BEARING CAPACITY IMPROVEMENT OF SOIL USING GEOSYNTHETIC REINFORCED GRANULAR COLUMNS

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ABSTRACT

Stone column technique of ground improvement is an effective method to strengthen poorly graded soil. The study deals with bearing capacity improvement of soil installed with coir geosynthetic reinforced crushed coconut shell column using experimental and numerical analysis. A number of plate load test were used to examine the behaviour of vertically and horizontally reinforced columns in soil. Study focus on using crushed coconut shell (CCS) a biomass waste product, used as infill material and coir geosynthetics used as reinforcement. Column of various diameter and length in-filled with crushed coconut shell was erected into soil were used for test. Geotextile wrapped around the column is used to provide vertical reinforcement and geogrid placed in the column at intervals of D, D/2 and D/4 to provide horizontal reinforcement. Finite element analysis using PLAXIS 2D was also carried out for the study to compare the laboratory results. Bearing capacity of effective sized CCS column increased by 130.8%, bearing capacity of vertically encased CCS column increased by 161% whereas bearing capacity of horizontally reinforced CCS column at S=D/4 increased by 238% compared with unreinforced sand. A variety of potential site applications were made possible by this range of performance for the geosynthetic reinforced crushed coconut shell column technique in soil.

Keywords: Granular column, Crushed coconut shell, Plate load test, Geosynthetics

1.Introduction

By enhancing the load carrying capacity, the concept of column construction was developed to fortify weak soil and enhance the ground. To strengthen the weak soil layers, a variety of soil improvement procedures are applied. One of the most efficient ways to increase the soil's bearing capacity, lessen settlement, and lower the risk of liquefaction is to use stone columns. It's crucial to carefully consider the benefits and drawbacks of each strategy when comparing granular columns to alternative layout options for a specific application. Granular column installation is more of an art than a true science, necessitating careful site management and a skilled contractor. As a result of the extensive use of natural resources for development, numerous environmental problems have arisen.Sustainable ecosystems and a brighter future demand environmentally friendly development and greener materials. Many researchers have created a range of waste products as alternatives due to the limited availability of non-renewable natural resources, including fly ash, bottom ash, slag, coconut shell, and many others. One of the agricultural by products is coconut shell, which is not as in demand as coconut milk.

Afshar et al. (2014) (Ref 1) investigated the bearing capacity of geosynthetically reinforced stone columns by experimental analysis. Stone columns reinforced both horizontally and vertically were tested in the

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laboratory. Stone pillars with diameters of 60, 80 and 100 mm and a length-to-diameter ratio of 5 were tested. After completing various tests, we found that both vertical and horizontal stiffeners have increased load-bearing capacity. By increasing the reinforcement strength of both the standing stone pillars and the lateral reinforcement stone pillars, the load capacity of the reinforcement stone pillars is also improved. Furthermore, we found that laterally reinforced stone pillars performed better than longitudinally enclosed stone pillars. Ali et al. (2012) (Ref 2) conducted a comparative study on geosynthetically reinforced stone pillars. The tests included a short, floating, fully penetrating single column with or without reinforcement. By comparing the ratings of columns with different geometries, different failure modes caused by different configurations and reinforcement types can be identified. After a comparison, it was determined that the front side stone cladding was the best technique. There is no big difference between the performance of the horizontal bar rebar and the performance of the floating stone column. The best geosynthetic foam for both types of reinforcement for end columns is geogrid, but for floating columns geotextile as enclosing material and geogrid as horizontal strips. The practical and theoretical evaluation of a stone column in soft clay was researched by Ambily et al. in 2004 (Ref 3). In this study, experiments are carried out to evaluate the behaviour of stone columns while varying variables like spacing, the shear strength of soft clay, moisture content, etc. The outcomes are examined using the PLAXIS finite element programme. Both the column loaded alone and the column laden with its surroundings were compared for bulging failure. The behaviour of a column's load settlement under load was compared numerically and experimentally. This study includes a review of the literature reviewed, details of the experimental work, a numerical analysis using a finite element programme, a comparison of the results, and comments. Batia et al. (2019) (Ref 4) investigated columns of geosynthetically coated construction debris (CCD) within fly ash based on experimental analysis. Results of many model tests performed on a single structural concrete rubble column installed in a fly ash fill. For an area replacement rate of 25%, the size of the foundation was set to twice the column diameter. Due to the repository and floating end situation, 50 mm and 75 mm diameter columns were used.Analysis of the results included investigation of settlement and load-bearing conditions. Through experimental modeling studies, geosynthetic wraparound liners have been shown to have a significant impact on the ultimate loadbearing capacity of structural concrete debris columns and reduce subsidence of treated fly ash-filled beds.

Beenaet al. (2010) (Ref 5) investigated soil improvement using stone pillars. The aim of this study was to conduct an experimental study to evaluate the behavior of geotextile-covered stone pillars when the stone was replaced with cheaper quarry dust. The effects of geotextiles have also been studied. Experiments have shown that some rock can be replaced with cheaper quarry dust without affecting column performance. The quarry dust displaced the pier stones without weakening the reinforced floor. It is conceivable to replace 30% of the stone with dust without reducing the strength and performance of the system. Bonab et al. (2020) (Ref 6) examined individual reinforced stone pillars with different geotextile arrangements. Reinforced floating stone columns with diameters of 80 and 100 mm and lengths of 400 and 500 mm were used for laboratory tests to study the impact of different geotextile placements. Tests were conducted on stone columns with vertical sheathing, horizontal reinforcement, and a combination of both. According to them, the usefulness of vertical sheaths decreases with increasing diameter, while horizontal and vertical-horizontal sheathed pillars perform better in reinforcement. The load capacity is also greater than other vertical and horizontal combination stone pillars. Ghazavi etc. (2013) (Ref 7) investigated the load-bearing capacity of geosynthetic-coated stone pillars. Stone pillars with diameters of 60, 80 and 100 mm were tested in the laboratory. The ratio of length to diameter was 5. Tests were conducted on geotextile reinforced stone columns in exposed and sealed conditions. In addition to the above tests, tests were also conducted on stone pillars with a diameter of 60 mm to investigate the load-bearing capacity of the enclosed stone pillars. All tests have been carried out and it has been found that the bearing capacity of vertically covered stone pillars is greater than that of normal stone pillars. Since the stone pillars are installed vertically, the greater the length and strength, the greater the load capacity. In the test of vertical stone pillars and normal stone pillars, it was found that the vertical stone pillars had higher load bearing capacity. Ghazavi etc. (2017) (Ref 8), the load-bearing capacity of horizontally stacked reinforced stone columns. Groups of horizontally reinforced stone pillars with diameters of 60, 80 and 100 mm and a single pillar with a diameter of 60 mm were tested in the laboratory. Numerical analysis was also performed in the same way. Experimental analysis shows that placing horizontally stacked reinforcing layers improves the load-bearing capacity of stone columns. Numerical analysis results show that reducing the number of horizontallayers and the distance between them significantly increases the bearing capacity.

Gupta et al. (2020) (Ref 9) evaluated soil improvement with sheath pillars. This study examines vertically fringed and horizontally reinforced stone columns. Three and four unreinforced and reinforced stone pillars were tested in loose sandy soil. Research has shown that reinforced stone pillars can support more weight than unreinforcedstone pillars. The results obtained were confirmed by theoretical knowledge. Gu et al. in (2016) (Ref 10) used model testing to study how geogrid wraps affect the lateral and longitudinal deformation of stone pillars. Casings of varying lengths were used for the stone pillars, and a reinforcement system was used for the geogrid-covered stone pillars. The stress and strain properties of the covers were measured and analyzed. Test results show that the geogrid-wrapped stone pillars greatly increase the bearing capacity of the soft ground. Hataf et al. (2020) (Ref 12) numerically and experimentally determined the load-bearing capacity of coated stone pillars. For very soft floors, lateral clamping pressure may not be sufficient, which can lead to column buckling. Each stone column casing improves lateral resistance to buckling by applying additional confining pressure. In this study, we investigated the effects of casing length and aggregate type on the ability of single stone columns to bear loads in both dry sand and clay beds. Results showed that wrapping the column halfway improved the situation significantly. Numerical analysis also showed that the effect of reinforcing stiffness decreased with increasing clay cohesion. Parametric analysis showed that the effect of casing stiffness was not significant for clay beds with high cohesion values. Hasan et al. (2019) (Ref 13) investigated the strength of soft clay reinforced with 10 mm single crushed coconut shell (CCS) pillars. Tests on mechanical and physical properties of materials, CCS columns, and shear strength parameters were performed on his four batches of kaolin. Column permeabilities of 0.60, 0.80 and 1.00 were considered along with CCS column heights of 60, 80 and 100 mm. Kaolin samples were subjected to 16 unrestrained compression tests with a diameter of 50 mm and a height of 100 mm. At an area displacement ratio of 4% and column penetrations of 0.60, 0.80 and 1.00, the shear strength enhancements embedded in the CCS columns are 19.02, 34.76 and 24.34% respectively. The data show that the maximum column height does not affect the peak intensity of the column, but increasing the shear strength does. Kurniatullah et al. (2019) (Ref 15) investigated the bearing capacity of geogrid-reinforced synthetic granular columns on soft ground. This study examines the use of geogrid-based artificial granular supports to reinforce friable soils. Geogrid-wrapped synthetic gravel was used as pillar infill. Synthetic gravel came in a variety of shapes, including triangles, cubes, and hexagonal columns. The test tube used has a diameter of 800 mm and a height of 1,400 mm. Column loading was performed for each variation of synthetic gravel size, and for a mix of the three sizes. A column load of 30 kN was applied to each variant. According to the load test results, the column with artificial gravel in the form of a hexagonal column and a filling made of a mixture of the three variations yielded the greatest load-bearing capacity. Lo S R in (2009) (Ref 16) investigated several numerical studies on the role of geosynthetic casings in improving the performance of rock pillars in very soft clay deposits. In this study, an infill dam imposes the load and stone columns act as reinforcement. Observation of a trial embankment reinforced with stone pillars on top of very soft clay revealed that the very soft clay could not provide sufficient confining stress to the stone, so stone pillars alone could minimize settlement. It turns out that it's not enough to limit it. A fully coherent survey was undertaken, as the main issue is the development of the settlement over time after the installation of the stone pillars has been completed. Unit cell idealization was used to reduce computational effort. In this study, the optimized analyzes provided in the previous study were accurate, demonstrating that the use of geosynthetic casing significantly improves the effectiveness of very soft clay pillars. It was also shown that the assumed stiffness parameter of the compacted stone does not affect the expected performance. We found that this relied on the stress trapped in the geosynthetic wrap created during installation.Madun et al. (2017) (Ref 17) used numerical analysis to investigate the mathematical solution of the stone effect on bearing capacity and settlement. This study demonstrates the use of response surface methodology (RSM) software to optimize the effect of column diameter and length on soft clay bearing capacity and settlement. Load tests were performed on a 66 mm load plate by numerical modelling using Plaxis 2D. Increasing both the diameter and length of a stone column increases the bearing capacity of the column and reduces subsidence. As a result, it was found that the longer the column length and the larger the column diameter, the less soil subsidence. For improvement, the design of the ideal stone pillar was changed separately for each factor (diameter and length). We investigated how loose sand behaves in the case of stone pillars. The study provides recommendations for choosing the most efficient and cost-effective materials for the construction of stone pillars. Bricks, crushed stone and crushed old concrete from several construction sites were selected as the waste material for this study. These remains were used to build stone pillars. Under the same loading conditions, the load-settling behavior of unreinforced and reinforced soils with single and multiple stone columns constructed from these fragments was evaluated. The results obtained showed a significant improvement in loose sand sedimentation behavior. The results obtained showed a significant improvement in loose sand sedimentation behavior. In summary, it is possible to make stone pillars from local scrap building materials. Using these waste materials supports environmental sustainability and recycling. Hamidi et al. (2018) (Ref 17) investigated the ability of individual stone columns to bear loads. Tests were conducted on a variety of steel fiber reinforced and gravel columns with different geometries and particle distributions. With a length-to-diameter ratio of 5, stone pillars with diameters of 63 mm and 92 mm were tested. Test results using different forms of geotextiles were studied and found that the use of mattresses, geotextiles and steel fibre reinforcements increased the loadbearing capacity of stone columns. Compared to normal stone pillars, the load-bearing capacity of coated stone pillars increases with diameter. Mehrannia et al. in (2017) (Ref 18) investigated the load bearing capacity of stone pillars using granular mats. This study examines the weight-bearing capacity of stone columns, granular ceilings, and a combination of both techniques using reinforced and unreinforced models. A floating stone pillar with a diameter of 60mm and a length of 350mm is used. Geotextiles were used for the cover and geogrids were used to reinforce the columns. A vertical geotextile cover served as a reinforcement for the granular mat. Alternatively, these ceilings were not reinforced. A biaxial geogrid was used as a horizontal stiffener to further reinforce the granular cover. Comparing all the results, it was found that the use of geogrid as reinforcement of granular cover and geotextile as cover of stone pillar enhances the effectiveness of granular cover and stone pillar. Furthermore, it was discovered that the highest load-bearing capacity could be achieved by combining reinforced stone pillars with reinforced granular ceilings. Reinforcing stone pillars with geogrids and covering them with geotextiles improved the bearing capacity of the pillars. Miranda and Costa (2016) (Ref 19) used laboratory analysis to analyze encased stone pillars. The effect of coatings on stone column behaviour is investigated in drained triaxial tests on gravel samples with and without coatings. Tests were conducted using two different geotextiles and two different gravel densities. This study highlights the increased containment pressure of geotextiles, the increased friction angle of gravel, and the increased strength of cased and uncased samples. The improvement possible by covering gravel with geotextile is evident in all results. At lower ambient pressures this effect becomes more pronounced. Murugesan and Rajagopal (2010) (Ref 20) studied the behavior of both individual and aggregate geosynthetic-coated stone pillars. Stone columns coated with geosynthetics were the subject of model testing. In a large test chamber, stone pillars were placed on prepared clay substrates under controlled conditions. The stone pillars were stress tested individually and in groups with and without cases. Tests were conducted on stone pillars covered with various geosynthetics. The end result was a noticeable increase in the load-bearing capacity of the stone pillars passing through the enclosure. The modulus of elasticity of the cladding and the diameter of the stone column determine how much the axial load capacity can be increased.

Prasad et al. (2016) (Ref 21) investigated how stone pillars reinforced with spherical disc geogrids improve soft soil performance. Two distances D and D/2 were considered as variable parameters. We found that submerging the stone column in soft soil increased the maximum load capacity by about 117%. Circular geogrid stiffeners with D and D/2 spacing increased the load-bearing capacity by 16% and 41%, respectively. Installation of geogrid reinforcement has also reduced subsidence of stone columns. The load-bearing capacity of soft soil is increased by lateral reinforcement using geogrid discs and also depends on the spacing of the reinforcements. Prasad et al. (2016) (Ref 22) investigated how geotextile-wrapped silica-manganese cinderlock columns could improve sea clay. Quartz manganese slag, a byproduct of the steel industry, is a coarse material. Geotextile shells with sheaths of varying lengths surround the stone pillars. We investigated how stone columns behave under different loads with respect to subsidence and buckling. Observations show that geotextile reinforcement improves load-bearing capacity and reduces subsidence. Spoorthi et al. (2019) (Ref 23) investigated how geosynthetic rock columns can increase bearing capacity. Granular layers with a diameter of 12 mm and stone pillars with a diameter of 50 mm are used. The geotextile covering the stone pillars had a length-to-diameter ratio of 4. Three different space-to-diameter ratios were used: 2, 3, and 4. We found that S/D = 2 gives the best results. We also found that the bearing capacity of geotextile-covered stone pillars was greater than that of unwrapped stone pillars. In other words, the bearing capacity of the stone with case was 75.43%, while the bearing capacity of the stone without case was 67.4%. Thakur et al. (2020) (Ref 24) use model testing to investigate the load-bearing capacity of a set of vertically and horizontally reinforced floating stone columns. Under compressive loading, two group configurations with 3 and 4 stone columns are tested in both reinforced and unreinforced situations. Geotextile reinforcements are provided vertically along the entire length of the stone column (300mm) and horizontally along the length of the row in the form of circular discs spaced 30mm apart. The test results showed that horizontally reinforced columns had less lateral buckling than vertically reinforced columns, and masonry columns had higher load-bearing capacity. Numerical modelling with the FE program Plaxis 2D was also performed to validate the experimental results. FE results show lower resilience than 30 model tests. Kausar Ali. (2014) studied the effects of covering length on geosynthetically reinforced stone pillars. One of the reinforcement methods he uses to improve the performance of pillars is to cover each individual pillar with a suitable geosynthetic. In this work, model tests were carried out on individual floating pillars and end he bearing pillars, with and without housing. The columns were strengthened by supplying geosynthetic casings over different column lengths. Studies have shown that covering the entire length of the column results in higher ultimate stresses than covering only part of the column for both floating and endbearing columns. Additionally, end-bearing columns were found to perform better than floating columns. Kalantary et al. (2018) conducted a study on soil improvement by stone pillars and granular covering. In this study, we used a scaled physical model to study the bearing capacity of stone pillars, granular decks, and a combination of both reinforced and non-reinforced mode techniques. The results show that the use of granular layers, stone columns, or a combination of both improves the load-bearing capacity of soft ground. The effectiveness of granular mats and stone pillars is greatly enhanced by using geogrids as reinforcement and geotextiles as cladding. Also, the use of geotextiles around stone pillars increases the stiffness and bearing capacity of the pillars, which also improves the stress concentration ratio.

In the current study, crushed coconut shell columns with diameters of 3, 5, 7, 9, 11, 13 and 16 cm and lengths of 10, 15, 20, and 25 cm were used. The behaviour of soil with and without columns was tested. Coconut shell crushed material (CCS) was used as infill material in the column. This work investigated the load-bearing capacity of columns of with varying diameter. Bearing capacity of vertically encased and horizontally reinforced effective diameter crushed coconut shell column was investigated. A comparative study on the behaviour of crushed coconut shell column as infill material using Plaxis 2D was performed.

2. MATERIALSAND EXPERIMENTAL PROGRAM

(2.1) SOIL

The soil used in the study was collected locally from Menamkulam, Thiruvananthapuram district. Sand particles that passed through 4.75 mm sieve were used for this study.The properties and there values are tabulated in Table 2.1.

Table 2.1 Material Properties of Sandy soil

Property	Values
IS Classification	SP
Initial Moisture content (%)	3.48
D_{10} (mm)	0.18
D_{30} (mm)	0.21
D_{60} (mm)	0.28
Cu	1.55
Cc	0.87
Percentage of Coarse Sand (%)	0
Percentage of Medium sand (%)	13
Percentage of fine sand (%)	87
Specific Gravity, G	2.6
Angle of internal friction (degree)	35
Cohesion (kg/cm^2)	0.1
Relative density (g/cc)	1.8

(2.2) CRUSHED COCONUT SHELL (CCS)

The crushed coconut shell was collected from Easy and Fresh, Anayara, Trivandrum District. The properties of crushed coconut shell are studied and the values attained are tabulated in Table 2.2.

Table 2.2: Properties of CCS

Properties	Values
Size (mm)	1-10
Bulk Density (g/cc)	0.60
Porosity (%)	55
Specific Gravity, G	1.33

(2.3) COIR GEOGRID

The coir geogrid used in this study was collected from National Coir Mills, Alappuzha district. The properties of the coir geogrid were studied and the values obtained are tabulated in Table 2.3.

Table 2.3: Properties of Coir Geogrid

(Source: National Coir Research & Management Institute, Trivandrum)

Properties	Values
Thickness (mm)	8.56
Tensile strength (N/m)	14971.47
Puncture resistance (mm)	17.33
Mass per unit area (GSM)	900

(2.4) COIR GEOTEXTILE

The coir geotextile used in this study was collected from Thirupuram, Neyyattinkara, Trivandrum district.The properties of the coir geotextile were studied and the values obtained are tabulated in Table 2.4.

Table 2.4 Properties of Coir Geotextile

(Source: National Coir Research & Management Institute, Trivandrum)

Properties	Values
Thickness (mm)	12.69
Tensile strength (N/m)	1006.93
Puncture resistance (mm)	10
Mass per unit area (GSM)	755

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(2.5) EXPERIMENTAL SET UP

Experimental set up carried out using plate load test was conducted to determine bearing capacity and settlement of crushed coconut shell (CCS) column. The dimension of the tank is 50 cm × 50 cm ×50 cm. The tank was made up of mild steel. A 20 cm × 20 cm bearing plate is used for the study. In this study plate load test of CCS column of different diameter and length was performed and from that CCS column of effective diameter and length is taken. Vertical encasement and horizontal reinforcement at different spacing are provided and corresponding bearing capacity and settlement is calculated.

3. EXPERIMENTAL PROGRAM

For the present study the required materials were collected. The test tank was filled with required amount of sand. The loading plate was centrally placed and the load was applied to the specimen with the help of a loading frame. During the load application the settlement of the sample was noted with the help of dial gauge of least count 0.01mm placed. The load was applied on a constant strain rate of 1.2mm/min. The first test was done for unreinforced sand and later the load settlement behaviour of sand with crushed coconut shell column was investigated. The load settlement behaviour of CCS column with various diameters and lengths were observed and calculated. From the various diameter and length of CCS column effective column was identified. In this effective column vertical encasement was provided. Coir geotextile was wrapped around the CCS column and its load settlement behaviour was calculated. Similarly in this effective column coir geogrid was provided as horizontal reinforcement at S = D, D/2 and D/4 spacing and its load settlement behaviour were calculated.

The study was also carried out by using Finite Element Software, PLAXIS 2D, a special purpose two dimensional finite element computer program used to perform deformation and stability analysis for various types of geotechnical applications and its output provides a detailed presentation of computational results. Crushed coconut shell was used as the in fill material and geosynthetics was used for reinforcement purpose. In this study finite element analysis was carried out to study the deformation of the column. Two models are available in PLAXIS, plane strain model and axisymmetric model. In this study, analysis was carried out using axisymmetric model. The CCS column was modelled using Mohr-Coulomb model. The sand and column are treated as drained material. The geogrid and geotextile were modelled as linear elastic material where geogrid provided as horizontal reinforcement and geotextile as vertical reinforcement in CCS column. From the numerical analysis the results obtained are connectivity plot, deformed mesh, total displacement, stress distribution, and various other parameters are obtained. In this study the values obtained with numerical analysis are compared with the values obtained in expermental analysis.

4. RESULTS AND DISCUSSIONS

Plate load test was conducted in standard procedure to study the load settlement behaviour of CCS columns with various conditions. The readings were obtained using two dial gauges placed on footing plate, opposite to each other. Comparison curve of experimental and numerical analysis of various conditions used in this study are discussed below.

(4.1) Pressure settlement and bearing capacity curve of unreinforced sand

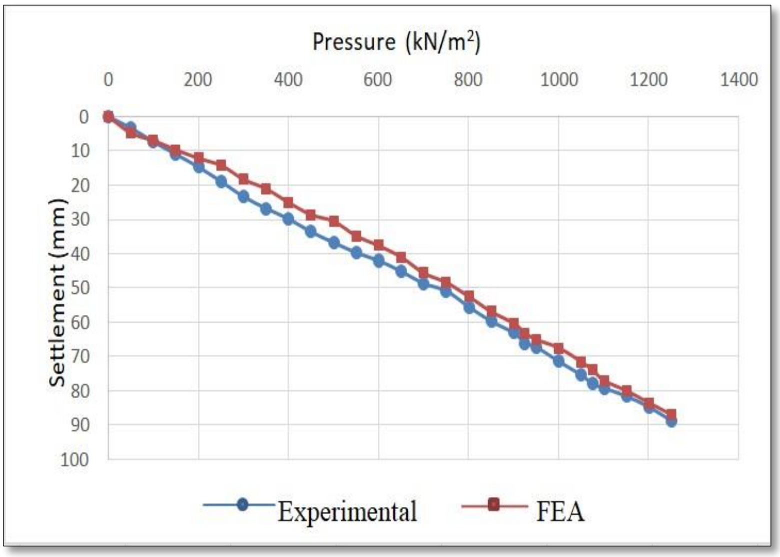

Fig 4.1: Pressure settlement curve of unreinforced sand

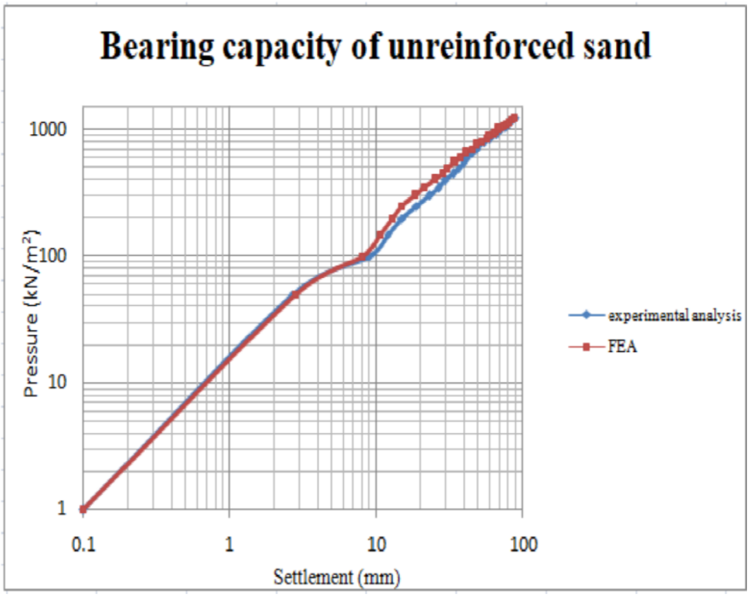

Fig 4.2: Bearing capacity curve of unreinforced sand

The pressure settlement curve of sand without column is shown in Fig 4.1. From Fig 4.2 the bearing capacity of sand can be found out. The maximum bearing capacity of sand was found as 325 kN/m² and the maximum settlement was obtained as 327.8 mm. From it is clear that the bearing capacity of sand is low. Therefore, column was inserted in sand.

(4.2) EFFECT OF CCS COLUMN IN SANDY SOIL

Settlement and load bearing capacity of CCS column in sandy soil was found out. Column with 3, 5, 7, 9, 11, 14 and 16 cm diameter and 10cm, 15cm, 20cm, and 25cm length was used. From the investigation it was found that as the diameter and length of the column increases bearing capacity increases and

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settlement decreases. From the investigation it was found that 16 cm diameter column with 25 cm length was effective CCS column. Fig 4.3 and 4.4 represents the bearing capacity and settlement of effective CCS column.

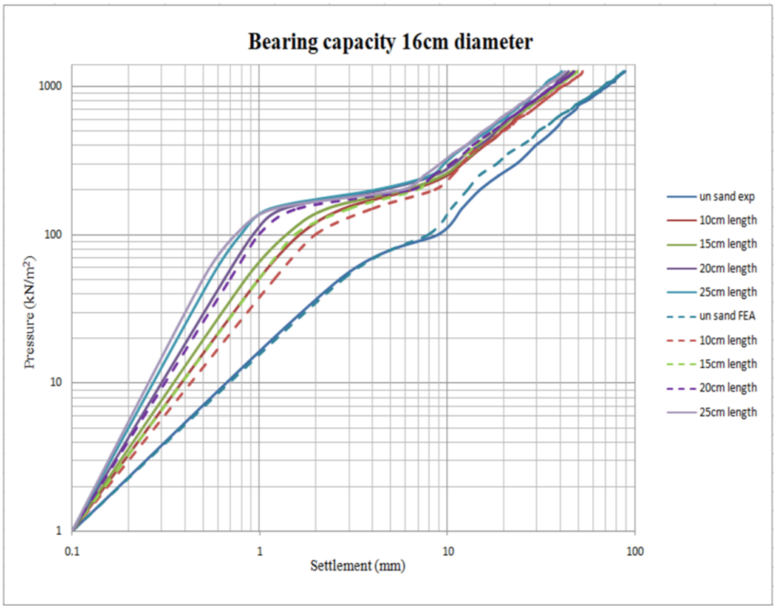

Fig 4.3: Bearing capacity curve of effective dimension CCS column

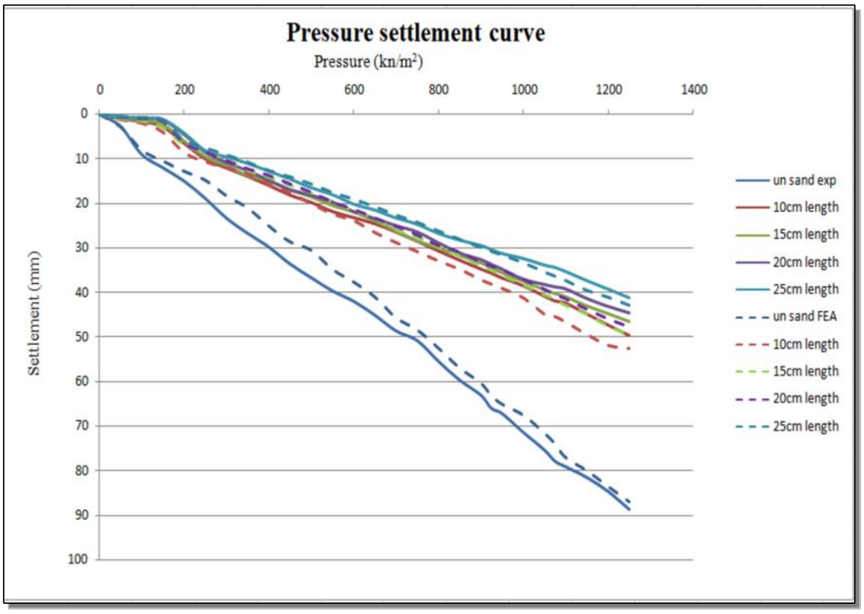

Fig 4.4: Pressure settlement curve of effective dimension in CCS column

(4.3) EFFECT OF VERTICALLY ENCASED CCS COLUMN IN SOIL

Effective dimension CCS column was vertically encased in order to find the bearing capacity and settlement using experimental and FEA method. Fig 4.5 and 4.6 represents the bearing capacity and settlement curve of vertically encased CCS column.

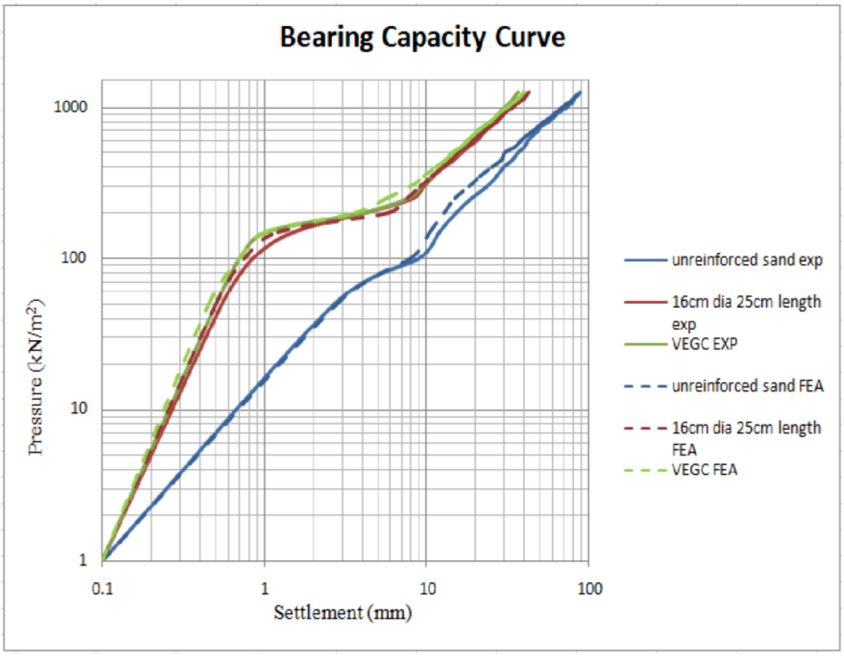

Fig 4.5: Bearing capacity curve of vertically encased CCS column

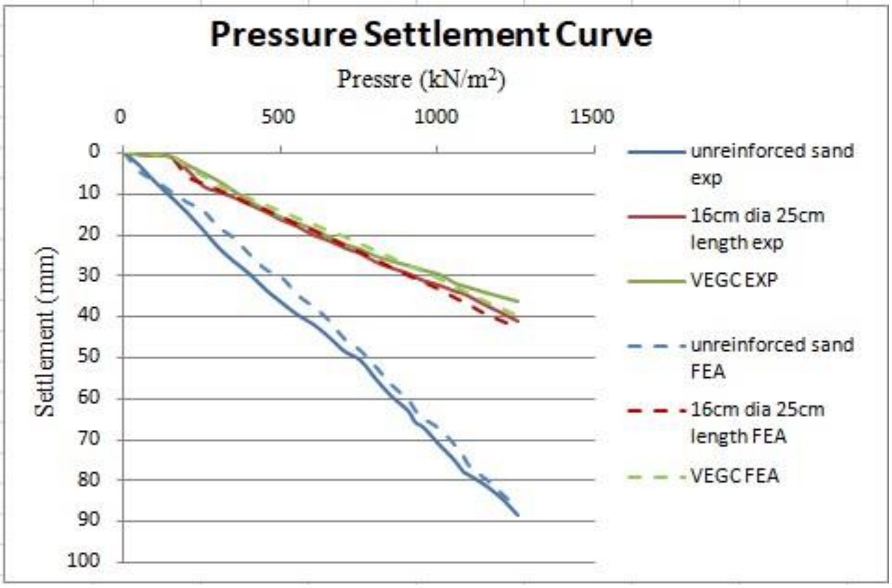

Fig 4.6: Pressure settlement curve of vertically encased CCS column

(4.4) EFFECT OF HORIZONTALLY REINFORCED CCS COLUMN IN SOIL

Horizontal reinforcement was provided at various spacing of optimum dimension CCS column and their bearing capacity and settlement was found using experimental and FEA method. The reinforcement was provided at S=D, D/2 and D/4 spacing. Fig 4.7 and 4.8 represents the bearing capacity and settlement curve of horizontally reinforced CCS column.

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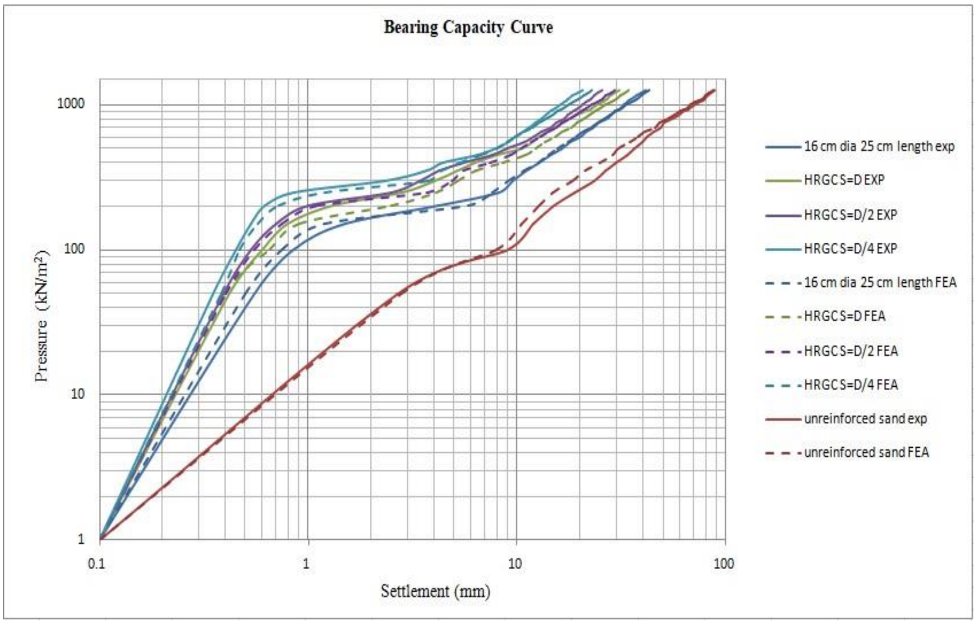

Fig 4.7: Bearing capacity curve of horizontally reinforced CCS column

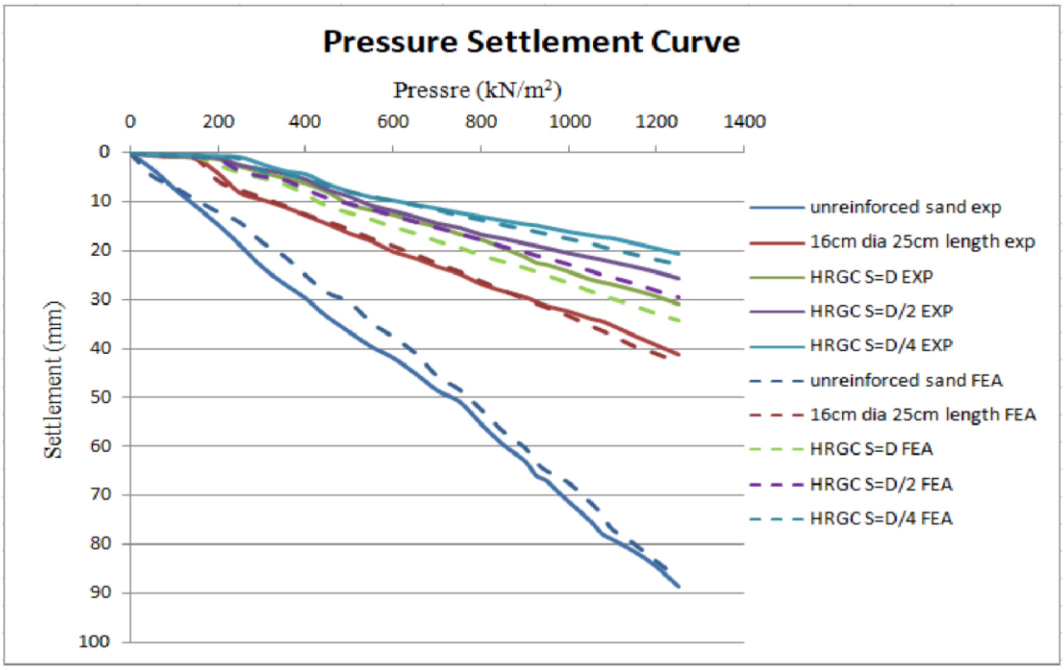

Fig 4.8: Pressure settlement curve of horizontally reinforced CCS column

5. CONCLUSIONS

The study has deal with the bearing capacity improvement of soil installed with coir geosynthetic reinforced crushed coconut shell column using experimental and numerical analysis. Bearing capacity was increased and settlement decreased as the depth and diameter of CCS column increased. Effective diameter and length of the CCS column was obtained as 16 cm and 25 cm respectively as per the experiment. When compared with unreinforced sand bearing capacity of effective sized CCS column was increased by 130.8 %. Bearing capacity of encased CCS column was increased by 161 % when compared with the unreinforced sand. At S = D/4 the bearing capacity improvement was more as compared with S = D and S = D/2. When compared with unreinforced sand bearing capacity of horizontally reinforced CCS column at S = D/4 was increased by 238 %. As per the experiment done it was found that Geotextile was effectively used as vertical encasement and geogrid was effectively used as horizontal reinforcement. As spacing between the layers decreased, bearing capacity increased and settlement decreased.

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No conflict of interest to be disclosed as per the experiment conducted.

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