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Stabilization of Black Cotton Soil using Epoxy Resin

S.Bharathi(1), S.Anwar Hussain(2), R.Abdul Rahuman(3),M.Abdul Basith(4)
(1)*Assistant Professor, Department of Civil Engineering, Sethu Institute of Technology, Viruthunagar-626115, Tamil Nadu, India.*
(2), (3), (4) *Final Year Students, Department of Civil Engineering, Sethu Institute of Technology, Viruthunagar-626115, Tamil Nadu, India.*

Abstract
In India, a major portion of total land area is covered by clayey soil. Of this, a large proportion is expansive soil. Expansive soils are often encountered in many parts of the world, especially in arid and semi-arid fields. . Soil stabilization is one of the promising techniques used to improve the geotechnical properties of soil and has become the major practice in construction engineering. This project aims to conduct a study to check the improvements in properties of black cotton soil by adding Epoxy resin. By varying percentage of resin (0%, 8%, 10%), the soil parameters such as UCS and CBR and LIQUID LIMIT and PLASTIC LIMIT and SHRINKAGE FACTORS and SPCT may be studied. These values are compared to that of a control specimen. As the chemical content increased, the unconfined compressive strength was increased. Finally, it can be said that stabilization of black cotton soils with epoxy resin and is an effective method.

IndexTerms: Expansive soil, Epoxy resin, UCS, CBR, LIQUID LIMIT, PLASTIC LIMIT, SHRINKAGE FACTORS, SPCT, Black cotton soil.

INTRODUCTION

For structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their parameters which affect their condition. The stabilization process helps to achieve the required parameters in a soil needed for the work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Expansive soils are one of the most serious problems that the geotechnical engineers encounter. They are considered a potential natural hazard, which can cause extensive damage to structures such as spread footings, roads, highways, airport runways and earth dams if not adequately treated. In the earth dams if not adequately treated. In the United States damage caused by expansive clays exceeds the combined average annual damage from floods, hurricanes, earthquakes Some measures can be taken to prevent the damages. Recently there is a growing attention to soil. The experimental program was carried out on compacted soil specimens with 0%, 8%, 10% epoxy resin additives and the results of unconfined compression tests and California bearing ratio test and liquid limit and plastic limit and shrinkage factors and SPCT on 0%, 8%, 10% of epoxy resin were swell tests and were discussed.

1.1) Importance

- ❖ The first priority of soil stabilization is to ensure that the proper techniques are utilized for the modification of it so it is able to provide peak performance.
- ❖ While soil stabilization is important throughout many of different industrial sectors it is often a requirement for those who are in the industry of providing paving services for roads and airfields.
- ❖ For the engineers who are responsible for making the decision as to the suitability of the soil for the specific project it means making that decision on some specific criteria. It is critically important that the dust control products being used are not going to compromise the judgement of the engineers.

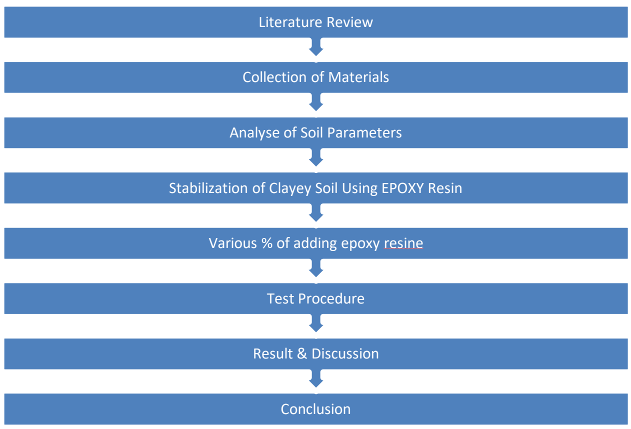
1.2) Objectives

- ❖ To evaluate the index properties of Black cotton soil.
- ❖ To increase the strength characteristic of soil by adding epoxy resin.
- ❖ To make comparison of strength properties between Black cotton soil with epoxy resin and without epoxy resin.
- ❖ To increase the soil bearing capacity by adding epoxy res and in varies percentages.

II. LITERATURE REVIEW

2)General

I.METHODOLOGY



Collection of Materials

1) Black cotton soil
2) Epoxy Resin

1) Black Cotton Soil

- Black cotton soil is a clayey soil. They are of variable thickness, density under layered by black sticky material known as "Black soil".

- It swells, shrinks enormously due to present of fine and dust clay particles. Hence black cotton soil must be treated by using suitable admixtures to compact it.

Black cotton soil

2) Epoxy Resin

- Araldite LY 556 epoxy and Aradur HY 951 hardner were used. Araldite LY 556 is medium viscosity, unmodified liquid epoxy resin based on Bisphenol-A, Aradur HY 951 is a low viscosity, unmodified, aliphatic polyamine.

Epoxy Resin

3.4) Experimental Tests

1) Specific Gravity

The specific gravity of the soil is ratio between weight of the solids and weight of equal volume of water.It is measured by the help of a volumetric flask in a very simple experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water. The specific gravity is denoted by "G".

Specific Gravity $G = (W2-W1)/(W4-W1) - (W3-W2)$

W1- Weight of bottle in gms
W2- Weight of bottle + Dry soil in gms
W3- Weight of bottle + Soil + Water
W4- Weight of bottle + Water

1) Liquid Limit

Weigh about 120gm of soil passing through 420 micron (I.S sieve).The soil sample is placed on the operating dish and thoroughly mixed with water using spatula until the mass becomes a thick paste of putty like consistency. Thecasagrande's device is checked to have a correct fall of 10mm and placed a portion of the prepared paste over the brass cup.A portion of the mixture is placed in the cup and leveled with the spatula to a maximum depth of 1cm.The grooving tool is used to cut a groove in the middle of the soil cake. The cam is rotated at a rate of 2 blows per second and the rotation are counted until the groove closer over a length of 12mm.A small quantity near the centre of test sample is collected in a container and weighed it. The sample is kept in the oven for 24 hours and weighed. The difference of the two weight will give the weight of water and from the moisture content is found out by the dry weight.The experiment is repeated by adding little more water. Four trials are made so that the numbers of blows are more than 25 in two cases and less than 25 in order two cases.In each trial the moisture content is determined the result of the test are plotted as a flow curve.The moisture content values are plotted to a natural scale against the number of blows to a logarithmic scale.The moisture content corresponding to 25 number of blows will give the liquid limit for the sample.It is denoted by WL.

2) Plastic Limit

A Sample of about 50gm is taken from the given soil sample.The sample is thoroughly mixed with water on the glass plate until it is plastic enough to be rolled into a ball.Theball of soil is taken rolled between the hand and the glass plate so as to form the soil mass into a thread of 3mm diameter without breaking.The soil is then kneaded together and rolled out again. The process of kneading and rolling thread is repeated until the soil just ceases to be plastic and crumbles.The portion of crumbled soil are gathered together and placed in a container for moisture content determination.The test is repeated twice more than fresh samples.The average of the three water contents gave the plastic limit of the soil.Plastic limit is denoted by WP.

3) Shrinkage Factors

The shrinkage limit of a soil and shrinkage factors about 30 gms of soil passing through 425 microns sieve is mixed with distilled water. The inside of the shrinkage dish is coated with thin layer of Vaseline. The soil sample is placed in this dish by giving gentle taps. The top surface is struck off with a straight edge. The shrinkage dish is weighted immediately full of wet soil. The dish is dried first in air and then in an oven. The shrinkage dish is weighted with dry soil pat and it is cleaned and dried to determine its empty mass. An empty porcelain dish is also weighted which will be used for weighing mercury. This dish is known as mercury weighting dish. This dish is known as mercury weighting dish. The shrinkage dish is kept in a large porcelain dish, and is filled to over flow with mercury and the excess is removed by pressing the plain glass plate firmly over the top of the dish. The content of the shrinkage dish is transferred to the mercury weighted dish and is weighted. the mercury is displaced by the dry soil pat is transferred to the mercury weighing dish and Place the sampling soil specimen at the desired water content and density in the large mould.Push the sampling tube into the large mould and remove the sampling tube filled with the soil. For undisturbed samples, push the sampling tube into the clay sample. Saturate the soil sample in the sampling tube by a suitable method. Coat the split mould lightly with a thin layer of grease. Weigh the mould. Adjust the upper plate to make contact with the specimen.Adjust the dial gauge and the proving ring gauge to zero. Apply the compression load to cause an axial strain at the rate of ½ to 2% per minute.Record the dial gauge reading, and the proving ring reading every thirty seconds up to a strain of 6%. The reading may be taken after every 60 seconds for a strain between 6%, 12% and every 2minutes or so beyond 12%.Continue the test until failure surfaces have clearly developed or until an axial strain of 20% is reached.Measure the angle between the failure surface and the horizontal, if possible.Take the sample from the failure zone of the specimen for the water content determination.

Qu = load/corrected area (A')
qu – compressive stress,A'= cross-sectional area/ (1- ε)

4) Unconfined Compression Test

Height of the mould. Remove the collar and cut out the projected soils to have a level surface with the top of the mould.Weight the mould with the soil (w_2) gm.Remove the soil from the cylinder and break up the soil by hand. Now Increase the moisture content by 2% mix thoroughly. Repeat the experiment .In the repeating process each time rise the moisture content by 2% until there is a considerable fall in the weight of the mould with compacted soils.Take samples from which operations and calculate the moisture content and corresponding dry density.Draw the graph between dry density and moisture content. Find the dry density and optimum moisture content from the graph.The equations used in this experiment are as follows,

Dry density= (G × ϒW) / (1+WG)

5) Proctor Compaction Test

Weigh the standard proctor mould with base and without collar(w1) gm.Take about 3kg of air dried soil passing through 4.5mm sieve.Take known quantity of water (6% by the weight of dried soil) and mix well with the soil.Attach the collar with proctor mould and fill the mixed soil in the mould in the three equal layers. compact each layer by the rammer weighing 2.6 kg allowing into drop 25 times from the height of 310mm.The total height of the compacted soil should be slightly more than the is weighted. The test is repeated thrice for each soil sample.

6) California Bearing Ratio Test

Place the mould assembly with surcharge weight on the penetration testing machine. Seat the penetration piston at the center of the specimen with the smallest possible load, but in no case in excess of 4kg so that full contact of the piston on the sample is established. Set the stress and strain dial gauge to read zero. Apply the load on the piston so that the penetration rate is about 1.25mm/min. Record the load readings at penetration of 0.5,1.0 ,1.5 ,2.0 ,2.5 ,3.0 ,4.0 ,5.0 ,7.5, 10 and 12.5mm.Note the maximum load and corresponding penetration if it occurs for a penetration less than 12.5mm.Detach the mould from the loading equipments. Take about 20 to 50 g of soil from the top 3cm layers and determine the moisture content.

CBR = P/Ps X100

IV. RESULTS AND DISCUSSIONS

4.1) Specific Gravity

Black Cotton Soil

S.NO	PARTICULARS	TRIAL 1(gms)
1	Mass of empty bottle (M1)	0.668
2	Mass of bottle + dry soil	1.068
3	Mass of bottle + dry soil + water	1.800
4	Mass of bottle + water	1.555
5	Specific gravity	2.52

Specific gravity of soil sample= 2.52g

4.2) Index Properties

4.2.1) Liquid Limit

S.NO.	MOISTURE CONTENT (%)	QUANTITY OF WATER (cc)	NO.OF.BLOWS (N)
1	20	18	128
2	25	24	97
3	30	30	63
4	35	36	38
5	40	42	17
6	45	48	4

Liquid Limit = 63%

4.2.2) Plastic Limit

S.NO.	PARTICULARS	TRIAL (gms)
1	Mass of empty can	20
2	Mass of can + wet soil	58
3	Mass of can + dry soil	46.1
4	Mass of pore water	11.9
5	Mass of soil solids	26.1
6	Water content (%)	45.6

Plastic Limit = 45.6%

4.3) Proctor Compaction Test

S.NO.	OBSERVATIONS	CALCULATIONS
1	Soil sample	Dry
2	Specific gravity	2.5
3	Diameter of mould	10cm
4	Height of mould	12.5cm
5	Volume of mould	981.24cm2
6	Weight of soil taken	5kgs
7	Weight of rammer	2.5kg
8	Number of layers	3layers
9	Number of blows	25/layer
10	Weight of mould	4240gms

Tabulation

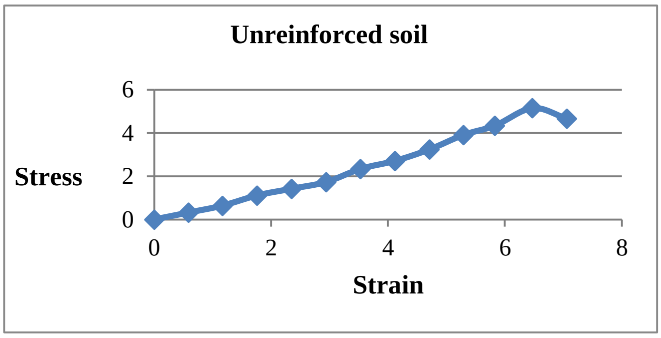
S.NO.	PARTICULARS	TRIALS				
1	Water content	4%	6%	8%	10%	12%
2	Weight of mould soil (w2)gm	632 0	636 0	643 0	6490	641 0
3	Weight of soil w=(w2-w1)gm	208 0	212 0	219 0	2250	217 0
4	Bulk density Y=w/v	2.12	2.16	2.23	2.29	2.21
5	Dry density Yd=Y/1+w	2.03	2.04	2.06	2.08	1.97
6	100% of saturation	2.44	2.32	2.22	2.13	2.04

4.4) Unconfined Compression Test

Observation

S.NO	PARTICULARS	OBSEVATIONS
1	Diameter of Soil Sample	3.8cm
2	Area Of Sample	$11.34cm^2$
3	Length Of Sample	8.5cm
4	Weight Of Sample	200g

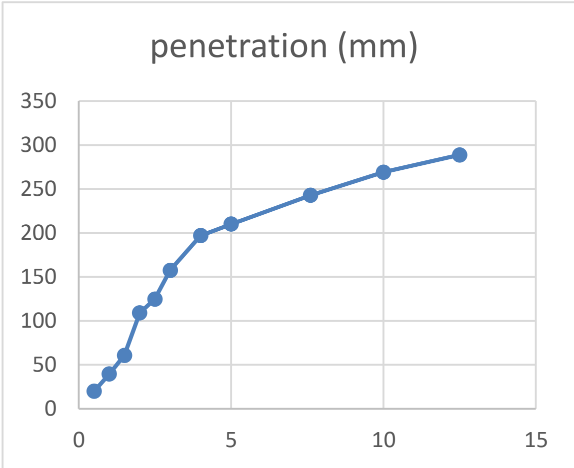
Unreinforced Soil



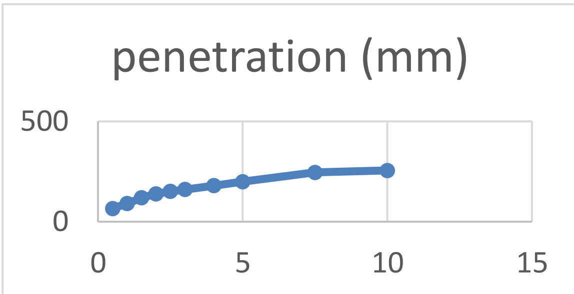
Unconfined compressive strength = $5.15Kg/cm^2$

4.5) California Bearing Ratio Test

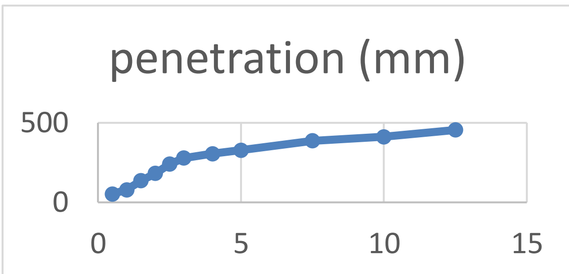
CBR for 0%



CBR for 8%



CBR for 10%



V.CONCLUSION AND REFERENCES

5.1) Conclusion

- This study results that the effect of adding Epoxy resin and strength behaviour of clayey soil**.**
- The effect of epoxy on clayey soil was studied by using the results obtained from a series of unconfined compressive stress and California bearing ratio test. Based on the result presented in this paper the following conclusions are drawn.
- With increase in the epoxy resin content, the unconfined compressive stress value of reinforced soil increases to zero at of epoxy resin.
- Due to increase in the epoxy resin content, the unconfined compressive stress reinforced soil decreases from 0 % of epoxy resin.
- The California bearing ratio of the soil increases with the addition of epoxy resin content up to 8% of epoxy resin and then decreases with the addition of epoxy resin.
- From this investigation, it is clearly indicated that the unconfined compressive stress and California bearing ratio value of the reinforced soil increased. Hence addition of 10 % of stabilizer was taken as the optimum percentage of epoxy resin for stabilizing the soil.
- Also the strength of the clayey soil was increased due to addition of epoxy resin and can be concluded that epoxy resin can be used effectively for the stabilization of clayey soil.

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