Research Summary of Concrete Filled Steel Columns - Steel Beam Connections

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Abstract

Based on the domestic and foreign relevant information about the connection of Concrete Filled Steel Columns - Steel Beams connections, the current research status of Concrete Filled Steel Columns - Steel Beams connections at home and abroad is introduced. The problems encountered in the research and application of Concrete-filled steel columns and steel beams are discussed and the prospects are put forward.

Keywords

Concrete filled steel column; Steel beam; connections.

1. Introduction

In recent years, with the formation of intensive urbanization development strategy in our country, more and more attention has been paid to the development and utilization of underground space. Due to the particularity of the underground engineering, people have introduced the CFST composite system based on the original RC structure system. The CFST uses the mutual restraint between the two kinds of materials of the steel pipe and the concrete in the stress process, that is, the constraint of the concrete to the steel pipe So that the concrete is in the three-direction stress state, and the concrete strength can be increased, brittleness decreased, plasticity and toughness greatly improved performance; at the same time, due to the deformation of concrete, the steel pipe is also in a complex state of stress, and enhanced steel pipe wall stability.

With the use of CFST composite structure in underground construction, the corresponding design and construction techniques also evolve. For the CFST-concrete beam frame system, the beam-column joint is the key part of the frame structure and also the construction difficulty. At present, the research on the beam-column joint of CFST is still not perfect, and there are still many technical and construction problems in practical application. For example, some nodes have low stiffness and cannot form rigid nodes, which make the node directly transmit the bending moment to the column so that the ability of steel pipe columns to participate in the bending moment distribution of beam and column is small; the structure of nodes does not reflect the strong compressive bearing capacity and the flexural capacity of CFST; the structure of node area is complex and increase the construction difficulty, reducing the construction progress, increasing the use of materials et al, but it do not have the green construction advantages.

The above problems show that the existing types of nodes have largely restricted the extensive use of CFST structure in underground buildings and also restricted the development and utilization of underground space in China objectively. Therefore, emphasizing the construction of intensive cities today, how to optimize the clarity and reliability of the force performance in node design and the convenience in the node construction process is very important. An urgent need to design a new type of concrete filled steel tubular columns - steel beam connection node, so that the force performance

is good, the construction of fast green. In order to constantly improve and innovate the related technology of CFST column-steel beam connection node, so as to continuously promote the extensive use of CFST structure in underground construction.

2. Research Status of Connection between CFST Column and Steel Beam

2.1 The status of foreign research

Foreign scholars started the research on the connection of concrete-filled steel tubular columns to steel frame joints earlier. In the early 1990s, American and Japanese scholars started the research, and the research was systematical, involving static test research, seismic test research, theoretical analysis and Finite element simulation. A. Azizinamini[1] (1999) studied the joints of CFST-steel beam reinforced ring. The results show that the stiffness of the full-ring node and some of the ring nodes are different. The stiffness of some of the ring nodes is about 89% of the full-ring node stiffness. Among the stiffness factors, the beam has the largest cross-section height and the web thickness is the smallest. SP Schneider et al. Studied the seismic behavior of 6 concrete-filled steel tubular columns with different connection forms. The results show that the external reinforcement ring can effectively transfer the stress of the flange of the steel beam so as to effectively increase the flexural capacity of the steel beam. Reduce the stress on the steel pipe wall; through-beam connection node can significantly improve the beam bending capacity, good seismic performance. A. Elremaily[1] tested seven concrete-filled steel tubular columns with steel beams. The experimental results show that the three failure modes of beam failure, column failure and node damage respectively occur in the nodes. The shear force of beams is fully transmitted to the node area When the node area will produce greater shear deformation, resulting in node area shear damage. Ricles[2] carried out the tests of hysteretic behavior of square concrete-filled steel tubular column-steel beam joints with 10 different structural measures. The results show that the hysteretic behavior of the weakened joints in the inner core of the partition board is stable and there is no obvious strength degradation under the reciprocating load. By strengthening the bolt flange of the beam flange of the bolt-through node with separate T-shaped end plates, bolt hole elongation and tear, thereby reducing the slip and hysteresis curve pinch. Due to the sudden change of geometry, the welded joints are prone to stress concentration, which leads to the tearing of the beam flange. In order to reduce the stress concentration and avoid the tearing phenomenon, it is recommended to adopt the node structure with tapered flange plate. Wang carried out the experimental study of 16 outer-ring plate joints subjected to horizontal reciprocating loads at the top of the column. The results show that: the ring plate size is too small may lead to failure of the specimen from the plastic hinge failure to ring plate fracture; ring plate when the size is enough, its node bearing capacity, stiffness and other properties are not much different from the theoretical calculation, to meet the requirements. A. Azizinamini tested and analyzed six kinds of concrete-filled steel tubular column-steel beam edge joints with different connection methods. The results show that the simple connection forms easily cause the wall of the pipe to bulge locally. Better elastic-plastic property, but the bending strength degenerated earlier. The through-flange connection showed sufficient strength, but it failed to dissipate energy due to premature sliding. The connection through the whole beam was closest to the rigid connection.

2.2 Domestic research status

The domestic research on the connection performance of CFST-steel beam joints is relatively backward. Only after the 21st century have scholars begun to study the performance of such joints. Such as Zhang Daxu[6], Su Hengqiang, Chen Juan et al., Liu Shuxian .All studied the concrete-filled steel tubular column-steel girder plus reinforced ring connections. The research shows that the overall rigidity of such nodes is large and the bearing capacity is high, inter-force transmission, seismic performance is good. Gao Zhanyang[3] The low-cycle reciprocating loading tests on the mechanical performance and the energy dissipation capacity of the four inner and outer bulkheads with four types of inner and outer bulkheads were carried out. The results show that, carrying capacity and energy performance. Wang XianTie[4]studied the influence of beam-column connections on the

performance of specimens with pierced-pierced-bolted-end-plate joints and inter-divider-type joints. The results show that the pierced high-strength bolts- Column wall drum song. Li Wei[5] conducted an experimental study on the seismic performance of the outer ring slab frame joints with slabs. The results show that the combination of slabs transforms the failure mode of the joints from bending failure at the beam end to shear failure at the core or bending at the column end. Nodes have higher carrying capacity and better ductility, and better energy dissipation. Wang[4] studied the seismic behavior of stiffened ring joints in a square tubular column-H type steel beam. The main research parameters are the inner stiffener ring thickness and plane dimension. Experimental results show that the bearing capacity and ductility of the joints are good, and the strength and rigidity are degenerated steadily.

However, in the above studies, for the outer ring plate connection, the node size is large, resulting in excessive steel consumption; for the inner plate connection, the welding process is complicated and the cost is high; for the core bolt, In the case of unilateral bolting, the bearing capacity of the column may be affected by the cracking of concrete in the core area.

3. Summary and development prospects

3.1 Summary of domestic and foreign research

It can be seen from the research status both at home and abroad that although many studies have been made on the connecting nodes of CFST column girders, there are still many problems and shortcomings:

(1) The ability of joints to transfer moment directly to CFST columns is weak. Because the greater the node stiffness, the stronger the node's ability to transmit the moment. However, the rigidity of the rigid node in the actual project weakened so that it cannot transfer all the bending moment, while the semi-rigid node itself can only transfer part of the bending moment, the hinge node itself cannot transfer bending moment. Therefore, the ability of concrete-filled steel tubular columns to participate in the bending moment distribution of beams and columns is small, which is not conducive to reducing the bending moment in beams.

(2) Most of the CFST-RC beams are mainly connected by ring beam joints. The structure of the joints does not reflect the strong compressive bearing capacity and the flexural capacity of CFST columns, which makes the material properties exist Great waste.

(3) The current connections of CFST-column girders are complex in the node area. For example, a large number of steel piercing, bundling, welding and so on are required in the node area of CFST-RC beams, which not only affects the construction schedule and difficulty, but also affect the steel consumption, etc., often cannot achieve the construction of fast, efficient and convenient green construction requirements.

(4) At home and abroad, a great deal of research has been done on the connections between CFST columns and RC beams, as well as the connections between SRC columns and steel beams. However, there are few researches on the connections between SRC columns and SRC beams. Compared with reinforced concrete structure and steel structure, SRC composite structure has obvious advantages such as good bearing capacity, good ductility and strong deformation ability, which is more suitable for the application of beam-column joints in underground space.

3.2 Future development prospects

The above problems make the node need to improve and perfect urgently in the reason of force transmission, bearing capacity, construction convenience and so on. Therefore, there is an urgent need to develop a new type of beam-column connection, which has the advantages of simple structure, reliable transmission, good bearing capacity, good seismic performance, good structural integrity and fast and efficient construction. In order to continue to promote the concrete filled steel tube structure in the underground engineering application and development.

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