Mitigation of Effect of Sulphate in Lime Stabilized Marine Clay

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Abstract - *Water plays an important role in the concrete preparation. It plays an important role in workability and strength of concrete. A new technology known as magnetized water in which when added to concrete improves the workability and compressive strength of concrete. Also, this magnetically processed water causes a reduction in the cement content required for the specified compressive strength value. In this project work, we check the effects of magnetic water on properties of concrete such as workability and strengths of M25 grade concrete. Magnetized water is prepared by passing the normal tap water through a magnetic field. When water passes through the magnetic field, some of the physical properties of water changes. The water clusters are broken due to magnetic field and which will increase the water activity. In this study magnetized water is used for mixing of concrete. When magnetic water was used there was an increase in compressive strength by 50% after 7days of curing and 60% after 28 days of curing, split tensile strength is increased by 44% after 7 days of curing and 39% after 28 days of curing and flexural strength is increased by 20% after 7 days of curing and 19% after 28 days of curing.*

Key Words: Magnetized water, stabilization, turbid metric method, free swell index, Desiccators

1. INTRODUCTION

Marine clays located in coastal and offshore areas of the world forms one of the important groups of fine grained soils and lots of civil construction activities take place in such marine clays throughout the world. Since these clays are characterized by low strength and high compressibility, the design and construction of many coastal and offshore structures in these deposits are confronted with many geotechnical problems. Such low strength and high compressible soils are generally associated with increased moisture content and they are weak in strength due to the presence of swelling clay minerals. Lime stabilization is one of the many processes available and is commonly resorted to improve the geotechnical properties of expansive and soft clays.

1.1 Problem Statement

Greater Cochin area forms part of a coastal belt which was first uplifted and then partially submerged by sea water and is covered by thick marine clay deposits. Structures resting on these soils are subjected to distresses caused by large scale total and differential settlements. It has been proved conclusively that the most effective stabilizing agent for marine clays in Cochin is lime.

1.2 Objectives

The objective of this study is to evaluate the long term influence of natural sulphate present in clays as well the effect of varying concentrations of sulphate on the physical and engineering properties lime treated Cochin marine clays. This study helps to understand the effect of barium hydrooxide in mitigating the deleterious long term effect of sulphate on lime treated marine clays.

2. METHODOLOGY

It explains about the literature review, material collection and tests to be accomplished for getting the final results. It also describes about preparation of samples with various percentage of materials. Rajasekaran et al [2] discussed about laboratory investigation was carried out to examine the influence of sodium and calcium sulphates on the behavior of lime column treated marine clay. The presence of sulphate in lime-treated clays may result in high swelling due to the formation of the expansive mineral, ettringite.

2.1 Raw Materials

a) Cochin marine clay

The Marine Clay conducted for this project is collected from Petta, located in Cochin. The depth at which marine clay deposits, usually overlain by loose sandy soils, found in these areas, varies from 2m to 9m. Clay was collected from a depth of 5m to9m by auguring from piling site.

Fig – 1 : Marine Clay

b) Lime

Specially selected uniform shells were used for the preparation of the stabilizing agent. The shells were burnt to remove CO_2 completely when they change to brittle white shells of calcium oxide which were preserved in air tight multilayer polyethylene bags. Just sufficient water was sprinkled over the lime shells taken from these bags, on each day till all the shells crumble to fine powder which was then sieved through IS 425 microns sieve. This method of preparation of lime was used because of its simplicity and ease with which it can be prepared for field application.

Fig – 2 : Lime

C) Other Additives

It includes sodium sulphate [Na2SO4], and barium hydroxide [Ba(OH)2].

2.2 Test for Soil

a) Test For Sulphate Content

1. Take 100 ml of the sample or a suitable portion made up to 100 ml into a 250ml in Erlenmeyer flask.

2. Add 20ml buffer solution and mix in stirring apparatus. While stirring, add a spoon full of barium chloride crystals and turning immediately. Stir for 60±2 seconds at constant speed.

3. Pour solution into absorption cell of nephelometer and measure turbidity at 5 min and stirring period.

4. Obtained Sulphate concentration in the sample from calibration curve prepared by carrying sulphate standards through the entire procedure.

Fig – 3 : Clay sample for the determination of sulphate content

b) Unconfined Compression Test (UCC)

1. The remolded soil was placed into a split mould of standard dimensions with a spatula, and care was taken so that no air was entrapped in the sample during for mingprocess.

2. The specimen was extruded from the sampling tube with the help of the sample extractor.

3. The initial length and diameter of the specimen was measured.

4. The specimen was placed in the compression apparatus, ready for testing.

5. Compression load was applied by giving about half a turn of the handle per second till the sample fails.

6. The readings of the dial gauge and the proving ring reading corresponding to each deformation was recorded.

c) Test For Liquid Limit

1. About 100 gm of air dried soil passing through 4.25μ sieve was taken, and it was mixed thoroughly with distilled water to form a uniform paste.

2. A portion of the paste was placed in the cup of the liquid limit device, and the surface was smoothened off to a maximum depth of 1cm.

3. The groove was cut by means of the grooving tool through the sample along the symmetrical axis of the cup.

4. The crank was turned at the rate of about 2 revolutions per second until the groove closed at the bottom to a distance of 12mm.

5. Approximately 10g of soil was taken from near the closed groove for water content determination.

6. The above procedure was repeated by altering the water content of the soil so as to get the number of blows ranging from 10 to 40.

d) Test For Plastic Limit

1. About 30g of air dry soil passing 425μ sieve was taken and it was mixed thoroughly with distilled water until the mass became plastic enough to be easily rolled into a ball.

2. A portion of the ball was taken and rolled on a glass plate with the hand to form the soil mass into a thread of uniform diameter of 3mm throughout its length.

3. The soil was now kneaded together and again rolled out in the form of a ball.

4. The step 2 was repeated until a 3mm diameter thread showed signs of crumbling. Some of the crumbled material was taken for water content determination.

e) Test For Free Swell Index

1. Take 20 grams of sand and pass it through the 4.25 µm sieve.

2. Then, dry it in the oven until it gets dry without any presence of moisture.

3. Take 10 grams of sand in a graduated glass cylinder with distilled water of 100 ml capacity, and another 10 grams of sand in a graduated glass cylinder with kerosene of 100 ml capacity.

4. Stir and shake both the glass cylinder thoroughly, until all entrapped air and bubbles get eliminated.

5. Allow the entire setup without disturbing for 24 hours, so that it will be in an equilibrium state.

6. After 24 hours period, determine the volume of the sand in distilled water as V_d and determine the volume of the sand in kerosene as V_k.

f) Test For Specific Gravity

1. Clean and dry the density bottle

- wash the bottle with water and allow it to drain.
- Wash it with alcohol and drain it to remove water.
- Wash it with ether, to remove alcohol and drain ether.

2. Weigh the empty bottle with stopper (W_1)

3. Take about 10 to 20 gm of oven soil sample which is cooled in a desiccator. Transfer it to the bottle. Find the weight of the bottle and soil (W_2).

4. Put 10ml of distilled water in the bottle to allow the soil to soak completely. Leave it for about 2 hours.

5. Again fill the bottle completely with distilled water put the stopper and keep the bottle under constant temperature water baths (T_{x0}).

6. Take the bottle outside and wipe it clean and dry note. Now determine the weight of the bottle and the contents (W_3).

7. Now empty the bottle and thoroughly clean it. Fill the bottle with only distilled water and weigh it. Let it be W_4 at temperature (T_{x0} C).

8. Repeat the same process for 2 to 3 times, to take the average reading of it.

g) Test For Moisture Content

1. Clean the container with lid and dry the container. After that weigh it and note it as (W1).

2. Take a specimen of the sample in the container and weigh with lid (W2).

3. Keep the container in the oven with lid removed. Dry the specimen to constant weight maintaining the temperature between 1050_0C to 1100_0C for a period varying with the type of soil. Usually 16 to 24 hours are taken for oven drying the specimen.

4. Record the final constant weight (W3) of the container with dried soil sample. Peat and other organic soils are to be dried at lower temperature (say 600) possibly for a longer period.

3. RESULTS AND DISSCUSSIONS

The test results of the samples are given below. **Table - 1:** Physical Properties of Clay

Sl No.	Soil Property	Clay
1	Specific Gravity	2.7
2	Natural Moisture Content (%)	92.23
3	Liquid Limit (%)	110
4	Plastic Limit (%)	52.1
5	Free Swell Index (cc/g)	4.15

Table – 2 : Physical Properties of Clay treated with 6% Lime and 4% Sulphate

Sl No	Curing Period	Liquid Limit (%)	Plastic Limit (%)	Free Swell Index (Cc / G)	Unconfined Compression Test (Kpa)
1	0 day	118	55.7	4.77	7.50
2	7 day	117	61.8	4.72	28.04
3	28 day	114	59.31	4.68	53.88
4	60 day	100	60.29	4.59	49.83

Table – 3 : Physical Properties of Clay treated with 6% Lime , 4% Sulphate and Barium Hydroxide

SL NO.	SAMPLE DESCRIPTION	CURING PERIOD	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	FREE SWELL INDEX (cc / g)	UNCONFINED COMPRESSION TEST (KPa)
1	Clay + 6% lime + 4% sulphate +0.5% barium	0 day	116	58.2	4.64	6.15
		7 day	113	60.15	4.60	26.57
		28 day	104	63.91	4.35	45.69
		60 day	96	64.48	4.27	69.43
2	Clay +	0	107	58.37	4.49	7.11

	6% lime + 4% sulphate +1.5% barium	day				
		7 day	100	60.29	4.21	25.80
		28 day	93	59.8	4.19	47.27
		60 day	89	63.4	4.07	81.99
3	Clay + 6% lime + 4% sulphate +3.5% barium	0 day	98	58.8	4.18	7.51
		7 day	95	59.74	4.09	27.4
		28 day	94	62.07	3.98	61.35
		60 day	87	64.6	-	100.9

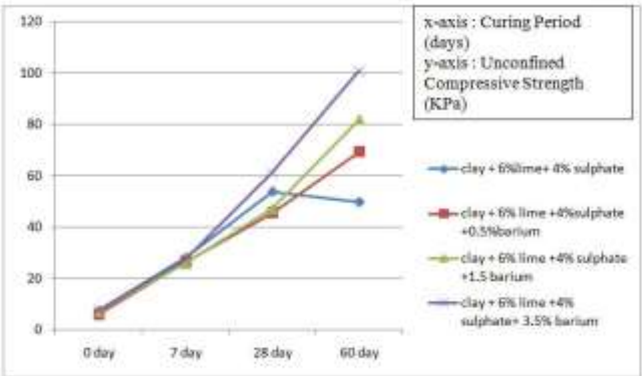

Chart – 1: Variation of Unconfined Compressive Strength with curing period

4. CONCLUSIONS

1. With 6% lime and presence of any quantity of sulphate, liquid limit is found to show a decreasing trend with time.

2. It is necessary to determine the sulphate content prior to stabilization of Cochin marine clays with lime.

3. Addition of barium compound further decreases the liquid limit.

4. Free swell index decreases with curing period for lime treated sulphatic clays.

5. Treatment with barium compounds further decreases free swell index.

6. The clay containing sodium sulphate has increased strength values when barium compound was used with lime as compared with specimens treated with lime only.

7. Percentage variation of strength by barium compound 0.5 Ba - 39.33% Ba - 64.53% Ba - 102.48%

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