Research on Reinforced Concrete Beam - Steel Tube Concrete Column Node

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Abstract. The steel pipe concrete column has been applied in construction projects. The prefabricated assembly era has also been quiet, but there is little research on steel pipe concrete columns and pre-concrete beam nodes. This paper summarizes the articles on concrete-filled steel tubular column and beam joint, and puts forward a kind of concrete-filled steel tubular column and precast beam joint strengthened by U-shaped plate and stud. The joint has clear force transmission, convenient site construction and saves materials, which provides reference for the joint form of reinforced concrete beam and concrete-filled steel tubular column.

1. Introduction
The steel pipe concrete column is a durable material. Under the earthquake, only the impact of the long quotation is required, and the area of the building can be effectively increased, and the structure of the construction is also reduced, and the large number of engineering examples have shown that the steel pipe concrete structure is used in the pressure rod. Steel structure can save about 50% of steel, and save a large amount of concrete accordingly. The assembly structure is the object of reform and development, especially during the emergency period of the new crown epidemic, emergency hospitals have successively emergency construction, reconstruction or expansion, application assembly structure, and the node damage can lead to collapse of structural buildings. Therefore, the prefabricated reinforced concrete beam and the steel pipe concrete column are connected, how to reinforce between nodes, and become the focus of research in engineering.

2. Reinforced concrete beam - steel pipe concrete column node connection status
The predecessor of the ring-type node is to strengthen the ring node. The ring node is replaced by reinforcing the reinforcing ring and the stiffener of the reinforcement in the reinforcement. Its advantage is that the steel bars can be connected to the steel bar in the frame beam, at the same time Pour, no soldering is required. First, this node is the way is Fang Xiaotan [1], and the reinforced concrete ring beam is arranged around the round steel pipe. The node diagram is as follows, and the research shows that the constraints of the ring beams and the floor will make up for the constraints of...
the ring beams and the floor. Node shear makes the additional vertical stress generated by the steel pipe, and the floor will increase the beam of the ring beam to a certain extent.

Sun Ke [2] combined with Hebei Province, a new type of node construction method was proposed in the process of laminate, and it saved the cost of economic cost, and the tie of the ring beam needs a lot of manpower. The technical level is uneven, replaced with CNC machine tools, lifting the ring beam steel bar; replacing the steel anchor plate instead of the weld anchor, this node improvement is more convenient to work.

Ding Martial Arts [3] proposes a new node reinforcement method for RC sorghum - round steel pipe column, and the circular steel pipe is turned off within the node loop, and T-type steel is added to the column while disposing the corresponding steel bar in the column to improve the steel pipe column. The carrying capacity is also the two test pieces of the steel pipe on the node area, design the beam height and the reinforcement rate different parameters, the test piece does not find a significant damage trend in the miraphic destruction, indicating The feasibility of the new node, the impact of the reinforcement rate on the strength and ductility of the node, the finite element simulation analysis is in combination with the bearing capacity of the test results, and the feasibility of ABAQUS is verified.

The bull leg node can be divided into a half-wearing atrium leg node, wearing a heart of a bull leg node and a heartbeat node. Rongbusheng [4] The actual wearing anxiety is difficult to apply, and propose a half-wearing atrium leg node. For the mixed node, it can arrange anti-raw legs within a certain range of beams, and make anti-bending legs in the four corners; For single girder nodes, it is proposed to increase the height of the cattle leg, which should try to increase the height of the crowd. According to the experiment, the bull leg deep into the diameter of the steel pipe, which can meet the anchoring and bending moment requirements, the double beam and the single beam nodes are as follows.
Quartet [5] designed a word-type node with a ring-free beam, and the test found that the ultimate bearing capacity of the test piece had no significant difference, but in the actual construction, the binding process of the ring beam was cumbersome, so the ring beam can be canceled.

Cai Jian [6] tests the concrete column nodes in the actual project in the actual engineering, and the light through the node first, and then enters the shear damage, the node is clear, and can be promoted in actual promotion. The destruction of the node is directly related to the welding quality between the bull leg and the steel pillars; the anchor length of the beam pilot should be paid to the anchor length of the beam in the opposite loading conditions.

Wang Xian, etc. [7]-[8] respectively perform low-week reciprocating test and Abaqus simulation analysis of the self-replenishing side of the tube-shaped device, and the ABAQUS simulation analysis. Seismic performance, analysis results in increasing the diameter of the steel rod, increasing the initial pre-tension and prestressed quantity of the prestressed thus can improve the node bearing capacity.

Nie Shaofeng et al [9] use finite element software Abaqus simulation analysis of the seismic performance of the concrete ring beam node, the finite element simulation analysis calculation results are consistent with the test results, verify the correctness of the ABAQUS simulation analysis, Simulation analysis of steel-containing steel-containing steel and romoring ratio and maximum load of the tester, the maximum load of the test piece, the pressure of the test piece is 0.63, and the node has a position of the spindle coefficient of 4.14, and the shaft When the secondary pressure ratio is 0.31, the displacement coefficient is reduced to 2.21, which is 15.16%, indicating that the axial pressure of this node is more delayed.

Dangan [10] for seismic performance analysis of round tube steel concrete columns (CTSRC) and square tube steel concrete column (STSRC), CTSRC column anti-bend strength, ductility, plastic deformation ability and energy consumption capacity are significantly higher than the same reinforcement Radical steel concrete column, and the circular steel pipe is more stronger than the square steel pipe, and the anti-bending strength and plastic deformation ability of the CTSRC column are higher than the STSRC column under the same bonding steel ratio and axial pressure. The author is higher than the STSRC column. Calculation of Metomance Strength of Concrete Column Presents Improvement Measures.

Wang Qingxiang et al [11] proposes a new type of round steel pipe concrete, such a node method needs to prepryn a boost of the plant, finite element analysis of the weak beam node test piece and the toolbench steel beam on the basis of the work-based steel beam The box-type beam node connection test piece in the form of a vertical panel, the simulation results are in line with the test results, the weak beam type node bearing capacity and ductility is higher than the strong beam type, in order to improve the resistance of the cross section, the center of the steel should be arranged in the rock leg Outer side.

PENGPAN [12] introduces a high-level first layer and underground steel concrete column and concrete beam nodes, combined with on-site construction conditions, and implement a new loop node connection form, with a finite element to the tester, hoop The rib is analyzed to verify the correctness of finite element analysis. The test and the actual comparison chart are as follows.
3. New node research content
Through the research analysis of the above nodes, the steel pipe thickness, the axial pressure ratio, the ring beam reinforcement rate, the plus rib size, etc. are important factors affecting nodes, and this paper is based on the respective advantages of assembly structure and steel pipe concrete structures. In the principle of simple construction, clear transmission, safe and reliable, saving materials and construction, proposes a steel-reinforced concrete beam - steel pipe concrete column assembly node.

Such a node first uses the outer sleeve segment and the steel pipe wall in the steel pipe to be welded to the steel pipe, and the webs are welded to the steel pipe outside the steel pipe; secondly, the steel bar passes through the opening of the steel pipe. And connect with prefabricated concrete beams; finally, in the form of pouring concrete in the connection site.

4. Conclusion
This paper summarizes the analysis of the new steel pipe concrete columns - prefabricated reinforced concrete beams, and there is a problem of calendering between node reinforced concrete concrete, and on-site welding quality leads to problems such as cracks. Assembly from the production line that starts production of prefabricated components, to ultimate placement assemblies, traditional migrant workers "dirty" working models and working environment have been greatly improved, and component quality has also been greatly improved.

In view of the above, a new joint connection mode is put forward, which has the advantages of clear force transmission path, simple process and no influence on the later interior decoration, and achieves a new breakthrough and innovation for the seismic design and application of concrete-filled steel tube column-reinforced concrete beam assembly structure.
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References

[1] Fang Xiaodan, Li Shaoyun, Chen Aijun. Experimental study on new type concrete filled steel tube column joints [J]. Journal of Building Structures, 1999(05):2-15.

[2] Sun Ke, Li Zhengyang. New construction method of concrete-filled steel tubular column ring beam joint [J]. Shanxi Jianzhu, 2018,44(08):84-87.

[3] Ding Wuxia. Experimental Study on the Seismic Behavior of RC Beam-Circular Steel Tube Restrainted SRC Column Ring Beam Joints [D]. Chang’an University, 2018.

[4] RONG Baisheng. Concrete filled steel tube columns and joints in high-rise buildings [J]. Journal of Civil Engineering and Architecture, 2002(01):3-8.

[5] Ji Jing, Chen Qingjun, Han Xiaolei. Journal of South China University of Technology (Natural Science Edition), 2001(07):70-73.

[6] Cai Jian, Yang Chun, Su Hengqiang. Experimental study on joint of concrete filled steel tubular columns with perforated steel bars [J]. Industrial Building, 2000(03):61-64.

[7] Zhang Jiaping, Wang Xiantie, Luo Yao, Xie Chuandong, Guo Yiwei. Finite element parameter analysis of seismic performance of self-resetting concrete-filled square steel tubular column-steel beam joint with wedge device [A]. Institute of Structural Stability and Fatigue of China Steel Structure Association, China Steel Construction Society). proceedings of the 17th academic exchange and teaching seminar of structural stability and fatigue branch of China steel structure association (ISSF-2021) [C] Institute of Structural Stability and Fatigue, China Steel Construction Society: Industrial Architecture Magazine, 2021:5.

[8] Wang Xiantie, Xie Chuandong, Luo Yao, Zhang Jiaping, Jia Zihan. Experimental study on seismic behavior of self-resetting concrete-filled square steel tubular column-steel beam joints with wedge-shaped devices [J/OL]. Journal of Building Structural Science: 1-10 [2021-04-13]. https://doi.org/10.14006/J.

[9] Nie Shaofeng, Ye Mengna, Wu Yangfan, Ding Wuxia, Zhu Jizhao. Journal of Building Science and Engineering, 2019,36(02):84-91.

[10] Gan, D., Guo, L., Liu, J., & Zhou, X. (2011). Seismic behavior and moment strength of tubed steel reinforced-concrete (SRC) beam-columns. Journal of Constructional Steel Research, 67(10), 1516–1524. doi:10.1016/j.jcsr.2011.03.025

[11] Wang Qingxiang, Sun Jian, Liu Shirun. Research on Dynamic Performance of New Type Concrete Steel-tube Beam and Column Joints with Pierce Reinforced Steel [J]. Steel Structure, 2009,24(01):15-20.

[12] Pan, P., Lam, A., Lin, X., Li, Y., & Ye, L. (2013). Cyclic loading tests and finite element analyses on performance of ring beam connections. Engineering Structures, 56, 682–690. doi:10.1016/j.engstruct.2013.05.033