The experimental study of the new pore-forming grouting connection joint with welded closure confinement steels

Wu Dongyue
Ph.D Candidate
Southeast University
Nanjing, Jiangsu, China
dongyuetaishan86@163.com

Liang Shuting
Professor
Southeast University
Nanjing, Jiangsu, China
stliang@seu.edu.cn

Guo Zhenxing
Professor
Southeast University
Nanjing, Jiangsu, China
guozx195608@126.com

Summary

This paper describes a new designed precast shear wall structure connection joint in China, which can effectively reduce the production costs of connectors and significantly improve the construction speed. This connection joint is the new pore-forming grouting connection joint with welded closure confinement steels (NPGCS). By the experimental test of two precast shear wall specimens using NPGCS and one cast-in-situ shear wall specimen which has the same parameters with the precast specimens, the performance of the connection joints were studied. The experimental results show that the mechanic properties of the NPGCS connection joint are close or even better than those of the cast-in-situ specimen contributing to the reinforcement of the welded closure confinement steels.
Keywords: new pore-forming grouting connection joint, welded closure confinement steels, precast wall.

1. Details of the NPGCS

The early researches of the pore-forming grouting connection joint with the rectangular and spiral confinement steel, the U shape steel and the anchor steel pore-forming grouting connection joint with the mesh steel plate confinement show that all the pore-forming grouted connection properties cannot match the requirements: the shear wall specimens using pore-forming grouting connection joint has a lower bearing capacity than that of the cast-in-situ specimen and the failure mechanism shows that the confinement is not sufficient . So, in order to improve the confinement and thusly improve the connection properties, the welded closure steel in buckle arrangement was used to form the NPGCS: the new pore-forming grouting connection joint with welded closure confinement steels. Fig.1 is the welded closure steel and Fig.2 is the configuration of the thin metal pore, the steels and the welded closure steels.

Fig.1 The welded closure confinement steel

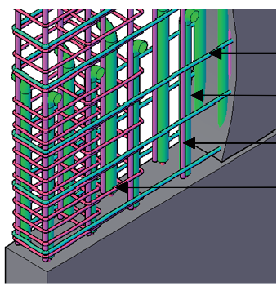

Fig.2 The configuration of the NPGCS

2. The experimental test results of the NPGCS precast wall

The experimental specimens contains one cast-in-situ specimen: XJ-1 and two precast specimens: YZ-1, YZ-2, using the NPGCS. The configuration of the connection steels are the same in the three specimens. The parameters of the specimens is selected form a high-rise residential building in China. The designed maximum seismic acceleration is 70 cm/s^2 according to the 'Code for seismic design of buildings' in China.

Table 1 are the tested capacity results and the summary of the failure modes. The cracking capacity, the yield capacity and the ultimate bearing capacity of the precast wall specimens using the NPGCS connections, are not less those of the cast-in-situ shear wall specimen, indicating that the NPGCS connection can effectively achieve the connecting of the longitudinal reinforcement.

In addition, the failure mode of the NPGCS precast specimens is bearing-shear failure. But the precast specimen occurs a certain lateral slip after the vertical steels yield. Usually, when a lateral slip occurs, the vertical grouted steel will be in a complex stress state, and the mechanical properties will be harmed and the bearing capacity will be reduced. But in the test, the precast specimen did not appear a lower bearing capacity than the cast-in-situ specimen. That is due to the welded closure buckle steels. Compared to the steel sleeve grouted connector, the NPGCS connector is equivalent to expand the confinement area for the certain sleeve interior region to the entire cross section of the concrete shear wall. Apart from that, the buckle arranged closure steels make the confinement stronger than normal concrete wall. As a result, the stronger confinement improved the concrete properties and thusly the overall sectional bearing capacities should also be improved on the promise that the vertical connection steels is still perfect. But due to the slip, which harmed the mechanical properties of the vertical connection steels, the overall sectional bearing capacity of the precast specimens remain no less than that of the cast-in-situ specimen and even little higher than that. In another words, the improvement of the stronger confinement supplied by the welded closure buckle steels offset the detrimental effect caused by the interface slips.

Table-2 are the tested ductility and stiffness results. The ductility coefficient of precast specimen using NPGCS connector is close to that of the cast-in-situ specimen, which means that the NPGCS precast wall has the same seismic performance with the cast-in-situ wall. The NPGCS can completely achieve the seismic design principles of ‘equivalent cast-in-situ’.

Table 1. The capacity result and the failure mechanism

Specimen No.	Crack load	Yield capacity	Ultimate capacity	The failure mode
XJ-1	200	320	580	Bearing-shear failure, the edge concrete completely damaged
ZP-1	200	340	605	Bearing-shear failure, interface slip (lateral load: 200kN), the edge Concrete completely damaged, Connection steel bar fracture for ZP-2
ZP-2	200	320	598	

Table 2. the ductility and stiffness results

Specimen No.	Yield drift$\triangle_y$ (mm)	Yield displacement angle θ_y	Ultimate drift$\triangle_u$ (mm)	Ultimate displacement angleθ_u	ductility coefficient μ
XJ-1	15	1/227	90	1/38	6
ZP-1	18.5	1/184	92.5	1/37	5
ZP-2	17.8	1/191	106.8	1/32	6

3. Conclusion

The expense of the new pore-forming grouting connection joint with welded closure confinement steels (NPGCS) is much lower and easy to manufacture.

The crack resisting ability, load capacity, stiffness properties, displacement ductility and energy dissipation capacity of NPGCS precast wall are close to that of the cast-in-situ wall. The NPGCS precast wall has a good seismic performance.

In the experiment, the lateral interface slip occurs. But the strong confinement completely offset the detrimental effect of the interface slips. This can be a new method to offset the detrimental effect of the interface slips.