International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-4 Issue-3, July 2015

Evaluation of Axially Loaded Piles in Sand

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Abstract*— The load carrying capacity and settlement behavior of the axially loaded pile embedded in layered soils were studied. The piles are made up of cement mortar and timber is placed in sand medium of different densities. The piles are tested in a testing tank for different layer density combinations of homogeneous, loose over dense, dense over loose, loose layer sand witched between two dense layers and vice-versa etc. The experimental results shows that the ultimate load carrying capacity of the pile is found to be maximum and minimum in homogeneous layered soil of higher and lower density respectively. The load carrying capacity of a cemented pile is greater than timber pile for all types of densities. The rate of settlement is much greater in timber pile with low density sand.

Keywords: wooden pile, cemented pile, sand.

I. INTRODUCTION

A pile foundation is a civil engineering concept that is, at its most basic, a substructure that is supported by piles. When it becomes impossible to provide the suitable surface foundation for a structure; the use of pile foundations becomes necessary, this situation arose from either the soil condition or the order of bottom layers, the nature of the loads transferred to the soil or the nature of the site and operational conditions. The main components of the foundation are the pile cap and the piles .piles are long and slender members which transfer the load to deeper soil or rock of high bearing capacity avoiding shallow soil of low bearing capacity. The main types of materials used for piles are wood, steel and concrete .Piles made from these materials are driven, drilled or jacked into the ground and connected to pile caps. used as load carrying and load transferring systems for many years .In the early days Timber Piles were driven in to the ground by hand or holes were dug and filled with sand and stones. Steel piles have been used since 1800 and concrete piles since about 1900.

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.

Revised Manuscript Received on 30 Jun 2015.
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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*.

B. Screw jack

A hand operated screw jack having a capacity of five tons was used in the present work.

Table.1 Basic index properties of Bhadra river sand

Parameters	Results
Specific Gravity (G)	2.68
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
Angle of internal friction$(\Phi)_{min}$	25°
$(\Phi)_{max}$	36°

C. Testing tank

The testing tank of size 800mm x 800mm x 800mm 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.

D. 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, a hand operated screw jack is fixed in the inverted direction.

E. 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.

F. 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. Cycle steel bar of 1 mm is used as the reinforcement and cement slurry is poured in the prepared mould. After removing the pile from casting, curing is done for 28 days.

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A timber pile is made by cutting a wooden piece of 3cm×3cm and 30 cm long and driven in the lathe till the wooden piece turn in to cylindrical slender wooden pile of 2cm diameter.

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 and timber 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 vertical axis of the screw jack should pass through the axis of the pile. The proving ring was fixed between the screw jack and the pile to measure the load. And two dial gauges are fixed diagonally to measure the settlement of the pile on each side of the pile cap. The vertical load was applied to the model pile using screw jack which was fixed to the loading frame. The loading of the pile is done at the interval of two divisions per minutes and corresponding settlement was recorded. The displacement of the pile was taken as the average of the two dial gauge readings. The loading was continued till the settlement of the pile is just more than 10% of pile diameter. The load-settlement 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-settlement 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-settlement curve and the point of intersection of these tangent line is the ultimate load (Qu).The load settlement curves of timber pile and cemented pile for the density of 18.5kN/m^3 and 17.0kN/m^3 is shown in figures 4.1,4.2,4.3 and 4.4 respectively, the ultimate load (Q_u) obtained from tangent intersection method for the density 18.5kN/m^3 of pile materials wood is 0.072kN Whereas, for the density 17.0kN/m^3, the ultimate load (Q_u) is 0.058kN,and in cemented pile for the density 18.5kN/m^3 0.090kN and for 17.0kN/m^3, the ultimate load (Q_u) is 0.078kN. From which it is clear that load carrying capacity of the pile depends on the pile material and density of soil.

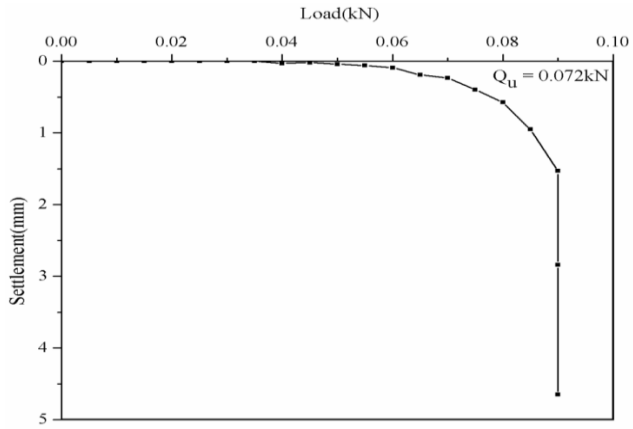

Fig. 4.1: Shows timber pile embedded in high density of sand.

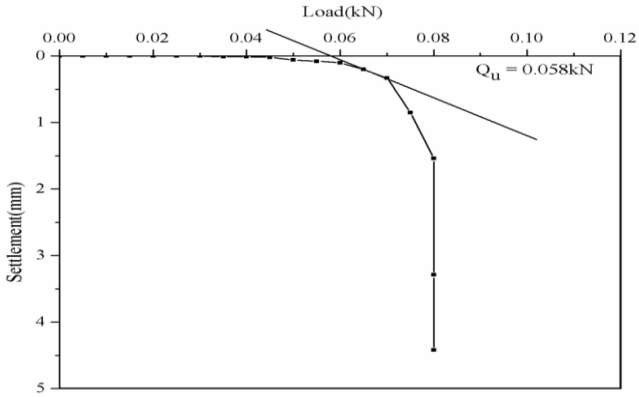

Fig. 4.2: Shows timber pile embedded in low density of sand.

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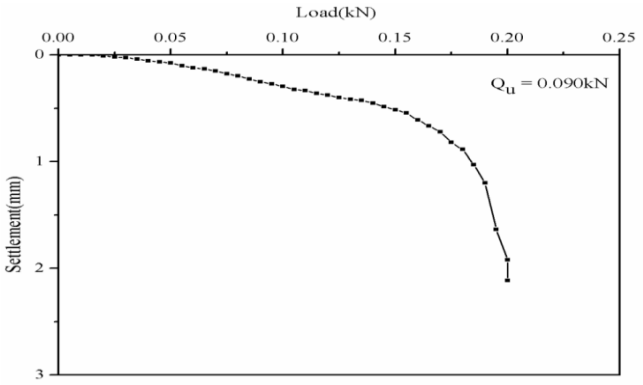

Fig. 4.3: Shows cemented pile embedded in high density of sand.

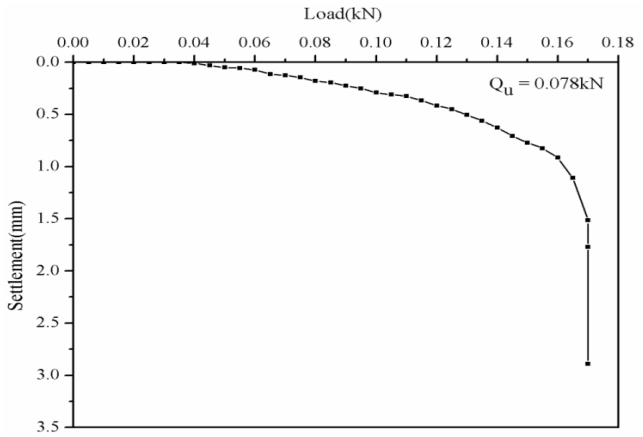

Fig. 4.4: Shows cemented pile embedded in low density of sand.

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 settlement 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.
- 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.

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