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Original Article

Soil Cement-Effective Method for Soil Stabilization

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Abstract: *In order to create a solid and long-lasting pavement basis, soil cement is a mixture of soil, Portland cement, and water. Concerns about suitable quality control procedures and testing process for soil cement have been raised as a result of construction practises and discrepancies in core strength data. They also debated and analysed the methods applied to various soil cement sample formats. Numerous soils and types of cement are briefly covered, as well. Likewise, figuring out different cement contents in soil for stabilisation and boosted soil strength.*

Keywords: *Soil Cement, Stabilization*

I. INTRODUCTION

When building roads, slope protection, or pipe bedding, soil cement is typically utilised as a sub-base layer to reinforce and safeguard the subgrade. It is brittle and has poor tensile strength, but it has strong compressive and shear strength and is hence prone to cracking. The quantity of paste (a cement-water mixture) in soil cement mixtures is different from Portland cement concrete. with contrast to Portland cement concrete, where the paste coats and binds all of the aggregate particles, with soil cements there are gaps left behind due to the decreased cement content, resulting in a cement matrix with nodules of uncemented material.

As a building material, soil cement is made of natural soil that has been ground up, a tiny amount of Portland cement, and water. It is often processed in a tumbler and compacted to a high density. The hydration of the cement particles produces a hard, semi-rigid, long-lasting substance.

II. NEED AND NECESSITY

A solid foundation is always important when building roads and pavements. The foundation itself needs to be constructed of a sturdy material that can withstand extended periods of increased traffic without losing its integrity. This can be accomplished by working with a substance known as soil cement. In order to support business lading, soil cement is utilised to strengthen the supporting soil conditions. Another frequent procedure to enhance the base section directly beneath rigid or flexible pavements is the use of cement stabilised base. To pave highways, parking lots, airfields, household thoroughfares, and more, utilise soil cement. It is an economical pavement base that is renowned for its durability and strength.

III. OBJECTIVE

1. To achieve the strength of soil by using cement in soil.
2. To study the black cotton soil.
3. Comparative study of various mixed soil cement.
4. To stabilize the soil by using a cement mix.
5. To study erosion of black cotton soil.

IV. LITERATURE REVIEW

A. Anil Pandey (June 2017)

General By blending and combining various elements, soil stabilisation is a technique for enhancing the qualities of soil. There are numerous soil stabilisation techniques, as well as numerous materials, available.

B. James Alexander. S, Antony Godwin, S. Alexander

In water permeability, It has 0% permeabilized it states that it is highly impervious for red to mixed concrete. In porosity, in red soil mixed concrete, porosity is higher than in plain concrete but the permeability is low in red soil compared to plain concrete. Due to tiny pores in fine s,oil can hold water tighter in small pores so that it is low in permeability, and it resists fluid passage. Hence it is impervious.

V. METHODOLOGY

A. Black Cotton Soil

Every building is supported on soil! Soil characteristics have a significant impact on how stable a structure is that is built on top of it. In India, a sizable amount of the land is muddy, and expansion soil makes up a sizable portion of this. Black cotton soils, also known as expansion soils, have the ability to expand and contract when subjected to changes in the climate. The complexion mineral montmorillonite is mostly to blame for these erratic behaviours. Despite being extremely valuable for agricultural, these soils are seriously endangering the structures built on them since they are lumpy and shrinking. Therefore, over the past few decades, numerous studies have been conducted to improve the parcels of Black Cotton Soils in order to address the issue of swelling and shrinking. According to the data analysis and experimental findings, soil stabilisation offered a solution to this issue. The soil stabilisation approach has succeeded in upgrading the Black Cotton Soil parcels in a fashionable manner. In this investigation, the Black Cotton Soil is stabilised by lime and fly ash at various probabilities, and a comparative investigation is made between the Stabilised Black Cotton Soil parcels and the Simple Black Cotton Soil parcels that were received from the point. Additionally, research was done to determine which stabilising agent among those utilised in this study was best.

B. Soil Stabilization Methods

Due to population growth, increasing productivity, the presence of companies, etc., there has been an increase in the usage of land in recent decades. Due to the decrease in available land as a result, there is now more demand for property on which to carry out building. Construction workers have begun building foundations on fragile or unstable soils as a result of the rising demand for land. Structures built on top of soft soil deposits that have a poor bearing capacity, a high agreement, swell and shrink, etc. are in serious difficulty. The accurate assessment of soft soils is one of the significant issues that geotechnical experts usually deal with. So, in order to improve these soils' mechanical properties, various ground improvement techniques, such as soil stabilisation and soil underpinning, were used.

After much research and analysis, experts devised a solution to all the issues they were having with soft soils, and it was the "Soil Stabilisation" approach. Soil stabilisation is a style of soil engineering that involves changing the soil's components so that it may be used in a vibrant engineering workshop and responds largely satisfactorily. Soil stabilisation, then, is the process of improving soil's engineering parcels by incorporating extra material. The weight-bearing capacity and performance of in-situ subsoils and other waste materials can be improved through soil stabilisation. By connecting the individual soil patches, soil stabilisation tries to increase soil strength and resistance to water softening. In general, technology offers a crucial structural solution to a real-world issue. Contraction and drainage (if water drains out of moist soil, it gets stronger) are the two simplest stabilisation mechanisms.

The alternative method entails perfecting the flyspeck size gradation, and further improvement is possible by adding binders to the poor soils. Numerous approaches can be used to stabilise soil. These designs all fit into one of two basic categories: Chemical Stabilisation or Mechanical Stabilisation. In mechanical stabilisation, soil stabilisation is accomplished through physical processes such as reducing vibration or contraction, incorporation of other physical elements like walls and nails, or changing the physical characteristics of native soil patches. Since mechanical stabilisation is not the primary focus of this study, it won't be discussed further. To provide the desired effect in chemical stabilisation, the stabilising agent (cementitious material) must chemically react with the soil minerals (pozzolanic accessories). The review's abecedarian is a chemical stabilisation system, hence for the remainder of this document, "soil stabilisation" will refer to chemical stabilisation. Footloose accoutrements can be stabilised with cementitious accoutrements (cement, lime, fly ash, bitumen, or a combination of these) through soil stabilisation.

In comparison to native soil, stabilised soil components are stronger, less permeable, and more compressible. There are two approaches to implement the system: in-situ stabilisation and ex-situ stabilisation. Stormy diamonds and lava make up Black Cotton Soil, which is regarded as a blessing for rural austerity. These soil types are notable for supporting cotton civilization.

C. Test on soil

1. Oven dry for water content in soil
2. Pycnometer for specific gravity
3. Grain size distribution
4. Dry density of soil by core cutter method
5. Liquid limit test
6. Plastic limit test

7. Standard Proctor test for maximum dry density and optimum moisture content

D. Test on Soil and Cement Mix

1. Liquid limit test adding 3% 5% & 10% cement
2. Plastic limit test adding 3% 5% & 10% cement
3. Standard Proctor test adding 3% 5% & 10% cement

VI. PERFORMANCE ANALYSIS

A. Test on soil

a) Oven Drying Method

Table 1: Oven Drying Method Determining Water Content

No	Sample No	1	2	3
1	Weight of Container With Lid (W1) in gm	11.5	11.5	11.5
2	Weight of Container With Lid + Wet Sample (W2) in gm	53	54.5	58
3	Weight of Container With Lid + Dry Sample (W3) in gm	46.5	48.5	51.5
4	Water / Moisture Content W = W2-W3 X 100 W3-W1	18.57	16.21	16.25

The natural moisture content of the soil sample is 16.98%.

Figure 1: Oven Drying Method

b) Pycnometer Method

Table 2: Observation of Pycnometer Method

No	Observations	1	2	3
1	Mass Of Empty Pycnometer (M1)	637.5	638	638
2	Mass Of Pycnometer And Dry Soil (M2)	837.5	838	838
3	Mass Of Pycnometer, Soil And Water (M3)	1511.5	1511	1509
4	Mass Of Pycnometer And Water (M4)	1426	1420	1430
5	Specific Gravity Of Soil G	1.74	1.83	1.65

Specific Gravity of Soils = 1.74, Hence the Type of Soil is Organic Soil.

c) Grain Size Distribution

Table 3: Observations of Grain Size Distribution

IS Sieve No	Weight of Soil Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Weight Retained (%)	Finer (%)
4.75	246	246	26.11	73.89
2.40	148	394	41.82	58.18
1.46	52	446	47.34	52.66
1.20	89	535	56.79	43.21
0.60	122	657	69.74	30.26
0.30	163	820	87.04	12.96
0.15	79	899	95.43	4.57
0.075	43	942	100	0

1) Uniformity Coefficient : $Cu = D60/ D10 = 1.28/0.28$, $Cu = 4.57$

2) Coefficient Of Curvature : $Cc = (D30)2/D10 X D60 = (0.61)2/ 1.28 X 0.28$ $CC = 1.03$

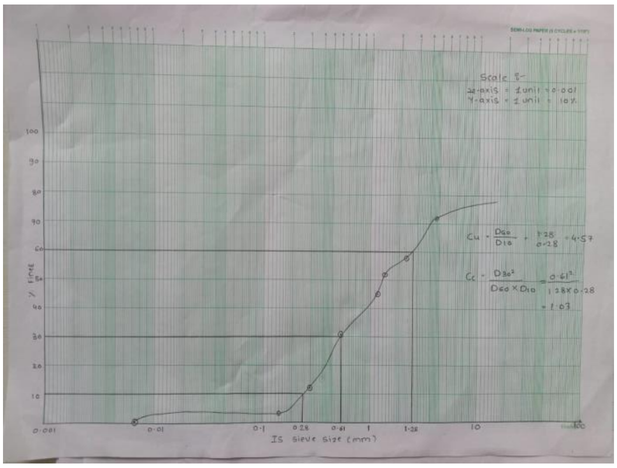

Figure 2: Graph of Grain Size Distribution

d) Liquid Limit Test

Table 4: Liquid Limit Test

No	Determination Number	I	II	III
1)	Container Number	1	2	3
2)	Weight of Container (Wo) gm	11	11.5	12
3)	Weight of container + Wet Soil (W1) gm	52	54	55
4)	Weight of Container + Oven Dry Soil (W2)gm	43	44	44
5)	Weight of Water (W1-W2)gm	9	10	11
6)	Weight of Dry Soil (W2-Wo)	32	28.5	29
7)	Moisture Content	28.12	30.76	33.33
8)	No. of Blows	24	22	20

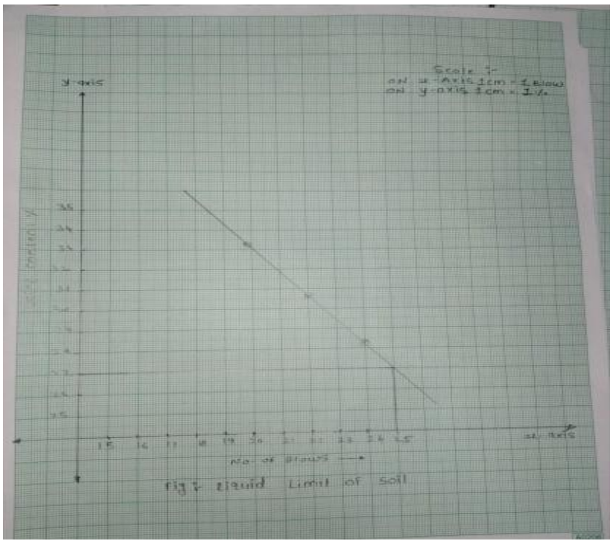

Figure 3: Liquid Limit of Soil

e) Plastic Limit Test

Table 5: Plastic Limit Test

No	Container Number	1	2	3
1)	Weight of Container + Lid (W1) in gm	11	12	12
2)	Weight of Container + Lid + Wet Sample (W2) in gm	45	40.5	42
3)	Weight of Container + Lid + Dry Sample (W3) in gm	41.5	35.5	36
4)	Weight Of Dry Sample = W3-W1 in gm	30.5	23.5	24
5)	Weight Of Water In The Soil = W2-W3 in gm	3.5	5	6
6)	Water Content = W2-W3 X 100 W3-W1	11.47	21.27	25

Average Plastic Limit = 19.27.

f) Standard Proctor Test

Table 6: Standard Proctor Test

No	Observation	1	2	3	4	5
1)	Cylinder Volume in Cc	911	911	911	911	911
2)	Cylinder Weight in gm	3900	3900	3900	3900	3900
3)	Weight Of Cylinder + Compacted Soil	5750	5825	5900	5850	5700
4)	Weight Of Compacted Soil in gm	1850	1925	2000	1950	1800
5)	Bulk Density in gm/cc	2.03	2.17	2.19	2.14	1.97

6)	Water Content in %	8	9.1	10.25	12.52	13.80
7)	Dry Density in gm/cc	1.87	1.93	1.99	1.91	1.74

Maximum Dry Density = 1.99 Optimum Moisture Content = 10.25

B. Test on soil Cement

a) Standard Proctor Test

For 3%, 5%, 10% Cement added in soil For 3% Cement

Table 7: SPT for 3% Cement

No	Observation	1	2	3	4	5
1)	Cylinder Volume in Cc	911	911	911	911	911
2)	Cylinder Weight in gm	3900	3900	3900	3900	3900
3)	Weight Of Cylinder + Compacted Soil	5550	5610	5800	5700	5650
4)	Weight Of Compacted Soil in gm	1650	1710	1900	1800	1750
5)	Bulk Density in gm/cc	1.81	1.87	2.08	1.97	1.92
6)	Water Content in %	9	9.80	10.27	12.75	13

Maximum Dry Density = 1.89, Optimum Moisture Content =10.27%

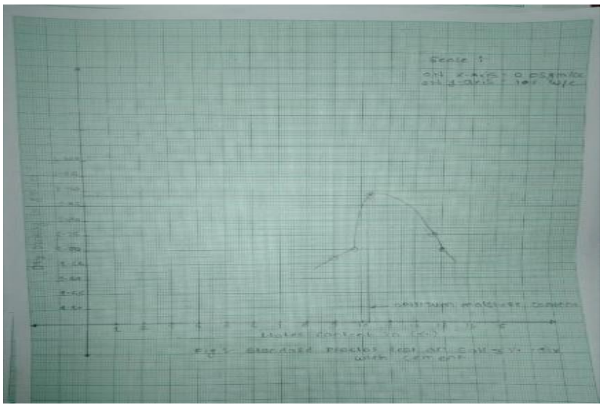

Figure 4: SPT for 3% Cement

b) For 5% Cement

Table 8: SPT for 3% Cement

No	Observation	1	2	3	4	5
1)	Cylinder Volume in Cc	911	911	911	911	911
2)	Cylinder Weight in gm	3900	3900	3900	3900	3900
3)	Weight Of Cylinder + Compacted Soil	5580	5600	5750	5620	5560
4)	Weight Of Compacted Soil in gm	1680	1700	1850	1720	1660
5)	Bulk Density in gm/cc	1.84	1.86	2.03	1.88	1.82
6)	Water Content in %	10.1	11.2	12	12.5	14.2

Maximum Dry Density = 1.81, Optimum Moisture Content =12%

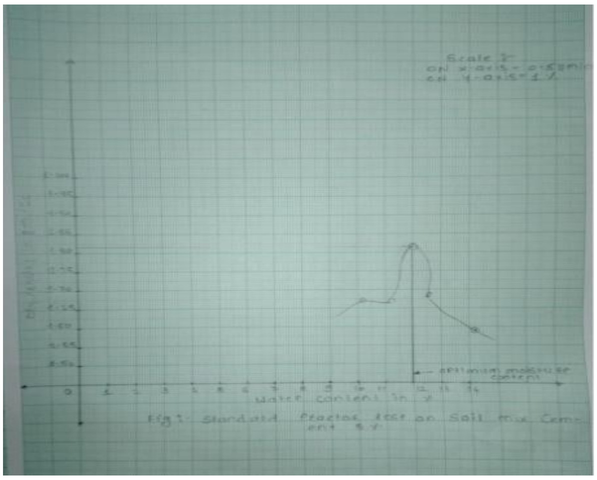

Figure 5: SPT for 5% Cement

c) For 10% Cement

Table 8: SPT for 10% Cement

No	Observation	1	2	3	4	5
1)	Cylinder Volume in Cc	911	911	911	911	911
2)	Cylinder Weight in gm	3900	3900	3900	3900	3900
3)	Weight Of Cylinder + Compacted Soil	5425	5540	5640	5580	5475
4)	Weight Of Compacted Soil in gm	1525	1640	1740	1680	1575
5)	Bulk Density in gm/cc	1.67	1.80	1.90	1.84	1.72
6)	Water Content in %	11.5	12	13.5	13.9	14.2

Maximum Dry Density = 1.67 Optimum Moisture Content =13.5%

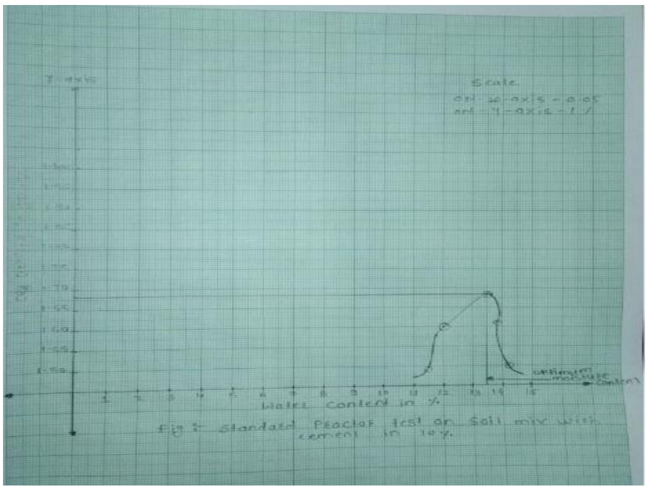

Figure 6: SPT for 10% Cement

VII. CONCLUSION

It was discovered that as cement was applied, the soil's dry density fell and its ideal moisture content rose. Unconfined compressive strength increased with the addition of cement to the soil, and it was also discovered to be higher with longer curing times. Swelling and shrinking are being experienced by the black cotton soil.

Expansive soil can create problems during and after construction so it must be identified before construction work. After identifying the type of expansively, mitigation measures and suitable stabilization technique can be considered

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