"AN EXPERIMENTAL STUDY OF GROUND IMPROVEMENT TECHNIQUE BY SAND COLUMN"

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Abstract :- Ground Improvement techniques are used to improve soil properties such as - bearing capacity, shear strength, consolidation, settlement, drainage, porosity, etc. These techniques of soil improvement have a wide range of applicability from coarse grained to fine grained soils, Soil improvement by coarse grains often called stone column technique and by fine grained is called sand column technique both are used as per side condition. Ground improvement when implemented through sand column technique is much stable solution to construction in weak cohesive soils. With the sand column I am trying to discuss in detail about improvement of soil bearing capacity and reduced its settlement, including it's salient features, major functions through sand column, The purpose of this work is to assess the suitability of reinforcing technique by sand columns is to improve the load carrying capacity of Black cotton soil through several laboratory model tests. Objective is achieved in two parts, In the first stage the characteristic of Black cotton soil is evaluated by the index properties like compaction characteristics under particular loading conditions, evaluation of shear strength parameters using Unconfined compression test and Tri-axial test at different testing conditions, this is done basically to find out the inherent strength of the Black cotton soil compacted to different densities and at different different degree of saturation and In the second series of tests the settlement parameters of the compacted Black cotton soil samples reinforced with sand columns of varying length ratios are evaluated from California Bearing Ratio test. In addition to this sand column having different length ratios such as full and half length are introduced of 25mm in diameter on the center of mould built for testing.In this study it is found that load carrying capacity of sampled soil is increased with increases the respective length but decreased with addition of more water content from there optimum moister content.

keywords: *Sand column, Specific Gravity, Liquid Limit ,Plastic Limit, OMC, MDD, CBR , Load and Settlement.*

I. INTRODUCTION

Black cotton Soils with considerable silt or clay content do no longer respond to deep vibratory compaction, to enhance those cohesive soil shorts to allow any varieties of construction, it's far important to create stiff reinforcing elements within the soil mass for any stable construction. In India have massive coastline area which mostly have black cotton soil and which is greater than approximately 6000kms, In the view of the developments on coastal areas in the latest past large number of ports and industries are being constructed, In addition the supply of land for the improvement as real property, business- housing, business and transportation, infrastructure and so on. And also expansive soils cover approximately 20% of the entire land area in India as referred as black cotton soil which have so many difficulty for any sort of construction works due to the fact those soils boom in quantity on absorbing water at some stage in wet seasons and decrease in extent while the water evaporates from them. Increase in volume (swell) if resisted by any structure resting on it; then vertical swelling strain is exerted with the aid of the soil at the shape this stress if not managed, can also motive uplifting and distress within the structure. The energy loss on wetting is another intense hassle with such soils. Due to this ordinary behavior many civil engineering structures built on expansive soils get seriously distressed and ultimately it may failed. Pavements are also have more problem with the aid of expansive soils because they may be lightweight and amplify over massive areas and Residential houses switch light loads to such soils and also subjected to maximum misery. Similarly, earth systems which encompass retaining walls, canals constructed with the ones soils go through slips and damages.
Cause of above properties of black cotton soil, there is requirement to improve the properties of that soil for any heavy and stable construction.

METHODS OF GROUND IMPROVEMENT

The methods of ground improvement that can be adopted basically on type of soil and purpose. The methods available are as follows

A. For cohesive soils:

Vertical Drains.

Vacuum Dewatering.

Sand columns.

In-situ deep mixing.

B. For cohesionless soils:

Compaction piles.

Vibro compaction.

Stone-columns.

Dynamic compaction.

Compaction by deep blasting.

Grouting .

Here I have to improve the soil properties with the help of sand column technique, necessity of its for any stable and permanent structure.

Sand column foundations, a fairly recent ground improvement technique, have been used successfully in several projects throughout the world, The scope and the range of their applications with the development of theoretical aspects is growing rapidly, Which consists of Fine aggregates of variable sizes (According to zone wise) filled in a cylindrical form in the ground with definite proportion into the soil at regular intervals through out the area of the land where the soil bearing capacity is to be improved. This is done either by using vibratory probes which are forced into the ground, the aggregates are then allowed to take the place of soil or by ramming the aggregates placed in a pre-bored hole by hammer.

Sand column technique, a old age technique but fairly more used recently for ground improvement, it have been used successfully in several projects throughout the world **(**Hirkane, N. G. Gore, P. J. Salunke (2014), Karun Mani, Nigee.K (2013), Sneha P and others (2014)), The scope and the range of their applications with the development of theoretical aspects is growing rapidly **(**J. Nazari Afshar, M. Ghazavi (2012)) , Which consists of Fine aggregates of variable sizes (According to zone wise) filled in a cylindrical form in the ground with definite proportion into the soil at regular intervals through out the area of the land where the soil load carrying capacity is to be improved. This is done either by using vibratory probes which are forced into the ground, the aggregates are then allowed to take the place of soil or by ramming the aggregates placed in a pre-bored hole by hammer (Haresh D. Golakiya, Mittal D. Lad (2015). The rate of improvement is depending on the soil characteristics and the spacing of the columns (B. Anil Kumar and others 2016). The sand columns can be arranged to suit range soil situations and layout requirements**(**S. Siva Gowri Prasad, P.V.V. Satyanarayana (Aparna 2014). Although the sand-column must be considered as a unit in terms of each compressibility and shear electricity (Sidhi Sabnis (2017)).

All above studies shows that load carrying capacity of weak soil can be improved by any granular column either by sand column or by stone column, one of these are used as per site condition. In this paper presents the experimental results on the sand column with variable length and size of sand column is fixed 25 mm installed in mould having dia 150 mm and length 175mm and also variable moister condition such as OMC ,20% and 22%.

II. EXPERIMENTAL PROGRAM

Laboratory investigations were carried out to determine the physical and mechanical properties of black cotton soil, In addition to this the suitability of sand columns in improving the load carrying capacity black cotton soil deposits were examined through a series of model tests under this experimental works undertaken, the methodology adopted and the salient test results. On the way of this an experiments were carried out in a cylindrical mould having dia.150 mm and height of 175mm . The soil beds of black cotton soil were prepared in the mould at a dry density of 1.842gm/cc. The initial mixing water content in the soil and the diameter of the sand columns were the fixed on the study. The bearing capacity and load settlement of composite soil (black cotton soil reinforced with a sand column) on wetting was recorded. Soil beds were prepared with OMC, 20%, and 22% of water content and for each test bed two length of sand columns (150 mm and 75 mm) were installed. One series of bearing capacity measurements were taken for black cotton soil beds without sand column and other one is prepared with the sand columns with varying water content.

III. MATERIAL PROPERTIES

Basically two types of material are used for this study: 1.The black cotton soil representing the soft soil to be improved and, 2.The fine river sand as sand column forming material. The properties of these materials are as follows:

Black cotton soil: The black cotton soil was taken from Bhoot Bangala Area of Vidisha district M.P. Its' properties are given in Table -1.

Table -1: Properties of Black Cotton Soil

S.No	Properties	Values
1.	Liquid limit (L.L.), %	**47.00**
2.	Plastic limit (P.L.)%	**28.48**
3.	Plasticity index (P.I.), %	**18.52**

4.	Maximum dry density (MDD), gm/cc	**1.84**
5.	Optimum water content (OMC), %	**13.01**
6.	Specific gravity (G)	**2.63**
7.	Soil Classification (IS:1498-1970)	**Clay ,high plastic, and cohesive**
8.	Bearing Capacity of soil sample, %	**8.83**

IV. TEST SETUP AND PROCEDURE

A typical test arrangement of sand column is shown in Fig. A CBR mould of 150 mm diameter and 175 mm height with one collar and two surcharge plates having weight 2.5kg was used. The soil was oven dried and a predetermined amount of water was mixed and compacted in five layers to attain a dry density of 1.842 gm/cc. A porous plate with filter paper was placed below the soil sample at the time of preparation of sample. Then a hole of required diameter was formed by using an auger and a casing steel pipe. The granular material (fine river sand) was filled in the hole and compacted in layers to get the required density with standard repetition. One porous plate with a filter paper is placed bellow the soil sample and the collar is fitted to the mould and surcharge (dish) weight of 2.5 kg placed over the sample at the time of soaking and testing .Heavy plunger was placed on the soil mould, a dial gauge and deformation gauge was fixed on the top of the sampled mould . This entire arrangement is placed inside the mould.. The swelling was monitored continuously by taking the dial gauge readings from time to time till dial reading ceases to change. Tests were conducted for all the specimens prepared with different water contents and with different different length of the sand columns.

Fig.1 CBR test with sand column

V. RESULTS AND DISCUSSIONS

The CBR test was conducted to study the bearing capacity and settlement behavior of Black cotton soil under certain loading condition with OMC and MDD and other condition of water content in sample. The tests were conducted at OMC which were obtained from compaction tests. The test specimens were of 150mm (dia.) × 175mm (high) in size. either in three or five equal layers using standard Proctor rammer of 2.6 kg or modified Proctor rammer of 4.89 kg, here I used 4.89 kg of rammer with 56 blow for each layer and mould was filled with 5 similar layers .The CBR test was conducted very carefully soaked for 72 hrs .

A. CBR value and load settlement graph sample with OMC

Takes about 5500 gm of soil sample passes through 4.75 mm IS sieve at oven dried condition and mixed it with optimum moisture content which is 13.012 % ,20% and 22% and mixed sample filled on mould with five similar layers and compacted it with heavy rammer whose weight is 4.89 kg, free fall from 45 cm having bottom dia is 50 mm .After complete the preparation of mould sample is submerge in water for atleast 72 hours and after completion of time, sample are tested on CBR compaction testing machines whose proving ring capacity is 10 kN. Results are in tabular form blow.

Table No.2- Experimental Results for CBR with OMC

S.No.	Description (condition)	CBR at 2.5 mm %	CBR at 5.0 mm %	CBR value for condition
1	With OMC condition	8.83	7.29	8.83%
2	Hole on center of mould having ½ length	9.19	8.56	9.19%
3	Hole on center of mould having full length	12.77	11.04	12.77%

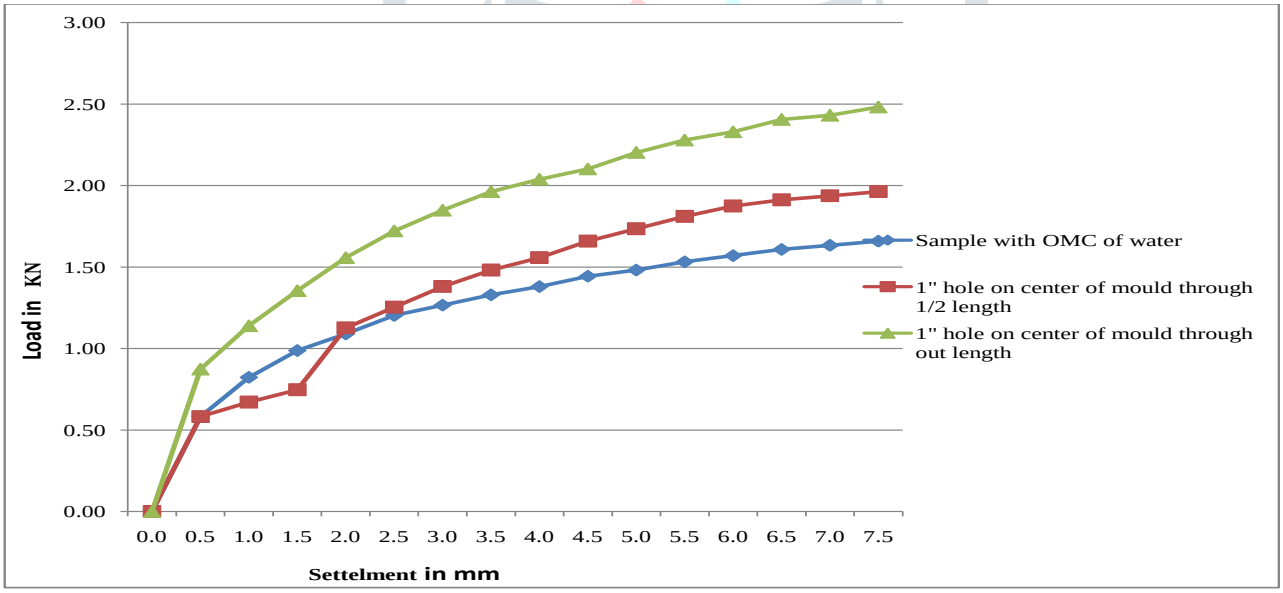


Table No.3 - Experimental Results for CBR with 20% of water

S.No.	Description (condition)	CBR at 2.5 mm %	CBR at 5.0 mm %	CBR value for condition
1	With 20% of water	3.28	2.73	3.28%
2	Hole on center of mould having ½ length	3.74	3.34	3.74%

3	Hole on center of mould having full length	3.91	3.58	3.91%

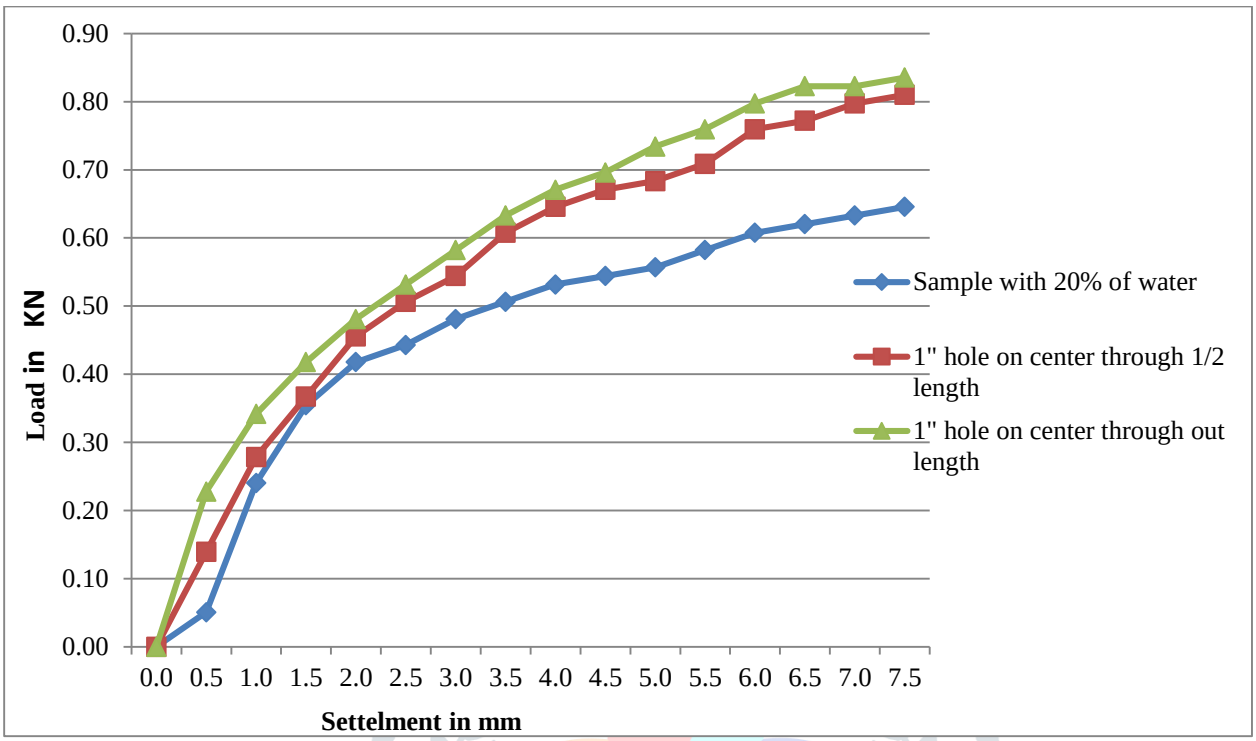
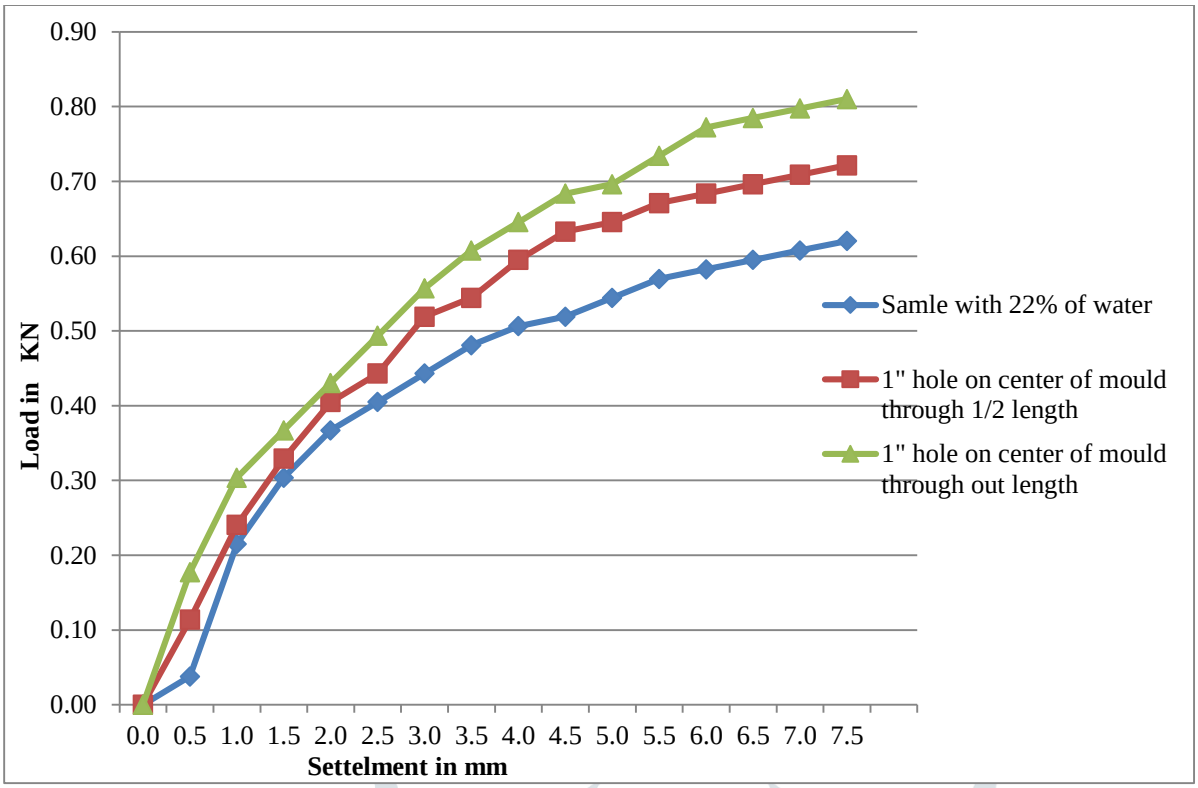


Table No.4 - Experimental Results for CBR with 22% of water

S.No.	**Description (condition)**	**CBR at 2.5 mm %**	**CBR at 5.0 mm %**	**CBR value for condition**
1	With 22% of water	3.007	2.676	3.00%
2	Hole on center of mould having ½ length	3.284	3.163	3.28%
3	Hole on center of mould having full length	3.649	3.406	3.64%



From above test results and load settlement graphs we have to found that load carrying capacity of sampled soil is increases when have to provide sand column and load carrying capacity is reduced when the entire length of sand column is reduced and when we have provide more water on sample from its optimum moister content the load carrying capacity is also reduced from OMC water level .

VI. CONCLUSIONS

- It is observe that with the increase of length ratio to their respected fixed area, bearing capacity increases linearly. It shows that with the increase of the reinforcing length due to high compacted density the frictional angle increases linearly in result bearing capacity also increases linearly. The sand column length plays a major part in increasing the bearing capacity of particular column and load settlement capacity also.
- When increase the water level on sampled soil from the OMC level it is observed that bearing capacity of soil decrease sequentially but bearing capacity is increased after the installation of sand column at particular water level.
- At 20% of water bearing capacity of soil is 3.28%, when sand column install at half length is 3.74% ,and when sand column is install through length is 3.91% ,it means bearing capacity increased by 14.02% and 19.20% after the installation of sand column.
- Similarly at 22% of water CBR of soil is found 3.007% and when sand column install at half length is 3.284% ,and when sand column is install through length is 3.649% ,it means bearing capacity increased by 9.21 and 21.35% after the installation of sand column.

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