A Summary of Research on Rigid Connection Joints of Concrete-Filled Steel Tube Columns

Liqun Du [a], Xiao Ling, Yonglong Wu

School of Civil Engineering and Architecture, Southwest Petroleum University, Chengdu 610500, China;

[a]1527116114@qq.com

Abstract

This article lists several rigid Steel tube concrete column-beam rigid node, which are briefly analyzed, and discusses the problems encountered in the research and use of rigid steel pipe columns today.

Keywords

Concrete column; rigid node.

1. Introduction

The joints of concrete-filled steel tubular columns and columns are usually divided into rigid nodes, semi-rigid nodes and hinged joints according to their stress properties. Rigid nodes can transmit all bending moments. The commonly used rigid nodes are in the form of steel-reinforced rigid-joint nodes, through-core steel ox leg nodes, external reinforced ring-type nodes, and anchored plate-type nodes. Semi-rigid nodes can only transmit partial bending moments. The commonly used semi-rigid nodes are ring beam type nodes, half-through pin type nodes, etc. Hinged joints cannot transmit bending moments. The commonly used articulated joints are: steel cow legs hinged joints, steel surround hinged joints, double beam articulated joints and so on.

2. Reinforced through-type rigidly connected node

In order to transfer the bending moments of the joints, such nodes open holes on the surface of the steel pipe and pass the upper and lower two layers of longitudinal bars in the beam at the construction site for pouring. In today's steel-reinforced joints, the form of openings is relatively diverse. Generally, for ease of construction, long holes are formed in the surface of the steel pipe. However, due to weakening of the pipe wall, stiffening ribs must be provided separately. The position setting reinforcement ring keeps the integrity of the node.

This kind of node is more rigid, and at the same time it reduces the cost due to the concrete beam. However, in the construction site, steel bars are used in the column, which increases the difficulty of construction and affects the watering of the concrete. At the same time, the steel pipe is weakened, which reduces the constraint of the pipe on the concrete. Therefore, the local stress performance of the concrete-filled steel tubular column is also improved. influences.

Lü Xilin[1], Li Xuepin conducted low-cycle reciprocating loading tests on two kinds of square concrete-filled steel tube column-reinforced concrete beam joints. Tests have shown that the improved steel penetration joints and ring beam joints have good ductility and energy dissipation capabilities. Reinforced steel runs through the joints with the best stiffness and strength, but the structure is also a complex.

Li Guochang[2] conducted a beam-side reciprocating loading test on steel-concrete gangue concrete columns-reinforced concrete beam steel penetrating joints, and obtained parameters such as hysteretic

performance and ductility coefficient. Tests have shown that this type of node has better ductility and more hysteretic curves. And no damage occurs in the node area test specimens, specimens were bending beam end after shear failure of nodes that reinforced through type steel tube coal gangue concrete has a good force performance, meet the strong column weak beam, strong shear weak bending more nodes and design principles.

Shi Qiyin[3] and others used ANSYS to perform three-dimensional nonlinear finite element simulations on two types of concrete-filled steel tube columns-composite beam nodes-beam rebar joints and welded joints between beam reinforcement and upper reinforcement ring, and analyzed hysteresis curves and skeleton curves. And compared with the test results, good agreement. At the same time, it shows that the two types of nodes have better seismic performance and meet the seismic design requirements.

3. Piercing steel beam cow leg node

The pierced steel leg forms a vertical notch on the steel pipe wall. The I-beam legs in both directions are inserted into the pipe and welded to each other to form a cruciform piercing corbel. At the same time, in order to facilitate the pouring of concrete, the upper and lower flanges of the steel cow's legs are often trimmed away. In this node, the shear force is transmitted through the weld between the steel ox leg and the wall bilge mouth. The bending moment is transmitted through the welding of the positive and negative bending ribs and the lower and the lower flanges of the overhanging part of the shin bovine leg, and in the reinforced concrete beam around the steel pipe made of round or square reinforced concrete ring beam. This kind of node has a large rigidity and satisfies the requirements of a rigidly connected node, but the processing is complex and time-consuming, and at the same time it consumes more steel.

For this node form, domestic scholars have conducted more research. Based on a telecommunications hub center, Guan Pinwu[4] proposed a new type of joint structure of the piercing corbels and ring beams, and carried out a test of static load on the scale and low-cycle repeated loading on the beam end. The test shows that the joints have good seismic performance and meet the seismic design requirements. In addition, the bending and shear failure of the beam ends occurred in the test during the test, and the loading level was less. In order to further improve the energy-consuming and energy-absorbing capacity, the test piece should adopt certain improvement measures, such as reducing the reinforcement ratio of longitudinal reinforcement and increasing the amount of transverse reinforcement.

Han Xiaolei[5] took the full-scale test and a series of static reduction and low-cycle reciprocating loading tests on the basis of a cross-type piercing-core dark-leg concrete-filled steel tubular joint used in actual projects. The influences of the parameters such as ring beam, reinforced concrete slab, and piercing bovine leg and the loading method on the bending, shearing and axial compression performance of the joints were studied. A node type improvement scheme with reasonable stress and structural optimization was proposed. On this basis, Han Xiaolei respectively proposed a piercing-core dark bovine leg with a ring plate and a piercing-core dark bovine leg with ring reinforcement. The joint experiment with the slab was performed before and the simulation was performed through a finite element program. The test and simulation results show that both of these two nodes meet the specifications on the ultimate limit of the bearing capacity and normal use requirements. One of the steel bars is connected by a steel sleeve and a steel bovine leg.

Mei Libiao[6] conducted a finite element simulation analysis of the double-channel steel cow leg concrete-filled steel tubular joints, I-beam steel ox leg, and the piercing dark ox leg joints, and compared them with Han Xiaolei et al. The analysis shows that each node can meet the strength and stiffness requirements, and also proposes improvement suggestions for relatively weak nodes. In the analysis of several types of nodes, taking into account the longitudinal reinforcement laps and welding of the situation, found that when the longitudinal reinforcement lap, the stress is smaller, then the ring tendons to withstand more bending moments, the stress is greater.

4. External reinforced ring type just connected node

External reinforced ring type rigid joints are divided into three types according to the characteristics of concrete beams and connection methods. In-situ reinforced concrete beam joints, prefabricated reinforced concrete beam joints and steel collars are just connected nodes. For the cast-in-situ reinforced concrete beam joints, the upper and lower outer reinforcement ring plates are arranged at the upper and lower longitudinal reinforcement positions of the beam. The connection width and thickness of the reinforcement ring plate are determined according to the principle that the welded beam is equal to the longitudinal reinforcement of the beam, so as to achieve optimization. In addition, the vertical steel plate between the ring plates is often used to weld the internal oblique beam to transmit the vertical shear force at the beam end, but often only welded with the lower reinforcing ring plate and separated from the upper reinforcing ring plate.

For the prefabricated reinforced concrete beam joints, the function and design principles of the vertical ribs between the ring plate and the ring plate are the same as those of the former. In addition, the vertical slot is set at the end of the prefabricated reinforced concrete beam, and the vertical rib plate between the ring plates can be inserted into it, and then the vertical rib and the embedded part in the tank are welded to transmit the shear force. The upper and lower surfaces of the beam are also pre-embedded with steel plates and welded to the ring plate to transfer the bending moments. For the steel collar ring joint, a steel collar is placed on the outer ring of the concrete-filled steel tubular column, and vertical steel plates are welded between the concrete-filled steel tubular column wall to ensure that they work together. Longitudinal bars in the concrete beams are fixed on the steel rings through the nuts, which are used to transfer bending moments or bend the steel bars to achieve anchorage. In this node, the periphery of the node domain is often cast as a square ring beam.

Based on the actual project, Sun Xiuli[7] conducted beam end low-cycle reciprocating loading tests on five new types of stiff concrete ring beam joints and four reinforced concrete beam-steel reinforcement ring joints. The node's yield load, ultimate load, joint stiffness, and energy dissipation capacity are considered. Through experiments, it has been found that the plastic hinges of the new stiffened concrete ring beams are located at the junction of the ring beam and the beam and are sufficiently ductile. However, the plastic hinges of the reinforced concrete beam-steel reinforcement ring joints occur within about 1.5 times the height of the beam outside the boundary between the ring beam and the beam, and have sufficient bearing capacity and ductility, and the seismic performance is excellent. Through experiments, both nodes are very rigid and can be regarded as rigid nodes for seismic design.

5. Anchor plate node

The node belongs to a rigid node. Its working principle and force characteristics are: welding a T-shaped anchor plate in the pipe corresponding to the upper and lower flanges of the steel beam to withstand the tensile force transmitted from the flange, and the shear force depends on the beam. The vertical seam of the board is transmitted. Advantages: Simpler construction and less steel consumption. Disadvantages: The rigidity of the node is small, and the scope of application can only be used when the force within the node is relatively small.

6. Conclusion

(1) The current connection of steel-concrete-concrete column-beam joints is complex in the joint area. For example, the steel pipe concrete column-reinforced concrete beam joint area needs a large number of reinforcement piercing, banding, and welding on the site, which not only affects the progress and difficulty of the construction, but also affects steel products, consumption, etc, and often fail to meet the requirements for quick, efficient and convenient construction of green construction.

(2) Most of the concrete-filled steel tubular columns-concrete beams are mainly connected by ring-beam joints, and their joint structure does not reflect the extremely strong compressive bearing

capacity of the concrete-filled steel tubular columns and the advantages of large bending capacity, there is a great waste of material properties.

References

[1] Lü Xilin, Li Xuepin: Experimental Study and Design Method of Externally Ring-beam Joints of Concrete-filled Square Steel Tubular Columns.No.01.2003.p.7-13

[2] Li Guochang, Sun Wei: Low-cycle repeated loading test of steel-coal gangue reinforced concrete middle-ring joint. No.01.2008.p.200-203

[3] Shi Qiyin, Ding Fang: Experimental Study on Connection Joints Between Steel-concrete Composite Beams and Concrete-filled Steel Tubular Columns.No.04.2011. p.109-115

[4] Guan Pinwu, Meng Huiying:Experimental study on the mechanical behavior of a new type of joint of a concrete-filled steel tube column.No.04.2001.148-153

[5]Han Xiaolei: Experimental Study on Piercings of Concrete-Filled Steel Tubular Column Joints.No.11.2005.21-23+30

[6]Mei Libiao,Zhouyun: Finite Element Analysis of Single-beam Through-core Joints of Concrete-Filled Steel Tubular Columns.No.01.2006.p.57-61.

[7]Sun Xiuli: Experimental study on RC beam-steel pipe column joints. No.03.2008. p.96-100

[8] A.Elremaily, A.Azizinamini: Design provisions for connections between steel beams and concrete filled tube columns, Vol.57(2001),p.971-995.

[9]Ricles,J.M.,Lu,L.W.,Peng,S.W.: CFT Column System as Seismic Resistant Composite Frames.Vol.1