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# UTILIZATION OF SEA SALT IN BLACK COTTON SOIL: A LITERATURE REVIEW

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**ABSTRACT**

*Soil modification has emerged as a new area for research in the geotechnicalengineering and the main purpose of most of researches is to determineoptimum amount of additive with considering economy and effectiveness. Inpresent study, sea salt has been used as an additive. The effect of addition ofsea salt on properties of fine grained black cotton soil is determined inlaboratory. This soil exhibits volume change behaviour with variation in thewater content. Volume changes has caused reduction in sustainability ofstructure supported on black cotton soil. From experimental results, it will be observed that plastic limit, liquid limit, plasticity index swelling pressure andswelling index decrease or increases with addition of salt in soil. Optimum moisturecontent and maximum dry density tests will also be carried out with addition of sea salt in the soil.*

***Key Words: Black Cotton Soil, Index Properties, Optimum Moisture Content,Swelling, 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's land. 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

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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.

### 1.1Need 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 LITERATURE REVIEW

### 2.1 Literature based on fly ash, lime, cement as a stabilizer

Investigations were performed based on use of fly ash, cement, and lime as a soil stabilizer. Effects of those stabilizer in different proportion on soil are explained in following literatures.

**J.M.Raut et.al. [2007]** studied the effect of fly ash and murrum on expansive soil. The study was carried out to check out the improvement in the properties of expansive soil with fly ash and murrum in varying percentage. Expansive soil (clay) was physically stabilized by adding 2.5%, 5%, 7.5%, and 10% of murrum similarly with fly ash. Also combination of equal amounts fly ash and murrum i.e. for 10% additive consists of 5% of murrum and 5% of fly ash. Laboratory tests were carried out and concluded that as the percentage of murrum and fly ash increases the Maximum Dry Density (MDD) and Unconfined compressive strength (UCS) increases upto a certain portion and afterwards value decreases. Maximum Dry Density (MDD) and Unconfined compressive strength (UCS) found for proportion of 7.5% murrum and 5% fly ash. As the percentage of fly ash additive increases the plasticity of the clay fly ash mixtures increases, the MDD values decreases and the corresponding Optimum Moisture Content increases.

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**Dr. Robert M. Brooks [2009]** studied stabilization of expansive soil with Rice Husk ash and Fly ash. Remolded expansive clay was blended with rice husk ash and fly ash and strength tests were conducted. Stress strain behavior of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the fly ash content was increased from 0 to 25%. When the RHA content was increased from 0 to 12%, Unconfined Compressive Stress was increased by 97% while CBR improved by 47%. Therefore it is concluded that RHA content of 12% and a fly ash content of 25% are recommended for strengthening the expansive subgrade soil.

**Dharamveer Singh et.al. [2010]** examined the effect of different percentage of lime and class C fly ash (CFA) on the engineering properties of stabilized sulfate containing soil. An experimental investigation consists of unconfined compressive strength test (UCS) and pH value test. Laboratory tests revealed that UCS of soil increased substantially with the addition of both lime and CFA compared to those raw soil at optimum moisture content (OMC). In addition 3-D swelling and Tube suction tests (TST) were conducted to determine the swelling and moisture susceptibility behaviors. It was concluded that volume changes was minimal from 1651$cm^3$ to 1664 $cm^3$ and the dielectric constant decreased from 30 to 20.

**OlugbengaOludolapo Amu et.al. [2011]** performed some experimental study on lateritic soil samples A, B and C collected from a dam site and stabilized with 0, 2, 4, 6, 8, 10% of lime. Samples were subjected to preliminary tests like natural moisture content, Atterberg limits (liquid limit, plastic limit), Particle size distribution, compaction, California bearing ratio (CBR), and Unconfined compressive strength (UCS) tests. It is observed that suitability of soil samples A, B and C was improved by optimum lime stabilization at 8 and 6% respectively, also the addition of lime to the samples caused a reduction in plasticity of the samples. The California Bearing Ratio of sample A was increased from 10.6% at 0% to 29% at 8% lime, while that of sample C improved from 2.5% to 8.6% at 6% lime. The Unconfined compressive strength of sample B improved from 119.13 $KN/m^2$ to 462.81$KN/m^2$, and found that with optimum stabilization samples A and B will be suitable as base material while sample C will perform well as sub-grade material in pavement construction.

**J.B. Oza et.al. [2013]** conducted some experimental study on stabilization of black cotton soil using1. Cement dust 2.Cement dust + Lime powder 3.Lime powder. Experimental tests were performed in three different stages. In first stage Cement dust was used to stabilize the black cotton soil. The content of cement dust varied from 1% to 9% by weight of soil. Experimental results concluded that 7% addition of Cement dust in black cotton soil was appropriate mixing. In second stage Cement dust + Lime powder was used to stabilize the black cotton soil. The content varied from 1% to 9% by weight of soil and it was concluded that 8% of combination of Cement dust + Lime gave better results. In last stage of experimental study only Lime was used to stabilize the soil and experimental study concluded that 9% addition of Lime was best suited for black cotton soil.

**Ankit Singh Negi et.al. [2013]** focused the research to investigate the stabilization of expansive soil using lime. The effect of addition of lime on soil parameters like plasticity index, compaction and bearing capacity was studied. The immediate effect showed that soil suddenly switches from being plastic to being crumbly also Maximum Dry density drops and Optimum Moisture Content rises and soil moves into a humidity range that

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can be easily compacted and there was increase in California bearing ratio which was 4 to 10 times higher than that of an untreated soil.

**GyaneneTakhelmayum et.al. [2013]** studied the effect of coarse and fine fly ash mixtures on properties black cotton soil. Fly ash consists of often hollow spheres of silicon, aluminum and iron oxides and oxidized carbon. There are two major classes of fly ash class C, class F. The former is produced from burning anthracite or bituminous coal and latter is produced from burning lignite and sub bituminous coal. Both the classes of fly ash are pozolanas, which are defined as siliceous and aluminous materials. The percentage of fine and coarse fly ash mixtures which was used in black cotton soil varied from 5 to 30% by weight of soil. Study concluded that with percentage addition of fine and coarse fly ash mixture improves the strength of stabilized black cotton soil and exhibit relatively well defined moisture density relationship, also strength attained by fine fly ash mixtures was 25% more when compared to coarse fly ash.

**BairwaRamlakhan et.al. [2013]** studied experimentally the effect of the lime and fly ash on some basic engineering properties of Black cotton soil such as liquid limit, plastic limit, compaction, California bearing ratio (CBR). The percentage of lime used in black cotton soil varied from 3% to 12% while the percentage of fly ash used in Black Cotton soil varies from 10% to 40%. It is observed that the liquid limit, plastic limit, and optimum moisture content (OMC), California bearing ratio (CBR) increased with an increase in lime percentage but maximum dry density (MDD) of soil decreased with increase in lime percentage, but the liquid limit, plastic limit and maximum dry density (MDD) of Black Cotton soil decreased and the optimum moisture content (OMC) increased with an increase in fly ash content. The optimum percentage of fly ash at 40% and lime at 12% gave best result for sub grade soil.

**Jyoti S. Trivedi et.al. [2013]**built a model based Genetic Algorithm which was used to predict the variations in the values of CBR of the sub grade soil. For analysis of stabilization of soil using fly ash, Evolver 5.7 an add-in software of excel was used.

The Genetic Algorithm was used to predict the California Bearing Ratio (CBR) values of fly ash stabilized soil. The accuracy of predicted values of CBR was checked by conducting experimental study on fly ash stabilized soil. The content of fly ash used in soil varies from 0% to 40% (0, 10, 20, 30 and 40%). The equation suggested to the value of CBR was

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$

Where,

Y = California Bearing Ratio (%)

b0, $b_1$, $b_2$, $b_3$, $b_4$ = constants

$X_1$ = Flay ash fraction (%)

$X_2$ = Value of liquid limit (%)

$X_3$ = Value of plasticity index (%) &

$X_4$ = Value of Optimum Moisture Content (%).

**Karthik.S et.al. [2014]** carried out experimental study on stabilization of soil using some waste material such as fly ash, rice husk ash, pond ash to make the soil sTable as well as to improve the physical and chemical properties of the soil. Fly ash content mixed with soil was 0, 3, 5, 6 and 9% on a dry weight basis. The experimental results showed that addition of fly ash resulted in appreciable increase in CBR of the soil and 6% addition of fly ash gives optimum value of California Bearing Ratio (C.B.R). Increment of CBR value is used to reduce the thickness of the pavement and increasing the bearing capacity of soil.

**S. Boobathiraja et.al. [2014]**presented the effect of lime and cement on peaty soils, as peaty soils are not suiTable for foundation as they are weak and highly compressible. The additives were added to the soil as percentage of the dry soil mass in the range of 10%, 30%, 50% respectively. The experimental results showed that the addition of lime and cement improved the strength characteristics of soil. The maximum dry density (MDD) of soil was found to increase while optimum moisture content was found to decrease with increase with increase in percentage of additives. The unconfined compressive strength was also found to increase significantly with increase in percentage of the additives. Comparison of additives showed that Ordinary Portland cement performance was better than hydrated lime.

**Aarohi V. Langalia et.al [2015]** conducted laboratory tests to stabilize black cotton soil with different admixtures like Cement Kiln Dust (CKD), fly ash, rice husk powder and bagasse ash. California bearing ratio, Plasticity index and unconfined compressive strength tests were conducted during an experimental study and it was concluded that 16% addition of cement kiln dust by dry weight of soil to assess its suitability for use as road pavement material, also the combination of fly ash rice husk powder (RHP) improves the unconfined compressive strength from 198KPa to 253 KPa with curing period of 28 days.

All the above investigations were based on stabilization of soil using different proportions of fly ash, cement, and lime as a stabilizer. Large studies have been done on stabilization of soil using lime, fly ash, cement as a stabilizer. On the other side less work has been carried out on sea salt which is also available in large amount with minimum cost or no cost. Hence following research papers found out the effect of sea salt and common salt on stabilization of soil.

**2.2Literature based on sea salt and common salt as a stabilizer**

Due to addition of salt with soil as a stabilizer, changes in stabilized soil takes place. Few experimental studies were performed on stabilization of soil using sea salt and common salt.

**Dr.P.D.Arumairaj[2011]** have studied the effect of sea water on properties of expansive soil and compared it with tap water. The results obtained showed that significant improvement upon the use sea water as compared to tap water. The results showed that plasticity index reduced from 11.90 for tap water to 7.66 for sea water. The free swell value reduced from 72.5% for control sample to 40% sea water sample. The swell pressure decreased from 7.5 $T/m^2$ for control sample to 7.06 $T/m^2$ for sea water. The co-efficient of consolidation has increased by about by 40% for sea water when compared to control sample. The unsoaked CBR value increased from 10.25% for tap water sample to 11.13% for sea water. The optimum moisture content increased from 14.25% for control sample to 16.5% for sea water, also light decrease in maximum dry density is observed for sea water when

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compared to tap water sample. There was slight decrease in unconfined compressive strength but after two days it remains same for both sea water and tap water.

**Rajesh Prasad Shukla et.al.[2014]** modified black cotton soil properties using sea salt. The experimental study showed that addition of sea salt in black cotton soil significantly reduces the liquid limit, plasticity index, swelling and plasticity index of soil with minimum cost. Optimum moisture content and dry density of soil has also found to be changed with addition of sea salt.

**PrakharDubey et.al. [2015]** studied the effect of Common salt (NaCl) on index properties of black cotton soil. The common salt was added in 0%,2%,4%,6% in black cotton soil and the soil-salt mixture was tested for consistency limits or index properties. The common salt in this research was collected Damohnaka, Jabalpur (M.P.) Based on consistency index and free swell of the soil falls under highly expensive soil category. The extent of modification of properties not only on nature of contaminant, but also on the type of soil such as physical nature, chemical composition and metallurgical properties. These contaminants may be inorganic, solvants or organic matter. Thests results showed significant improvements upon the use of of common salts (NaCl). The plasticity index reduced from 22.6 to 16.84. The free swell value reduced from 41% to 19%. The liquid limit decreased from 45.05% to 34.89%. The plastic limit decreased from 22.6% to 18.41%, also increase in shrinkage limit from 13.48% to 15.76% was observed.

Very Few studies have been done using sea salt as a stabilizer for soil. Since sea salt is largely available and also economical. Hence there is need to use sea salt as a stabilizer.

## 2.3 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 CONCLUSION

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

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salt on engineering properties of expansive soil like black cotton soil.All the laboratory tests will be conducted in accordance with Indian standards codes. Indexproperties, swelling properties and OMC of black cotton soil will be determined in laboratory.Index properties such as liquid limit, plastic limit and plasticity index of black cotton soils will betested with addition of salt in soil. Engineering properties of soil may be changed,but authors are not sure about the changes in engineering propertiesof black cotton soil. Number of tests willbe required on soil of different plasticity to draw a certain conclusion regarding the change instrength of soil. Swelling characteristic is a main characteristic of black cotton soil and tests will be carried out with the addition of salt.swelling pressure and swelling index properties will be studied by a significant amount. Optimum moisture content will also be observed. From all observation made in present study it will be concluded that sustainability of soil and structure on black cotton soil will increase or decrease with theaddition of sea salt.

## REFERENCES

1) Karthik. S (2014) – " Soil stabilization by using fly ash" *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 10, Issue 6 (Jan. 2014), PP 20-26*

2) Prof.J.M. Raut, Dr. S.P.Bajad, Dr. S.R.Khadeshwar (2014) - "Stabilization of expansive soil using fly ash and murrum" International *Journal of Innovative Research in Science, Engineering and Technology,Vol. 3, Issue 7, July 2014*

3) Ankit Singh Negi (2013) – "Soil stabilization using Lime" *International Journal Of Innovative Research in Science, Engineering and Technology.Volume.2, Issue 2*

4) Pengpeng Wu (2013) – "International journal of pavement conference", Sao Paulo, Brazil *PP 227-1*

5) Gyanen. Takhelmayum, Savita A.L. Krishna Gaudi (2013) – "Laboratory study on the soil stabilization using fly ash mixtures". *ISOR journal of Mechanical and Civil engineering Volume 2, Issue 1, January 2013*

6) KunalAnandet (2013)- " A comparative study of black cotton soil and alluvial soilfor economical design by lime and fly ash stabilization" *ISOR journal of Mechanical and Civil engineering Volume 3, Issue 6, January 2013*

7) BairwaRamalakhan, Saxena Anil Kumar, Arora T.R. (2013)- "Effect of Lime and Fly ash on *engineering* properties of black cotton soil" *ISOR journal of Emerging Technology and Advanced engineering*. *ISSN 2250-2459 Volume 3, Issue 11, PP 09-15.*

8) Olugbengaoludolupoamu (2011) –"The suitability and lime stabilization requirement of some lateritic soil samples as pavement." *International Journal of Pure and Applied Science and Technology*. *ISSN 2269-6107. PP 29-46*

9) S. Bhuvaneshwari, R. G. Robinson ,S. R. Gandhi (2005)-"Stabilization of Expansive soils using fly ash" *Fly Ash Utilization Programme(FAUP)*

10) Dr. Robert M. Brooks (2009)–"Soil stabilization with fly ash and rice husk ash" *International Journal of Research and Reviews in Applied Sciences,*Philadelphia,*Volume 1, Issue 3*

11) S. Boobathiraja et al (2014) – "Study on Strength of Peat soil stabilized With Cement and Other PozzolanicMaterrials. *International journal of Civil Engineering Research.Volume 5 Issue 4, PP431-438 February 2014*

12) Jyoti S Trivedi (2013)- "Optimum Utilization of Fly ash For stabilization of subgrade soil using genetic algoritham." *Procedia Engineering, PP 250-258* (2013)

13) HabeebAdedjiQuadni (2013) – "Impact of compaction delay on the Engineering properties of Cement-Treated soil."

14) Bello AfeezAdefemi (2013) – "Regression analysis of compaction delay on CBR and UCS of Lime stabilized Yellowish Brown Lateritic soil."

15) Kolawole J. Osinubi (2013) – "Influence of compactive efforts and compaction delays on Lime-Treated soil."*Journal of transportation engineering.*124*:124-155*

16) S. SahayaVincy and M. Muttharam (2009) – "Delayed compaction effects on the behaviour of stabilized soil." *IGC 2009,Guntur*

17) U. N. Okonkwo – "Effects of compaction delay on the properties of Cement –Bound lateritic soil."*Nigerian journal of technology, Volume 28 No.2*

18) Baleshwar Singh (2003) – "Effect of compaction delay on lateritic soil Using Fly ash, Lime mixtures." *Geotechnical engineering for infrastructural development.Roorkee18-20*

19) Kolwale J. Osinubi(2013)- "Influence of compactive efforts and compaction delay on lime treated soil." *Journal of transportation engineering, March/April PP149-155*

20) L. J. M. Houben (2013) – "Study of the variables in laboratory testing of cement stabilized materials." *International Journal Of Pavement Conference*Sau Paulo. Brazil Paper 227-1

21) Udayashankar D. Hakari et al (2012) – "Stabilization of black cotton soil using fly ash, Hubballi – DharwadMuncipal corporation area" *Global Journal of research of engineering*, Volume XII Issue II version I.

22) Saeid. Amiralian, Amin. Chegenizadeh, and Hamid. Nikraz (2012)- "A Review on The Lime and Fly ash Application in Soil Stabilization" *International Journal of Biological,Ecological and Environmental Sciences (IJBEES*) Vol. 1, No. 3, 2012 ISSN 2277 – 4394

23) Dilip Shrivastava1*, A K Singhai[2] and R K Yadav[3] (2014) -"Effect of lime and rice husk ash on engineering properties of black cotton soil" *International journal of CivilEngineering Research.* ISSN 2319-5991 Vol. 3, No. 2, May, 2014