Uplift capacity of group pile under vertical loading in black cotton soil

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***Abstract* - As in the geotechnical engineering the uplift capacity of pile is shown to be the directly depending on the shear failure between the soil and pile. Where the pile failure also depends on the several factors like the frictional resistance of pile and soil type ie., into which strata the pile is embedded into. Hence in this uplifting testing setup a whole apparatus is made taking IS codes into consideration having a massive cylindrical tank of size 60cm diameter and 80cm height and 12mm thickness of the tank with 12mm thickness of plate as one end of the tank which is welded. And the whole tank is rested onto the frame of C-sections, angles and pulleys. And tensional wire which holds the pile and pile group onto its position. Hence the testing is done in the geotechnical laboratory of Parul University. The model piles were having the embedment depth to diameter ratios of 11. The soil used in testing is Black cotton soil. Here also the soil is saturated to 60percent, 75percent, 90percent of OMC and where MDD is seen to be remained constant while the time of testing. It is also observed that the results presented in the paper has shown the better professional understanding between the soil-pile uplifting interaction and the response of it to different loading conditions.**

***keywords* - uplift load capacity, single pile, group of piles, frictional resistance.**

I. *INTRODUCTION*

Pile foundations are hereby introduced into the strata of soil to transfer the loads coming from the superstructure to deeper strata of soil. When it comes to cohesive soils there plays a major role is angle of shearing resistance. In general the uplifting capacity of pile depends upon the angle of shearing resistance, Nature of soil, and several other factors hence there are several ways to increase the uplifting capacities of piles by increasing the frictional resistance of piles known as frictional piles or by increasing the diameter of base of piles known as belled piles. Hence To study the effect of pile length, pile diameter, shape, surface characteristics and pile tip properties on uplift capacity of piles, laboratory testing is carried out. The structures are constructed below the ground water table or if they are constructed under water then uplift forces are applied on the basement of the structures.

Black cotton soils are the most problematic soil when compared to other soils because of the expansive and shrinkage characteristics on the addition of water directly onto it. Hence as a result to which the BCS soil shows larger volume change in the monsoon and rainy season. As to which the moisture content of natural soil increases the degree of expansiveness also increases. Sometimes pavements are seen to heaved and cracks are formed on the surface of soils.

2. EXPERIMENTAL INVESTIGATIONS

Model piles were prepared from 50mm diameter and 550mm in length with using 6mm diameter steel rods as reinforcement and a steel bent hook of 6mm diameter to keep the tensional wire and pile in contact and to pull-out the pile from the cylindrical tank. The cylindrical tank was of 600mm*800mm*12mm in diameter, length, and thickness in dimensions respectively. The tensional wire was welded to the Anchor to which the bent hook of pile is connected and then pull-out testing is done by addition of weights on the other side of tensional wire and entire test setup.

3 PROPERTIES OF SOIL

3.1 Materials used: Black cotton soil

Table -3.1: Classification of soil as per IS CODES is **CH** TYPE OF SOIL

The results obtained are as follows:	
Liquid limit of soil on testing	45.8%
Plastic limit of soil on testing	22.0%
SF.Gravity of soil on testing	2.583
Free swell index	50%
Standard Proctor Test OMC MDD	 13.2% 1.98gm/cm3
Tri-axial tests Shear stress Cohesion intersect Angle of shearing resistance	 1.32kg/cm2 c=0.58(kg/cm2). 3° three degrees

Consolidation testing	Cc=0.221
Unconfined Compression Test	Qu=1.85kg/cm2 giveC= 0.926kg/cm2 Qu=1.59kg/cm2 giveC= 0.793kg/cm2

Sieving of entire soil required for testing is done.(4.75mm).

3.2 Pile Casting Images

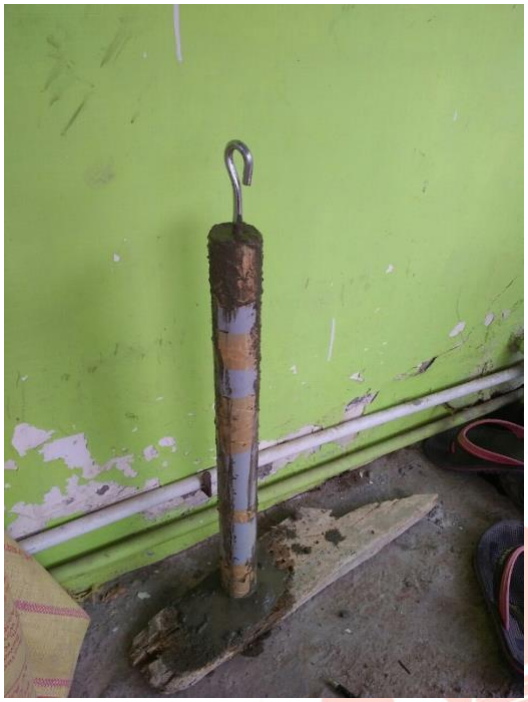

Fig3.2.1 The casting of pile

Fig 3.2.2 the setup of group pile

The Model concrete piles were prepared from 50mm diameter and 550mm in length with using 6mm diameter steel rods as reinforcement and a steel bent hook of 6mm diameter. Experiment was carried out with dial gauge sitting on top of pile where the dial gauge is fixed to the 5mm thickness angle bar as shown in fig1.1

Fig3.2.3 showing the placement of dial gauge on group pile.

4.Uplift capacity Testing for Single Pile (IS:2911, part iv, 2010)
Testing Procedure:

1. Take an oven dried soil sample of 150kg and thoroughly mix it with the water at different saturation percentage i.e., 60%, 75% and 90%.
2. Fill 60% saturated soil into the Tank and compact it in 5 layers giving 25 blows per layer with the ...kg rammer. The blows shall be distributed uniformly over the surface of each layer.
3. Between the placing of soil layers, place the concrete pile vertically on the existing compacted soil layer 250mm above the bottom of the tank.
4. Fill the tank up to 600mm height.
5. Place the Cast iron plate on the center of the pile.
6. Dial gauges were fixed on this plate with the support of angle which is having a thickness of 5mm, which was fixed by the screw to vertical angles.
7. Fix the horizontal angles to vertical channels.
8. Apply the vertical uplifting load gradually with the help of weights on the other side of the setup.
9. Take the reading of dial gauges and measure the weights.
10. Take out the soil and make tank empty.
11. Fill the tank again with 75% saturated soil and repeat the procedure (2-10) and then 90%saturation.

5. Observations

Pile Dimensions. = 550mm total length
Embedded length. = 450mm length
Diameter = 50mm
Tank Dimensions. = 800mm height,
600mm diameter
Dead Load = 0.04kN
Reinforcement bar = 6mm

6. Results *and Discussions*

60% Saturation

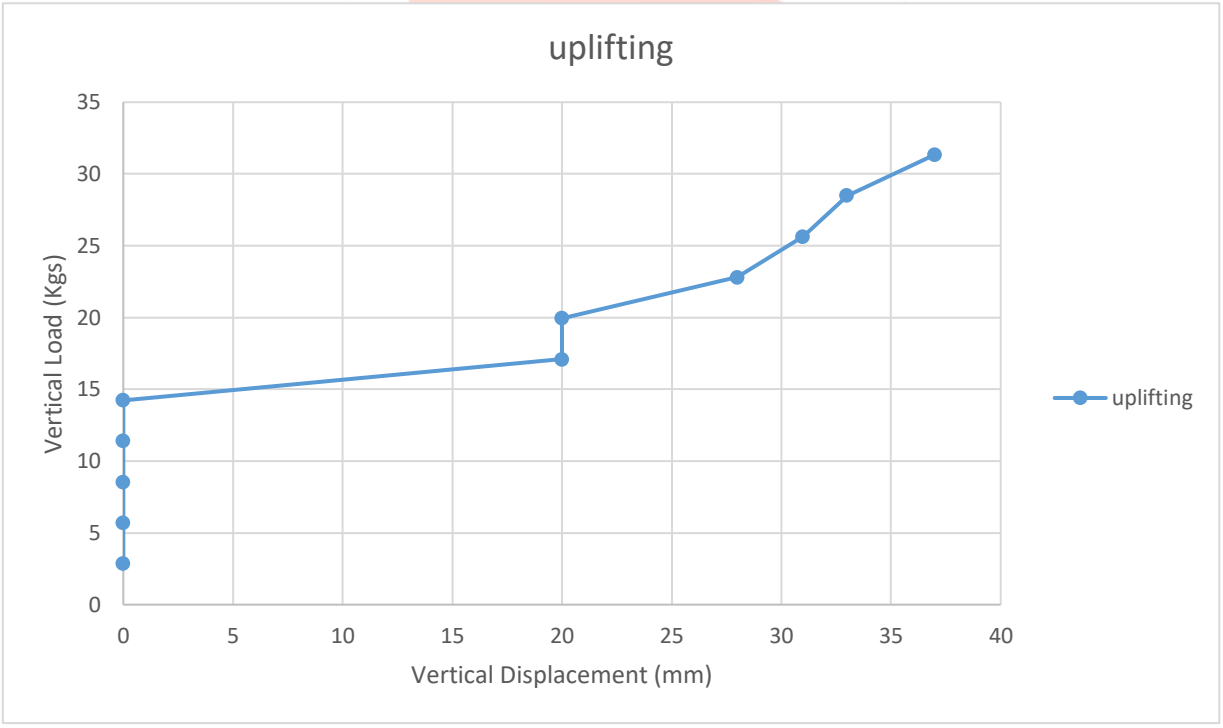

Fig. 6.1.1: Load-displacement for single Pile at 60% saturation.

***75%* Saturation**

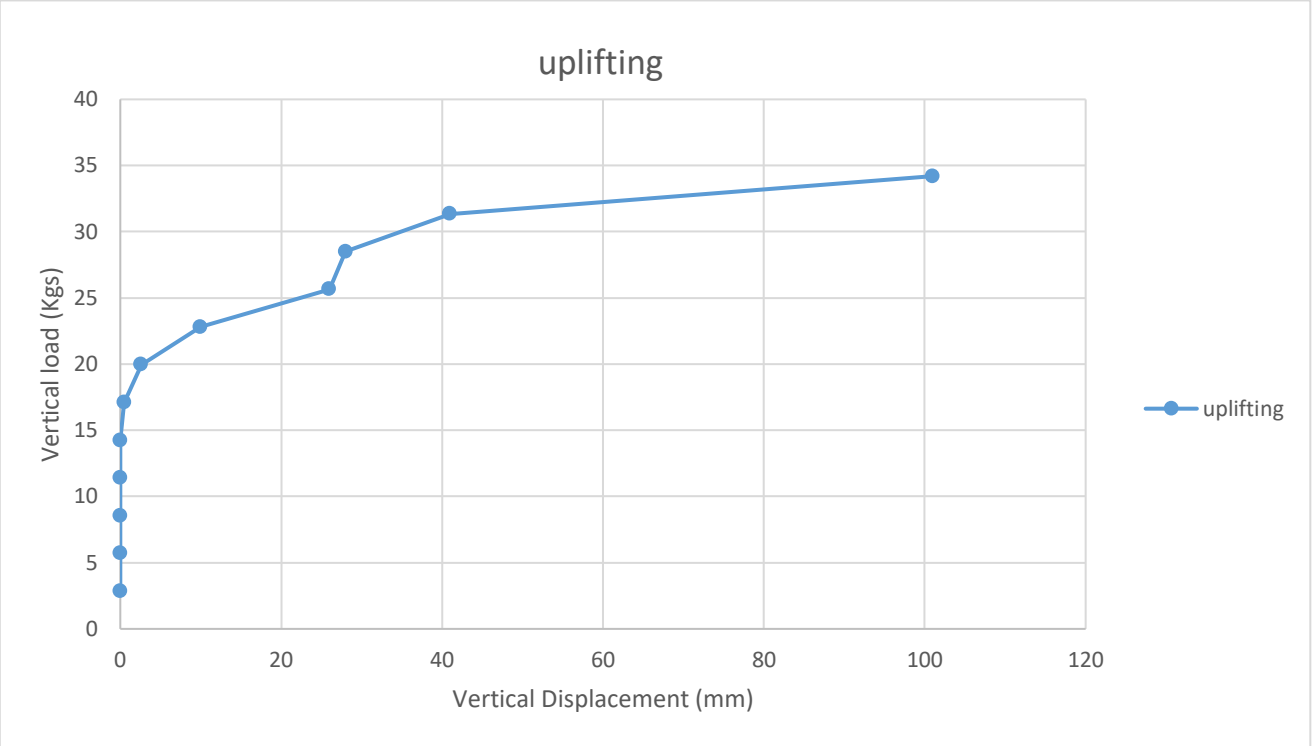

Fig. 6.1.2: Load-displacement for single Pile at 75% saturation.

90% Saturation

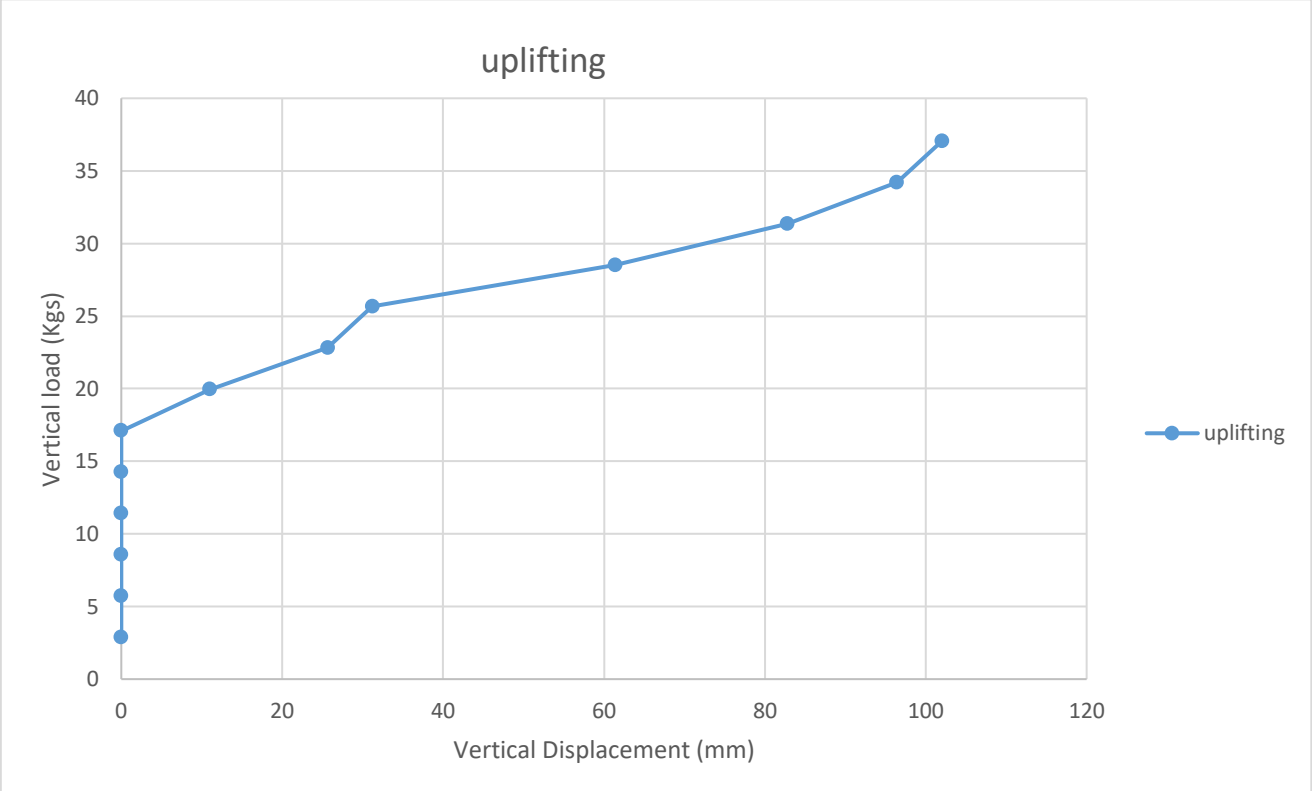

Fig. 6.1.3: Load-displacement for single Pile at 90% saturation.

Conclusions.

1. It is observed that laboratory concrete piles possessed higher uplift loading than calculated theory results.
2. Increase in water content in Black cotton soil tends to increase in uplift pressure of single pile.
3. Hence it is observed that further increase in density of soil resulted in increasing of uplift capacity.
4. The failure observed was a sudden failure resulting in pull-out of pile from the compacted soil placed the cylindrical tank.

5. As the saturation increases, the uplift capacity is seemed to increase till the state of OMC of Black Cotton Soil. And again decreases on further saturation of soil.

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