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An Efficient and Encasement of Stone column with Geo-grid in Clayey Soils

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ABSTRACT:*Stone columns are extensively utilized to enhance the bearing capacity of very poor ground and minimize the settlement of structures designed on them. A stone column is among the dirt stabilization approaches that are used to boost strength,decrease the compressibility of loose and soft fine graded soils, speed up a consolidation result and minimize the liquefaction potential of soils.Improvement of subgrade making use of conventional designstrategies which are actually preloading, dredging, and dirt displacement strategies, among all these techniques, the Stone columnmethod is actually preferred since the main part of reinforcement is provided by it and also to boost the strength and lowers the settlement.when stone column packed in smooth Clay undergoes increased bulging due to insufficient lateralassistance from the neighboring Clay soil.To stay away from increased bulging, Stone column is actually encased with geogrids.In presentanalysis experiments accomplished on Stone column with as well as with no encasement.*

KEYWORDS-Stone column, bearing capacity, settlement, stabilization, soft soil

I. INTRODUCTION

Stone columns were well known in 1830 to French military engineers to support theheavy foundation of iron work at the artillery arsenal that was founded on soft soil. Thecolumns were (2 m) long and (0.2 m) in diameter constructed by driving stakes into groundwithdrawing them then backfilling the hole with crushed stone, but they are not ideal forbehaviour of foundation stone column system. Stone columns were then forgotten until the1930's when they were rediscovered as by product of the technique of vibroflotation forcompacting granular soils. In the last part of 1950’s, the use of compacted stone column insoft clay deposits was started in Germany, and the construction of sand compaction pile wasdeveloped in Japan by Murayama in 1957 (Tanimoto, 1973).In recent years, a new kind of sand/gravel column appeared and called geotextile orgeogrid encased sand/gravel column. It is primarily used for improvement of foundation inmany countries around the world; they are placed in regular patterns through the soft soildown to lower bearing stratum (Kempfert and Gebreselassi, 2006).

The use of the stone column as a soil improvement technique is actually of recent origin. Stone columnsare extensively utilized to enhance the bearing capability of the very poor ground, the time speed of settlements,stiffness, shear sturdiness of dirt and can certainly also be applied to bring down the settlement of structure, liquefaction possibility of ground that is soft. The stone column strategy is commonly used to strengthenthe ground and so as to help different geotechnical facilities as embankments, engine oil tanks on the very poor ground, low rise buildings, highway facilities, bridge abutments. The strategy is generallyused in clayey soils. Different scientists have worked on stone columns. Lots of numericalanalyses, unit examinations, area tests, mathematical simulations are actually carried out to learn the consequences of stone columns on the very poor ground. Nevertheless, the layout of stone columns till date is founded on theempirical approach to the load-settlement behavior of stone columns are actually affected by a numberof factors

II. RELATED WORKS

[1] Ahmet Demir, et al [2013] made an experimental study on behaviour of geosynthetic reinforced stonecolumns on unreinforced and reinforced soft clay. Firstly, unreinforced tests was carried out and thenreinforced with only stone column and geogrid encasement stone column were investigated. Some propertiessuch as, diameter of stone column and encasement effect on improvement of soft clay were also observed.They have concluded with the following findings:Stone column improves bearing capacity of clay bed anddecreases settlement.Smaller diameter stone column has lower bearing capacity than larger diameter stonecolumn. Geogrid encasement increases bearing capacity of stone column because bulging behaviour of stonecolumn decrease.Sand

embankment increases bearing capacity of stone column slightly but it is not asignificant improvement.

[2] Tendal Y.K, et al [2012] A review is Provided Reinforced granular column for deep soil stabilizationaiming to identify key considerations for the general use of encased stone columns, To provide insights fordesign and construction, To compile the latest research developments. Case histories of field applications andobserved field performance. Geosynthetic encased stone column reduces settlement almost half that ofuntreated ground The ultimate bearing capacity of reinforced stone column and stone column treated beds areabout three times and two times that of the untreated bed. While theoretical analyses and model testing resultsindicate that geosynthetic encased stone column methods can be efficient for soft soil improvement, welldocumented case histories of successful utilization are rather limited. There remains a great need for welldocumented data sets of field performance scenarios. The paper identifies areas where more research isneeded and includes recommendations for future research and development.

[3] HamedNiroumand et al [2011] in their research on Soil improvement by reinforced stone columns basedon experimental work made a review on ground improvement for using reinforced stone columns ingeotechnical engineering projects. There was a special focus on how to performance and evaluate groundimprovement using reinforced stone column for special purposes. The previous results indicated thereinforced stone columns significantly increase the bearing capacity and tension of the soil. Based on previousresults, critical values were discussed and recommended. The inclusion of horizontal meshes increased theload carrying capacity of granular columns. The performance increased with increasing mesh numbers. Itwas also found that ductile materials in the plate forms were the best reinforcement arrangement for thegranular columns. The geosynthetic encasement prevents the contamination of stone column and thus will notreduce the friction between the stone aggregates and clay bed.

III. THE PROPOSED APPROACHES

The materials that are adopted in this study are soft Clay, stone aggregate, Geo-grids, Sand.The sources and propertiesof these materials described in below.

Soft Clay: Soft Clay is excavated from Visakhapatnam port trust at coast guard where piling work is being carried out. The soil ishighly compressible Clay.

Fig.1 Soft Clay sample

Stone aggregate: Pure granite crushedstone aggregateis used as a backfill in this study. These aggregates are collected from madhavacrushers in anakapalli and aggregates retained on 10mm and passing through 12.5mm are taken for the present study.The physical properties ofstoneaggregates are given below.

Fig.2 Stone aggregate

Table1.Physical properties of stone aggregates.

Properties	Values
Specific Gravity (Gs)	2.76
Water absorption	0.60%

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Unit weight	1.86 g/c.c

Geo-grid:The geo-gridsisused for this study collected from Ayyappa Geo-textile installers, Lankelapalem,Vishakhapatnam. Table 2 shows the Properties of geo grids.fig 3 shows the geo grid of size 10mmX10mm is taken for the is takenfor the present study.

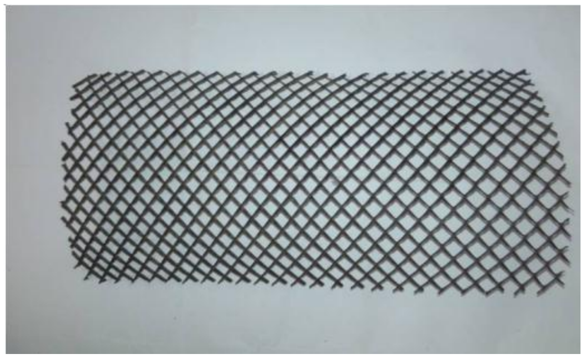

Fig.3 SG350 geo-grid

Sand: The sand is collected from government provided ramps in srikakulam. The sand adopted is classified as well graded.

Fig.4 Sand samples

IV. EXPERIMENTAL SETUP

Preparation of Clay bed: The air-dried and pulverized Clay sample was mixed with required quantity of water to achieve uniformconsistency. Moisture content of 35% is added to the soil. Initially soil is thoroughly mixed with water to get uniformconsistency. The container walls are coated with grease to decrease adhesion between the walls of the container and theClay bed.The uniformly mixed paste was then filled in the tank in layers of 50mm thickness to the desired depth of300mm by means of hand compaction to get desired dry density.. For each load test, the Clay bed was prepared afreshin the test tank and Stone columns were installed in it. After preparation of Clay bed, it is covered with wet gunny clothand then left for 24 hours for moisture equalization. Figure 5 shows the Clay bed prepared in the cylindrical tank usedin this study. Tests were conducted on Stone columns formedin a Clay bed of 200mm diameter and 300mm height.Figure 6 shows the Schematic view of Stone column foundation for test.

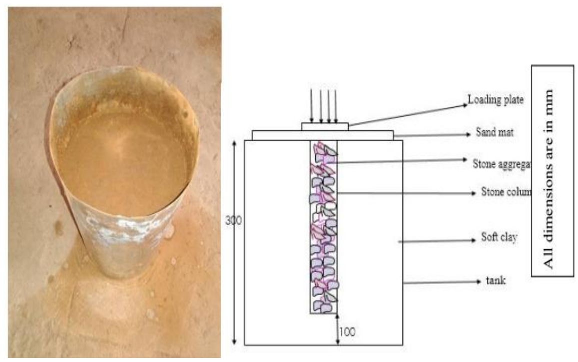

Fig.5Clay bed and Schematic diagram of Stone column

Construction of ordinary floating Stone column: As shown in fig 6 the Clay bed was prepared to a desired depth of 100mm ,the centre of the cylindrical mouldwas properly marked and the pvcpipe of 50mm diameter was placed at the the marked portion of mould. Around thispipe, Clay bed was prepared in three layers each of 50mm for compaction till the entire Stone column is formed .In thisstudystone aggregates was used as the backfill. Add2.6% of water to the coarse aggregate to avoid the absorption ofwater from surroundingClay bed. The Stone column material charged into pvc pipe to certain level,compactedwithdrawal of pipe were carried out simultaneously. After compaction of each layer, the pipe is lifted gently to a heightsuch that there will be an overlap of 5mm between the surface of the stone chips and the bottom of the casing pipe. Theaggregates were compacted by 10mm diameter tampering rod with 10blows from a height of fall of 100 mm. Furtherthe bed prepared should left for the 24hrscovered with polythene cover to ensure proper contact between the Clay andStone column and to gain strength of disturbed Clay.

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Fig.6 Ordinary floating Stone column

Construction of laterally confinedStone columns with geogrids:

After the Clay bed was prepared to a desired depth of 100mm,thecentre of the cylindrical mould was properly markedand the pvc pipe of 50mm diameter was placed at the marked portion of mould. Around this pipe, Clay bed wasprepared in three layers each of 50mm for compaction till the entire Stone column is formed.The reinforced Stonecolumn portion is provided after ensuring proper reinforcement depth from bottom. Here geogrid material is used as anencasement to reinforce the Stone column.After ensuring reinforcement depth the geo grid shell as shown in the figure.7 is placed in the pvc pipe. The Stone column material charged into pvc pipe to desired level of reinforcement(0.25L,0.5L, 0.75L and L from bottom) compacted withdrawal of pipe were carried out simultaneously leaving the geo gridshell with stone aggregates . After compaction of each layer, the pipe is lifted gently to a height such that there will bean overlap of 5mm between the surface of the stone chips and the bottom of the casing pipe. The aggregates werecompacted by 10mm diameter tampering rod with 10 blows from a height of fall of 100 mm. Further the bed preparedshould left for 24 hrscovered with polythene cover to ensure proper contact between the Clay, geogrid and Stonecolumn and to gain strength of disturbed Clay.

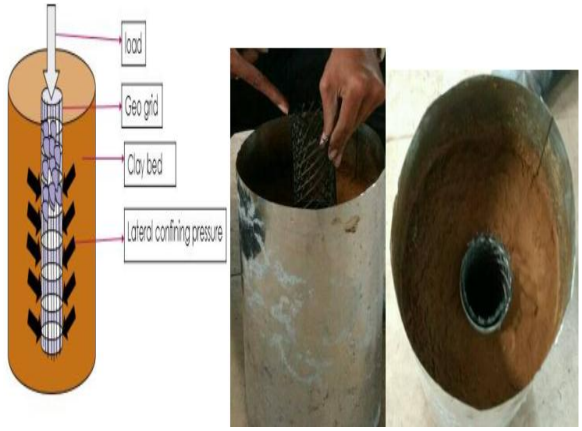

Fig.7 Placing of geo-grids

Testing of Clay bed/ Stone columns

After construction of plain Clay bed and Stone column, load was applied through the 12 mm thick Perspexcircular footing having diameter double the diameter of the Stone column (10cm) which represents 25% areareplacement ratio. Models were subjected to strain-controlled compression loading in a conventional loading frame at afast rate of settlement of 0.24mm/min to ensure undrained condition up to a maximum footing settlement of 20 mm.The applied load on footing was observed by a proving ring at every 1 mm settlement.A complete test set uparrangement is shown in Figure 8

Fig.8 Test set up for loading

Post test Analysis:

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After completion of the test, stone aggregate chips from the column were carefully picked out and a thin pasteof Plaster of Paris was poured into the hole and kept it for 24 hours to get the deformed shape of the column. The soiloutside the Stone column was carefully removed and the hardened Plaster of Paris is taken out and the deformationproperties are studied.

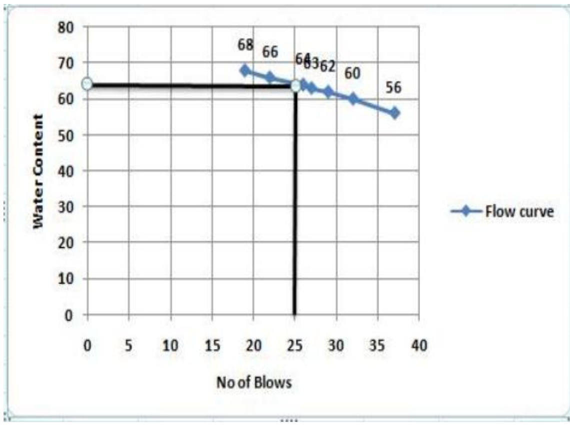

Fig.9Liquid limit curve for soft Clay

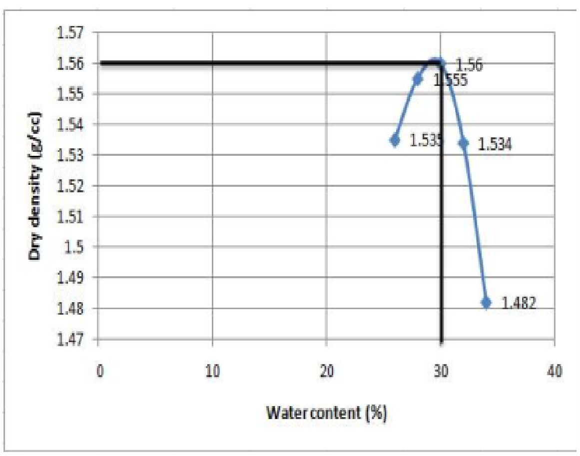

Fig.10 Compaction curve for soft Clay

Load settlement response of plain Clay bed:

Figure shows the load versus settlement curve obtained from load tests on plain Clay bed. The ultimate load carryingcapacity can be obtained by drawing double tangent to the load settlement curve which is shown in figure11. Theultimate load carrying capacity of the unreinforced Clay bed is 29 kg. The settlement at the ultimate load is 8.1 mm.

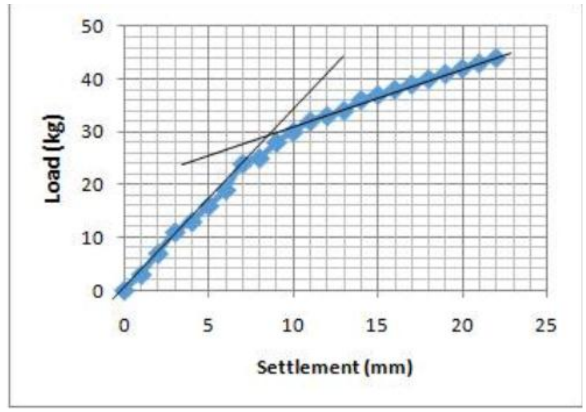

Fig.11 Load-settlement curve of unreinforced Clay bed

V. CONCLUSION

Installation of ordinary floating Stone column increased the load carrying capacity of plain Clay bed by 31%. The encasement of Stone column with geogrid increases the load carrying capacity and stiffness of the floatingStone column. The variation in depths of reinforcement influences the load carrying capacity of Stone column.Theperformance of Stone column is increased to its full reinforcement depth by58% to that of bottom quarterreinforcement and increased by 100% to that of ordinary floating Stone column. Reinforcement of Stone column with geogrids results in decrease of settlements.There is a decrement ofsettlement for reinforced Stone column to its full depth by 75% respectively when compared to the ordinaryfloating Stone column.

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BIODATA

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