International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 3, No. 3, September - November, 2018 | Pages 131-149

SOIL STABILISATION USING SAND PILE

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Abstract-This project deals with the stabilization of soil using sand pile. The main aim of this project is to increase the bearing capacity of the soil by erecting sand pile. The soil collected and is tested to find out the type of the soil. Two boxes are taken and they are filled with the soil sample collected and they are filled with the same compaction and same void ratio so that the soil is uniform. Then the soil is mixed with the water content and the load is applied to the soil. One sample is without the sand pile and the other sample is with the sand pile. The settlement of the plate in the two samples is found out and they are plotted in the graph. The graph is drawn for load vs settlement and the bearing capacity of the soil is found out.

I. INTRODUCITON

The soil at a construction site may not always be totally suitable for supporting structures such as buildings, bridges, highways and dams. In granular soil, the in-situ deposits may be very loose and undergo a large settlement. Depending on the structural load and the depth of the layers large consolidation settlement may occur in these deposits. In the past, the third bullet played a major in decision making on site selection. Once the bearing capacity of the soil was poor change the design to suit site condition, remove and replace the in situ soil, abandon the site. Affected areas include those which were susceptible to liquefaction and those covered with soft clay and organic soils. Other areas were those in a landslide and contaminated land. However, in most geotechnical projects, it is not possible to obtain a construction site that will meet the design requirements without ground modification. The current practice is to modify the engineering properties of the native problematic soils to meet the design specifications. Nowadays, soils such as, soft clays and organic soils can be improved to the civil engineering requirements. This state of the art review focuses on soil stabilization method which is one of the several methods of soil improvement. Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two. Usually, the technology provides an alternative provision structural solution to a practical problem. The simplest stabilization processes are compaction and drainage (if water drains out of wet soil it becomes stronger). Various techniques are used for stabilization. Stabilization of soil using sand pile is fastest growing techniques in the field of geotechnical engineering. One of the similarities of between concrete and soil is that both materials are strong in compression and weak in tension. When the load is applied to the soil mass, these piles resist the settlement due to the load, thereby increasing the bearing capacity. **Soil stabilization** a general term for any physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities and performance of in-situ sub soils, sands, and other waste materials in order to strengthen the surfaces.

II. BASIC TEST FOR SOIL

DETERMINATION OF SPECIFIC GRAVITY OF SOIL SOLIDS

Fig 1- specific gravity test

Table – 1-specifc gravity test

SAMPLE NO	W1 in gms	W2 in gms	W3 in gms	W4in gms	Specific gravity (G)
1	632	832	1602	1473	2.82
2	640	842	1620	1490	2.81
				Mean	2.82

The specific gravity of soil sample G = 2.82

DETERMINATION OF GRAIN SIZE DISTRIBUTION OF SOIL BY SIEVE ANALYSIS

Fig 2 sieve analysis test

Table – 2- Sieve test

S. NO	APERTURE SIZE OF SIEVE in mm	WEIGHT OF SOIL RETAINED (gm)	% WEIGHT RETAINED	CUMULATIVE % RETAINED	% FINER
1	4.75mm	139	27.8	27.8	72.2
2	2.36mm	112	22.4	50.2	49.8
3	1.18mm	104	20.8	71	29
4	0.600mm	44	8.8	79.8	20.2
5	0.300mm	50	10	89.8	10.2
6	0.150mm	30	6	95.8	4.2
7	0.075mm	13	2.6	98.4	1.6
8	Base	8	1.6	100	0

Result:

Percentage of grave (> 4.75mm) = 27.8%
Percentage of coarse sand (4.75mm-2mm) = 30%
Percentage of medium sand (2mm-0.425mm) = 20%
Percentage of fine sand (0.425mm-0.0075mm) = 20.5%
Percentage of fines (<0.0075mm) = 1.7%
Coefficient of curvature $c_c = 3.77$

LIQUID LIMIT AND PLASTIC LIMIT TEST:

Fig 3 liquid limit test

Table – 3-liquid limit test

S.No	Description	Trial-1	Trial-2	Trial-3
1	No of blows	77	48	26
2	Weight of container + wet soil	0.021	0.024	0.027
3	Weight of container + dry soil	0.018	0.020	0.022
4	Weight of water (2)- (3)	0.003	0.004	0.005
5	Weight of container	0.010	0.011	0.013
6	Weight of dry soil(3)- (5)	0.008	0.009	0.009
7	Moisture content(4/6)	0.375	0.444	0.555
8	Moisture content in percentage	33%	44.4%	55.5%

Table – 4-water content table

Trial no	Water content(%)	No of blows
1	33	77
2	44.4	48
3	55.5	26

Plastic limit:

Fig 4 plastic limit test

Table -5-plastic limit test

S.No	Description	Trial
1	Weight of container + wet soil	0.019
2	Weight of container + dry soil	0.016
3	Weight of water (1-2)	0.003
4	Weight of dry soil	0.01
5	Moisture content	0.3
6	Moisture content in percentage	30

Calculation:
Plastic index=**20%**
Plastic index$_{(A)}$=**15.4%**
PI > PI(A)
Hence soil is clay.

DETERMINATION OF UNIT WEIGHT OF SOIL BY SAND REPLACEMENT METHOD

Table -6-to find unit wt.of sand

S.NO	DESCRIPTION	TRIAL
1	Volume of calibrating container (v)	1021.01 cm^3
2	Weight of SPC + sand w1	7.114 kg
3	Weight of SPC + sand w_2 after filling conical portion on a flat surface	6.764 kg
4	Weight of SPC + sand $w_3$nafter filling calibrating can	4.927 kg
5	Weight of soil required to fill cone w_c=w_1-w2	0.35 kg
6	Weight of sand required to fill cone and can w_{cc}=w_2-w3	1.837 kg
7	Weight of sand in calibrating can w_{cc}-wc	1.487 kg
8	Unit weight of sand γ_{sand}=(w_{cc}-w_c)/v	14.28 KN/m^3

DETERMINATION OF UNIT WEIGHT OF SOIL:

Table – 7- to find the unit wt. of soil

S.NO	DESCRIPITION	TRIAL
1	Weight of SPC after filling the hole and conical portion w4	3.246 kg
2	Weight of sand in the hole and cone w_3-w4	1.681 kg
3	Weight of sand in the pit $w_p=(w_3-w_4)-wc$	1.331 kg
4	Volume of sand required to fill the pit v_p=wp	0.914 m^3
5	Weight of the soil excavated from the pit (w)	1.607 kg
6	Wet unit weight of the soil γ_{wet}=w/vp	17.25 KN/m^3
7	Dry unit weight of the soil $\gamma_{dry}= \gamma_{wet}/(1+w)$	16.04 KN/m^3
8	Void ratio of the soil $e=(\gamma_w G_s/\gamma_{dry})-1$	0.725

Calculation:

γ_{wet}=w/vp

=17.25 KN/m^3

$\gamma_{dry}= \gamma_{wet}/(1+w)$

=16.04KN/m^3

$\gamma_{dry}=G_s*\gamma_w/(1+e)$

e=0.725

Result:

Dry unit weight of soil=**16.04 KN/m^3**

Wet unit weight of soil=**17.25 KN/m^3**

Void ratio of soil=**0.725**

STANDARD PROCTOR COMPACTION TEST:

Fig 5 standard proctor test

Observation

Diameter of mould, d=10cm
Height of mould, h=12.5cm
Weight of mould, w_1=4.191Kg
Volume of mould, V=981.75cm^3.

Table – 8- To find OMC

S.NO	DESCRIPTION	TRIAL1	TRIAL2	TRIAL3
1	Weight of mould+ compacted wet soil(W_2)	6.209	6.391	6.412
2	Weight of compacted wet soil W=W_2-W1	2.018	2.200	2.221
3	Wet density of soil γ_{wet}=W/V	2.055	2.241	2.263
4	Moisture content in %	6	8	10
5	Dry density γ_{wet}/(1+W)	1.938	2.075	2.057

Result:

1. Optimum moisture content OMC(%) = **8%**
2. Maximum dry density =**2.075Kn/m^3.**

UNCONFINED COMPRESSIVE STRENGTH TEST:

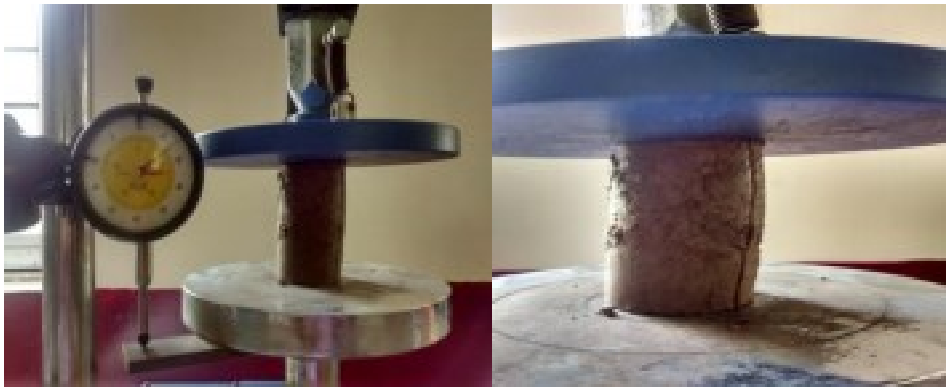

Fig 6 unconfined compression test

Observation and calculation:

Proving ring constant = 4.14

Initial length of sample, L_o =70 mm

Initial cross sectional area of sample A_o = 962.11 mm^2

Table – 9- To find shear strength of soil

Dial gauge	Deformation	Strain= Σ=L/Lo	Corrected area (A_c=A_o/1-Σ)	Proving reading (mm)	Load (KN)	Stress (KN/mm^2)
0	0	0	0	0	0	0
20	0.2	2.857*10^{-3}	964.866	0.8	3.52	3.64
40	0.4	5.714*10^{-3}	967.63	0.8	3.52	3.63
60	0.6	8.57	970.4	0.8	3.52	3.62
80	0.8	0.011	972.8	0.8	3.52	3.61
100	1.0	0.014	975.77	1.3	5.72	5.86
120	1.2	0.017	978.74	1.6	7.04	7.19
140	1.4	0.02	981.714	1.8	7.92	8.06

160	1.6	0.022	983.75	1.9	8.36	8.49
180	1.8	0.025	986.77	2.0	8.8	8.91
200	2.0	0.028	989.82	2.2	9.68	9.78
220	2.2	0.0314	993.29	2.3	10.12	10.18
240	2.4	0.0342	996.17	2.4	10.56	10.6
260	2.6	0.0371	999.17	2.6	11.44	11.44
280	2.8	0.04	1002.3	2.7	11.88	11.85
300	3.0	0.0428	1005.1	2.8	12.32	12.25
320	3.2	0.0457	1008.18	2.8	12.32	12.22
340	3.4	0.0485	1011.15	2.9	12.76	12.61
360	3.6	0.0514	1014.25	3.0	13.2	13.01
380	3.8	0.0542	1017.24	3.0	13.2	12.97
400	4.0	0.0571	1020.37	3.0	13.2	12.93
420	4.2	0.06	1023.52	3.0	13.2	12.89
440	4.4	0.0628	1026.57	3.0	13.2	12.86
460	4.6	0.0657	1029.76	3.1	13.64	13.24
480	4.8	0.0685	1032.86	3.1	13.64	13.20

RESULT:

The shear strength of soil is **13.24 KN/m^2**

III. EXPERIMENTAL INVESTIGATION

LOAD TEST ON THE SOIL SAMPLE WITHOUT SAND PILE

- The soil sample is taken and the water content is added to the sample. • The sample is mixed thoroughly.
- Then the samples is taken in a box and well compacted in the box.
- The surface is made even for the placement of iron plate.
- A string is tied across the box.
- After placing the load the plate started to settle. The settlement is measured by the measuring the height of the plate from the string.
- A graph is potted for load vs settlement and thus the bearing capacity is measured.


Fig 7 plate used for load test

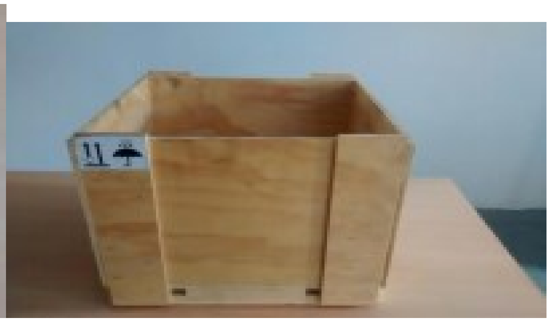
Fig 8 box used for load test

LOAD TEST ON SOIL SAMPLE WITH SAND PILE

- The soil samples is taken in another box with the same water content being added.
- The sand pile is erected using pvc pipe. A hole was drilled with the help of this pile.
- In the place of soil drilled the sand was filled.
- The plate was placed over the soil and the load was applied. • The settlement was measured as in the case of without the sand pile. • The load vs settlement graph was plotted and the bearing capacity was measured.


Fig 9 pipe used for drilling the soil

THEORITICAL CALCULATION:

LOAD BEARING CAPACITY OF GROUP PILE:

$q_u = CN_c + CPL$

= 6.62 * 5.14 + 6.62*4(5.5+3)

= 34.02+ 225.08*25

= 5661.02 KN/m²

LOAD BEARING CAPACITY OF INDIVIDUAL PILE:

$q = CN_c + n(mCA_p)$

$A_p = (\pi*3^2)/4$

$= 7.06\ m^2$

n = 4

m = 0.7

= 6.62 * 5.14 +(4*0.7*6.62*7.06) **= 164.89KN/m²**

we should take the lesser value among the group and individual pile. Since the load bearing capacity of individual pile is smaller than the group pile so that is the load bearing capacity of the pile.

CALCULATION OF LOAD BEARING CAPACITY OF PILE IN Kg

=164.89/9.81

=16.81*4

= 67.23 kg

BEARING CAPACITY OF SOIL:

$q_{ut} = CN_e(1+0.3B/L) + \gamma D\ N_q + 0.4\gamma B\ N\gamma$

$N_e = 5.7$

$N_q = 1$

$N\gamma = 0$

$q_{ut} = 6.62*5.7(1+0.3*1) + 16.04 * 0.28 *1+0$

= 53.54 KN/m²

To calculate the load acting on the soil:

= 53.54*0.85*0.85

= 0.386 KN

$= 0.386*10^{\wedge 3}/9.81$

= 40 kg

SOIL STABILISATION TESTS:

As a first step of the soil stabilization test the load was applied over the dry soil. We actually applied the greater load first over the soil and then the lesser load so there occurs the pre-consolidation pressure.

Pre-consolidation pressure:

Pre-consolidation pressure is the maximum vertical overburden stress that a particular soil sample has sustained in the past. It can also help determine the largest overburden pressure that can be exerted on a soil without irrecoverable volume change. This type of volume change is important for understanding shrinkage behavior, crack and structure formation and resistance to shearing stresses. This value is important in geotechnical engineering. Previous stresses and other changes in a soils history are preserved within the soils structure.[3] If a soil is loaded beyond this point the soil is unable to sustain the increased load and the structure will break down. This breakdown can cause a number of different things depending on type of soil and its geologic history. Since the load cannot be applied directly over the plate small supporting material was placed over the plate.

Fig 10 - Application of load over dry soil

APPLICATION OF LOAD OVER THE SOIL WITHOUT THE PILE STEP:

ADDITION OF WATER CONTENT TO THE SOIL

To find the water content to be added in the soil:

when the saturation is 100 %

G_s*w = e* s

w = e*s/G

= 100 * 0.7/ 2.82

w = 26..6 %

The total weight of the soil taken in the box is 45.

So the water to be added is

=(26.6 * 45)/ 100

= 11.6 litres

Fig 11 Addition of water content to soil

STEP: 2 APPLICATION OF LOAD OVER THE SOIL

We applied the load on the same day when we added the water. Since the soil was very wet as soon as the load was applied the plate started to settle at faster rate.

Fig 12 Application of load over soil

Since the water content is more the plate got well settled in the soil.

Table -10-settlement of plate on application of load

Load	Settlement
11	0.9
22	2.5
33	3.3
44	4.2

STEP: 3 APPLICATION OF LOAD WITHOUT THE SAND PILE:

The soil sample is allowed to set for one day after the water content is added, so that the excess water can drain off. So after one day the soil got well settled and the load is applied over it.

Fig 13- Application of load without the sand pile

The plate got gradually settled. The settlement was measured by measuring the distance between the string and plate.

APPLICATION OF LOAD OVER THE SOIL WITHOUT SAND PILE:

Table – 11-settlement of plate when sand pile is not used

LOAD (kg)	SETTLEMENT (mm)
0	0
11	4
22	10
33	25
44	30
54	46

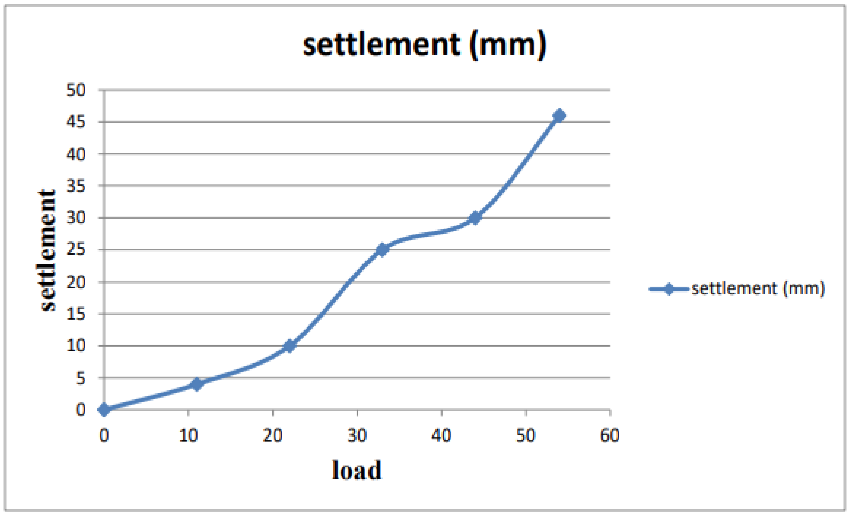

Fig 14 – Load vs settlement (when pile is not used)

This graph shows that the settlement got increased when the load is increased. So from this graph we can understand the settlement in the normal soil is more when load is applied.

APPLICATION OF LOAD WITH SAND PILE:

After the load was applied without the sand pile, another sample is taken in the box. The soil is well compacted and the same water content is added. Then the soil was drilled with the help of the pvc pipe. The pile was erected upto 25 cm. Each and every time the length was accurately measured with the help of a scale.

Fig 15- Drilling the hole for pile

Fig 16 - Measuring the depth of pile

A hole was created in the soil mass and it was filled with the sand

Fig 17 Filling the hole using sand

The second pile is drilled in the diagonal direction. So that there won't be any damage in the soil mass. Similarly the remaining two piles are drilled in the diagonal direction.

Fig 18 - Erection of sand pile in diagonal direction

As soon as the pile was erected the iron plate was kept over the soil mass. Then the load was applied over the plate. Since the pile was erected the plate doesn't settle till 22 kg.

Fig 19 - Application of load

By adding more loads one by one the plate started to settle gradually.

Fig 20 - Addition of loads over the plate

The settlement was measured by measuring the distance between the string and plate. After removing the plate the soil will be looking like this.

Fig 21 -After removing the plate appearance of the soil

APPLICATION OF LOAD OVER THE SOIL WITH USAGE OF PILE:

Table – 12 settlement of the plate when pile is used

LOAD (kg)	SETTLEMENT (mm)
11	0
22	0
33	1
44	6
52	11
60	12
63	15
70	25

A graph was plotted between the load and settlement. From the graph we can understand that when pile was applied the bearing capacity of the soil is increased.

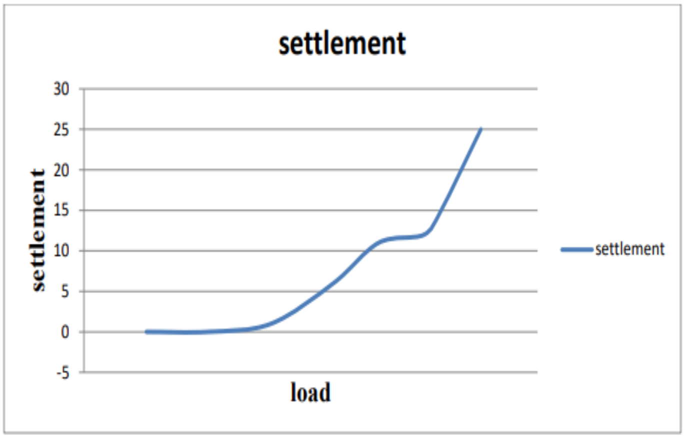

Fig 22- Load vs settlement graph when sand pile is used

COMPARISON OF GRAPHS:

When we see the graph two graphs (i.e) one without the sand pile and other without the sand we can understand the bearing capacity of soil. In the first graph the settlement got increased when the load is increased. In the second graph the settlement increased at slower rate even when more loads are applied. Thus we come to know that when sand pile is used the bearing capacity can be increased.

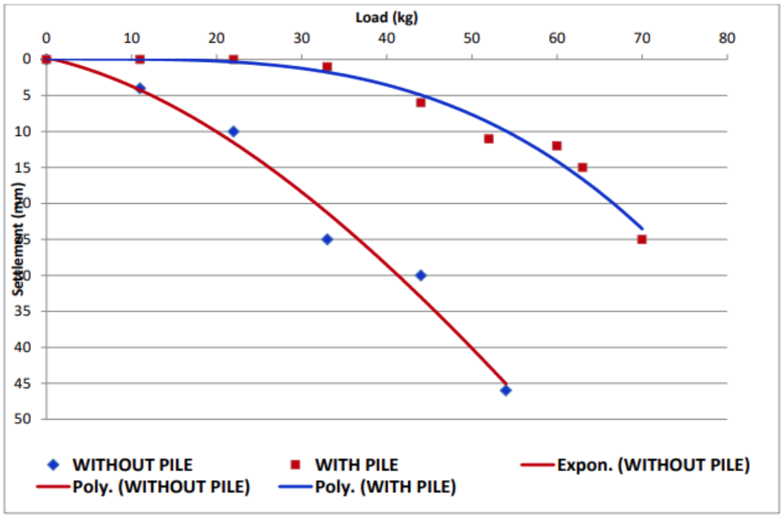

Fig 23 - Comparison of the settlement of two soil samples

IV. CONCLUSIONS

In the fastest growing population people are searching for places to get settle, so they are destroying the natural resources which are naturally got disturbed. Also they are settling in places where the soil is having poor bearing capacity. Most of the places the piles not used and moreover soil test is also not carried out. The greatest example for this is moulivakkam incident. The soil is also one of the natural resources which are being destroyed because of which their natural strength and bearing capacities are disturbed and minerals in them are exploited. Once if we are going to construct a building we have to first check the condition of soil and if there is any problem we have to think over the alternate resources. So our project to improve the bearing capacity is one of the solutions to preserve the soil and improve the strength of the soil. Thus to increase the bearing capacity we are using piles which are very costly. In place of using that types of piles we can use the sand pile which are economical. Erection of sand pile is economical and is very easy process to carry out. From the two graphs we came to conclusion that earing capacities are increased when sand pile is used. Thus by using the sand pile we can increase the bearing capacity.

V. REFERENCE

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