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A Model Study on Effect of Pattern on Group Efficiency of Micropile

Aswathy P.A.[1], Meera Manuel[2]

[1]MTech student (Geomechanics & Structures), Jai Bharath College of Management & Engineering technology, Ernakulam, Kerala, India

[2]Assistant Professor, Department of Civil Engineering, Jai Bharath College of Management & Engineering technology, Ernakulam, Kerala, India

Abstract: ***The micropiles are small diameter (100-300mm) non displacement piles. It can be favored over conventional piles, because they can be drilled under difficult subsoil conditions, where conventional piles cannot be constructed, and can be used for strengthening the existing foundation or retrofitting. The capacity of micropiles depends on the micropile size and subsurface profile. In this study, the effect of pattern on group efficiency of micropiles on sand was studied. Load test was carried out on a model footing resting on sand with and without Micropiles. Group efficiencies of micropile groups having 20mm diameter spaced at 2D, 3D and 4D, where D is the diameter of the micropile, arranged in triangular and square pattern were determined. The preservation of natural aggregate is also an aim of this study. In order to preserve this naturally available material, the micropile is casted by replacing the fine aggregate with 2% of PET bottle fiber.***

Keywords: micropile, pattern, group efficiency, PET

1. Introduction

The construction activities in coastal area of our country often demand deep foundation because of poor engineering properties and the related problems arising from weak soil at shallow depth. The soil profile in coastal area often consists of very loose sandy soils extending from the ground level underlain by clayey soils of medium consistency. Hence structures built on these soils may suffer from excessive settlements. This type of soil profile is very common in coastal areas of Kerala, especially in Mulavukad. In this region soil requires deep foundation such as pile foundation even for low rise buildings. The installations of conventional piles are expensive and can't be affordable for small construction works. The introduction of micropile, in construction industry, is a good solution to overcome this problem. Micropile installation is economic, simple, and cost effective and can be used to improve the engineering properties of soil.

Micropiles are constructed using high-strength, small-diameter steel casing or threaded bar. The strength of grout used for micropile construction can be increased by partially replacing the aggregate by fly ash, silica fume, different type of fibers etc, but these methods are expensive. So the additive should be replaced by locally available low cost material. The PET bottle fibers from waste plastic bottles can be used to increase the strength of the grout.

2. Materials Used

2.1 Soil

Soil used for this study was collected from Mulavukad region, Ernakulam District. Disturbed and undisturbed samples were collected. Various index properties and engineering properties of the soil were found out. Properties of the soil are given in Table1.

Table 1: Properties of Soil

Property	*Value*
Field density	13.86 kN/m^3
Field moisture content	24.55%
Specific gravity	2.67
Direct shear test results Cohesion Angle of internal friction	 1.125 kg/cm^2 20^0
Percentage of coarse particles	94.005%
Percentage of fine particles	5.995%
Uniformity Co-efficient, C_U Coefficient of curvature, C_C	2.31 1.356
Maximum dry density	1.37g/cm^3
Optimum moisture content	5.5%

2.2 Fine Aggregate

M sand conforming to zone III was used to prepare the grout. The properties of fine aggregate are shown in Table 2.

Table 2: Properties of Fine Aggregate

Property	*Value*
Specific gravity	2.62
Fineness	2%
Moisture content	2.4%
Water absorption	2%

2.2 Cement

53 grade Ordinary Portland cement, were used in this investigation. Table 3 shows the properties of cement.

Table 3: Properties of Cement

Property	*Value*
Specific gravity	3
Fineness modulus	2%
Consistency	32%
Initial setting time	33 min.
Final setting time	360 min.

2.3 PET Bottle Fiber

PET bottle fibers passing through 4.75mm IS sieve were used for this study.

3. Experimental Program

The sand bed for the test was prepared in a tank of plan dimensions 280mm x 280mm and depth 300mm, by pouring the sand in four layers. The surface of each layer was provided with a uniform compaction for achieving the field density.

As the micropiles are non-displacement piles, a pipe was placed in the sand bed with corresponding diameter to make a hole where micropile to be casted. The micro piles were casted using 53 grade cement and sand in the ratio 1:1 with water cement ratio 0.5 .The pile is to be provided with a central reinforcement having a diameter of 2mm. As the grouting progresses the pipe was withdrawn from the hole.

Micropiles having diameter 20 mm were casted in triangular and square pattern by varying the spacing as 2D, 3D and 4D, where D is the diameter of micropiles. Then the micropiles were kept for curing for four days. Figure 1 shows the four group micropile and Figure 2 shows the three group micropile.

The load deformation behaviour of the soil was studied by applying axial load. A model footing square plate of plan dimension 100 x 100 mm and 6 mm thickness was selected and was placed over the casted micropile, so that the centre of plate coincides with the centre of reaction. The load was applied at a constant rate of 3 mm/min. The load is applied without impact, fluctuation or eccentricity. Settlements were observed for each increment of load after an interval of 1, 2.25, 4, 6.25, 9, 16 and 25 min and thereafter at hourly intervals to the nearest 0.02 mm. The next increment of load was applied and the observations repeated. The settlement readings up to 25mm were recorded. Vertical loading on micropile is given in Figure 3.

Figure 1: Four Group Micropile

Figure 2: Three Group Micropile

Figure 3: Vertical loading on Micropile

4. Result and Discussions

The vertical load tests were conducted on the micropiles with triangular and square pattern in 2D, 3D and 4D spacing. The loads corresponding to 25mm settlement were recorded for each pattern. Table 4 shows the ultimate load corresponding to each pattern with varying spacing.

Table 4: Ultimate Load for different pattern of micropile

Spacing	*Ultimate load (kN/m^2)*		
	Single pile	*Triangular pattern*	*Square pattern*
2D		19.42	24.42
3D	12.98	24.38	31.78
4D		21.57	27.84

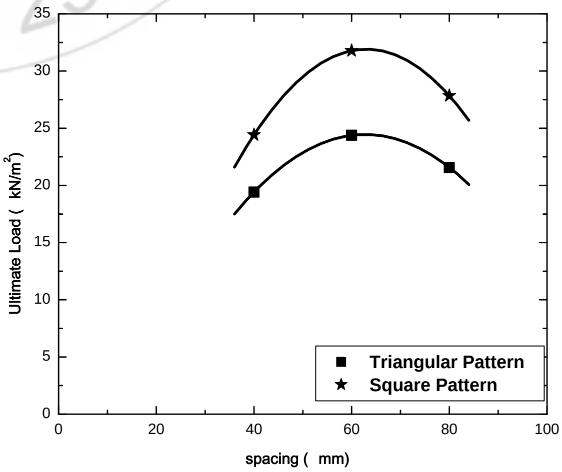

Figure 4: Ultimate Load Vs Spacing

In the study of piles under vertical loading, efficiency is used to evaluate the group effect:

$$\eta = Qg/nQs$$

Where η= efficiency of the pile group
Qg = axial capacity of pile group
Qs= axial capacity of single pile
n = number of pile group

The group efficiencies of the pile groups at 2D, 3D, and 4D spacing had been determined. Table 5 shows the group efficiency of the various pile groups that studied in experiment.

Table 5: Group efficiency for different pattern of micropile

Spacing	*Group efficiency (%)*	
	Triangular pattern	*Square pattern*
2D	50	47
3D	63	61
4D	55	53

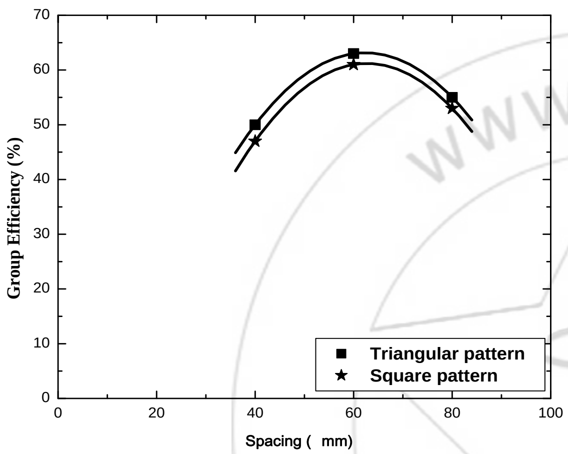

Figure 5: Group Efficiency Vs Spacing

Group efficiency for 20mm diameter micropile with triangular pattern and square pattern are shown in Figure 5. From the graph, it is clear that the group efficiency is maximum, when the spacing between the micropiles is 3 times the diameter of micropile. By analyzing the figure, it can be seen that for different spacing, maximum group efficiency has been obtained for micropiles with triangular pattern.

5. Conclusions

- The load bearing capacity is remarkably increased using both single and group micropiles in marine sand.
- The strength improvement was noted to be affected by spacing in such a way that the group efficiency increased with increase in spacing from two times diameter to three times the diameter of micropile and found a reduction with four times the diameter spacing.
- The pattern of pile is a factor that influences the strength improvement of micropile. The micropiles with three times diameter spacing in triangular pattern of pile had greater efficiency than square pattern of pile.

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Author Profile

Aswathy P.A. received the B.Tech and M.tech degrees in Civil Engineering from Mahatma Gandhi University in 2014 and 2016, respectively.