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Experimental Study on Presence of Calcium Exchange Capacity on the Properties of Expansive Soils

Sunkara Suresh, Asst. Prof. A. Sarath Babu
Department of Civil Engineering
Sri Sunflower College of Engineering & Technology

***Abstract*- This research work presents the efficacy of salt and ash as an additive in improving the engineering properties of Black cotton soil which is expansive soil. Salt of 1%, 2% and three were mixed with black cotton soil utilized in the laboratory experiments. The ash percentages of 20% and 30% were used for compare the results obtained with salt percentages. The effectiveness of the salt and ash tested by conducting unconfined compressive strength and swelling pressure test. The unconfined compressive test has finished curing period of seven, 14, and 28 days to match the results with 0 days unconfined compressive strength. The soil samples were subjected to wet and dry cycles and observed that increase of unconfined compressive strength and reduction of swelling pressure. The results were obtained from salt mixes soil sample after wet and dry cycles has better strength, less swelling pressure and fewer swelling index.**

***Keywords*- black cotton soil utilized, dry cycles etc.**

I.INTRODUCTION

Black cotton soils are the swelling soils or shrink swells soils which have tendency to shrink or swell with the changes of moisture content. Expansive soils are predominant in many parts of the planet. The variation of water content cause cracking of the structures which built on them. These problems thanks to expansive soils cause billions of dollars for his or her repair annually (Nelson and Miller). This expansive behavior not only causes the loss of property but also lost of the lives.

The state Texas was used quite 1 billion dollars for the restore the inspiration of the buildings, buried utilities, highways and pavements of airports, and embankments which constructed on expansive soils. These soils also called regur soils in some parts of the planet.

Over the past 30 years enormous research were executed on the reduction of swelling behavior of expansive soils. Supported methods available for soil stabilization it are often divided into physical mechanical and chemical stabilization. Using different chemical admixtures the stabilization of black cotton soil is usually adopted in India. Among various chemicals available the foremost commonly used methods are ash stabilization, lime stabilization and cement stabilization.

Black cotton soils are vastly spread within the regions of middle India Andhra Pradesh, Madhya Pradesh, Gujarat, and Maharashtra and in some places of Orissa, expansive soils are available within the regions of Narmada, Tapi, Krishna, and Godavari. In north western India the depth of availability of black cotton soil is extremely high. The black cotton soils are the residual soils formed thanks to weathering or chemical decomposition of the rock, left at that place itself after formation from the rocks. The black cotton soils contain high percentage of montomorollonite content which is liable for expansion and shrinkage of the soil.

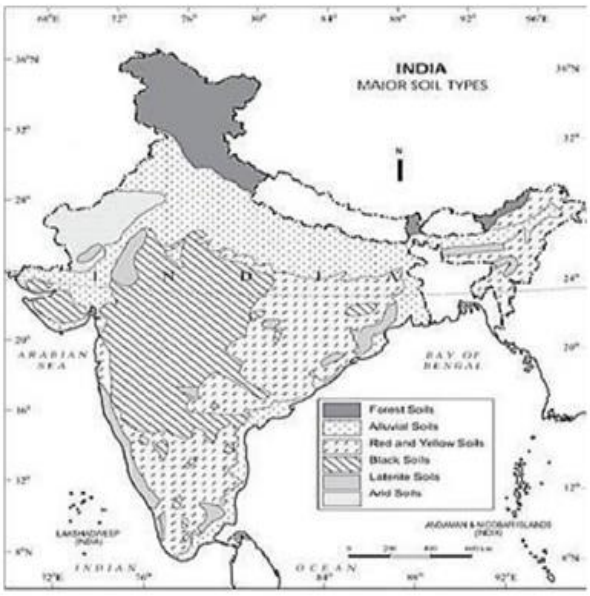

Fig 1. Soil distribution in India.

Presently at India nearly 25% of the soils are covered by the expansive soils. These soils are having affinity to carry large moisture content so suitable for the growing of the crops like jower, oilseeds, citrus fruits, cereals, sugarcane and vegetables. Black cotton soils are very profitable for the forming and problematic to the constructive point of view.

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The wetting and dry of the black cotton soils causes the swelling and shrinkage of the soils which causes progressive damage to the structure.

The influence of wetting and dry cycle has been well shown by popesco 1980, Chen and ma, 1987 subbarao and satya das, 1988. However the wetting and dry cycles does not effect on the chemically stabilized expansive soils.

II. MATERIALS

In the present research, expansive black cotton soil obtained from the geologist, Nagpur, Maharashrtra. The black cotton soil was obtained after removing 0.5 m depth top soil by the method of disturbed sampling and transported in sacks to the laboratory.

The sample is carefully transported to the laboratory without losing the moisture content to determine moisture content of the soil. The soil is dried and grinded to 4.75 mm sieve to carry out laboratory experiments. The various geotechnical properties shown below.

Table 1. Physical properties of black cotton soil.

S. No	Properties	Confirming To Is Code	Value
1	Specific Gravity	IS 2720:PART 3: SEC1:1980	2.57
2	Liquid Limit	IS 2720:PART 5:1985	75%
3	Plastic Limit	IS 2720:PART 5:1985	27%
4	OMC	IS 2720:PART VII: 1980	25.10%
5	MDD	IS 2720:PART VII:1980	1.56g/Cc
6	UCS	IS 2720:PART 3:1980	26.58 N/Cm2
7	Natural Moisture	IS 2720:PART 2:1973	9.2%
8	Free Swell Index	IS 2720:PART XL:1977	75
9	Swelling Pressure	IS2720:PART XLI:1977	5.2kg/Cm2

To evaluate the effect of soil/calcium ration and soil/fly ash ratio of swelling pressure and mechanical strength. Three different types of calcium chloride and two different fly ash ratios were used. The calcium ratios were 1%, 2% and 3% and two different proportions of fly ash uses in the present study.

The soil and fly ash were mixed thoroughly before the experimental programs conducted. All the tests were conducted according to the IS code method. The following experiments were conducted in the laboratory.

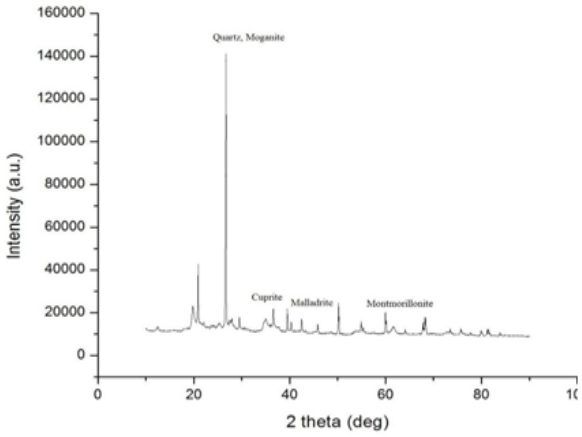

Fig 2. XRD Analysis of black cotton soil.

III. WET AND DRY CYCLES

Black cotton soil specimens were mixed with water and different proportions of calcium chloride solutions and different proportions of fly ash then After Atterberg limits will be measured.

Then the black cotton soil was left to air dry in the laboratory environment (at controlled temperature of 21± 5C) until the loss of moisture ceased. Each black cotton soil specimen was then re- wetted with the same concentration of liquid as used initially.

The soil specimens were tested for up to five wet–dry cycles. In each cycle the behavior of the soil was observed.

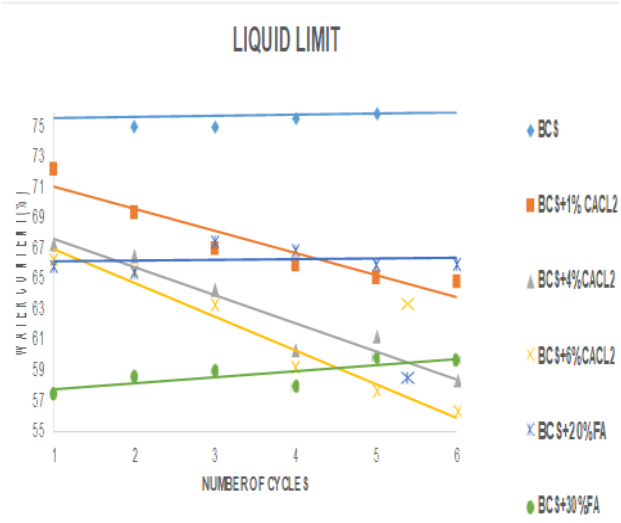

Fig 3. Graph between liquid limit and number of cycles.

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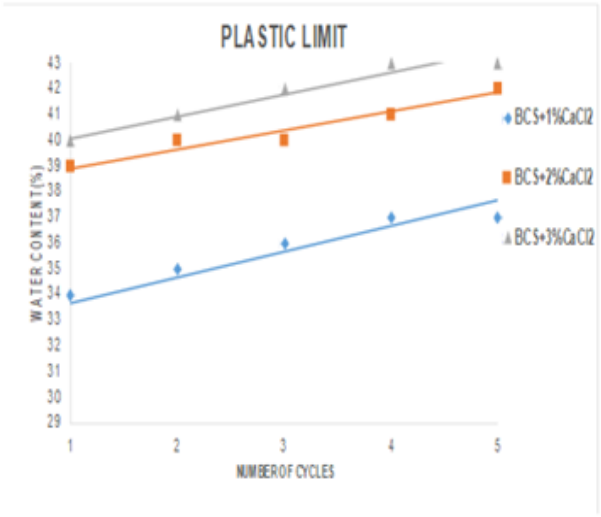

Fig 4. Graph between plastic limit and number of cycles.

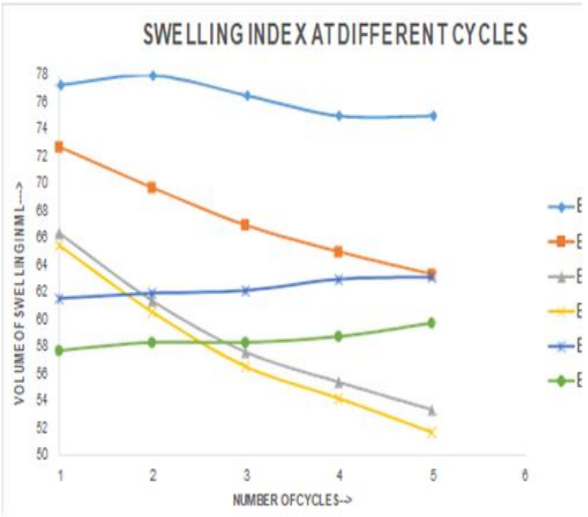

Fig 5. Swelling index at different cycles.

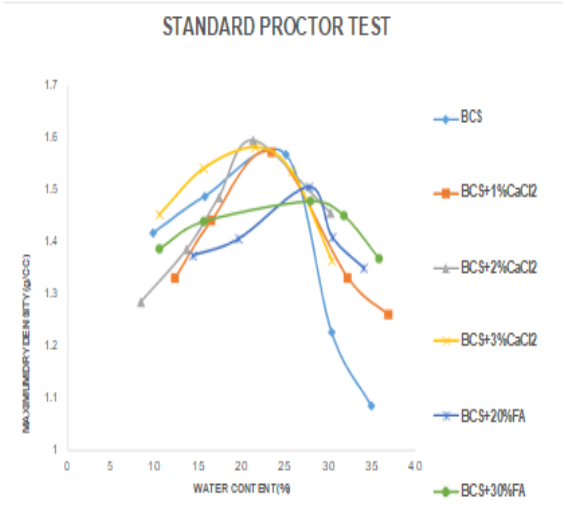

Fig 6. Standard proctor test for different proportions of calcium chloride and fly ash.

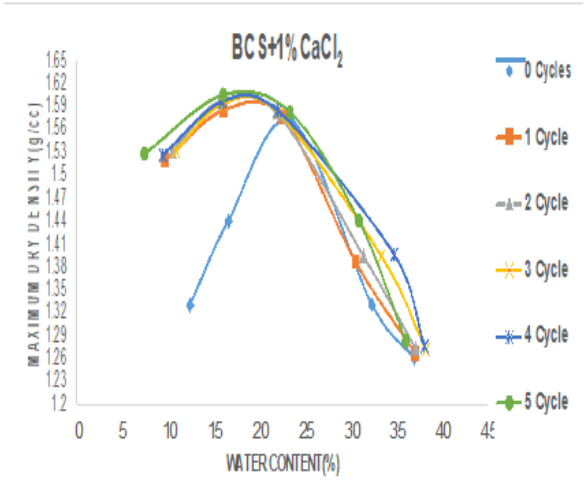

Fig 7. Standard proctor test for different cycles of BCS+1%CaCl2.

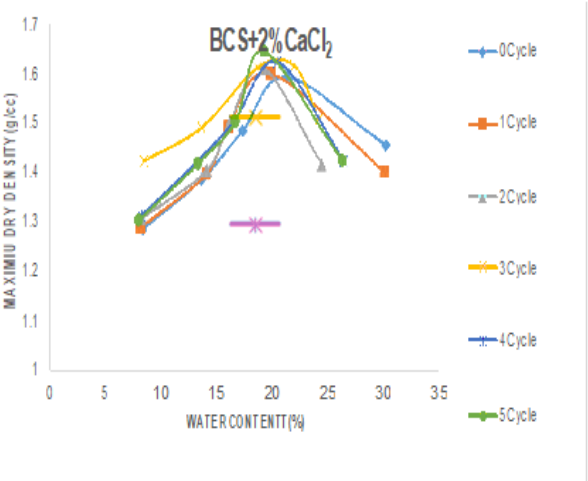

Fig 8. Standard proctor test for different cycles of BCS+2%CaCl2.

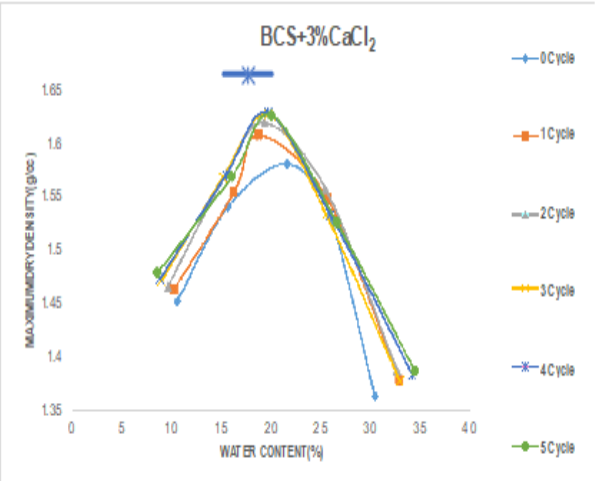

Fig 9. Standard proctor test for different cycles of BCS+3%CaCl2.

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IV. CONCLUSIONS

Based on the experimental study and analysis of results following conclusions are made.

Liquid limit of the soil decreases with change of calcium chloride percentage. Thus with increase in calcium chloride cation exchange of the soil increases. Liquid limit also decreases with number of wet and dry cycles so we can conclude full cation exchange capacity does not takes place instantly after adding to the soil.
Plastic limit of the soil increases with change of calcium chloride percentage so we can conclude that plasticity index of the soil decreases, so the swelling characteristics also decreases

UCS value of the soil increases with increases of calcium chloride. The UCS results of 3% CaCl2 and black cotton soil slightly above the results of 2% CaCl2 and black cotton soil. So economically 2% calcium chloride has been recommended for stabilization of soil UCS values increases with increase of number of days of curing. And also increases with increases of wet and dry cycles.

The swelling pressure value of the soil decreases with increases of calcium chloride. The swelling pressure results of 3% CaCl2 and black cotton soil slightly lower than the results of 2% CaCl2 and black cotton soil. So economically 2% calcium chloride has been recommended for stabilization of soil.

V. FUTURE SCOPE

Efforts should be made to obtain less cost material for the cation exchange in the place of calcium chloride. Field application of this method by the suitable technology Use of other chemical their effect on the cation exchange of the black cotton soil. Application of this calcium chloride for other highly expansive soil materials.

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