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IMPROVEMENT OF LOAD BEARING CAPACITY OF BLACK COTTON SOIL BY USING STONE COLUMN AND GEOSYNTHETICS

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Abstract: - **A Black cotton soil has *low bearing capacity and high compressibility and more settlement. Black cotton soils are more reactive to seasonal moisture content so need to improve the soil properties and improving the load carrying capacity by providing geo textile discs at various depths and various diameter of stone column. Stone column diameter used are 2.5cm and 5 cm and reinforcement placed at depths of 0.25, 0.5, 0.75, 1.0 of the length respectively. For every settlement of 30mm ultimate load is determined.***

The experiment carried out gives the result that there is an increase in load carrying capacity in ordinary floating column compared to plain bed i.e. 425 KN/m^3 to 520 KN/m^3. When ordinary floating column compared with reinforced stone column ultimate load carrying capacity increased by 30% for 30mm settlement of stone column 5 cm and reinforcement geo textile discs placed at 0.25L. Results shows that there is an improvement in stone column of 2.5cm dia than 5 cm dia. When compared with the ordinary stone column and stone column of 5cm dia load carrying capacity increased by 23% to 58 %. When compared with the ordinary stone column and stone column of 2.5cm dia load carrying capacity increased by 23% to 86 %.

Keywords— ***Black cotton soil, stone column***

INTRODUCTION

More area which covers the soft soil which are present in layers are not able to take the safe load which is coming from the structure to foundation due to increase of population every year in cities. so needs for the improvement of soil quality to improvement of infrastructure like roads, bridges, high rise buildings, tunnels, buildings, flyovers, etc. Black cotton soils have low bearing capacity and are highly compressible which is most commonly present in many areas of Karnataka. Black cotton soils which are more reactive to occasional moisture /water content variations are main reason. For high rise structures Pile foundation is most suitable ground improvement technique. For low rise structures like oil storage tanks, rail, road embankments, factories, stone column is the more effective technique. Stone column technique is selected due to they help in giving primary reinforcement and imparts more strength and less deformation**.** Stone column penetrated through the soft soil and rests hard strata are end bearing stone column.

Stone column is in circular column shape and are vertical elements are constructed by replacing 15 to 45 percent of weaker soil with granular material and coarse materials like stones, sand and stone-sand mixture. Floating stone column means stone column which rests on weak soil. If stone column alone is installed in weak soil (clay) it may not give much resistance to low lateral internment. Collapse of stone columns under compressive load may be due to shear failure, bulging and sliding. Performance of stone column should be enhanced when penetrate in soft soil, tendency of bulging should be reduced effectively.

2. LITERATURE REVIEW

(Alexiew, Raithel et al 2005). There is some lack of lateral resistance offered by the surrounding soil resulting in poor load carrying capacity of the column. Further, due to the soft nature of surrounding soil, there may be intermixing of stone and soft soil. To overcome these problems, stone columns can be encapsulated by geo-grid geo-composite, which improves the efficiency of the stone column with 8 respect to strength as well as compressibility. This is a recent advancement to enhance the load carrying capacity of stone column and is practiced on a very limited scale.

(Ilamparuthi, Malarvizihi 2010) In this study model investigation was made on mechanism of stone column and analysed with finite element software. The test result of both stone column and stone column are analysed by software, to know resistance offered by bulging and settlement. The passive Resistance of column material was found to be close to stiffness of reinforcement used

P.K. Jain, Rakesh Kumar This study discuss the results obtained from the tests conducted on floating granular piles in soft black cotton soil. Model circular tank of size 155mm diameter and 578mm height. Granular pile of diameter 65mm at the centre of soil is made up by crushed stones. Series of test are performed using varied Length and diameter ratios from 1 to 10 and length varies from 65mm, 265mm, 475mm, 585mm, 695mm, and 705mm.

3. OBJECTIVE AND SCOPE OF WORK

3.1 OBJECTIVE

The main objective of this model is to analyse the load settlement for different depth of reinforcement and bulging analysis. Reinforced stone column with circular geo-textile discs on varying depth of reinforcement for different diameter under vertical loading on plain clay bed. Analyse the stone column with different depth on load versus settlement interaction.

3.2 SCOPE OF WORK

To distinguish the interaction of load against settlement with different reinforcement depth.

To analyse the load settlement interaction of stone columns with reinforcement depth of 0.25L, 0.5L, 0.75L. and 1.0 L with spacing D and with spacing D/2.Bulging analysis.

4. MATERIAL AND METHODOLOGY

4.1 collection of soil sample.

Soil sample was collected from Harihara, Davanagere district. Disturbed and undisturbed sample were collected by open trench of 1.5 meter below the ground surface.

Fig.1 Black Cotton Soil

SOIL PROPERTIES	
Clay (%)	55%
Silt (%)	39%
Sand (%)	6%
Liquid Limit (%)	65%
Plastic Limit (%)	23%
Plasticity Index (%)	42%
Soil Classification	CH
Free Swell Index (%)	41.75%
Specific Gravity	2.75

Table1. Soil Properties

STONE COLUMN MATERIALS

COLUMN MATERIAL

Stones are used as column material which are collected in near-by site of specific gravity 2.75

GEOTEXTILES

The geo-textile material used in this study for reinforcement is non-woven geo-textile with 1.3 mm thick with different diameters. geo textile material has tensile strength of 4.4 KN/mm and mass per unit area is 130 g/m^2.

4. **METHODOLOGY**

Test to be conducted in circular test tank made up of size 300mm diameter, 400mm height and thickness 4mm. oil or grease to be applied to the inner surface of tank to avoid the friction between surface and soil. The air dried and pulverized and powdered soil and weigh the soil required according to size of the tank was mixed with optimum water content. water should be mixed properly and soil filled with the layers and tamping for each layer is to be done. The stone column is prepared by casting by using materials such as stone, pvc pipes and reinforcement. Pvc kept at centre of the tank and pvc pipes are filled up with stones and hand compaction by tampering rod to be done to avoid voids. To maintain undrained condition whole model is kept for one day. Sand bed is placed over soil top and loading plate is placed over the sand bed and load is applied through it.

Fig.2 Proving Ring Attachment.

4.1 EXPERIMENTAL PROCEDURE

The experiment work was conducted out in tri-axial compression machine at the rate of strain 1.25mm/min. dial gauge mounting bracket are provided at pillars of machine. To ensure load settlement interaction of D and D/2 spacing of floating stone column into black cotton soil. Size of the tank is design to take the sufficient to size of footing to be testing. Size of the footing taken 10cm and 10mm thick. size of the tank taken is of 300 mm height and 200 mm dia. At the varying depths of reinforcement 0.25L, .0.5L, 0.75L,.and 1.0L spacing of reinforced stone column is D and D/2. To make the floating stone column pvc pipe size 50mm is used. Dial gauges are fixed to record the settlement.

5 RESULTS AND DISCUSSION

Test to be conducted to observe the settlement happened by varying the diameter and spacing. Comparison to be made with settlement observed with varying diameters of stone column. Also test to be conducted with the geo textile discs with varying depths. Bulging analysis also made after settlement observed.

COMPARING THE LOAD AND SETTLEMENT AT DIFFERENT DEPTHS

For different depth load and settlement graph shown below. Ultimate load for plain clay bed, floating stone column and 0.25L, 0.5L.,0.75L, and 1.0L are 425.5, 520.8, 674.5, 702.4, 720.2, 824. there is an improvement in load carrying capacities when geo textile is placed than ordinary floating stone column.

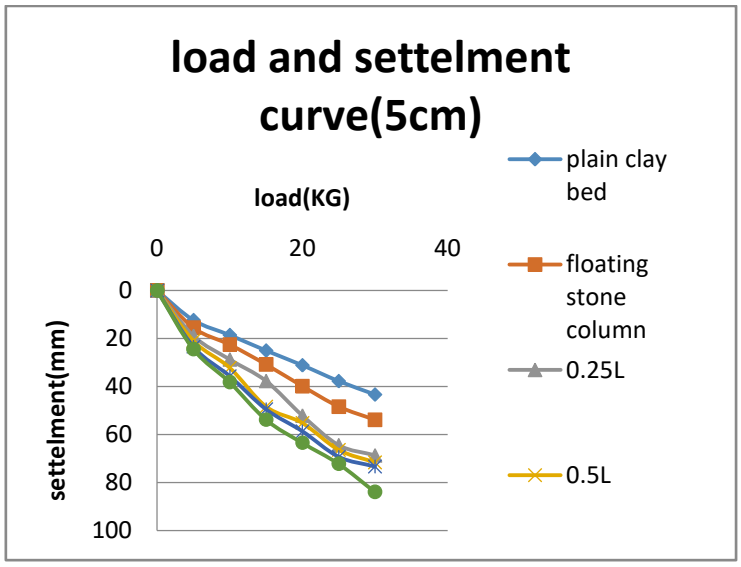


Fig3. Load Settlement Curve

For different depth load and settlement graph shown below. Ultimate load for plain clay bed, floating stone column and 0.25L, 0.5L, .0.75L, and 1.0L are 425.5, 520.8, 730.36, 850.2, 920.2, and 972.3. There is an improvement in load carrying capacities when geo textile is placed than ordinary floating stone column.

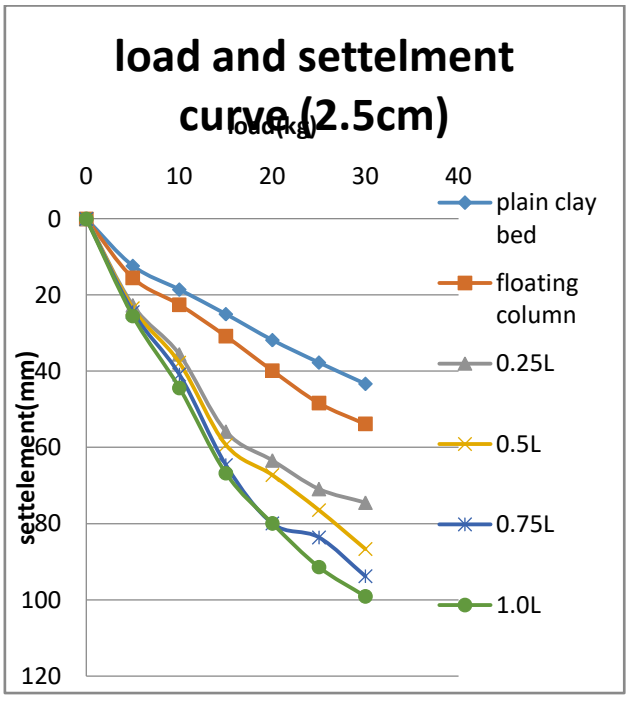
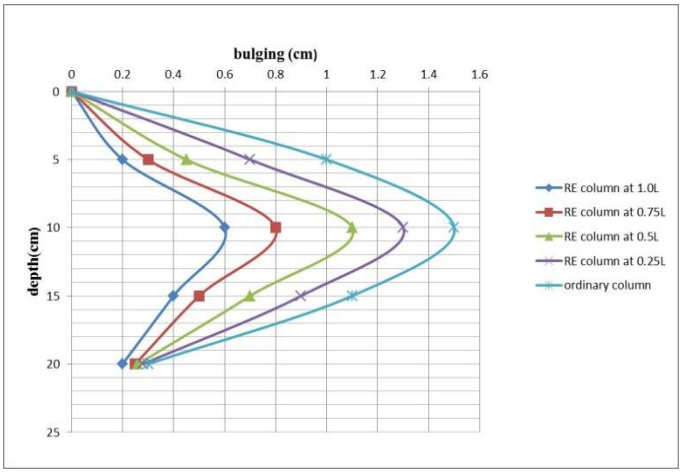


Fig4. Comparison of Load And Settlement for Different Depths

BULGING ANALYSIS OF STONE COLUMN

After the completion of tests stone column removed from the column of mould. Then plaster of Paris is filled into to that column to know the bulging of stone column. Bulging analysis made for all the depths 0.25L, 0.5L, .0.75L, 1.0L. after filling the plaster of Paris whole model is kept for hardening then bulging analysis made.



From bulging curve, graph was drawn between depth and bulging of stone column. values of maximum bulging for 0.25L, 0.5L, 0.75L, 1.0L, are1.6cm, 1.4cm,1.2cm, 0.9cm, for ordinary stone column bulging is 0.6cm.

6. CONCLUSIONS

The investigation made on stone column for different diameter of stone column. By using the geo textiles discs with varying spacing test are conducted.

The ultimate load withstand by plain clay bed is 425.2 N for 30mm settlement and ordinary column carries the load of 520.8 N for 25mm settlement. when we compare with plain clay bed and ordinary stone there was increment of 23% in load carrying capacity. By using geo textile there was more load carrying capacity. Smaller the. diameter of stone column less settlement and more load carrying capacity.

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