Lateral Behavior of Group of Piles under the Effect of Vertical Loading

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Abstract - *Pile foundations is the foundation type that is used to transmit the heavy structural loads of superstructure to deeper strata either as a single/mono pile or as group piles. On the reaction of piles for joined vertical and lateral loads in the research facility and field test information are restricted. The present practice is to consider vertical and lateral load freely for design of piles. This paper exhibits the conduct of group of piles for lateral load under the impact of vertical load through research center trials on aluminum pipe piles with external diameter and inside diameter of 25 mm and 19 mm separately. In inadequately evaluated sand with 60% relative density the pile group was driven. Impact was seen of steady size of vertical load in the scope of 20%, 40%, 60%, 80%, and ultimate vertical load on the lateral reaction for slenderness ratio of 10, 15 and 20 was concentrated of group of piles. Dial gauges were masterminded on the heap group to quantify the displacement. The test outcomes have demonstrated a critical increment in the load carrying capacity under vertical loads on the lateral reaction of group of piles because of expanding length of piles from 250 mm to 375 mm and 375 mm to 500 mm. The test results and results found from the literature are compared and are found to be in favourable agreement. This research of hollow pile foundation will be the most efficient pile foundation technique in terms of economy, stability, construction methods and post settlement problems to transfer very heavy dynamic loads safely to greater depths.*

Keyword: Pile load test, Lateral load test, Combined load, Lateral load

1. INTRODUCTION

Pile foundation are broadly used to help different structures based on free/soft soils, where shallow foundations would experience over the top settlements or shear failure. These piles are utilized to help vertical loads, lateral loads, or a blend of vertical and lateral loads. In any case, in perspective of the intricacy associated with breaking down the piles under combined loading, the present practice is to examine the piles autonomously for vertical loads to decide their bearing capacity and settlement and for the lateral load to decide their flexural behavior.

Concentrate the interaction effects on piles under combined loads would no uncertainty call for a precise and modern analysis. The writing accessible in this field is inadequate. The limited information on this topic reveals that for a given lateral load, the lateral deflection increases with the combination of vertical loads. [1] endeavored to clarify this phenomenon by three-dimensional (3D) finite element analysis and detailed that (1) the response of the piles in both clayey and announced that (2) the nearness of vertical loads expands the lateral load capacity of piles in sandy soils by as much as 40% relying upon the level of vertical load. Therefore explore model testing would be the most appropriate way to deal with think about and anaylse the response of pile under lateral load within the sight of vertical load. Since the piles are not often enough designed to resist lateral loads, the response of piles under lateral load within the sight of vertical loads is more critical and intriguing for the outline engineers. In addition, the impact of the pile slenderness ratio (L/D) is also an essential parameter to be considered in pile plan. In perspective of this, the present paper centers around the investigation of piles subjected to pure lateral loads and combined vertical and lateral loads through model testing. The details of the numerical model, the validation of the created model against some field cases, and results from parameteric examines are talked about in the paper.

2. EXPERIMENTAL INVESTIGATION

A. Test Programme

Test Program Total 18 numbers of lateral load tests were conducted on sand with no vertical load and with constant extent of vertical load (in scope of 20%, 40%, 60%, 80% and 100% of Ultimate vertical load).

B. Test Setup

Model pile load test was conducted on sand in the Geotechnical Laboratory, Applied Mechanics department, L.D. College of Engineering, Ahmedabad.

The experimental tests are performed on model group of piles in a RCC round tank of Internal diameter = 0.9 m, external diameter = 1.0 m and Height of tank = 0.9 m as appeared in Fig. 1. The limits of the tank influences the pressure and displacement fields in the soil subsequently general clearance of least five times the pile-diameter was kept up between the bottom of tank and bottom surface of aluminum hollow pile, also dimensions of the tank gives a base lateral clearance of five times the pile-diameter. The soil model was set up by compacting the sand in layers, every one of 100 mm thick up to 750 mm tallness. The sand was compacted at a relative density of 60%. Test setup for pullout test.

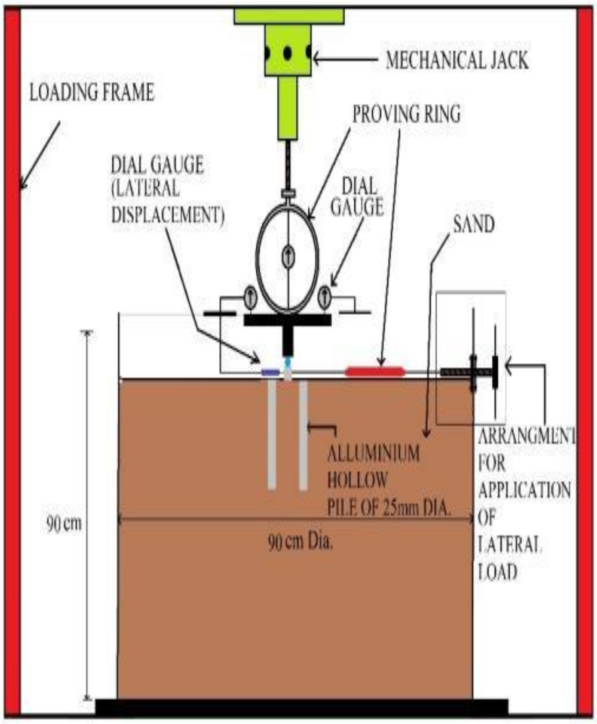

Fig. 1. Test setup for pullout test

C. Properties of Sand

The dry sand utilized was spotless and poorly graded, with the gradation appeared in Fig. 2. The index and engineering properties of silty sand utilized for the investigation are appeared in Table 1.

For all tests, the sand was put with a relative density of 60%. To achieve uniform density, the surface vibration technique, with the surface vibrator device was used.

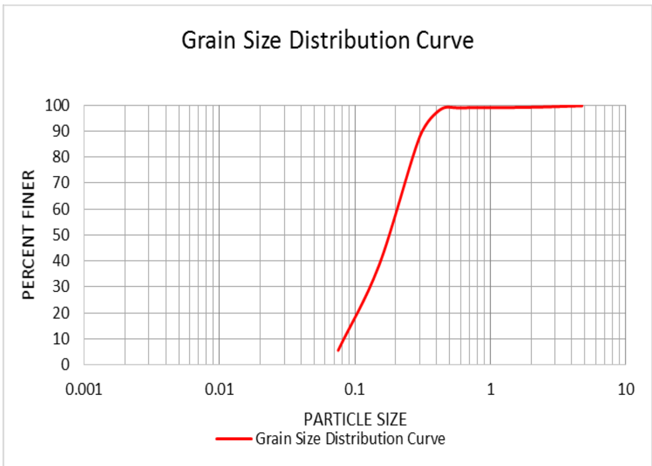

Fig. 2. Particle size distribution curve

TABLE I: PHYSICAL PROPERTIES OF SAND

Sr. No.	Properties of sand	Value
1	Coefficient of uniformity,Cu	2.2
2	Coefficient of curvature,Cc	1.25
3	IS soil classification	SP
4	Specific gravity,G	2.7
5	Angle of internal friction,Φ	36°
6	Cohesion,C	0
7	Minimum density,$\gamma_{d\ min}$	16.78KN/m³
8	Maximum density,$\gamma_{d\ max}$	18.18KN/m³
10	Relative density,I_d	60%

D. Model piles and Instrumentation

Aluminum pipes with external diameters of 25 mm and wall thicknesses of 3 mm were utilized as model piles. L/D ratio was 10, 15 and 20 so the length of pile was 250 mm, 375 mm and 500 mm separately. Piles were instrumented for estimating displacement at the top of the pile. The dial gauge was kept on pile top edge. The dial gauge tip was refreshed on the pile top.

Fig. 3. Experimental setup for the test

E. Pile Installation

The group of piles was put with the tip laying on the sand surface in the test tank. A 6-mm-thick steel plate was set over the pile top. The group of piles were gradually driven into the sand by delicate blows with a small weight on the steel plate. The verticality of the pile group was checked with a plumb after each 50 mm penetration. The pile of 250 mm and 375 mm length was driven to a depth of 220 mm and 345 mm separately from the sand surface. The pile top head was kept 30 mm over the sand surface to influence provision for application of lateral to load.

F. Test Procedure

A progression of 18 tests were completed on group of piles with the distinctive size of constant vertical load. Lateral load tests were completed on group of piles for no vertical load and for 20%, 40%, 60%, 80% and 100% of the Experimental Ultimate Vertical Load. The lateral load was connected by around 10 equal additions. The horizontal displacement of the pile head was estimated utilizing mechanical dial gauges. Each load augmentation was kept up for at least 30 min till the displacement balanced out with no development.

The combined loads are connected in two phases. In the primary stage, vertical loads were connected and then in the second stage, lateral loads were connected while the vertical load was kept constant. This sort of loading is like that in field situations, for example, pile jetties, transmission line towers, and overhead water tanks, etc. Here, the piles are first subjected to vertical loading from the heaviness of the deck or superstructure. The lateral loading might be caused by wind, wave loading, deliver affect, etc. while the piles are subjected to vertical loads.

3. RESULTS AND DISCUSSION

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A ultimate lateral resistance group of piles subjected to pure lateral load is 1000 N.

The lateral load carrying capacity of group of piles is expanded when it is subjected to vertical load. The expansion in extreme lateral resistance of pile when subjected to 20%, 40%, 60%, 80% and 100% of extreme vertical load regarding pure lateral load test is 3 times, 4.65 times, 5.5 times, 6.3 times and 7 times individually.

The comparison of the impact of vertical load on the lateral response of the group of piles for different level of constant greatness of vertical load is appeared in the Fig. 10, Fig. 11 and Fig. 12. The application of vertical load unmistakably demonstrates the expansion in a definitive lateral resistance of pile.

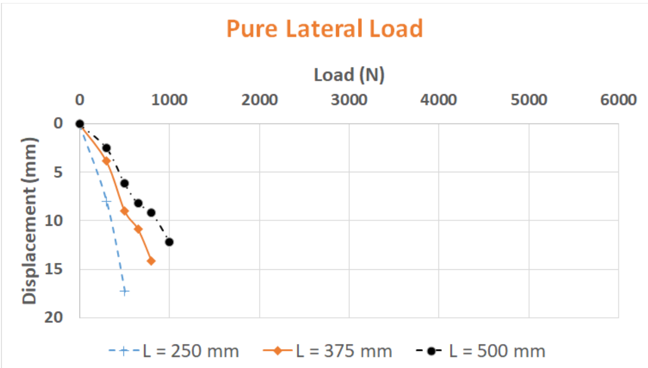

Fig. 4. Lateral load vs Displacement graph for NO vertical load

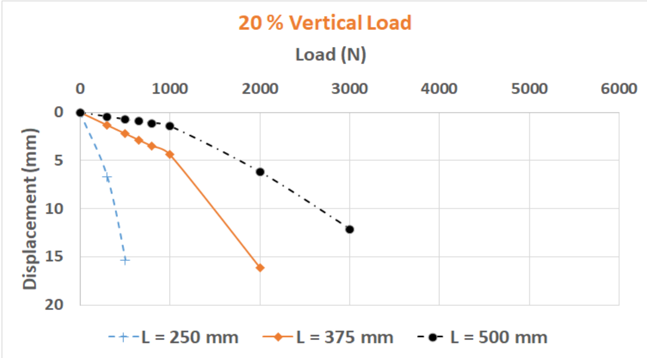

Fig. 5. Lateral load vs Displacement graph for 20% vertical load

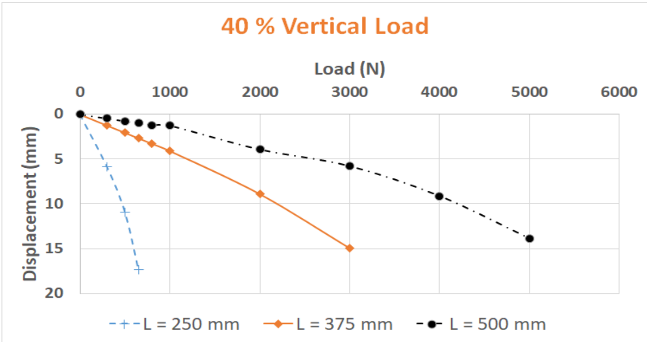

Fig. 6. Lateral load vs Displacement graph for 40% vertical load

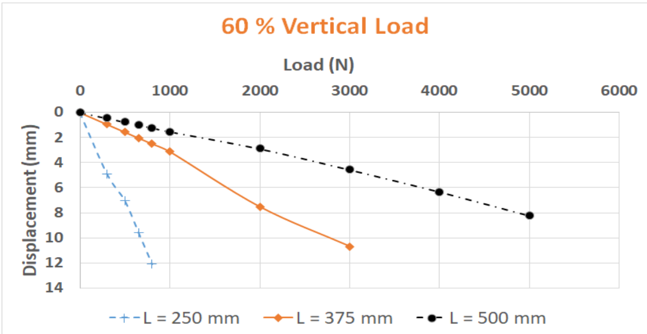

Fig. 7. Lateral load vs Displacement graph for 60% vertical load

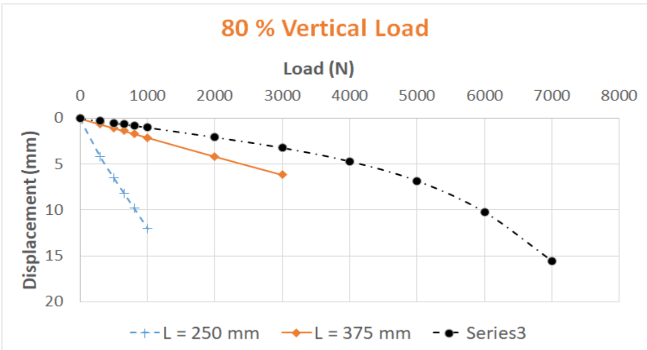

Fig. 8. Lateral load vs Displacement graph for 80% vertical load

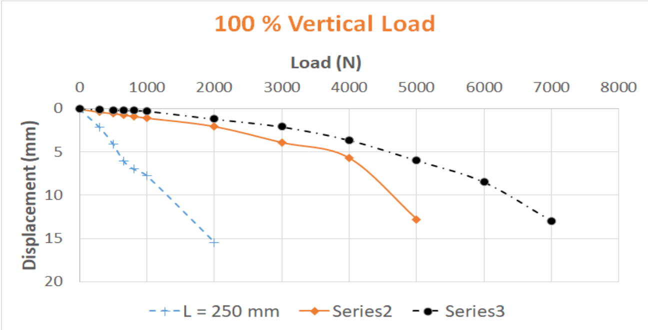

Fig. 9. Lateral load vs Displacement graph for 100% vertical load

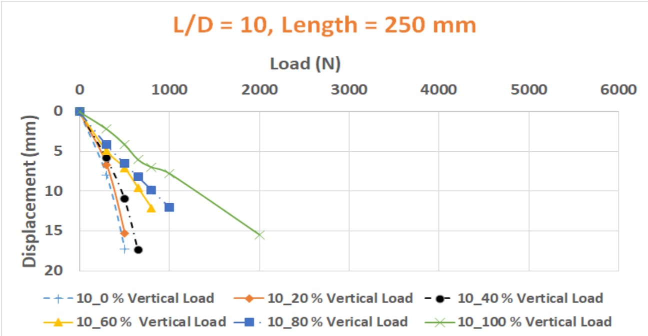

Fig. 10. Comparison of Lateral load vs Displacement result for different vertical load of L/D = 10

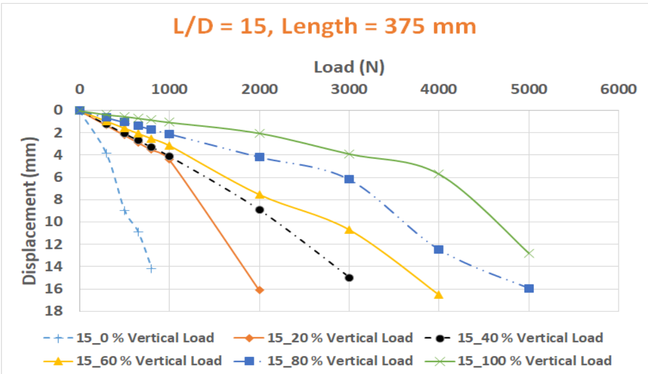

Fig. 11. Comparison of Lateral load vs Displacement result for different vertical load of L/D = 15

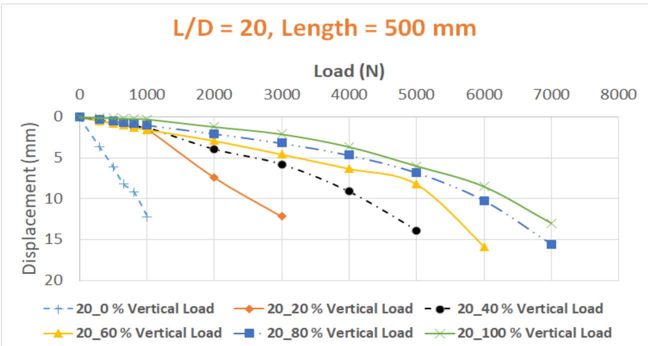

Fig. 12. Comparison of Lateral load vs Displacement result for different vertical load of L/D = 20

4. CONCLUSION

Model tests were done on Aluminum group piles of settled L/D ratio of 10, 15 and 20. The test outcomes are analyzed and displayed in here. In light of the prior examination, the accompanying conclusions are drawn:

1. The vertical load impacts the response of group of piles inserted in sand as pile instigates complex interaction effects because of concurrent mobilization of detached earth weight because of a horizontal load and pile skin friction because of vertical load.

2. A ultimate lateral resistance of group of piles increments with the expansion in the extent of vertical load up to seven times as for pure lateral load test.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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