

The undisturbed soil experiment of the comparison about the failure of the half and whole cross-section piles under the resistance compression

Wei Tian^{1a}, Yongmei Qian^{1,2b*}, Tongjiang Lu^{3c}, Ruozhu Wang^{1d},

^a55356045@qq.com, ^b654675316@qq.com, ^c1247653424@qq.com, ^d306109357@qq.com,

(1 Jilin Jianzhu University, Changchun, China)

(2 Jilin Structure and Earthquake Resistance Technology Innovation Center, Changchun, China)

(3 Northeast Electric Power Design Institute Co. LTD of China Power Engineering Consulting Group, Changchun, China)

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Abstract: In this paper, adopting the small scale model experimental method, made the test pile with half and whole cross-section, and through the homemade soil device to extract the undisturbed soil to carry out the load experiment. Observe the failure process of the soil around the pile body, at the same time, extract the load and displacement of the top of pile to form the curve. Finally, by comparing the the soil failure state 、 bearing capacity 、 the displacement-load curve of the half and whole cross-section piles and so on, further verify the reliability of the half cross-section pile experiment, set good theoretical and practical basis for the further promotion of half section pile experiment.

Introduction

Half section pile experimental method has an irreplaceable role in scientific research of the concrete plates-expanded pile, the biggest advantage of the experimental method is the ability to see the damage situation of piles and soil, through the experiment can reveal the damage state and interaction of piles and soil, is the main approach to verify various theoretical and numerical results[1]. Model experiment is the most common method in pile foundation experiment. Generally shrink the true pile in accordance with small proportion, and load through the special reaction. The advantage of this method is simple, convenient operation, low cost, stronger repeat maneuverability. Due to the affect of its own factors such as size effect、 pile body material properties and so on which have certain difference with the actual situation, but the changing rule of the data obtained from model experiment and the failure pattern of piles and soil should be consistent with actual situation. Model experiment of pile foundation mainly use the model box to buried pile and soil, and records displacement at the top of pile, set strain gages along the pile body to collect strain, can also obtain the stress according to the elastic modulus, the pile end and installation of the tray pressure box to collect pressure situation. Through analysis and sort the above data can form the s-Q curve, and observe and describe damage situation of pile and soil.

The soil properties and model specimens

The physical property indexes of undisturbed soil

Choosing the clay as the experimental soil which common in the practical engineering, and take the soil by homemade soil sampler, as shown in Fig.1. From the geotechnical engineering survey report and indoor soil test results can contain that the value of cohesion is 59KPa, internal friction angle is 12 °, the density is 1.86 g/cm³, natural moisture content is 29.6%, liquid limit is 35.1%, plastic limit is 22.7%, elastic modulus is 2.5 x 10⁴ MPa.

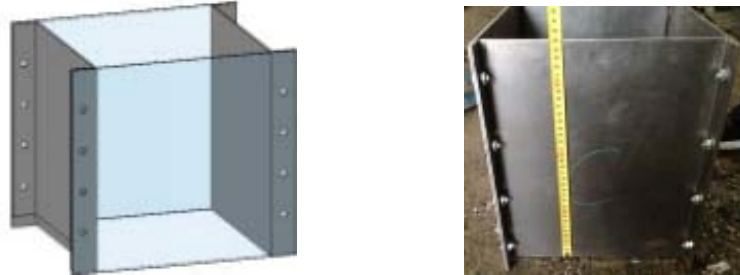


Fig.1 Undisturbed soil sampler

The half and whole cross-section pile test specimens

In this experiment, assumption that the pile is rigid and the soil flexible, in the progress of loading, only the soil produce destruction. So the pile body is made up of steel which has certain difference with the actual material property, but the variation trend of curve should consist with the practical engineering. The biggest difference of half and whole section pile is the cross section form that the section size of the half cross-section pile is half of the whole cross-section pile, as the Fig.2, other parameters such as the length、 diameter of pile and plate and so on are exactly same, model pile size is the one fifty of actual pile, the length of pile is 10mm, plate diameter is 30mm, the height of plate is 12mm, the angle of plate is 31 ° , the flying diameter of plate is 10mm, the length of pile is 210mm.



(a) Half cross-section pile

(b) Whole cross-section pile

Fig.2 The half and total cross-section experimental pile

The progress of embedded pile

This experiment was different with traditional embedded pile, previously, always keep the pile embedded in the model box and then buried them with soil[2]. Due to using the soil sampler instead of model box, greatly reduced the disturbance of undisturbed soil, solve the problem of distortion of the undisturbed soil. The progress of embedded pile also is one of the major difference between the half cross-section pile and the whole cross-section pile, therefore, introduce the point that the progress of embedded pile of the half cross-section pile and the whole cross-section pile.

The progress of embedded pile of half cross-section

The progress of embedded pile of half cross-section is that remove the side board from the soil sampler and push the pile into soil in the side. The specific progress of embedded pile as follows (Fig.3).

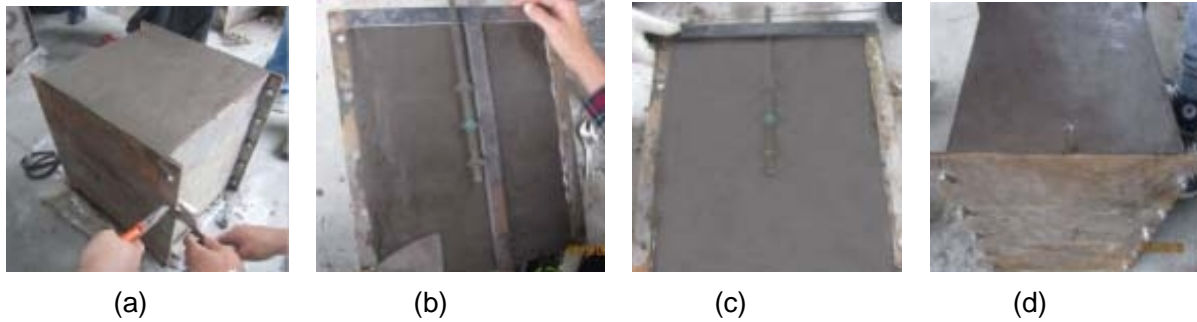


Fig3 The progress of embedded pile of half section

(a) The demolition of side board: In the progress of removing side board of soil sampler, have to separate the side board from the soil sampler along the lateral tangent direction, not take away the side board along the lateral normal direction. Only in this way, can avoid breaking the completeness of side soil due to the bond of soil and board , and bad for the observation of experimental effect.

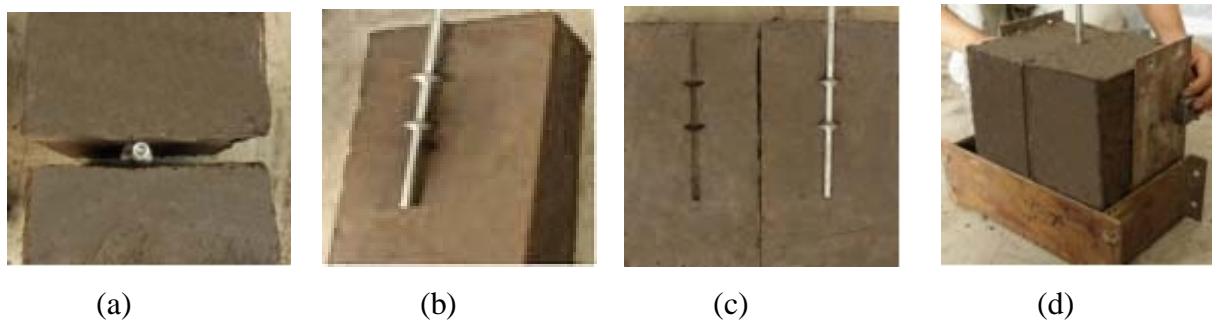
(b) The centering of pile body: Find the center line of soil with the L-square, make the pile body coincide with the center line. Due to the direction of load is vertical, in order to ensure enough displacement of the trip, reserve the length of 50mm at the top of pile.

(c) Press pile and installation of side board: Marked the out shell of pile body with geological knife on the soil, push the pile into the soil along the out shell. Because the size of specimen is small, for ensuring the stress uniform along the pile body when pressing pile, with the aid of steel plate pressing the pile . Make sure that the pile body is vertical, otherwise, will produce eccentric torque, affect the experimental results. In the progress of pressing pile, has an extrusion effect on the soil around the soil, and so the state of stress of soil close to the practical engineering.

(d) After accomplished the pressing pile, install the side board: Subsequently, replace the side board with glass plate, can observe the whole failure progress of pile and soil.

The progress of embedded pile of whole cross-section

The progress of embedded pile of whole cross-section is the combine of two symmetrical soil specimens on the side with the half of pile space, and then fix the two soil specimens, as shown in Fig.4.



(a)The demolition of side board (b) Location and cut soil
(c)Install pile (d)Combination and fixation

Fig.4 The progress of embedded pile of whole cross-section

For whole cross-section pile experiment, the pile in the internal of soil, can't see the interaction of piles and soil with the increase of load. Yet, after the accomplish of loading, separate the two soil specimens and then observe the final damage state of soil around the pile. For half cross-section pile experiment, the side of pile body which with the flat surface stick to the glass pane, can observe the interaction of pile and soil at any time through the glass pane.

Experimental equipment and devices

Table 1 Statistics of experimental equipment

Device name	Type	Quantity
Displacement sensor	YHD-100	2
Hydro-hoisting jack	ZY-2	1
Digital camera	Canon700D	1

The experimental system is consists of loading system, reaction system and observation system [3].

(1)Loading system: in order to improve the accuracy of reading, adopting manual hydro-hoisting jack of two tonnage, the displacement trip of piston is 40mm, t the display of press using digital display, the unit is KN, meet the requirements of the precision of the model experimental.

(2)Reaction system: considering the size of soil sampler, making the reaction force loading station, install two joist steel in vertical direction up the rigid flat board, set a steel beam between the two joist steel as a counter-force beam, as shown in Fig.5.

(3) Observation system: the observation system is mainly composed of displacement sensor、 jack digital pressure gauge、 digital camera, primary record the values of displacement and load in the process of loading, and record the damage progress of soil around pile with a digital camera.



Fig 5

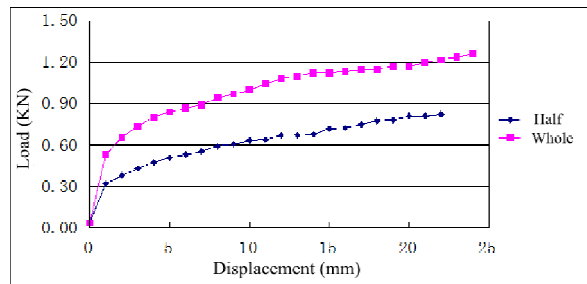


Fig.6

Fig 5 Reaction force loading station

Fig.6 The s-Q curve comparison chart of half and whole cross-section pile

The comparison of results of half and whole cross-section pile experiment

From the Fig.6, it can be seen that the growth rate of curve of whole cross-sections pile curve is greater than the half cross-section pile at the beginning of the displacement growth stage. In the middle and later periods, the variation tendency of curve more and more similar. The variation tendency is very coincident in the mass.

In the way of bearing capacity[4], when the displacement of pile up to 20mm, the value of load of half and whole cross-section pile are 0.813KN and 1.173KN respectively. Apparently, the bearing capacity of whole cross-section pile less than the double bearing capacity of half-section pile, the reason for that dividing the whole cross-section pile into two part equivalent to add two sides, which increases the friction between the pile and glass. Therefore, in the way of bearing capacity, the results of half and whole cross-section piles are very coincident.



(a)Half cross-section pile

(b)Whole cross-section pile

Fig7 The final collapse of soil around pile

From the Fig.7, it can be seen that the soil under the plate has obvious watermark due to the soil suffer from vertical press and horizontal restraint of the glass pane for half cross-section pile. Compared with the whole cross-section pile, the watermark of the soil under the plate of half cross-section pile is shallow, but also can see the destroying extent of soil. The final collapse of soil of half and whole cross-section pile are same that the soil between the plate under shear and the soil under the plate close to the pile tip under shear and press simultaneously, the pressure range of shape and size start from plate pointed to pile tip^[3] along the direction of 45°.

Conclusion

Through contrasting of results of the half and whole cross-section pile experiment, it can be concluded that the results of half cross-section pile experiment in displacement load curve、 the bearing capacity and collapse state of piles and soil and so on are consist with the whole cross-section pile experiment, so by the half cross-section pile experiment instead of whole cross-section pile is reliable.

Acknowledgments

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