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UTILIZATION OF SEA SALT IN BLACK COTTON SOIL FOR STABILIZATON

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ABSTRACT

Black Soil is a most common soil in India, which covers more than 20 percentage land area of India and is also known as 'regur'. This soil is spread over Madhyapradesh, Gujarat, Andhrapradesh, Tamil Nadu, Maharashtra, Karnataka and other parts of India as well. Presence of montmorillonite clay minerals is mainly responsible for swelling and shrinkage characteristic of black cotton soil. The swelling and shrinkage characteristics of black cotton soil pose a serious threat to foundations and structures constructed on them. Light weight and small structures are generally more susceptible to damage due to their less amount of overburden pressure. In this study, experiments have been conducted to find out the effect of addition of sea salt on the behaviour of black cotton soil. From the laboratory test results it is observed that the addition of salt in black cotton soil significantly reduces the liquid limit, plastic index, swelling and plasticity index of soil with a minimum cost. Optimum moisture content and dry density of soil has also found to be changed with addition of sea salt.

Keywords -Black Cotton Soil, Index Properties, Optimum Moisture Content, Maximum Dry Dencity,Sea Salt

I. INTRODUCTION

Increased costs associated with the use of high quality materials led to the need of local soils to be used in geotechnical and highway construction . Often however high water content and low workability create difficulties for construction projects. In many situation soil present in the field may be a problematic one such as expensive soils. Expansive soils with high swell and shrinkage behavior prone to be challenging for construction and pavement activities. Expensive soils will heave and can cause lifting of building or other structures during high moisture variations and they suffer shrinkage and can result in building settlement during dry spells. They also exert pressure on the vertical face of the foundations, basement and the retaining walls resulting in lateral movements. Apart from its effect on building construction and foundation they have severe impacts on roads, ground anchors and underground pipelines and other buried structures. Pavements are in particular susceptible to damage by expansive soils because they are light weight an d extended over large areas. Expansive soils covers almost 20% of India'sland. Hence they cannot be simply ignored of construction and pavement activities because of their problematic nature. There are several methods available for improving characteristics of expansive soils.

Previous researches on improvement in the characteristics of expansive soils have come out with fruitful solutions including chemical stabilization techniques and deep foundation techniques. The most significant among them is stabilization techniques. Stabilization in broad sense incorporates the various methods employed for modifying the properties of soil and to reduce the construction cost by making best use of locally available materials. At the same time large amount of salt is produced from sea everyday and the utilization of such salt is very important. Salt is classified as sea salt and table salt (common salt). Sea salt is produced through evaporation of ocean water or water from saltwater lakes, usually with little processing. Depending on the water source, this leaves behind certain trace minerals and elements. The minerals add flavor and color to sea salt, which also comes in a variety of coarseness levels. However Table salt is typically mined from underground salt deposits. Table salt is more heavily processed to eliminate minerals and usually contains an additive to prevent clumping. Sea salt and table salt contain comparable amounts of sodium by weight.

1.1 Need of Study

Studies have been conducted in the past about the problems and damages posed by the black cotton soil. A large number of research has been done on the improvement of engineering properties of expansive soils to find out economical and efficient means of using common salt. However less work has been carried out on sea salt which is also available in large amount with minimum cost or no cost. So there is need to study the effect of sea salt on engineering properties of expansive soil like black cotton soil.

1.2 Objectives of study

1) To study properties of black cotton soil.

2) To study the effect of sea salt on index properties of black cotton soil.

3) To study the effect of sea salt mixture on engineering properties of black cotton soil.

4) To find out best sea salt mixture.

II. EXPERIMENTAL METHODOLOGY

The purpose of this chapter is to give detail information about materials used in present work and experimental methodology used for the same.

2.1 Materials used

2.1.1 Black cotton soil

Natural black cotton soil was collected from behind K.V.Naikcollege of engineering near Gangapur road, Nasik district in Maharashtra state. The soil was excavated from a depth of 1m from the natural ground level. The soil is dark grey to black in color. The obtained soil was air dried, pulverized manually and passing through 425 micron and 4.75 mm IS sieve was used. The soil has a property of high volume change and develops cracks in summer. This soil predominantly consists of montmorillonites the principal clay mineral.

The index properties of the soil used in the investigation are given in Table.

Table 3.1 Properties of soil

Sr. No.	Parameter	Symbol or Percentage	Values obtained
1.	Specific gravity	Gs	2.58
2.	Natural water content	%	11
3.	Liquid limit	%	63
4.	Plastic limit	%	41.58
5.	Shrinkage limit	%	12.35
6.	Plasticity index	Ip	21.42
7.	MDD	g/cc	1.627
8.	OMC	%	19.20
9.	Swelling Index	%	37
10.	C.B.R (unsoaked)	%	performed
11.	C.B.R(soaked)	%	Not performed
12	Colour		Black

2.1.2.Sea Salt

Sea Salt, also known as common salt, table salt, or halite, is a chemical compound with the formula NaCl. Sodium chloride is the salt most responsible for the salinity of the ocean and of the extracellular fluid of many multicellular organisms. As the major ingredient in edible salt, it iscommonlyused as a condiment and food preservative. Production and use of Sea Salt is currently mass-produced by evaporation of seawater or brine from other sources, such as brine wells and salt lakes, and by mining rock salt, called halite. In 2002, world production was estimated at 210 million metric tonnes, the top five producers being the United States (40.3 million tonnes), China (32.9), Germany (17.7), India (14.5), and Canada (12.3).Sea Salt is present in ample of quantity in India.However less work has been carried out on sea salt which is also available in large amount with minimum cost or no cost. So there is need to study the effect of sea salt on engineering properties of expansive soil like black cotton soil.

III. PRELIMINARY TESTS ON SOIL

Following Preliminary tests were carried out on soil.

3.1 Specific Gravity

Thespecific gravity of a soil is used in the phase relationship of air, water and solids in a given volume of the soil. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of same volume of distilled water at a stated temperature. Specific gravity was found out with the help of pycnometer and it was observed that specific gravity of soil is 2.58

3.2Liquid limit (LL)

The liquid limit is defined as the minimum moisture content at which soil will flow upon application of very small shearing force or it is the moisture content corresponding to the boundary between liquid and plastic states of soil mass. Plastic limit was conducted as per I.S.2720 (Part 5) 1985. Cassagrandes apparatus was used to determine the liquid limit and it was found that **63%.**

3.3 Plastic limit (PL)

Theplastic limit is the moisture content at which the soil remains in plastic state or it is the water content at which the soil is just begins to crumble when rolled into a thread of 3 mm diameter. Plastic limit was conducted as per IS2720 (Part-6)-1972 and it was observed that the plastic limit was 41.58%.

3.4 Plasticity index (I_P)

Plasticity index was determined by subtracting plastic limit from liquid limit, hence plasticity index for experimental soil was (65-43.58) 22.42%.

3.5 Shrinkage limit (SL)

Shrinkage limit (SL) is the maximum water content at which reduction of water will not cause a decrease in the volume of soil mass. Shrinkage limit for soil was 12.35%.

IV. RESULTS AND DISCUSSIONS

The specific gravity value of soil mixed with various percentages of sea salt are

Type of soil	Specific gravity value %
98% B.C.S.+2% Sea Salt	2.556
96%B.C.S.+4% Sea Salt	2.515
94%B.C.S.+6%Sea Salt	2.483
92%B.C.S.+8% Sea Salt	2.427
90%B.C.S.+10% Sea Salt	2.339

By addition of sea salt as 2%,4%,6%,8% and 10% the values of specific gravity decreses.

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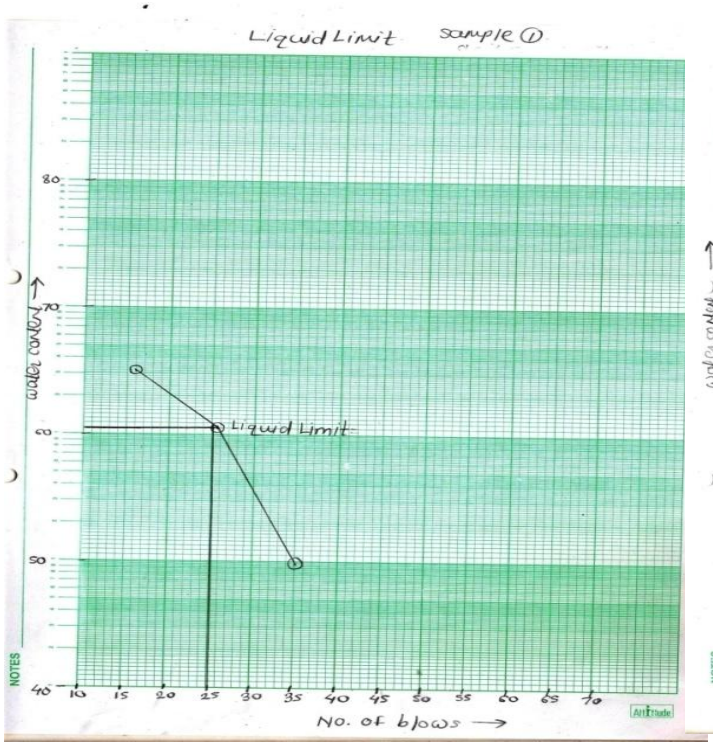
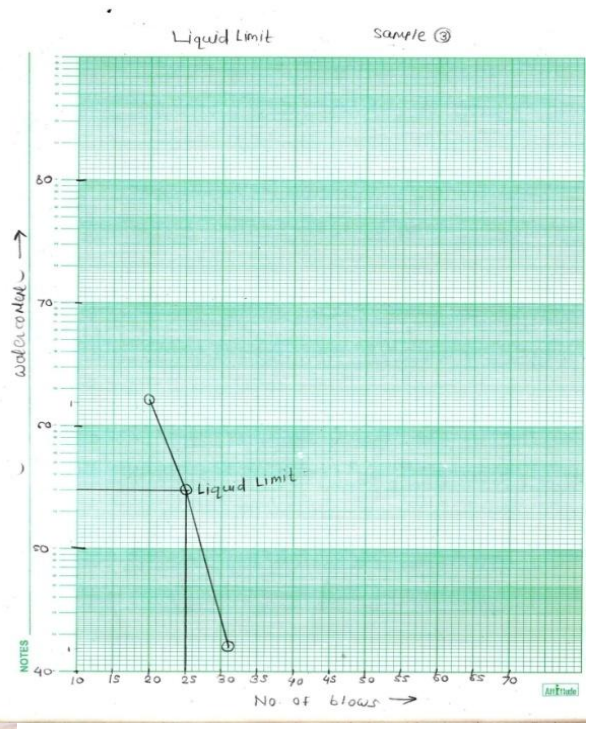
Index And Engineering Properties

Index and engineering properties of treated soil with sea salt

Sr.No.	Property	2%	4%	6%	8%	10%
1	Liquid Limit	60.47	56.46	53.01	48.15	50
2	Plastic Limit	40.18	38.72	37.05	34.77	31.54
3	Plasticity Index	20.29	17.74	15.96	13.38	18.46
4	Shrinkage Limit Part A	62.15	60.74	59.17	57.84	
5	Shtinkage Limit Part B	23.30	23.08	22.13	21.10	
6	Shrinkage Limit Part C	12.21	11.36	12.37	12.14	
7	Maximum Dry Density (gm/cc)	1.64	1.74	1.67	1.62	1.34
8	Optimum Moisture Content(%)	14.59	16.22	16.65	19.26	18.36





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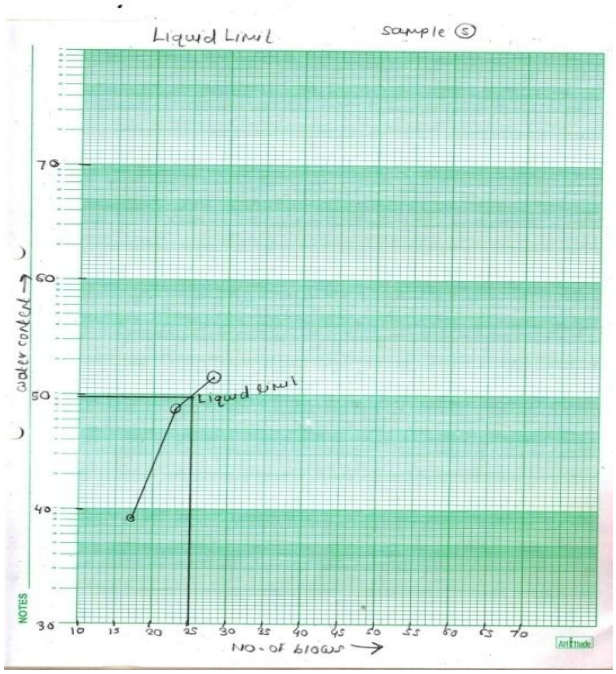
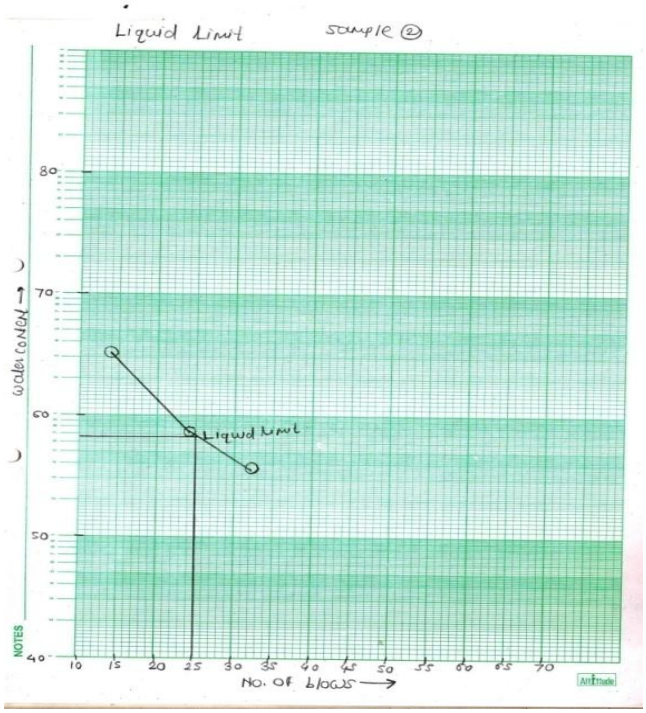
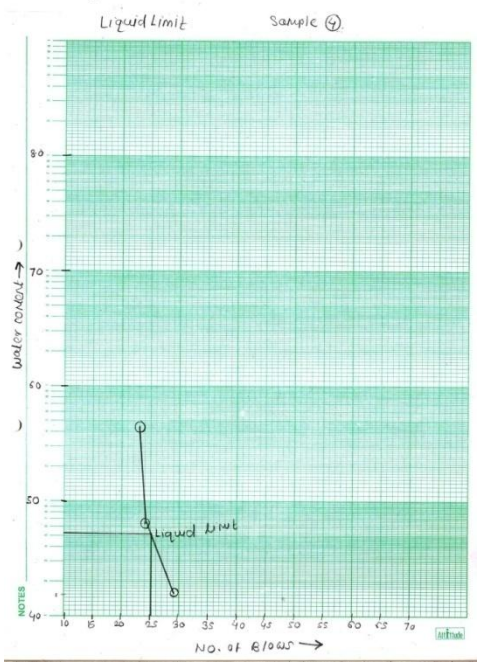


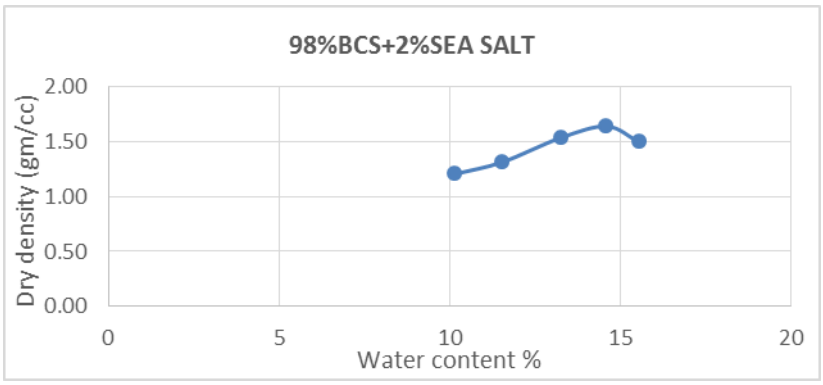


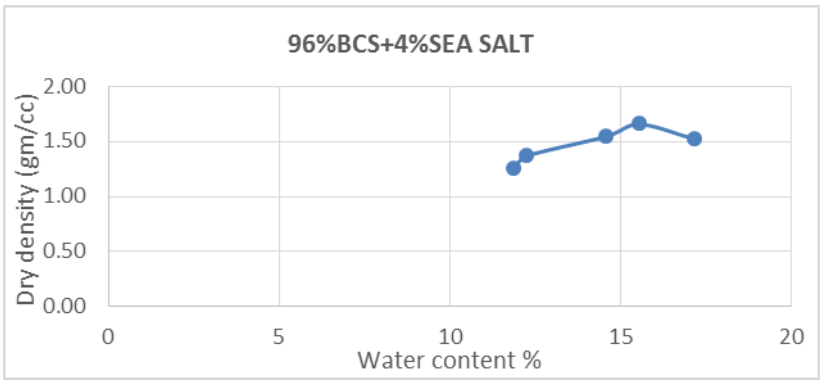


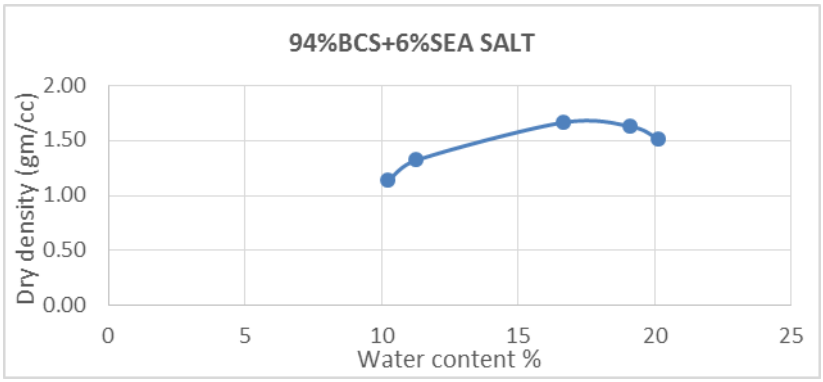
Addition of salt in black cotton soil reduces the average liquid limit of all samples to 48.15% from 63%. It may be concluded that the sea salt has reduced the thickness of the diffused double layer by flocculation of clay particles that leads to the reduction of liquid limit of black cotton soil. After addition of salt in black cotton soil, average value of plastic limit reduced to 31.54% from 41.58%. Plasticity index is decreased to 13.38% from 21.42%. This reduction is huge compared to plastic limit. It was observed a reduction in plasticity index of expansive soil upto addition of 8% Sea salt. High value of plasticity index and high activity of a soil indicates the high swelling potential. So addition of sea salt do cause reductions in plasticity.

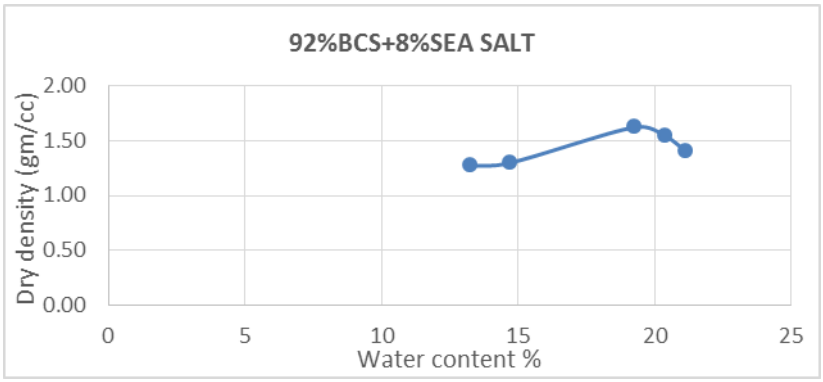
VII. OPTIMUM MOISTURE CONTENTS AND MAXIMUM DRY DENSITY

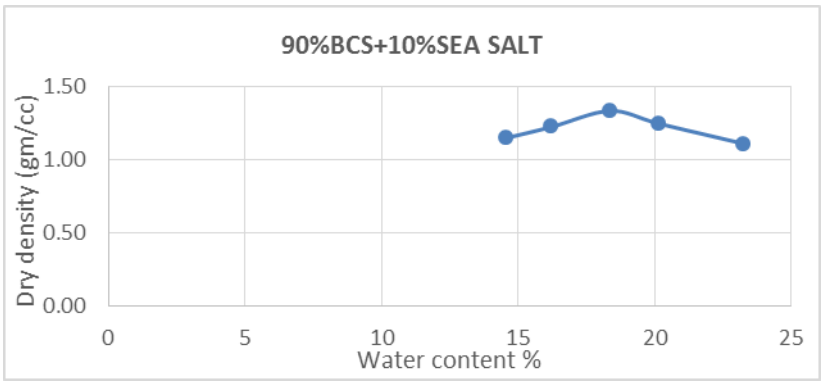
Optimum moisture content and max dry density has been found to be decreasing and increasing respectively with mixing of salt.











VIII. CONCLUSION

All the laboratory tests were conducted as per Indian standards. Index properties of black cotton soil were determined in laboratory. A reduction in value of index properties such as liquid limit, plastic limit and plasticity index of black cotton soil have been observed with addition of sea salt in black cotton soil. The most interesting change observed in swelling potential of black cotton soil with the addition of salt is that the swelling has been reduced with a significant amount. The reaction between sea salt and fine grained black cotton soil is mainly responsible for the flocculation of soil particles and decrease in thickness of double diffused layer. This may have resulted in increase in density and shear strength of soil. Optimum moisture content was decreased with addition of salt in soil.

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