AN EXPERIMENTAL STUDY ON THE SOIL STABILIZATION METHOD BY ADDING THE CALCIUM CHLORIDE AND THE SODIUM CHLORIDE

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Abstract
In this project an experimental study was conducted in the soil stabilization method by using the chemical admixtures like calcium Chloride (CaCl2) and Sodium chloride (NaCl). Stabilization is the process of physical and chemical alternation of soil to increase their engineering properties. And this process used to improving the load bearing capacity for the pavement works. In India expansive soil is popularly known as black Cotton soil. Compared to red soil the Black Cotton Soil is the problematic soil that has high potential for shrinking or swelling due to change of moisture content. Soils are stabilized with various proportion of chemicals (0%, 5%, 10%, and 15%) up to optimum percentage .And the properties are compared after done the following tests, Specific Gravity Test, Plastic Limit and Liquid Limit Test, California Bearing Ratio test. Unconfined compression test.
Keywords: soil stabilization, calcium chloride, sodium chloride, Red soil, Black cotton soil, Specific Gravity Test, Plastic Limit and Liquid Limit Test, California Bearing Ratio test. Unconfined compression test

1. INTRODUCTION

The soil stabilization is generally used for modify the engineering properties of the soil. Soil stabilization is broadly used in connection with road, pavement and foundation construction. It improves the engineering properties of the soil in terms of volume stability, strength, and durability. Soil stabilization occurs over a longer time period of curing.

Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing. The simplest stabilization processes are compaction and drainage (if water drains out of wet soil it becomes stronger). The other process is by improving gradation of particle size and further improvement can be achieved by adding binders to the weak soils, and the stabilisation commonly done in several methods like chemical method, mechanical method, etc. Soil stabilization involves the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability. The components of stabilization technology include soils and or soil minerals and stabilizing agent or binders.

1.1.OBJECTIVE

1. To modify the engineering properties of the soil,
2. To improve the stiffness and the tensile strength of the soil,
3. To decrease the pavement thickness,
4. Improve durability and the resistance to the effect of the water,
5. Life of landfill is extended and natural resource is extended.

1.2 SCOPE OF OUR PROJECT

- The scope of the study is used for finding the best pair of chemical to use it in the stabilisation method by strength characteristics and compression characteristics.
- The soil stabilisation will increase the soil properties.

1.3 METHODOLOGY

- Literature Collection And Study
- Material Collection And Study
- Sieve analysis
- Specific gravity test,
- Atterberg's test,
- California bearing ratio test,
- Unconfined compression tests,
- Result And Discussions
- Conclusion

2.MATERIAL PROPERTIES

*2.*1 MATERIAL UESD

- Black cotton soil
- Red soil
- Calcium chloride
- Sodium chloride
- Desired water

2.1.1 Black cotton soil

The black cotton soil is collected from Kadanthapatty, Namakkal (D.T),Tamil Nadu, India.

In India deposition of Black cotton soil is very good and prosperous for farmers. All the basic amenities of life i.e. Food, clothes and house have been fulfilled by the soil, without soil It is just next to impossible to think about life on the earth. But on the other side in Civil Engineering aspects Black cotton soil is very troublesome and problematic and hazardous due to its characteristics. Because of its high swelling and shrinkage characteristics, the black cotton soil has been a challenge to the Engineers. The black cotton soil is very hard when dry but loses its strength completely when in wet.

S. No	Test for soil	Value obtained
1.	Specific gravity	2.325
2.	Plastic limit	26.51%
3.	Liquid limit	31.35%

2.1.2 Red soil

Generally this soil visible in red colour so it is also known as red soil. This kind of soil having the desired cohesiveness. And this soil is generally preferable for the agricultural purposes. It is suitable for growth the various crops.This soil is widely available in India so that we choosing it and taken for tests.

S.No	Test for soil	Value obtained
1.	Specific gravity	3.75
2.	Plastic limit	25.2%
3.	Liquid limit	31.6%

2.1.3 Calcium Chloride

The $Cacl_2$ bought from the market at Salem. It is collected in lab graded type. Calcium Chloride (CaCl2) is a white or off-white odourless powder with a high purity of 93 – 97 %wt. It is an inorganic salt highly soluble in water. CaCl2 is hygroscopic in nature and it is recommended to be packaged in sealed containers and stored in low humidity conditions whenever possible.

S.No	Test for fine calcium chloride	Value obtained
1.	colour	White
2.	Specific gravity	2.1
3.	Appearance	Powder
4.	Solubility	74gm / 100 ml Water

2.1.4 Sodium chloride

Sodium chloride also directly bought from the market at lab graded state. And the chemical formula for the sodium chloride is NaCl. Sodium chloride is a familiar salt which is

used for soil stabilisation and it is a colourless salt.

A Colourless or white crystalline compound NaCl, used in the manufacture of chemicals and as a food preservative and seasoning Salt is not made of NaCl molecules.

2.1.5 Water

According to IS 3025, water to be used for mixing and curing should be free from injurious or deleterious materials. Portable Water is generally considered satisfactory. In the present investigation, available water within the campus is used for both mixing and curing purposes**.**

3.MIX PROPORTION

3.1 Soil mix proportion

For the red soil and calcium chloride,

1.SOIL + 0% Cacl2 = SAMPLE 1
2.SOIL + 5% Cacl2 = SAMPLE 2
3. SOIL + 10% Cacl2 = SAMPLE 3
4. SOIL + 15% Cacl2 = SAMPLE 4

For the red soil and Sodium Chloride,

1.SOIL + 0% Nacl = SAMPLE 5
2.SOIL + 5% Nacl = SAMPLE 6
3.SOIL + 10% Nacl = SAMPLE 7
4. SOIL + 15% Nacl = SAMPLE 8

For the block cotton soil and calcium chloride,

1.SOIL + 0% Cacl2 = SAMPLE 9
2.SOIL + 5% Cacl2 = SAMPLE 10
3.SOIL + 10% Cacl2 = SAMPLE 11
4. SOIL + 15% Cacl2 = SAMPLE 12

For block cotton soil and Sodium chloride ,

1.SOIL + 0% Nacl = SAMPLE 13
2.SOIL + 5% Nacl = SAMPLE 14
3.SOIL + 10% Nacl = SAMPLE 15
4. SOIL + 15% Nacl = SAMPLE 16

4.TESTING OF SAMPLES

4.1.Sieve analysis test

The sieve analysis is an important test to find the grain size of the soil. In this test the most finer sieve screen is 0.075 mm. The sieve sets are arranged in the order of IS code book provisions.

4.2.Specific gravity test

The specific gravity is a unique property to everything. But the value may change by their water absorption characteristics. And the specific gravity is tested with adding various chemicals with the soil by using the pycnometer and weighing balance.

For red soil with chemicals, specific gravity value.

S. NO	CHEMICALS	0%	5%	10%	15%
1	CALCIUM CHLORIDE	3.75	3.91	4.012	3.87
2	SODIUM CHLORIDE	3.75	3.88	4.105	3.95

For black cotton with chemicals, specific gravity value.

S.NO	CHEMICALS	0%	5%	10%	15%
1	CALCIUM CHLORIDE	2.325	2.42	2.82	2.69
2	SODIUM CHLORIDE	2.325	2.51	2.73	2.55

4.3. Plastic limit and liquid limit test

This test is conducted to find the optimum moisture content taken by a soil to get the liquidity and the plasticity.The plasticity Index value find by subtracting the Liquid limit value with the Plastic Limit.

Ip = (Liquid limit) – (Plastic Limit) by using this formula we can say the condition of the soil.

The plasticity index test is done by IS 1498 codes.

For red soil plasticity index value

S.NO	CHEMICALS	0%	5%	10%	15%
1	Calcium chloride	6.4	4.8	4.02	5.04
2	Sodium chloride	6.4	4.05	3.78	4.17

For black cotton soil the plasticity index value

S.NO	CHEMICALS	FOR 0%	FOR 5%	FOR 10%	FOR 15%
1	Calcium chloride	4.84	4.92	3.98	5.54
2	Sodium chloride	4.84	4.260	3.78	4.17

4.4. California bearing ratio

The California bearing ratio test is used to find the penetration stress. The CBR value is determined by the ration of test load to the standard load. The test procedure involves two parts, one is preparing the test specimen and another is penetration test. There is two type of compaction is used by two methods, 1. Static compaction, 2. Dynamic Compaction.

The loading machine having the capacity of 5000kg of loading. The loading value is 1.25 mm per minute.

In the CBR test , up to the 5mm penetration sample is taken to design.

The CBR test is done by IS 2720 part 16, 1979.

4.5. Unconfined compression test

The unconfined compression test is used to find the compressive strength of the soil sample. The sample is sieved and mixed with the chemicals. Then added with desire quantity of water and filling in the lubricated oil applied mould with three layer of proper compaction. And then allowed to certain load till the specimen gets failure.

5. RESULTS AND DISCUSSION

5.1. SIEVE ANALYSIS

Sieve analysis results for the black cotton soil.

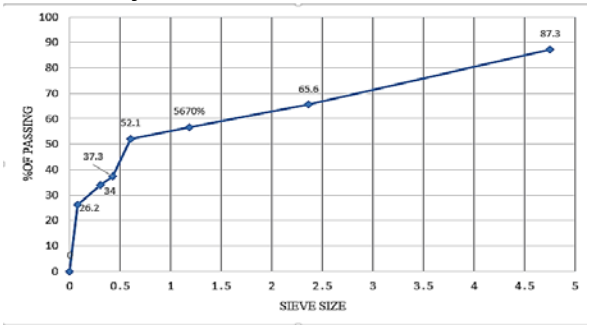

Fig. 5.1.1

Sieve analysis test results for the red soil,

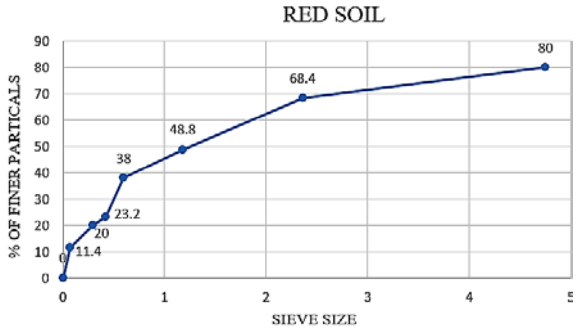

Fig. 5.1.2

5.2.Specific gravity test

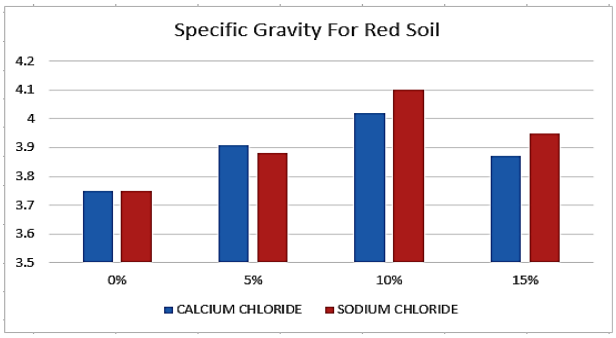

Fig . 5.2.1

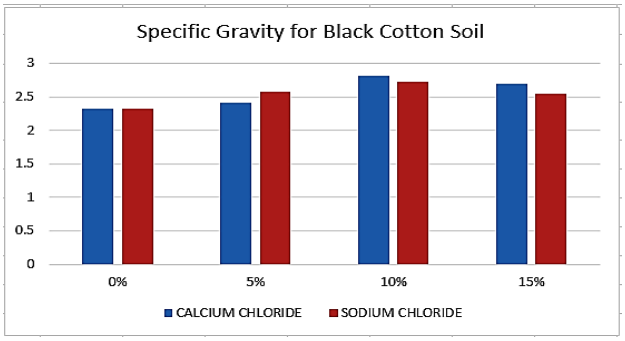

Fig.5.2.2

5.3. Plasticity index values

For the Black cotton soil,

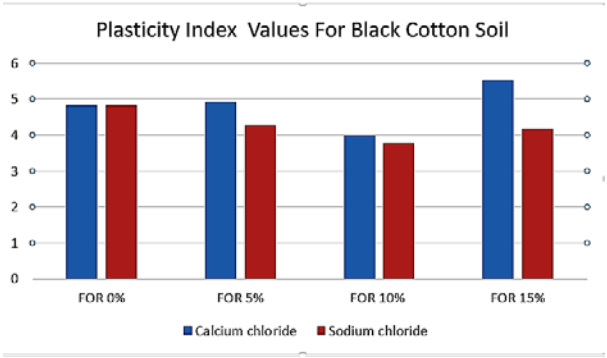

Fig .5.3.1.

For black cotton soil,

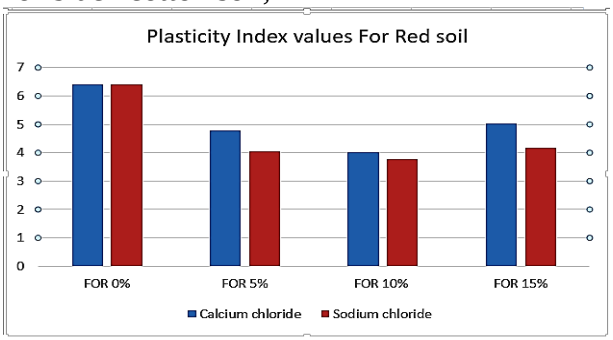

Fig .5.3.2.

5.4.CBR TEST RESULTS

The CBR test is conducted on both two soils in two type of condition i) without Chemicals. ii) With chemicals in the following ranges 5%, 10%, 15%. And the test results are shown in the following figures.

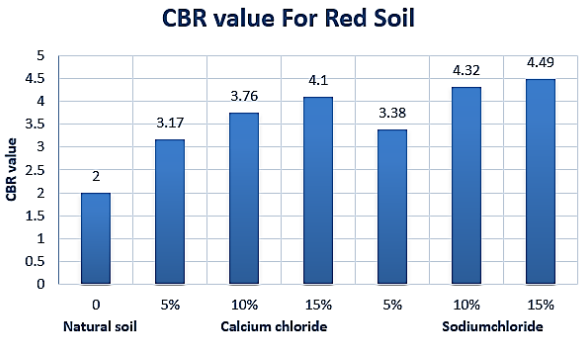

Fig . 5.4.1 The CBR values for Red soil

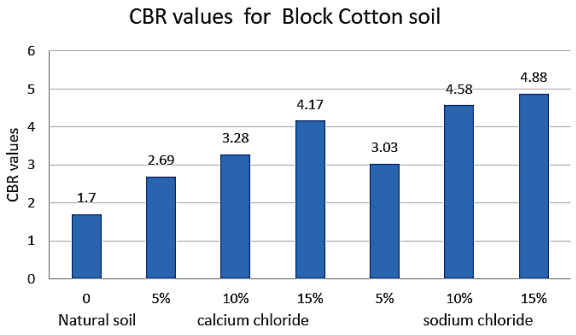

Fig. 5.4.2. The CBR values for black cotton soil

5.5. Unconfined Compressive Strength Test

The unconfined compression test is conducted for both soils in various mix designs like 5%, 10%, 15% to find the maximum strength giving mix. The values are graphed for the red soil and the black cotton soil , in three periods (1day, 7 days, 14 days,).

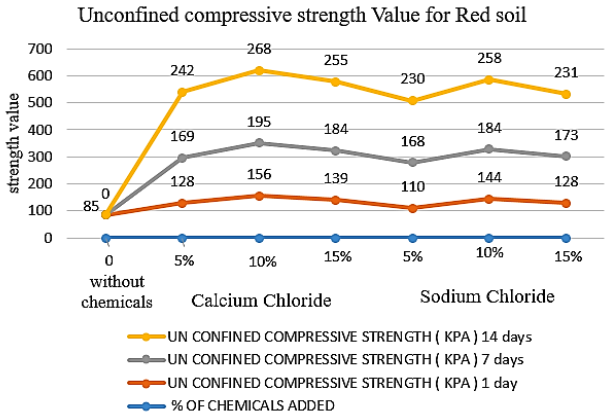

Fig.5.5.1.Strength value for the red soil

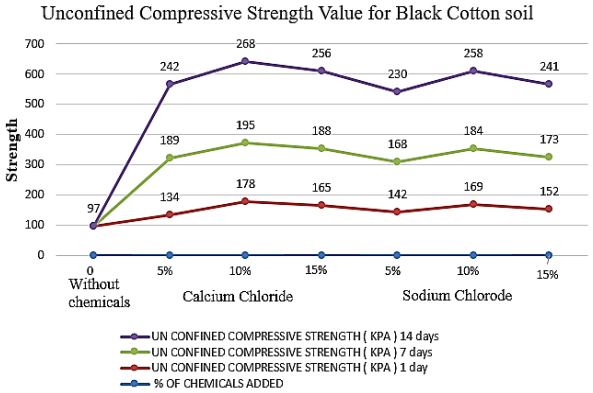

Fig. 5.5.2. Strength value for Black cotton soil

6. CONCLUSIONS

1. The sieve analysis is having same values compare to chemicals adding. Because of the grain size of the pan value and the chemicals value remain same. And the values are shown as graph in the fig 5.1.1 and fig 5.1.2

2. The Specific gravity test is conducted with the soil mix of chemicals in the range of 0%, 5%, 10%, 15%. Compare to all the percentages the 10% is found as the optimum percentage. The values are return low range after reaching the 10%. The specific Gravity Values of the Red soil and The Black cotton soil are shown in figure 5.2.1. and 5.2.2.

3. The Plasticity index values are finding by subtracting the liquid limit value and

the plastic limit. And if the liquid limit increase means, the strength of the soil is reduced. By adding the chemicals the Atterberg limit both the liquid limit and the plastic limits are reduced. The reduced level of Ip is shown in the fig.5.3.1. and fig. 5.3.2. By comparing the figures the optimum percentage is 10%. After the 10% the value is getting changes.

4. In the CBR test results, the values are having ups and down after reaching the 10% of chemical mix. The CBR test is generally based on the penetration values. In the red soil the sodium chloride mix raising the strength as high as the calcium chloride mix with the soil. And the Black cotton soil takes the sodium chloride to reach the strength higher. And the California Bearing Ratio test results are shown in fig 5.4.1. and the fig 5.4.2.

5. The unconfined compressive strength test is conducted both the soils. By comparing the test results we can find , which mix is giving high strength. This test is conducted with three stage of soil samples (1 day, 7 days, 14 days). Day by day the strength is increased for both the soils in any kind if mixture. In this test also the sodium chloride takes place for giving high strength as high as the calcium chloride. And the test results are shown in the fig 5.5.1. and fig 5.5.2.

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