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IMPROVEMENT IN BEARING CAPACITY OF SOIL

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Abstract: **In order to enhance the load bearing capacity of the testing soil by adopting a textile based material called as geotextile material; an experimental investigation has been carried out. In this current study, geotextile is being used as a geosynthetic material, and the sand being the basic and foremost material is being considered for the study. Here, laboratory load tests outcomes on a strip footing has been presented which is assumed to be as rectangular supported on the sand bed. The deflections have been observed in the sand in oven-dried condition without reinforcing and in the sand when reinforcement is being provided has been compared. Moreover, the test results in bearing capacity of footings by geotextile are compared to soil without geosynthetic.**

Keywords **–** Bearing Capacity Geotextile Strip Footing Soil Reinforcement

I. INTRODUCTION

The strengthening of soil by the use of geosynthetic material with in mass of soil is known as reinforcement in soil or reinforcing soil. The material can be provided in the form of geosynthetic, geogrid, geo fibers, metal strips, and geocell etc.

Since, in the subgrade during pavement construction generally clay is being used but , near the sea shore, docks and harbours where the clay is not easily available sand is being used for the subgrade construction. In our present study the bearing capacity of the sand has been increased by the use of geotextile as a geosynthetic material. The provision of this material stabilizes the soil and the main motive of using this geosynthetic material i.e. geotextile being a permeable fabric have the ability to act as a separate filter which, when used in association with soil, and can control pore water pressure. This method can be used for stabilizing the soils which futher used in soil subgrade for constructing the pavements, embankments construction, harbours, landfills, drainage structures, and other civil projects.

II. OBJECTIVES OF THE PRESENT STUDY

Thus, this present study carried out for research work in effect in sand on using the stabilizer.

This present study is having a given scope below -

1. To determine the improvement in bearing capacity of oven dried reinforced soil and oven dried unreinforced soil.
2. To determine the deflections in unreinforced and reinforced sand.
3. To evaluate the load settlement behaviour in both the sands.

III. MATERIALS USED

In order for carring out the study for load bearing capacity of the soil media i.e. sand and to carry out the further testing, following materials are being collected and used –

- Sand
- Geotextile

Sand- The Sand which is being used is collected from the River Markanda at Mullana, Ambala.. The washing of sand is done and efforts is made so that the organic matter will be removed. Afterwards, the sand is kept for oven drying and properly sieved from 4.75 mm and retained in pan after passing from 75 µ sieve and used for carry out further testing.

Non-Woven Geotextile- The thickness of the geotextile fabric for each of the strand is nearly about 02 cm.

IV. EXPERIMENTAL TESTING

According to the above objectives described of this study, an experimental programme is prepared for carrying out the further testing and to analysise the improvement in the testing soil bearing capacity with the help of geotextile fibre. In order to analyize the bearing capacity of a reinforcing soil a model for the laboratory used has been prepared. The provision of the geotextile strand of unifom size (1.6B x 1.5B) are used as stabilizer to reinforce the sand layers. Geotextiles are placed at three different depth from the top in sand layers at a depths i.e. 2.71B, 1.35B, and 0.94B, where B is nothing but the assumed footing width. The assumed footing model is rectangular in shape made of concrete in M20 of size 30 cm × 19 cm × 2.5 cm are used.

Preparation of the testing bed

An unbreakable glass tank of size 50 cm × 30 cm × 40 cm is made for the test purpose. Then the further testing is carried in the tank for unreinforced and reinforced sand (Fig-1). The

quantity of oven dried sand is taken as per the volume of the testing bed. In order to maintain the uniform density of sand in whole experiment, a funnel is being used to pour the sand into the tank from the height of 10 cm. The tank is filled in four layers of sand and three layers of the same sand but coloured (the sand is made coloured by adding the different pigments in sand; pigments have no effect on soil properties). Each layer of sand is poured at a thickness of at 5cm and coloured layer of sand is 2cm thick. The funnel has been moved from the edge first or from the corners towards the tank center. The sand top surface is made smooth with the help of a straight edge made up of wood. It is important to maintain the suface of the sand bed as horizontal. In order to carry out the further testing; the same sand bed is emptied and again filled the emptied sand bed with the sand.

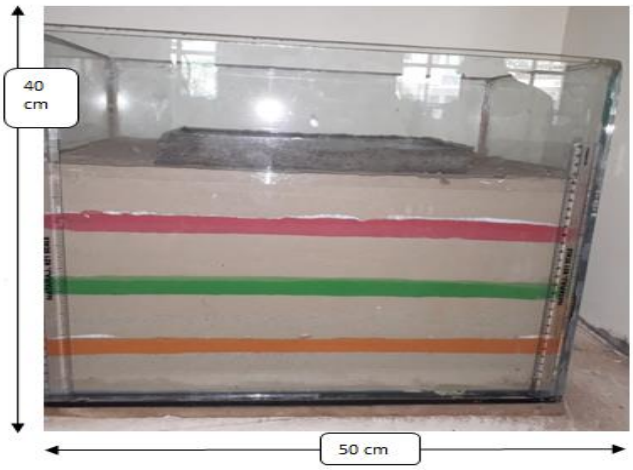


Fig 1 Test Bed Preparation

V. METHODOLOGY OF TEST

Testing on Unreinforced soil

After preparing the testing bed, the model of rectangular footing is to be placed on the midway of the suitable size test bed. The settlement of the respective footing is being recorded with the help of dial gauges fitted at two ends as shown in Fig. 2. Then, loading has to be applied in such a way that it will act in centre of the assumed rectangular footing. The initial reading of both the dial gauges is being noted down before placing down the loads on the footing. The load is applied starting from the minimum load on the footing and under the intensity of applied load footing is being let on to set down. Then, the determination in settlement of the respective footing is being reported by the device i.e. dial gauges on either sides.

The next load is applied on the rectangular footing when the dial gauge has shown no reading and hence, again reported down the settlement of respective footing. As soon the footing is punch into the sand the application of the load has to be stopped. The dial gauges are removed, on completion of the test. Further preparations is made for the next set of test using geosynthetic by emptying the test tank.

Fig 2. Dial Gauges Used for Settlement

Testing when the soil is being reinforced

After pouring of sand and coloured as per the above thickness a geosynthetic layer of size in placed on the coloured layer of sand before pacing the another layer of sand on the coloured. This placing of sand and geosynthetic layer is continue till the tank is filled upto the height of 34cm. Again dial gauges are being setup in the same position as previous. The load is applied starting from the minimum load on the footing and thus under the load intensity the footing is let on to settle down. Then, the changes in the settlement of the respective footing is noted with the help of dial gauges on either sides as in above case. Figure 3 shows the preliminary set up or system of the load test and Figure 4 shows the simplified i.e. schematic view of the testing set up.

Fig 3. Experimental Set up

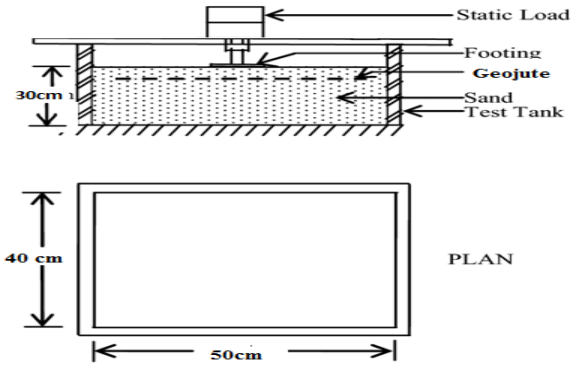


Fig 4. Schematic View

RESULT AND DISCUSSION

The results of the Index properties of the testing sand are recorded in Table 1

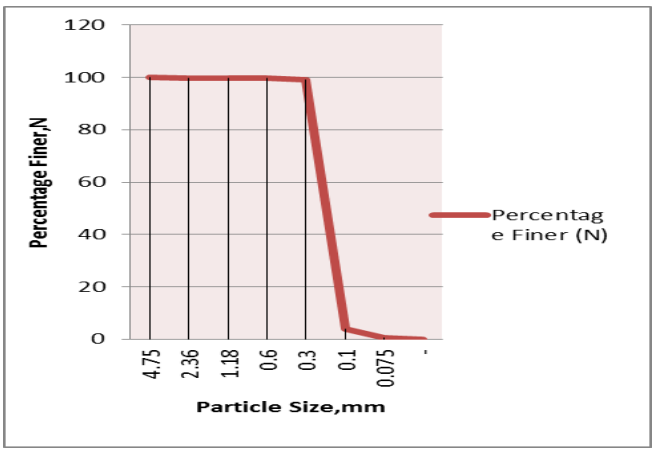
Table1 Index properties of sand

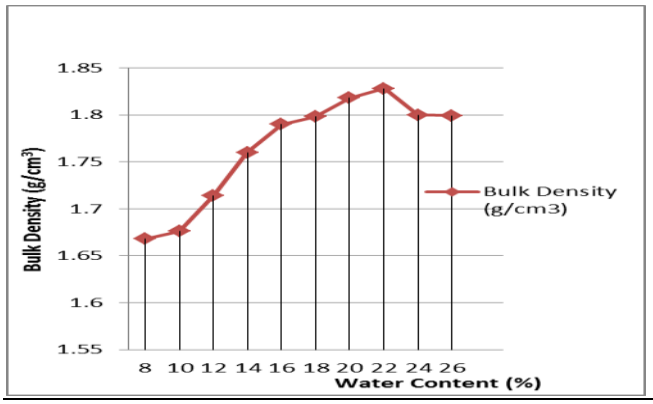
Properties	Sand
Water Content (%)	18.47
Permeability Test (mm/sec)	0.01035
Maximum unit weight (gd_{max}) in compacted condition (kN/m^3)	16.7
Minimum unit weight (gd_{min}) in loose condition (kN/m^3)	14.8
Maximum void ratio (e_{max})	0.77
Minimum void ratio (e_{min})	0.57
Relative density (I_D) (%)	61.92
Specific Gravity (G)	2.6

The results of the engineering properties of sand are recorded down in Table 2

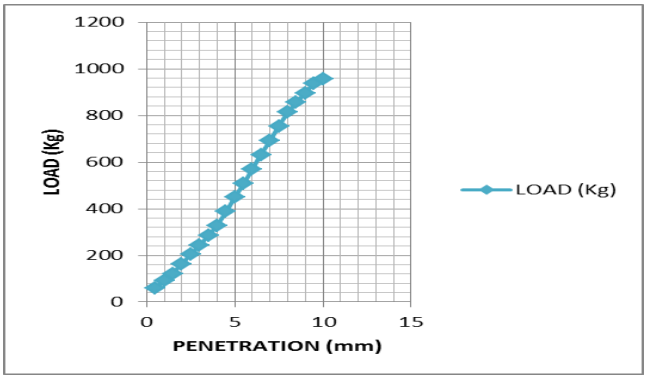
Table 2 Engineering Properties

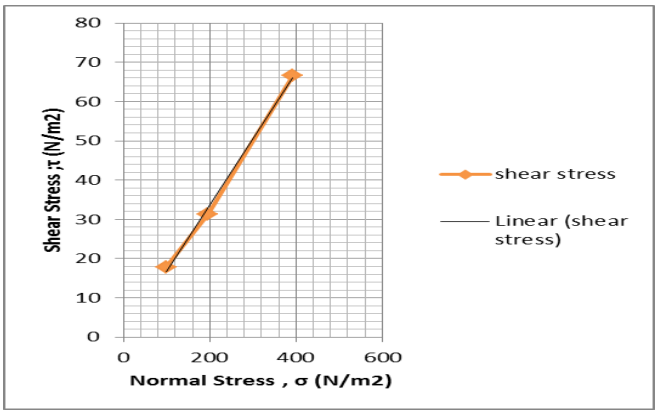
Properties	Sand
Shear Strength Parameters ;KN/m^2	4.42
Cohesion intercept (c) (kPa)	0
Angle of internal friction ϕ (degree)	49°
Permeability (Coefficient of Hydraulic conductivity) (k) (m/sec)	0.01035
Minimum unit weight (gd_{min}) in loose condition (kN/m^2)	14.7
Maximum void ratio (e_{max})	0.77
Minimum void ratio (e_{min})	0.57





Graph 1 Particle Size v/s Percentage Finer
Graph 2 Bulk Density v/s Water Content

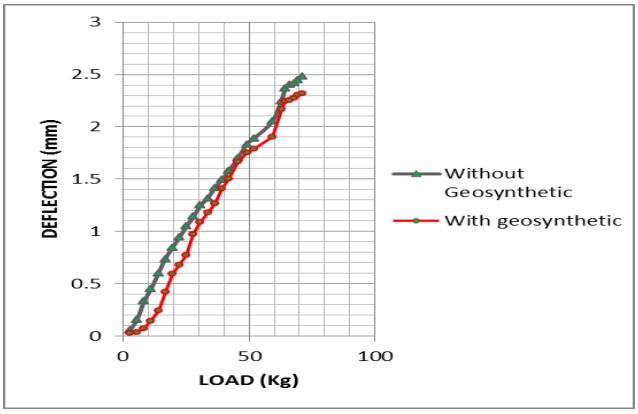




Graph 3 Load Penetration Curve, CBR
Graph 4 Normal Stress v/s Shear Stress.

Table 3 Comparison of results for Unreinforced and Reinforced Soil

Load (Kg)	Deflection (mm)	
2.8	Without Geosynthetic Layer	Geosynthetic Layer
5.6	0.06	0.03
8.4	0.16	0.04
11.2	0.335	0.07
14	0.455	0.145
16.8	0.6	0.245
19.6	0.74	0.425
22.4	0.845	0.595
25.2	0.945	0.68
28	1.05	0.775
30.8	1.145	0.975
33.6	1.25	1.09
36.4	1.32	1.18
39.2	1.415	1.265
42	1.495	1.41
45.6	1.58	1.5
49.2	1.705	1.665
52	1.835	1.75
59.2	1.89	1.79
62.8	2.05	1.9
64.48	2.25	2.17
66.16	2.37	2.245
67.84	2.405	2.255
69.52	2.42	2.275
71.2	2.445	2.305
	2.485	2.32



Graph 5 Load v/s Deflection

VI. CONCLUSION

Testing for evaluating the potential or ability of the geotextile in bettering of the bearing capacity of the sand are carried out. A three layers of geotextile (for reinforcement) is placed below the 50cm x 30cm x 40cm in rectangular footings in testing soil. The ratio of reinforcement depth to span or width of respective footing (D/B) is varied from 0.20 to 2 and therefore reinforcement area varing between 1B × 1B to 4B × 4B.

The conclusions below are strained on the above experimental results-

The maximal increase in ultimate bearing capacity is ascertained on placing the reinforcement at a depth of half the width of footing (B).

1. An increment by a factor of 2.03 to 2.47 is found in bearing capacity ratio.
2. A reinforcement at depths of 0.25B to 0.75B is the most effective zone.
3. The Ultimate Bearing Capacity is being enhanced by an aspect factor of 2.7 to 3.6 in contrast to the normal i.e. un-reinforced soil, at optimum (greatest) size and optimum depth of reinforcement.
4. The most favourable size of reinforcement is found to be 3.5B × 3.5B irrespective of the size of footing.

Hence, the geotextile of size 3.5B is used in the bearing capacity of sandy soil.

VII. FUTURE SCOPE

Validating the proposed theory with experimental data produced for the case of strip footings under vertical loads in a dense upper sand layer overlying loose sand deposit.

Extending the punching theory for all shapes of foundations, circular and rectangular foundations, in order to develop the respective shape factors. Extending the punching theory to foundations under inclined loads in order to develop the respective inclination factors.

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