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Construction Technology and Quality Control of Reinforced Concrete Beam and Column Joints

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Reinforced concrete beam-column joints are critical components in building structures, and their construction quality directly affects the safety and stability of the entire building. This paper first introduces the construction characteristics and challenges of reinforced concrete beam-column joints, then elaborates on the construction techniques and quality control measures, and finally analyzes the precautions in the construction of reinforced concrete beam-column joints. The aim is to provide valuable references and insights for relevant engineering projects.

Keywords: Reinforced concrete; beam-column joint; construction technology; quality control.

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1. INTRODUCTION

With the continuous development of construction technology, reinforced concrete structures have been widely applied in the construction field. As an important connection part of reinforced concrete structures, the construction quality of beam-column nodes has a crucial impact on the safety and stability of the entire building. Cast-in-place reinforced concrete frame structures have good integrity and strong seismic resistance, and are commonly adopted in medium and small cities. For frame structures, the beam-column nodes are subjected to bending moments and shear forces transmitted from the beams and columns, making their force distribution relatively complex (Mousavi & Dehestani, 2022; Allam et al., 2018). The typical failure mode is shear failure, and under seismic action, cross cracks may occur. Due to the core of the node being divided into many concrete blocks, the concrete strength in the node area significantly decreases. Therefore, attention should be paid to whether the strength of the nodes meets the requirements during construction. Beam-column joint BCJ role in a building is to connect its components together and enable these component to reach their ultimate resistance. BCJ stiffness, strength and ductility are key characteristics needed to guarantee efficient building behaviour under the action of different loads. Columns and beams are two fundamental structural elements that are essential to stability. They support the weight of the building and create a safe load path, transferring the weight and forces applied to the structure of the building to the foundation and the ground. Thus, this article will provide a detailed discussion on the construction technology and quality control of reinforced concrete beam-column nodes.

2. CONSTRUCTION CHARACTERISTICS AND DIFFICULTIES

The construction characteristics of reinforced concrete beam-column joints are mainly manifested in the following aspects: Firstly, the joints have dense reinforcement and complex structure, which brings significant difficulties to construction; Secondly, the beam-column joints bear pressure from the upper floor slab and tensile force from the lower column, making the stress conditions complex; Lastly, due to the intersection and overlap of reinforcing bars at the joints, the concrete pouring and vibration are more challenging (Nadir et al., 2021; Attari et al., 2019).

The construction challenges of reinforced concrete beam-column joints mainly include: firstly how to ensure the accurate placement and connection of reinforcing bars at the joints to guarantee the integrity and stability of the structure; secondly how to avoid issues such as voids and cracks during concrete pouring; finally how to effectively control the quality of the joints to ensure that construction quality meets the requirements.

3. CONSTRUCTION TECHNOLOGY

3.1 Reinforcement Layout and Connection

In the construction of reinforced concrete beam-column joints, the layout and connection of reinforcing steel are critical steps. Before construction, precise layout and positioning should be carried out according to the design drawings to ensure that the position and quantity of reinforcing steel are accurate and error-free. At the same time, attention should be paid to the connection methods of reinforcing steel, such as welding and binding, to ensure effective connections between reinforcing steel (Shihada & Oida, 2013).

3.2 Design and Installation of Templates

The design and installation of formwork have a significant impact on the construction quality of reinforced concrete beam-column nodes. The formwork should be customized according to the shape and size of the nodes, ensuring a tight bond with the reinforcement. During installation, attention should be paid to the stability and sealing of the formwork to prevent issues such as slurry leakage during concrete pouring.

3.3 Concrete Pouring and Vibration

Concrete pouring is a critical step in the construction of reinforced concrete beams and columns joints. During the pouring process, attention should be paid to controlling the mix ratio and water-cement ratio of concrete to ensure its quality. At the same time, appropriate vibration methods should be adopted to ensure the density and uniformity of the concrete (Tiwary et al., 2022).

4. QUALITY CONTROL

4.1 Material Quality Control

Material quality control of reinforced concrete beam and column joints mainly includes the

inspection and acceptance of raw materials such as steel bars, cement, sand and stone. It is necessary to ensure that raw materials meet relevant standards and specifications, and it is strictly prohibited to use unqualified materials.

4.2 Quality Control of Construction Process

During the construction process, strict quality control should be exercised over key aspects such as the layout and connection of reinforcing steel, installation of formwork, concrete pouring, and vibration. Construction personnel should be familiar with construction drawings and technical requirements, and operate according to construction standards. At the same time, on-site supervision and management should be strengthened to ensure that construction quality meets the required standards (Feng & Fu, 2020).

4.3 Acceptance and Testing

After the construction of reinforced concrete beam and column joints is completed, a comprehensive acceptance and testing work should be carried out. This includes checking and testing aspects such as the connection of reinforcing steel, the strength, and density of concrete. If any problems are found, they should be addressed promptly and re-accepted until they meet the standards.

5. PREVENTIVE MEASURES

According to the causes of node cracks in beams and columns, corresponding improvement measures can be taken to prevent them to a certain extent as follows:

Propose requirements for adjusting the mix design of concrete and in the current construction process to meet the nodal requirements strict quality control should be maintained during construction and continuously improve construction control methods and approaches. In addition under the condition of ensuring compressive strength grade and pumpability the sand content in the concrete of columns should be minimized as much as possible. The amount of cement is increased, and the content of its stone is increased, etc.

For concrete at the nodes, the principle of "high first, then low" should be adopted for pouring, which means that concrete with higher strength and grade should be poured first, followed by the corresponding pouring of concrete with lower strength and grade. Strict control should be exercised over the concrete poured first, and corresponding preparations should be made and technical briefings conducted before construction begins.

Pour the concrete for the beams and slabs, in most cases using secondary vibration, which means re-vibrating once before it begins to set, to effectively enhance the density of high and low strength grades of concrete at the interface, thereby reducing their shrinkage. For beams with more cracks on the side, the amount of horizontal reinforcement should be increased to enhance the crack resistance of the beam. Additionally, the slump of the mixture must be strictly controlled, and the concrete at the core of the joints should be conveyed using a tower crane to effectively reduce its slump.

Concrete curing should be fully strengthened, especially for the concrete of beams, in addition to necessary watering of the slab surface, corresponding watering should also be applied to the lower side of the slab, and before the full load-bearing scaffolding is removed, necessary watering curing of the beam can be carried out using a high-pressure water gun; meanwhile, the removal time of the side formwork of the beam should be postponed accordingly (Dabiri et al., 2020; Karabini et al., 2024).

6. CONCLUSION

The construction quality of reinforced concrete beam-column joints has a significant impact on the safety and stability of the entire building. By adopting reasonable construction techniques and strict quality control measures, the construction quality can be ensured to meet requirements and enhance the safety and stability of the entire building. In future construction practices, there should be continued efforts to strengthen research and application of reinforced concrete beam-column joint construction techniques to improve building quality standards and ensure the safety and property of the people.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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