Behaviour of Uplift Capacity of Piles in Sand

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Abstract— ***Understanding the pile behavior and predicting the capacity of piles under uplift loading are important topics in foundation design. Experimental model tests have been conducted on single piles and pile groups embedded in cohesion less soil and subjected to pure uplift loading. The piles are made up of cement. The influences of pile embedment depth, relative density of soil, and arrangement of piles in a group on the uplift capacity of piles are investigated. The study revealed that the behavior of single piles under uplift loading depends mainly on both the pile embedment depth-to-diameter ratio and the soil property . When the net uplift load per pile in a group is equal to a single pile load, the upward displacement increased in the pile group due to interaction effects between piles. The obtained group efficiency under uplift loading is illustrated and found to be in a good agreement with previous studies.***

Keywords: cemented pile, sand. Testing tank

I. INTRODUCTION

A pile foundation is a civil engineering concept that is, at its most basic, a substructure that is supported by piles. Pile foundations are generally used to support compressive loads from superstructure. Some structures such as tall chimneys, transmission towers and jetty structures are subjected to overturning loads imposed by wind. In such cases, piles are required to resist uplift forces which are much greater than the weight of the structure itself. In addition to wind, marine structures and transmission line towers are hit by wave forces and line tension respectively. In cohesion less soils, the shaft resistance is an important source of pile capacity under axial loading, especially when the pile is subjected to uplift loading. uplift forces act on the supporting piles if structures such as dry docks, basements, and pumping stations are constructed below the water table.

II. MATERIAL

A. Soil

The soil used in the present study is collected from Bhadra river sand, Galagnath, Haveri. The grain size analysis test was carried out according to IS 2720 (Part 4)-1985. The basic and index properties of the sand are also determined in the laboratory according to IS Code of practices and the results are summarized in Table.1 the soil is graded as well graded soil and symbolic representation as *SW*.

Table.1 Basic index properties of Bhadra river sand

Parameters	Results
Specific Gravity (G)	2.45
Uniformity coefficient	2.9
Coefficient of curvature	1.01
Maximum dry unit weight ($\gamma_{d\ max}$) (kN/m^3)	18.5
Minimum dry unit weight ($\gamma_{d\ min}$) (kN/m^3)	17.0
Bulking of sand	38.46%
Bulk density (kN/m^3)	1.4055

B. Testing tank

The testing tank of size 1000mm x 1000mm x 1000mm was prepared using good quality wood of sufficient thickness. The dimensions of the tank are fixed taking care to avoid the boundary effects. The sides of the testing tank were strengthened in the horizontal direction using wooden planks of 40mm width and 20mm thickness to avoid the bulging of the tank during preparation of sand bed and also at the time of loading the pile.

C. Loading frame

The loading frame consists of two vertical steel L section channels of size 185cm width, 6mm thickness and height meter from the ground level. The two channels are spaced at a distance of 150 cm, and the horizontal C section steel channel used size of 4cm width, 6mm.Thick at the centre of the horizontal channel, we used hook for place the weights to apply the load.

D. Dial gauge

The two dial gauges are fixed to the steel bar which is connected to horizontal channel. The average of two Dial gauges readings should be taken.

E. Casting of piles

The model pile is casted in the laboratory the casting of the pile is carried out by preparing the mould of required dimensions are as length 25 cm and diameter 2.2 cm with Cycle steel bar of 1 mm is used as the reinforcement and cement slurry is poured

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in the prepared mould. After removing the pile from casting, curing is done for 28 days.

III. EXPERIMENTAL SETUP

The present investigation was carried out in the geotechnical engineering laboratory of the civil engineering department S.K.S.V.M. Agadi College, Laxmeshwar, Karnataka, India. All the tests were conducted using the setup shown in fig 2, which consists of sand tank, testing piles, loading frame, dial gauges and proving ring. The dial gauges, 5 tons with least count of (1div = 0.063KN) proving ring are of 25mm run with 0.001mm least count respectively. The following figure shows photo graphic view of experimental setup.

A. Preparation of Sand Bed

The procedure of sand pouring technique is explained below. The 5cm thread and bolt was fixed to the end of the fennel at downward direction and the sand is filled with the help of bucket in to the fennel, the tip of the bolt should touch at surface of bottom layer as goes on filling the sand the funnel should be rise up slowly to the touching the tip of bolt in to the surface of achieved sand layer, and required density is achieved after that the single pile should be placed at center of the box, and the sand pouring technique is continues till the full of wooden box, the surface of sand layer is leveled with the help of glass piece. The test was conducted in different types of densities such as low densities, high densities with cemented pile.

Fig.1: Shows the photo graphic view of experimental setup.

B. Loading procedure

The care is taken while placing the testing tank in such way that the Axial pullout loads were applied to the piles through double pulley arrangement The steel loading frame. movable along the length of chamber. The wire rope was taken first through an inverted pulley and then over the second pulley. Loading pan where dead weights were put for loading was fixed at the other end of wire And two dial gauges are fixed diagonally to measure the displacement of the pile on each side of the pile cap. The loads were applied by dead weights in the loading pan starting the smallest, with gradual increase in stages. Dial gauge readings were observed for both dial gauges for each increment of loading when it becomes stable. Average value of displacement as recorded from both the dial gauges have been taken as axial displacement of the pile corresponding to the pullout load applied. The load-displacement curve was plotted to determine the ultimate load carrying capacity, the testing tank was emptied and the same procedure is followed to carry out the other tests.

IV. RESULTS AND DISCUSSION

The load-Displacement curve is plotted from the test results, the ultimate load is obtained by the tangent intersection method, in which initial and final tangent lines are drawn to the load-Displacement curve and the point of intersection of these tangent line is the ultimate load (Qu).The load Displacement curves of cemented pile for the high density of 15.7kN/m^3 and low density of 14.81kN/m^3 is shown in figures 4.1,4.2,4.3 and 4.4,4.5,4.6 respectively, the ultimate load (Q_u) obtained from tangent intersection method for the cement pile for the density of 15.7KN/m³ is 0.003 KN and for 14.81 KN/m³,the ultimate load (Q_u) is 0.0025 KN. From which it is clear that load carrying capacity of the pile depends on the group of piles and density of sand.

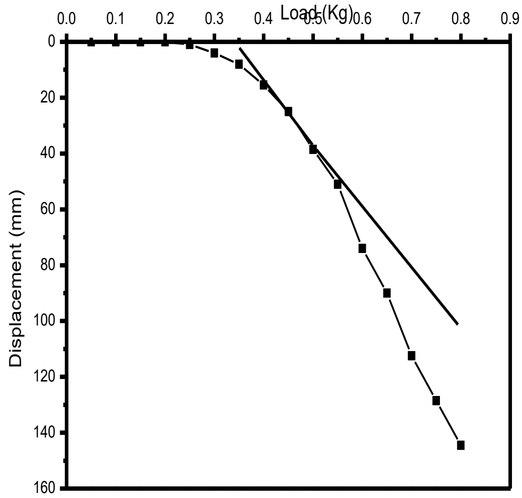

Fig.4.1: Shows single Cement pile embedded in high density of sand.

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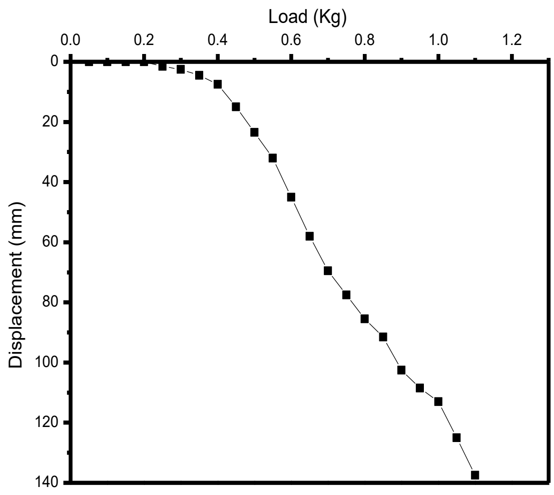

Fig.4.2: Shows double cement piles embedded in high density of sand.

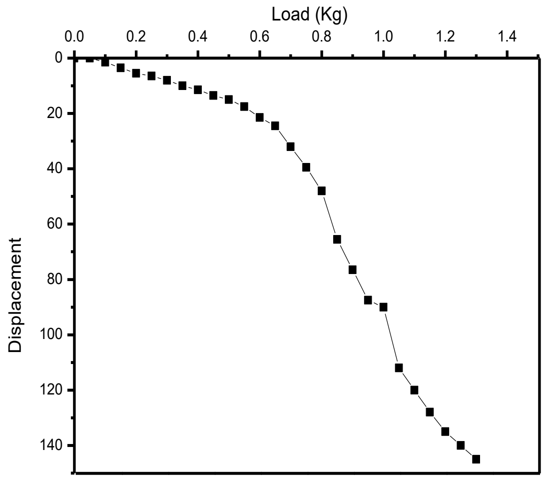

Fig.4.3: Shows three cement piles embedded in high density of sand.

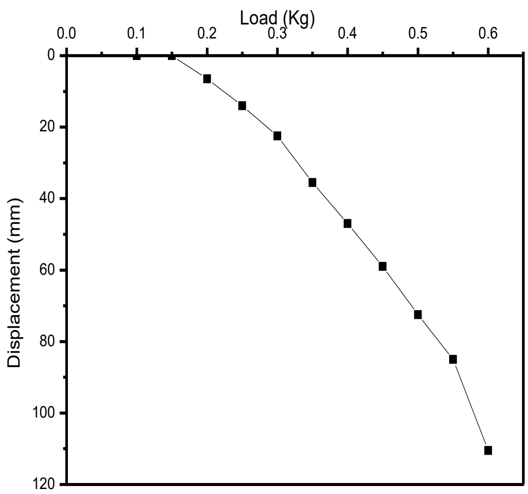

Fig.4.4: Shows single cement pile embedded in low density of sand.

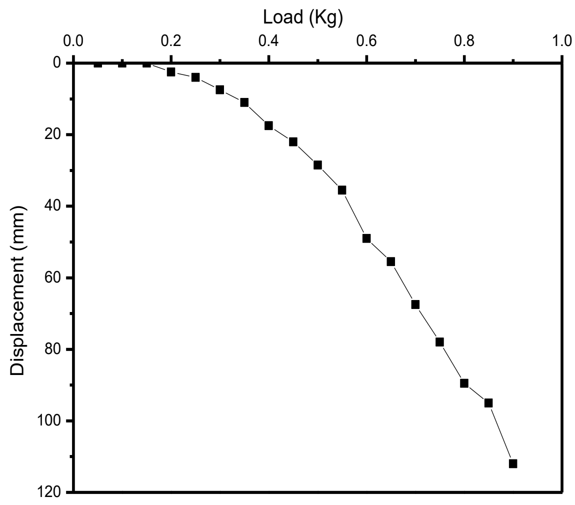

Fig.4.5: Shows double cement piles embedded in low density of sand.

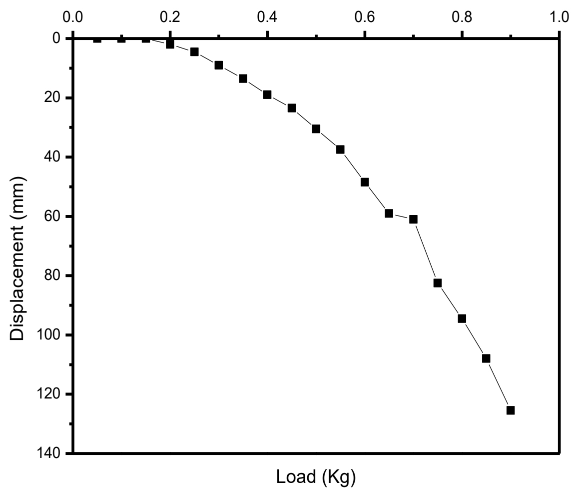

Fig.4.6: Shows three cement piles embedded in low density of sand.

V. CONCLUSIONS

Laboratory model test results for pile materials and density of sand have been presented. Based on the results, following conclusions were drawn.

- The increase in the density of soil leads to the increase in load carrying capacity
- The rate of Displacement is lesser at the initial loads and increases with the increase in the loading.
- As the angle of wall friction increases, the ultimate bearing capacity of piles also increases.
- The ultimate load carrying capacity of the pile is high in case of cemented pile as compared to timber piles. The ultimate load carrying capacity timber pile having low density is 0.070kN and for cemented pile having low density is 0.078kN.

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- The ultimate load carrying capacity of the pile is high in case of cemented pile as compared to timber piles. In the high density also the ultimate load carrying capacity timber pile having high density is 0.072kN and for cemented pile having high density is 0.090kN.

REFERENCES

1. Birger Schinidt (1987). Pull Out Capacity of Single Batter Pile in Sand. Canadian Geotechnical Journal. 24. pp. 467-468.
2. Chattopadhyay and Pise, P.J. (1986a). Uplift Capacity of Pile in Sand. Journal of the Geotechnical Engineering Division ASCE. 112. No. 9 paper No. 20919.
3. Clemence, C.P. and Brumund, W.F. (1975). Large Scale Model Test of Drilled Piers in Sand. Journal of the Geotechnical Engineering Division ASCE. 101. GT.6.paper No. 11369.
4. Das, B. M. (1983). A Procedure for Estimation of Uplift Capacity of Rough Piles. Journal of Soil and Foundation Division ASCE. 109. No.3. pp. 122-126.
5. Das, B. M. and Seeley, G. R. (1975b). Uplift capacity of buried model pile in Sand.
6. Journal of the Geotechnical Engineering Division ASCE. 101. No. 20. pp. 1091-1094.
7. Dickin, E.A. and Leung, C.F. (1990). Performance of Pile With Enlarge Base Subject to Uplift Force. Canadian Geotechnical Journal. 27. pp. 546-556.
8. Meyerhof, G. G. and Adams (1968). The Ultimate Uplift Capacity of Foundations.
9. Canadian Geotechnical Journal. 5. No. 4. Nov. pp. 225-244.
10. Dickin, E.A. and Leung, C.F. (1992). The Influence of Foundation Geometry on the Uplift Behavior of Pile With Enlarge Bases. Canadian Geotechnical Journal. 29. pp. 498-505.
11. Zheng zhang (2009), "Simplified nonlinear analysis methods for vertically loaded piles and piled raft in layered soil" Brdge science research institute, civil eng. Dalian university of technology, Dalian, Vol.14.
12. Basu .D, Salgado .R, Prezzi.M, Lee.J and Paik.K "Recent advances in the design of axially loaded piles in sandy soils" GSP 132 Advances in deep foundation, ASCE, 2012.
13. Poulos.G.H (1989), "Cyclic axial loading analysis of piles in sand" Journal of geotechnical and geo environmental engineering, ASCE, Vol.115. No.6, 1989.
14. Indian Standard-IS: 2720 (Part 3)1980 "Methods of test for soils, determination of specific gravity, fine, medium and coarse grained soils", New Delhi.
15. Indian Standard-IS: 2720 (Part 4)-1985 "Methods of test for soils, grain size analysis-mechanical method", New Delhi
16. IS: 2386 (Part III) – 1963 "Part III Specific Gravity, Density, Voids, Absorption and Bulking" Indian standard methods of test for aggregates for concrete.
17. 2911 (Part4)-1985 "Part 4 Load Test on Piles" Indian Standard Code of Practice for Design and Construction of Pile Foundations.