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"A MODEL INVESTIGATION ON EFFECT OF PATTERN ON GROUP EFFICIENCY OF MICRO PILE IN BC SOIL"

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Abstract

This study had made to reinforce the problematic black cotton soil and to avoid the settlement of the foundation, by installing Micro-Piles (M-P) individually and in group. In the group piles, the three pile group and four piles group is adopted in this study. The three pile group is installed in triangular pattern, whereas the four pile groups installed in square pattern at different length and different spacing, also the group efficiency is determined for both patterns and is compared with each other. The model tests were performed with the use of mild steel model test tank of dimension 350mm in length, 350mm in width, 350mm in depth and the model footing of the size 140mm x 140mm of 6mm thick. The analysis was carried out for individual and group piles of respective pattern which are installed in the black cotton soil with different lengths i.e. 30%, 50% and 70% of length and spacing of 2D, 3D and 4D respectively, where D=dia of micro-pile. The vertical load is applied to experimental setup and the ultimate bearing resistance is recorded with respect to 30mm settlement. It is examined that, the ultimate loads bearing resistance of the M-P in Black Cotton Soil rises with increase in length and spacing between the piles. Due to upraise in the load holding capacity, inversely the foundation settlement also decreases, it also observed that the load taken by the piles increases with increase in their numbers. The maximum load of 14.6 KN and 18.8KN is observed in three and four numbers of piles and 7.8 and 13.5KN is the least loads observed in

three and square group piles respectively. When it comes to the Group efficiency (GE), it is found that the GE decrease with increase in the length, but the GE elevates with increase in distance between the piles, the GE observed in different patterns of triangular and square pattern of group piles. It is observed that the GE has a peak value of 79.24% in Square pattern at 30% of length and spacing of 4D, minimum value of GE is found to be 42.59% in triangular pattern at 70% length i.e. 245mm length at spacing of 2D.

Key Words: Black cotton Soil, SCBA, Micro Piles, CPVC Pipes, Ultimate Bearing Capacity.

1. INTRODUCTION

Micro-piles (M-P) are those piles having pile diameter ≤ 300mm, and they are drilled grouted piles, which are usually introduced for any type of soil. They have been utilized all through the world for strengthening and retrofitting the foundations. The micro piles will contain focal reinforcement and encompassed by a grout collection of concrete around the reinforcement which permits transfer of tension and compressive forces to the deep hard stratum. Micro piles are utilized to strengthen the soil and to help the foundation. It is very well suited to increase the strength of existing foundation through skin friction and about to bring a strong composite firm soil mass. Because of its little dia, mini-piles can be utilized at any size of ground conditions. It is progressively being utilized, more than that of the normal one as it is considered affordable and requires less time for its construction. Micro piles, introduced by Dr. Fernando Lizzi in 1950 in Italy, were successfully used to re-establish the designs and landmarks which were harmed during World War II. From 1960 onwards mini-piles were utilized worldwide for supporting old precious constructions and as soil support. Micro-piles can withstand both vertical and horizontal loads and are profoundly adaptable in any condition, so it can also be used in seismic regions.

2. LITERATURE REREVIE

Lekshmi S, Roshni Chacko, Sruthi Vinod, Treesa Jose, Joe G Philip (2020) : In this research A tank of dimensions 300mm*300mm and depth of 600mm is full of soil and a metal plate of dimensions 80*80mm is used as footing. The micro piles are located across the footing and load is implemented. The corresponding settlement is noted the use of dial gauges. Another trail was carried without micro piles across the footing are also examined. Settlement of soil bed is more when load is applied directly on the plate without micro piles. For group micro pile of 12mm diameter all-round the metallic plate, the weight is carried out and by adding the number of piles, with increase in their length and decreasing space between them, reduces the settlement of foundation.

Vikas Kumar, Abhishek Arya (2019): In this paper, the laboratory work involved soil stabilized with varying percentages of sugar cane bagasse ash (3%, 5%, 7%, 10%, 15%, 20%, 25% and 30%) by dry weight of the soil individually. The results of conducted tests show that initially OMC of soil is (21.9%) and for addition of bagasse ash up to (30%) it becomes (34.52%) and the increase is about (57.6%), to the contrary the initially MDD of soil is (1.59 gm/cm3) and for addition of bagasse ash up to (30%) it has become in decrease upto (1.11

gm/cm3) where the reduction is about (30.2%). For attterbergs limit ,the results of it at 30% bagasse ash is slightly lower than it for nature soil and the reduction is about (4.9%) for liquid limit , (2%) for plastic limit and (2.9%) for plasticity index. Finally, for the specific gravity (Gs) the initial value of it for soil is (2.7) and for (30%) bagasse stabilized soil decrease to be (2.5) with reduction about (0.2%).

Syed Minhaj Saleem Kazmi et al.(2017): The outcome of this paper is that, Single positive battered micro piles are more resistant to lateral load than vertical micro-piles. Single negative battered micro piles are much less proof against lateral masses than vertical micro piles. Pile companies having each batter and vertical piles are greater proof against lateral loads, the groups having both batters and vertical pile provides high resistance to the horizontal loads, when compared to the group of piles consisting of vertical piles. And group of piles with positive batterapiles is better than that of negative one.

Jin-Tae Han, Chengcan Wang (2019): This investigation evaluates the effect of the pile stiffness in load sharing activity of the piles at the time of extension of the old building. Here, a sequence of 1g model tests were conducted at 1/20 scale factor to analyse the performance of M-P of varying stiffness. The assessment was done based on the reduction in total settlement and load bearing capacity. The outcomes concluded that performance is improved with increase in the pile stiffness. And load carrying ability of the existing building increases linearly with increase in stiffness.

NiharbGogoi, SanandambBordoloi and BinubSharma (2014): the M-P‟s were used for retrofitting the structural unit and it is technically feasible and of low cost. The model experimentation was carried out on the sand, with maximum and minimum void ratio. The single and group of 4 piles were used here of different L/D ratio and experiments were carried out by applying axial load and ultimate axial resistance was calculated. The group efficiency increases with increase in spacing, such that the maximum efficiency is observed at 4D spacing of group piles. Also observed that efficiency depends on the L/D ratio also fiber content.

3. MATERIALS AND METHODOLOGY

Table 1: Properties of black cotton soil

SI NO	PROPERTIES`	Values
1	Specific Gravity	2.71
2	Water content	26%
3	Liquid Limit	61.3%
4	Plastic Limit	21.05 %
5	Plasticity index	40.25 %
6	Maximum Dry Density	15.4 KN/m^3
7	Optimum moisture content	28%
8	Unconfined Compression strength	0.136 N/mm^2
9	Percentage of Sand particles	28.3%
10	Percentage of silt and clay	71.7%
11	Indian soil Classification	CH
12	Free Swell index	45.0%

Fig 3.1: Black Cotton Soil

CEMENT AND SAND

The micro-piles used for this test were casted using cement of grade 53 and the sand passing through 4.75mm IS. The sand and cement were blended in the ratio of 1:1, with the water cement ratio 0.45. And central reinforcement of 2mm dia mild steel is used.

TECHNICAL INSTRUCTION OF CPVC PIPES

CPVC are those which are thermoplastic, which is manufactured by chlorination of polyvinylchloride resin. The CPVC pipes are excellent resistance to aggressive environments and the both naturally occurring and result of industrial activity. The CPVC (chlorinated polyvinyl chloride) pipes are more flexible and have a capability to withstand the high temperature. The CPVC is non-conductor, galvanic and no chemical effects occur in CPVC pipes.

Table 2: Properties of CPVC pipes

SL No	Test	Value
1	Specific gravity	1.50-1.53
2	Water Adsorption	0.03%
3	Compression strength	70 N/mm^2
4	Tensile strength	55 N/mm^2
5	Flexural Strength	104 N/mm^2

Methodology

For the current experimentation the square mould of test tank is utilized. The dimension of the mould is decided based on the dimension of footing. The square mould of dimension is 350mm in length, 350mm in width and 350mm in depth, which is made up of MS steel of 3mm in thick. The model square footing of dimension 140mm x 140mm and 6mm in thickness. Before conducting the experiments the M-P‟s of different lengths were casted using cpvc pipes and cured for 15 days. Then the air dried black cotton soil is taken then mixed with OMC of 28%, then the soilssample is filed into the square mould in layers and compacted to achieve the required density of soil. Once this is completed then the piles were inserted individually and in group into the compacted soil bed at the centre. Then the mould is placed in UTM, and the footing is placedbover the inserted pile, then the vertical load is applied through the loading jack and the dial gauge is placed to record the settlement. The ultimate load reading is taken for each trail at maximum settlement of 30mm, also the corresponding reading at the 5, 10, 15, 20, 25 and 30mm were also noted. This method is replicated for the various lengths i.e. 30% of length (105mm), 50% of length (175mm) and 70% of length (245mm) and spacing of 2D, 3D and 4D between the piles. The above all steps are replicated for every testing of other criteria

Fig 3.2 : Test Arrangement using UTM

PILES 2D, 3D AND 4D PATTERNS

Fig 3.3: Top and C/S view of single pile with different lengths.

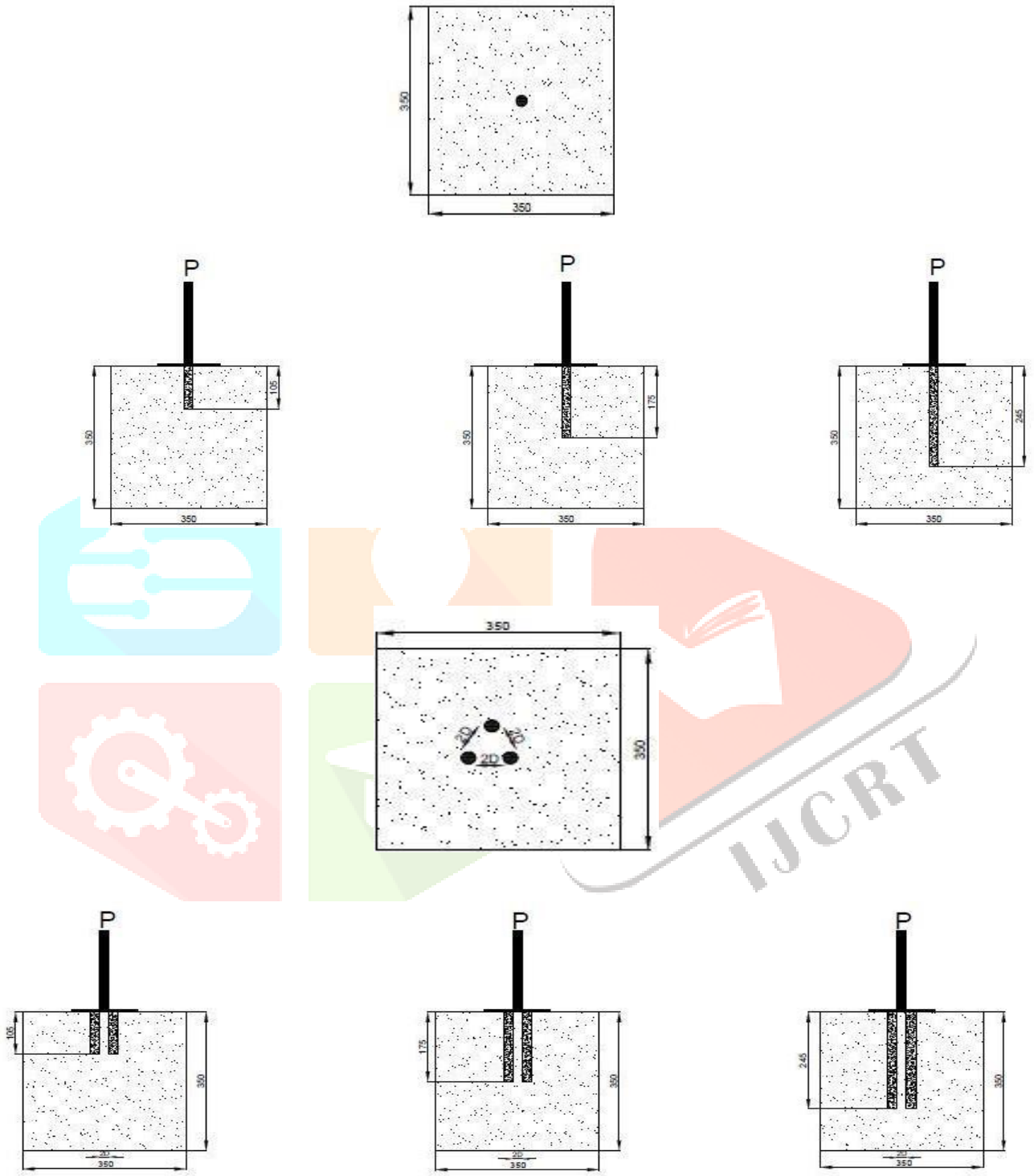

Fig 3.4: Top and C/S view of change in length of triangular pattern piles at 2Dspacing.

Fig 3.5: Top and C/S view of change in length of triangular pattern piles at 3Dspacing.

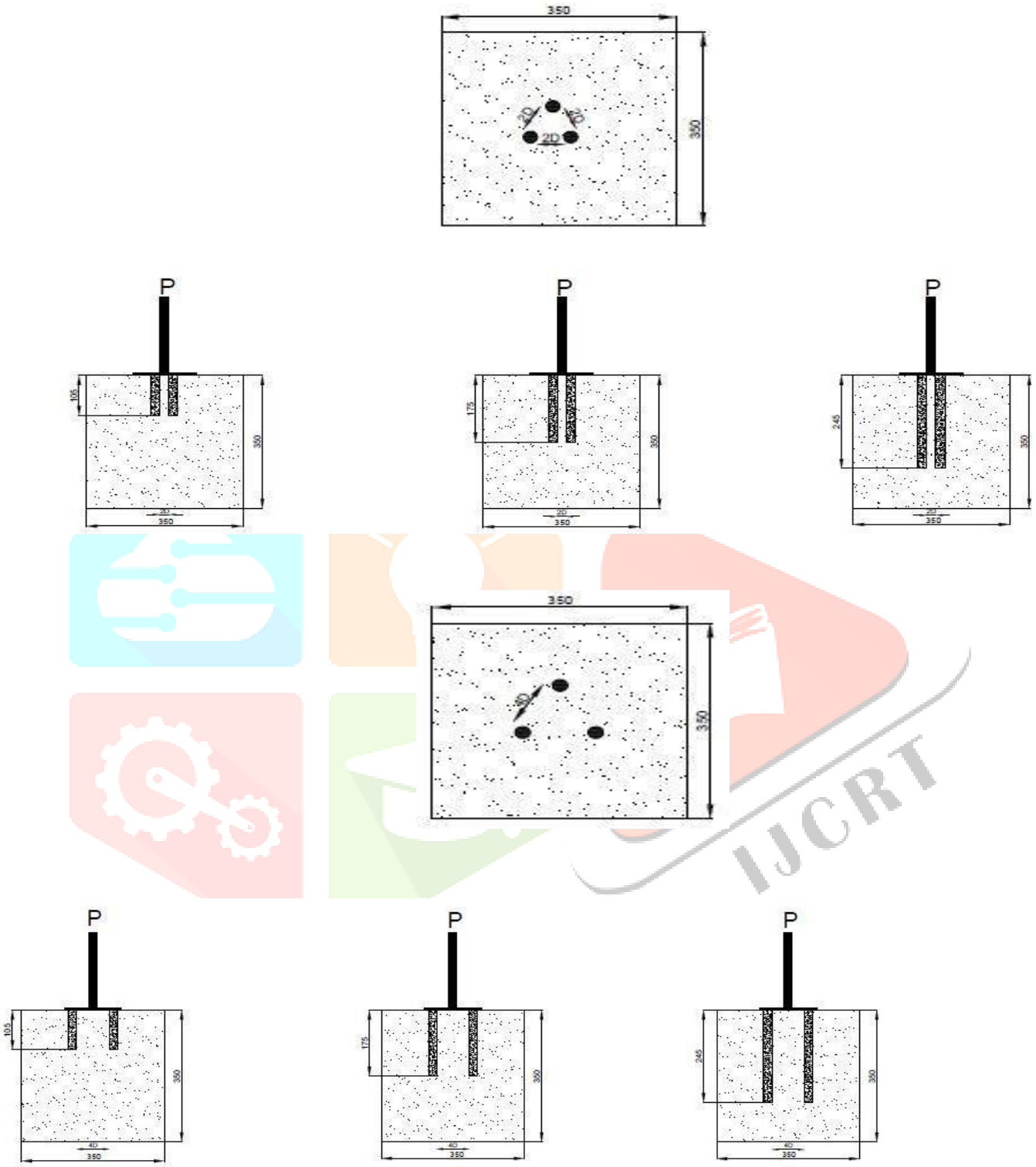

Fig 3.6: Top and C/S view of change in length of triangular pattern piles at 4Dspacing.

Result Analysis:

From the current experimental study, the tests of piles was conducted under various length and spacing criteria. The primary test was carried-out on the individual pile of different pile length (i.e.30%, 50% and 70% of lengths). And the tests for the group piles were also carried out under different length, as well as for the different spacing between the respective piles (2D, 3D, 4D), where D is the diameter of the precast piles. Here while conducting the tests the load settlement character was observed for the individual pile as well as the M-P group. And in present study the settlement was observed up to 30mm.

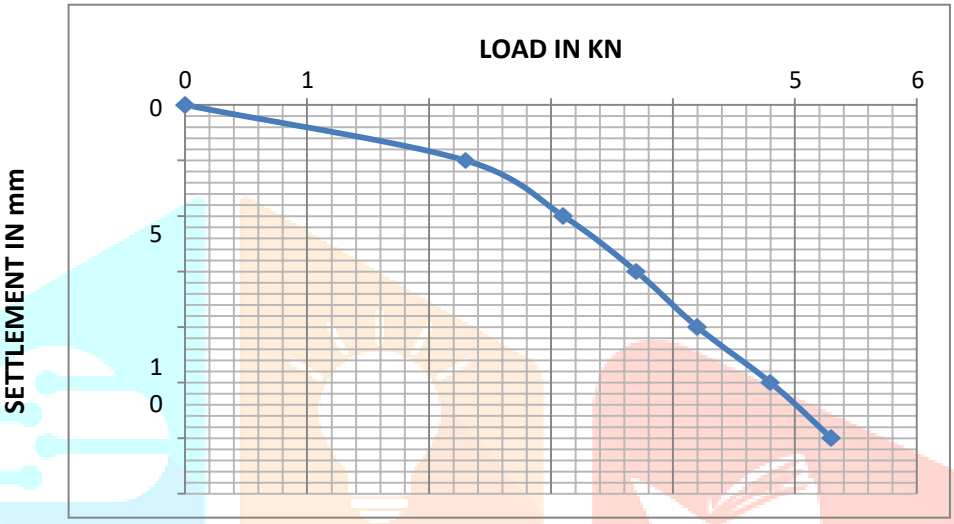

Fig.3.7 Load v/s Settlement of individual pile of 30% length.

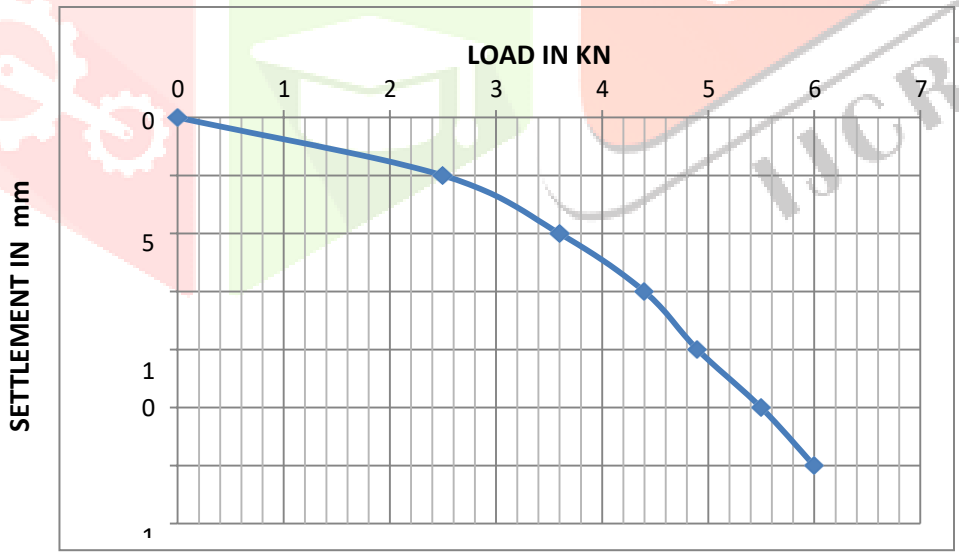

Fig.3.8: Load v/s Settlement of individual pile of 50% length.

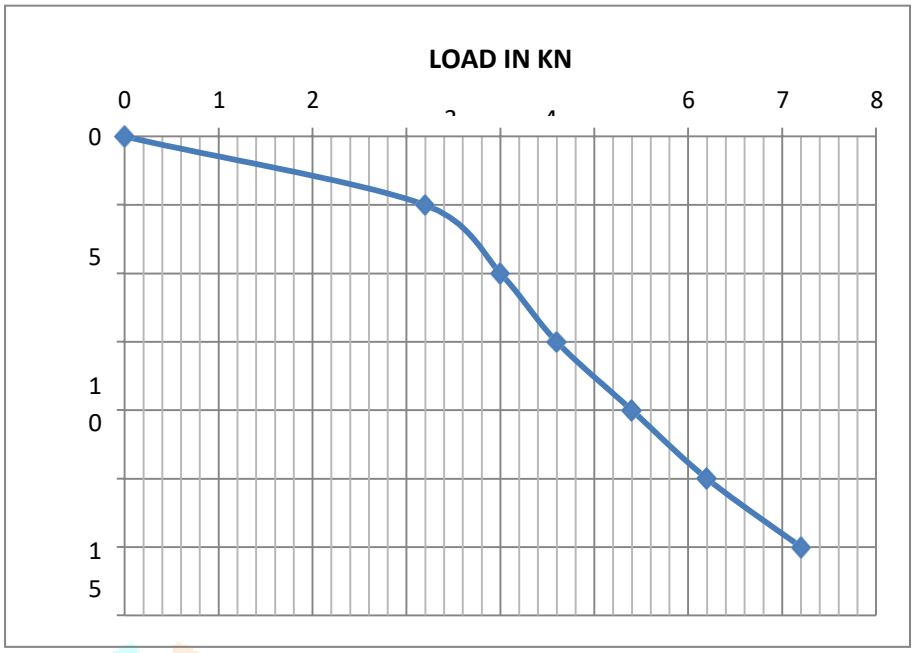

Fig.3.9: Load v/s Settlement of individual pile of 70% length.

Table 1: The ultimate load carried by the Triangular Group piles.

TRIANGULAR PATTERN			
LENGTH OF PILE	ULTIMATE LOAD IN KN		
	2D	**3D**	**4D**
30% (105mm)	7.8	9.6	12.3
50%(175mm)	8.6	10.5	13.4
70%(245mm)	9.2	11.6	14.6

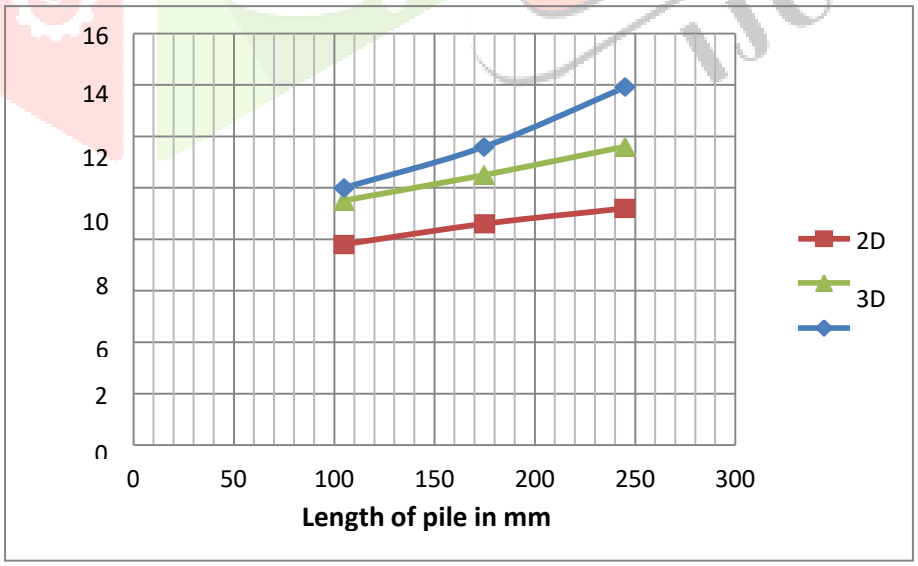

Fig.4: Length v/s ultimate load of triangular group piles.

Table 2: Represents the ultimate load carried by the square Grouppiles.

SQUARE PATTERN			
LENGTH OF PILE	ULTIMATE LOAD IN KN		
	2D	**3D**	**4D**
30%(105mm)	13.5	14.2	16.8
50%(175mm)	14	15.2	17.6
70%(245mm)	14.8	16.1	18.8

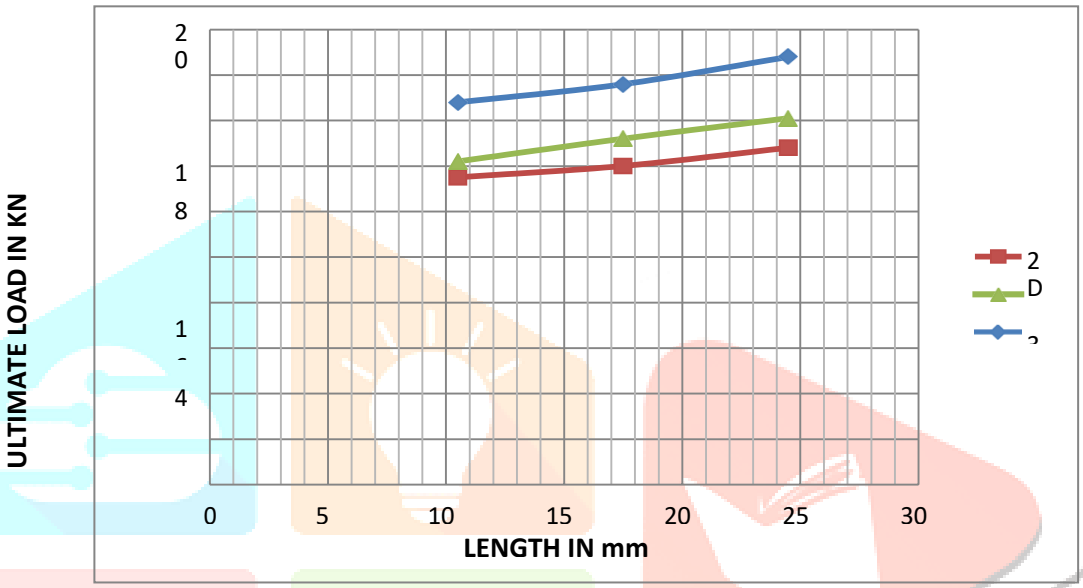

Fig 4.1: Length v/s Ultimate Load of Square group piles.

CONCLUSIONS

The ultimate load bearing resistance of the individual micro-pile considerably rises with increase in length. The ultimate load bearing resistance of the three and four piles in a group increases with increase in length of the pile and with rise in spacing between the piles. It is examined that the ultimate bearing capacity increases with increase in the number of piles. Due to increase in the load bearing resistance, there will be drop in the settlementof the foundation in black cotton soil. Group of the M-P group in the weaker soil is also a technique of ground reinforcement. The maximum load bearing capacity of 18.8KN was carried by the four numbers ofpiles at 70% of length i.e. 245mm length piles, at 4D spacing, and the least value is observed in the individual piles. The GE of both the triangular and Square pattern group piles decreases withincreases the length of piles. The GE of the Triangular and square pattern group piles increases with increase in the spacing between the piles in black cotton soil. The maximum GE is found to be 79.24% in Square pattern of group piles and 77.36% in Triangular pattern respectively.

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