not easy to be damaged.

5. Conclusion
(1) In view of the existing beam-column structure connection strength is insufficient. This paper designs a composite fabricated beam-column connection structure, and analyzes the characteristics of the node. Finding that the structure characteristics of the node and cast-in-situ beam-column joints are similar, and make up for the inadequacy of cast-in-situ node.

  (2) Based on the actual engineering requirements of prefabricated concrete beam and column joints
and the possible engineering quality problems in the construction process, the main control points in the construction process are expounded.

(3) Comparing the difference between the existing concrete column joints and the laminated beam and column connection structures, analyzing the process principle of the structure. The results show that the structural performance of the composite beam and column joint is reasonable and practicable.

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