Assembled Optimized Design and Analysis of Prefabricated Pipe Piles

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Abstract. Prefabricated prefabricated pipe piles are major changes in pipe piles. They are characterized by standardized design, factory production, assembly construction, information management, and intelligent application, which are conducive to saving resources and energy, reducing construction pollution, and improving labor productivity and quality. The level of safety is conducive to promoting the deep integration of construction industry and information industrialization, cultivating new kinetic energy of new industries. It is an important measure for the transformation of new and old kinetic energy in the construction field and the promotion of construction methods. It is in line with the national green, circular and low-carbon sustainable development direction. . This paper verifies the tube with ten pin connectors and eight pin connectors in the prefabricated pipe pile assembly connection process by comparing the test data of ten pin connector and eight pin connector structural performance tests. The structural bearing capacity of the pile joints is basically the same, and does not affect the structural performance of the prefabricated pipe piles in the normal use stage. In this way, the amount of steel is reduced, the engineering cost is reduced, and the construction period is shortened.

1. Introduction

Steel materials are combined on a prefabricated basis and then applied to commercial buildings in the form of molded modules. With the global promotion of energy conservation and consumption reduction, and the development of green industry, China has strict requirements for the control and development of green resources. Green assembled buildings have outstanding advantages in energy saving and environmental protection in many structural building systems, and there is a large market potential and development space. Therefore, it is necessary to vigorously promote and continuously develop its performance, improve the design, improve the quality, make its building structure more in line with the working and living requirements of the masses, and strive to continuously innovate on the basis of quality and quantity, so that it can a higher share of the market and promote the development of the construction industry.

Prefabricated concrete pipe piles are important cement products. They were divided into pre-tensioning method and post-tensioning method in the early stage of production and development, and later produced by pre-tensioning method. Pre-tensioned prestressed concrete pipe piles are widely

used in railway systems. The single pile has high bearing capacity and a wide design range. In the same building foundation, pipe piles of different diameters can be used, which easily solves the problem of piles and can fully exert the bearing capacity of each pile. In the construction of underground rail transit, the pipe piles in the deep foundation pits are connected to the two prefabricated pipe piles through the steel bolt joints, which improve the depth of the prefabricated pipe piles and is not limited by the construction machinery capacity and construction conditions.

2. The Experiment of Structural Performance

Two prefabricated pipe piles with joints were randomly selected and tested respectively for bending resistance and shear resistance. Firstly, prefabricated pipe pile was installed in place. Secondly, the joints of prefabricated pipe were tested with the equipment of force value, displacement, deformation and other items ,and according to "pre-tensioned prestressed concrete pipe pile" GB13476-2009. The sketch is shown in Fig. 1.

2.1. The experiment of pile joint of ten pin shaft

Electric hydraulic jack were loaded with 540kN and holding 10 minutes, the deflection is 6.400mm; load to 684kN ,holding 10 minutes, the crack width is 0.14mm; load to 1085.4kN, holding load 30 minutes, the deflection is 20.237mm, the cracks width of 0.22mm, pile joints to yield strength. The pile joint of ten pin shaft is shown.

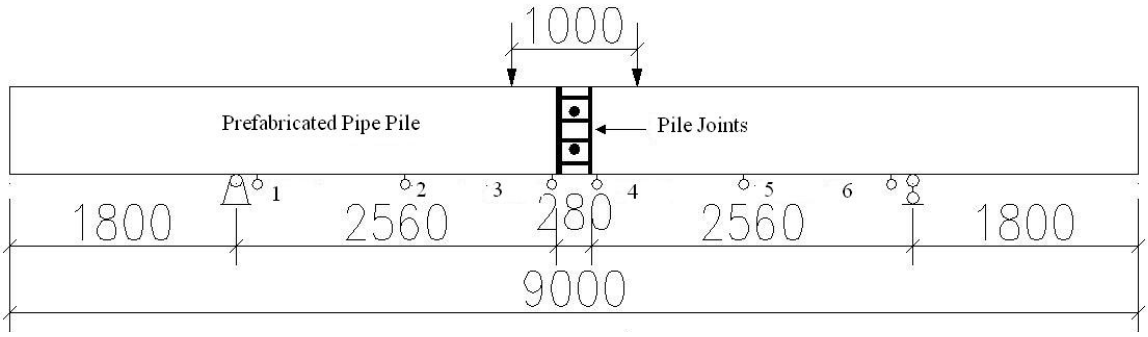

Figure 1. The sketch of loading.

2.2. The experiment of pile joint of eight pin shaft

Electric hydraulic jack were loaded with 486kN and holding 10 minutes, the deflection is 6.044mm; load to 684kN ,holding 10 minutes, the crack width is 0.14mm; load to 1123kN, holding load 30 minutes, the deflection is 21.99mm, the cracks width of 0.28mm, pile joints to yield strength. The pile joint of eight pin shaft is shown in Fig. 3.

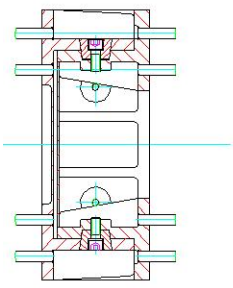

Figure 2. The pile joint of ten pin shaft.

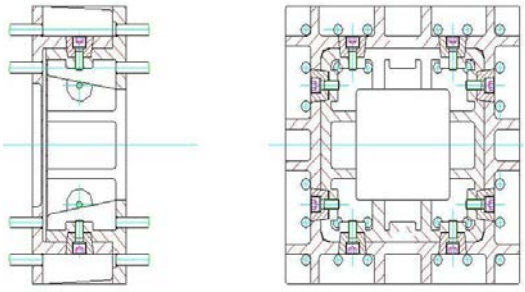

Figure 3. The pile joint of eight pin shaft.

3. Structural Performance Analysis

3.1. The experiment surveys of pile joint of ten pin shaft

The width of the crack in the prefabricated pipe pile of ten pin shaft is as shown in Fig. 4. The black track is the theoretical crack width and the red track is the measured crack width. It can be seen from the figure that the measured value is basically consistent with the theoretical value during the application of the load. After the load reaches 1000kN, the measured value is more and more larger than the theoretical value. The mid-span deflection of the prefabricated pipe piles of ten pin shaft, as shown in Fig. 5, the black line is the theoretical deflection value, and the red line is the measured deflection value. It can be seen from the figure that the theoretical value and the measured value start to deviate during the application of the load, and the theoretical value is linearly distributed, and the measured value is a quadratic curve.

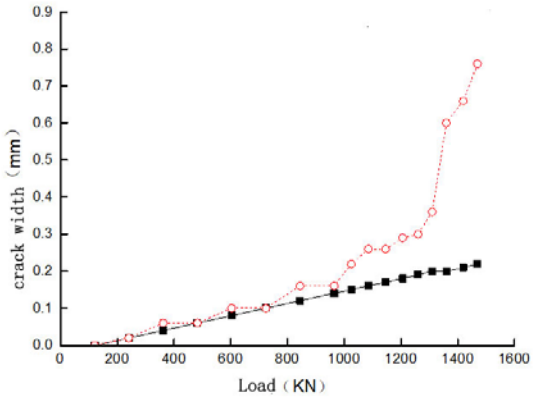

Figure 4. Crack width.

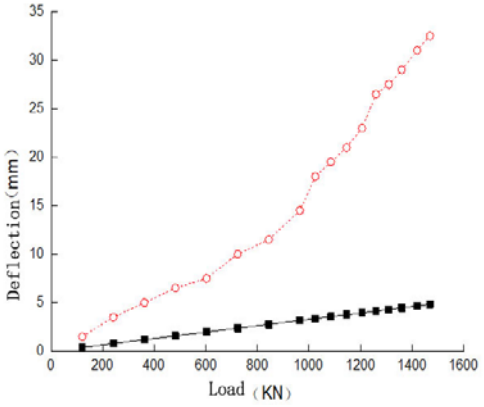

Figure 5. Deflection.

When loaded to 1025.1KN, the pile joint reaches the yield strength (1801MPa); at this time, the crack width: 0.76mm 1.5mm, the deflection: 32.5mm 64.5mm, the steel stress is 206.38N/mm2 360N/mm2. Therefore, the precast pile Ultimate bearing capacity: (1025.1+1085.4)/2/1.32=799.4KN (904.2KN.m). This is shown in Fig. 6.

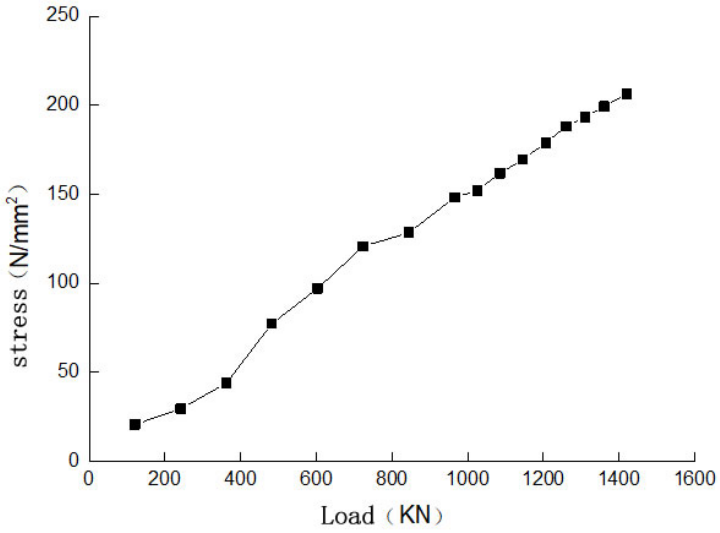

Figure 6. Tensile longitudinal reinforcement

3.2. The experiment surveys of pile joint of eight pin shaft

The width of the intermediate crack of the prefabricated pipe pile of the eight pins is as shown in Fig. 7, the black track is the theoretical crack width, and the red track is the measured crack width. It can be seen from the figure that the measured value is basically consistent with the theoretical value

during the application of the load. After the load reaches 800kN, the measured value is more and more larger than the theoretical value. The mid-span deflection of the prefabricated pipe piles of the eight pins, as shown in Fig. 8, the black line is the theoretical deflection value, and the red line is the measured deflection value. It can be seen from the figure that the theoretical value and the measured value start to deviate during the application of the load, and the theoretical value is linearly distributed, and the measured value is a quadratic curve.

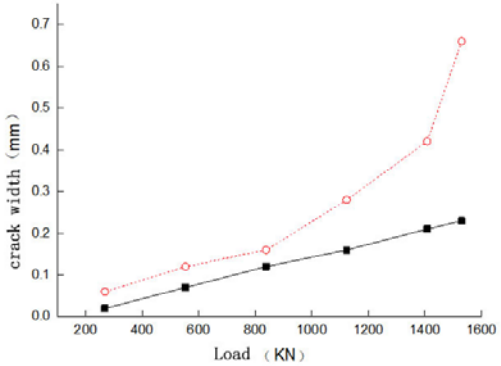

Figure 7. Crack width.

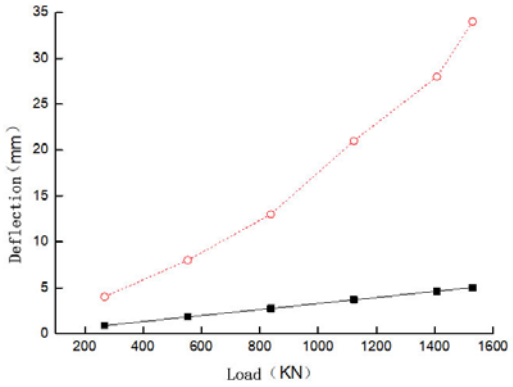

Figure 8. Deflection.

When loaded to 1123KN, the pile joint reached the yield strength (1801MPa); at this time, the crack width: 0.66mm 1.5mm, the deflection: 34.0mm 64.5mm, the steel bar stress is 201.04N/mm2 360N/mm2. Therefore, the precast pile Ultimate bearing capacity: (1123+838)/2/1.32=742KN (841.9KN.m), which is shown in Fig. 9.

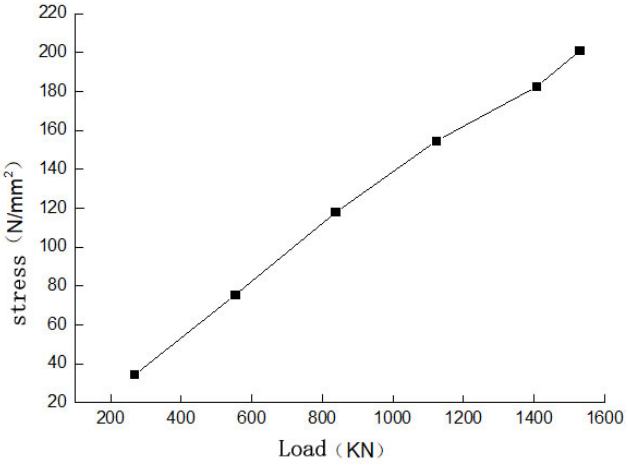

Figure 9. Tensile longitudinal reinforcement

4. Conclusion

The connection of the prefabricated pipe piles is an assembly process. The concrete members and steel components are produced by the prefabricated factory batch molds, the corresponding construction process is omitted, the installation is cross-worked, the construction speed is fast, and the construction period is short. The optimal design and analysis of its connection points is more practical. In this paper, through the structural performance test at the node, it is verified that the original ten-pin connection is used, and now the eight-pin connection is used, and the bearing capacity at the component node can meet the performance requirements. This improvement is feasible, saves material, and can be extended to engineering practice.

Acknowledgments

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