

# EXPERIMENTAL STUDY ON LOAD SETTLEMENT BEHAVIORS OF MICRO PILE UNDER VERTICAL LOADING

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**Abstract** - The micro piles are the one which are similar to piles but their diameter is less than 300 mm .The group micro pile is high performances, drilling and grouting the pile. It is used to resist the horizontal force that is acting additional to the vertical loading to the earth structures. The black cotton soil is swell or shrinking as the water content changes. The pile is transfer of the load below the stratum. The Micro piles have a smaller diameter than conventional pile. This pile composed of a central steel reinforcement circumferential by grout that fastens the pile with the soil.

The experimental model study of single and group pile with different spacing between the piles with four numbers of piles in a group. The piles were installed in black cotton soil and subjected to vertical loading. The Group efficiency of micro pile group having 2.0cm diameter spacing at 1 times the Diameter, 2 times the Diameter and 3 times the Diameter of group micro pile was determined. The group efficiency was commenced to be increasing with spacing from 1D to 2D. The pile group efficiency increases with increase in spacing. The group efficiency decreases as the length of the pile increases.

**Key Words:** diameter, micro pile L/d ratio 40%, 60%&80%.

## 1.0 INTRODUCTION

The micro piles are the one which are similar to piles but their diameter is less than 300 mm. These micro piles are having the central steel reinforcement. The central reinforcement was covered by mortar. The concreting was carried out by pressure grouting. The

grouting pressure will be in the range of 0.8 Mpa to 1 Mpa. To study the load settlement behavior of the micro piles, model studies were carried out on single micro piles and group of micro piles of different length. The study was also carried out for the group of micro piles placed at different spacing.

## 1.1 REQUIREMENTS OF PILE FOUNDATION

- ❖ The pile foundation is required to reduce differential settlement.
- ❖ The pile foundation of some structures as transmission off -shore platforms are subjected to uplift.
- ❖ In case black cotton soil is swell or shrinking as the water content changes. The pile is transfer of the load below the stratum.
- ❖ The collapsible soils as loess a breakdown and sudden decrease in void ratio and increase in the water content.
- ❖ It is used to resist the horizontal force that is acting additional to the vertical loading to the earth structures.

## 2. CLAYEY SOIL

The soil used in this study was self-possessed from Kodaganura region, Davangere. That site clay sample is collected form Disturbed and undisturbed clay soil

obtained by open dugout from the draft of 1.5 meter underneath the consistent ground surface.

Table -1: Property clayey soil of soil

PROPERTY	VALUES
Specific Gravity	2.72
Water content	28%
Liquid Limit	62.85%
Plastic Limit	21.18%
Plasticity index	41.67%
MDD	15.2 KN/m <sup>3</sup>
OMC	27.2%
Undrained cohesion	11.348 KN/m <sup>2</sup>
free swell index	45.47%

The clay soil will obtain air dried and pulverized systemically. The black cotton soil should be passing 4.75 mm Indian standard sieve using for the practice and all the test are determined as per is code 2720 standard . The properties of expansive clay shown in above table.

**2.1 EXPERIMENTAL PROCEDURE**

Test was conducted in square test tank. It was built up of mild steel plate obtain size 300×300×300 mm and the thickness 3mm. The test tank size was decided by the footing size. The width of footing was 120×120×6 mm thick. The model footing made up of mild steel plate. The air desiccated to the soil was composite to the optimum water content 27.2%. And the soil was

permeated to the square test tank in three covering and tamping was made to achieve the required density.

The micro pile was casted in UPVC pipes. The micro piles were made by mixing the cement & sand at equal proportion of 1:1. By keeping the reinforcement at the centre of UPVC pipe. Micro pile was cured for days. The model test was carried out on these micro piles for different L/d ratio. The test tank was filled with black cotton soil, micro piles were inserted within the soil at spacing. The footing was placed over the inserted micro piles and the load was applied over the footing plate through the loading jack. The same procedure was repeated for L/d ratios.



Fig 1.0 Experimental setup with a square tank and dial gauge

**2.2 RESULTS AND DISCUSSION**

**2.2.1 SINGLE MICRO PILE**

In this model study, test were conducted under different length and spacing condition. The first test is conducted on single micro pile for varying L/d ratio. Single micro pile test was also conducted for different

length and spacing (1D, 2D 3D) conditions. The load settlement behavior was observed for the entire single micro pile test. The settlement was observed upto 25mm.

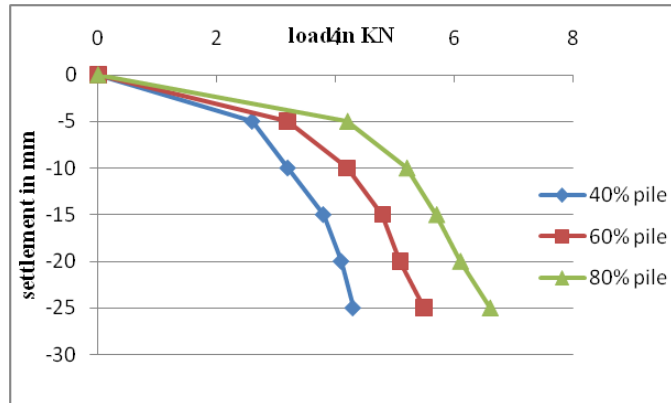


Fig 1.1 Load -settlement plotting on L/d ratio

### 2.2.2 ULTIMATE LOAD CAPACITY

From the graph it is clear that, for different L/d ratios of single micro pile the load carrying capacity increases in a linear manner

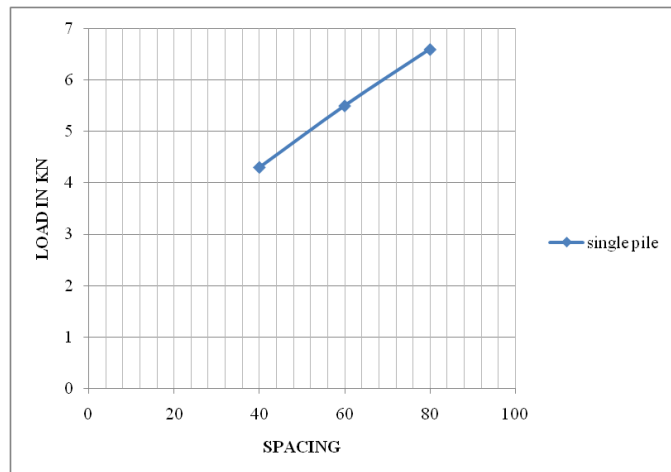


Fig 1.2 Load in KN v/s spacing

### 2.2.3 MICRO PILE GROUPS

To study the group efficiency of the micro piles, tests were conducted for the different L/d ratios and spacings of micro piles.

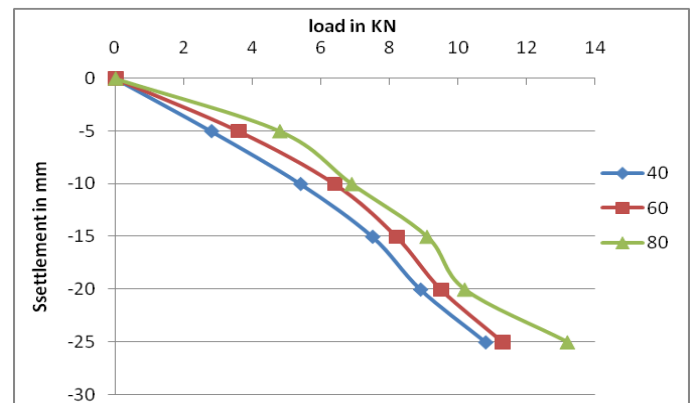


Fig 1.3 Load -settlement plotting on L/d ratio with 1D spacing.

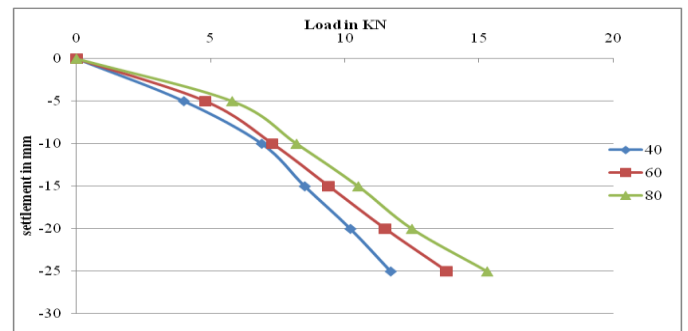


Fig 1.4 Load -settlement plotting on L/d ratio with 2D spacing.

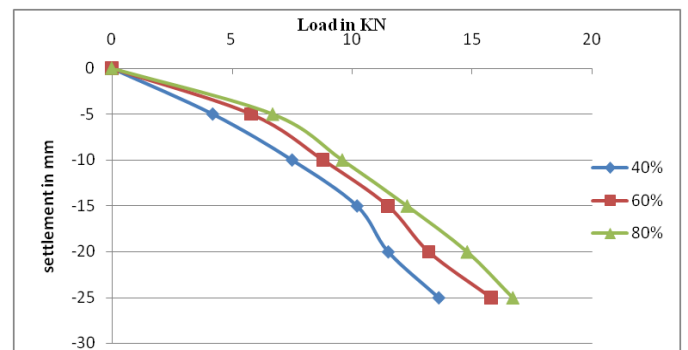


Fig 1.5 Load -settlement plotting on L/d ratio with 3D spacing.

### 2.2.4 ULTIMATE LOAD CAPACITY

The group micro pile on the different Length and spacing for the ultimate load capacity increases with the increase in Length 40%,60%&80% and spacing (1D,2D&3D) the plotting the graph load v/s spacing

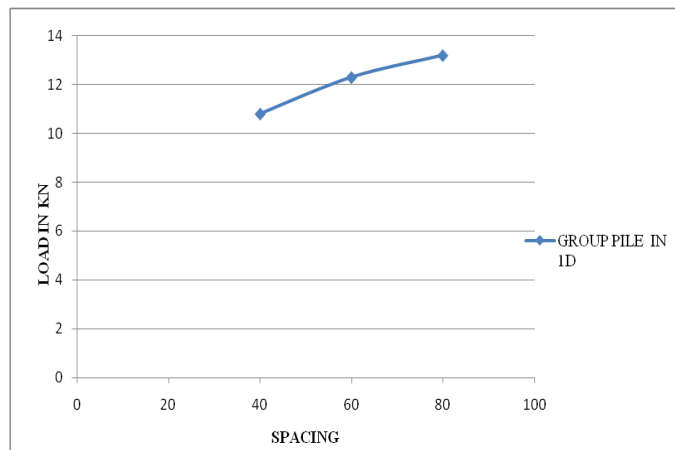


Fig 1.6 Load v/s L/d ratio spacing 1D

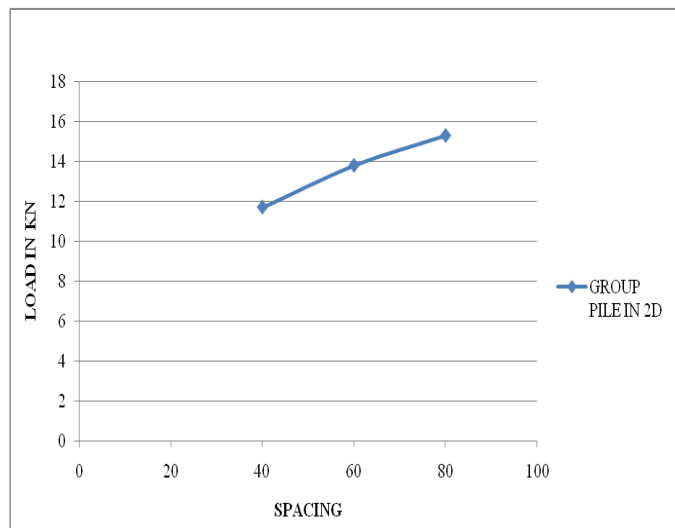


Fig 1.7 Load v/s L/d ratio spacing 2D

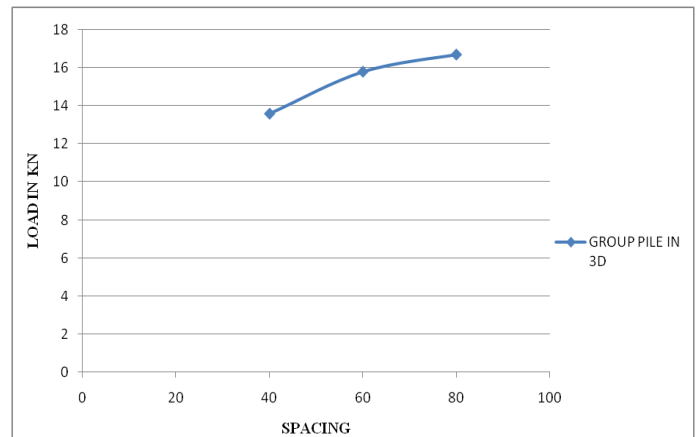


Fig 1.8 Load v/s L/d ratio spacing 3D

### 3.0 GROUP EFFICIENCY

The pile batch efficiency is specifying into the ratio definite group accommodation into the value of the characteristic pile expanse. The group efficiency depends mainly on the spacing between piles, type of soil in which the pile are installed and the manner of pile installation that is driven, bored, cast in –situ etc...

The pile group efficiency, for the piles under vertical loading is calculated from the formula given below.

$$\eta = (Q_g/nQ_s) \times 100$$

Where:

$\eta$  = group pile of the efficiency

$Q_g$  = group pile under vertical capacity

$Q_s$  = single pile under vertical capacity

$n$  = pile numbers

The group pile efficiency for the group pile at 1D, 2D and 3D spacing had been determined

Table-2 Group micro pile efficiency for different spacing

Length (cm)	L/d ratio	Single pile (qu)kN	Group pile (qu) kN			Group efficiency		
			1D	2D	3D	1D	2D	3D
12	6	4.3	10.8	12.3	13.2	0.62	0.72	0.79
18	9	5.5	11.7	13.5	15.3	0.55	0.64	0.71
24	12	6.6	13.6	15.8	16.7	0.5	0.57	0.63

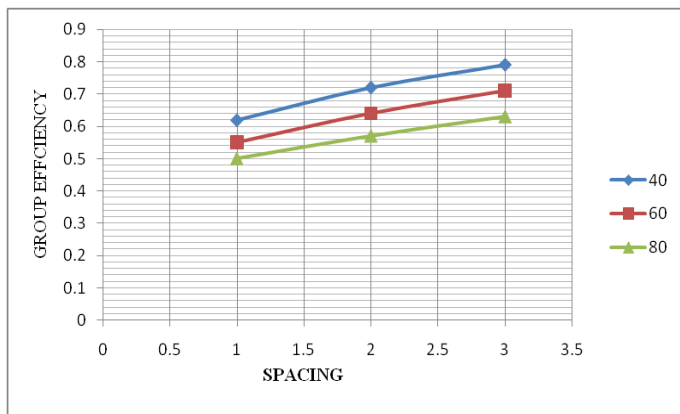


Fig 1.9 Group efficiency v/s spacing

#### 4.0 CONCLUSIONS

The test was conducted in a square tank. From the load v/s settlement graphs ultimate bearing sufficiency of the group piles were determined from the group efficiency v/s spacing plots the group efficiency of the piles were determined.

- ❖ The pile group efficiency increases with increase in spacing.
- ❖ The group efficiency decreases as the length of the pile increases.

- ❖ To installation of the group micro piles in the weak soil is one of the methods of ground improvement technique.

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