Effect of Common Salt (NaCl) on Index Properties of Black Cotton Soil

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Abstract

The object of this paper is to investigate the effect of Common Salt (NaCl) on the index properties of Black Cotton Soil. Various amounts of Common Salt (0%, 2%, 4%, 6% and 8%) were added to the soil to study the effect of Common Salt on consistency limits or index properties. The Common Salt (NaCl) for the study is collected from shop in Damohnaka, Jabalpur (M.P) and the soil sample collected from behind Jabalpur Engineering College, near N.C.C campus, Jabalpur (M.P). Based on consistency Index and free swell the soil falls under highly expansive soil category. The extent of modification of properties depends not only on the nature of contaminant, but also on the type of soil such as physical nature, chemical composition and metallurgical properties. These contaminants may be inorganic, organic Solvents or organic matter. Test results showed significant improvements upon the use of Common Salt (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% is observed.

Keywords: Expansive soil (Black Cotton Soil), Common Salt (NaCl), Index properties

I. INTRODUCTION

In India, expansive soils are called as Black Cotton soil. The name "Black Cotton" as an agricultural origin. Most of these soils are black in colour and are good for growing Cotton. All the black soils are not expansive soils and all the expansive soils are not black in colour. These soils passed high strength in summer and decreased rapidly in winter. Problematic soil is known for civil engineers as the soils which should be studied well before construct buildings on it.

Behavior of these problematic soils is different than other soils due the behavior of its structure condition. Expansive soil is one type of these problematic soils which occupies about 20% of the world surface area. Expansive strata are soil and/or rocks that contain clay minerals that have potential for swelling and shrinkage under changing moisture condition. In order to overcome this problem research has been carried out in the different parts of the world, to find out the economical and efficient means of using Common Salt. Common Salt is white in colour and is in the form of crystals. It is deliquescent and hygroscopic. It lowers the vapour pressure of water. It also reduces or prevents frost heave in soil by lowering the freezing point of water. It is very effective as dust palliative. It checks the formation of shrinkage cracks. Common Salt is easily available in markets so the transportation charges will reduced. Black soil contains a high percentage of montmorillionite mineral which imparts expansive behaviour to it. In this study it is proposed to investigate the influence of Common Salt on expansive (black cotton) soil.

II. LITERATURE REVIEW

In order to overcome the problem in black soil, research has been carried out in the different parts of the world, to find out the economical and efficient means of using Common Salt. "Effect of sodium chloride on some geo-technical properties of expansive clay" studied by T Srikanth and K L A V Harnadh (2013). It has been reported that plasticity index, different free swell, and some other index properties (Liquid Limit and Plastic Limit decreases substantially due to addition of sodium chloride. The index properties were modified to a great extent. Ahmed T. M., Mohamed I. Wahdan, Geotechnical Institute Housing and National Building Research Center, (HBRC) Cairo, Egypt(2013) gave the detailed outcome of "Behavior of Expansive Soil Treated by using Different Electrolyte Substances" compared experimental programs on Common Salt from other additives, Literature review of Common Salt usage in Silty Clay soil stabilization by Tamadher T.Abood, , Anuar bin kasa, Zamri bin Chik (2007) gave the experimental results clearly that use of Common Salt decreases index properties.

III. METHODOLOGY

The methodology comprises of collection of soil and Common Salt samples from the desired locations. The black-cotton soil used in this study mixed with Common Salt in different proportions and a series of laboratory tests were conducted on samples

containing various percentages of Common Salt i.e. 0%, 2%, 4%, 6% and 8% by dry weight of the soil. All the tests were conducted as per IS Code.

The experiments conducted are:

- Grain - size distribution.
- Liquid limit.
- Plastic limit
- Plasticity index.
- Shrinkage limit.
- Differential free swell (DFS) test.

A. Black Cotton Soil:

Black cotton soil used in this research was brought from behind Jabalpur Engineering College, near N.C.C campus, Jabalpur (M.P.). The expansive soil is classified as clay of intermediate compressibility (CI) (Gs=2.30 with 92% fines) with expansive behaviour.

A physical characteristic of clay sample is listed in table-1.

Grain size distribution curve of Black cotton soil is shown in figure-1.

Table – 1
Index Properties of black cotton soil

S.No.	*Parameters*	*Test Values*
1.	*Soil classification*	*CI*
2.	*Specific gravity g/cc*	*2.30*
3.	*Liquid limit % (LL)*	*45.05*
4.	*Plastic limit %(PL)*	*22.45*
5.	*Plasticity index%(PI)*	*22.6*
6.	*Shrinkage limit%(SL)*	*13.48*
7.	*Differential Free Swell%(DFS)*	*41*
8.	*Grain size distribution (%)* *Sand (%)* *Silt+Clay (%)*	*8* *92*

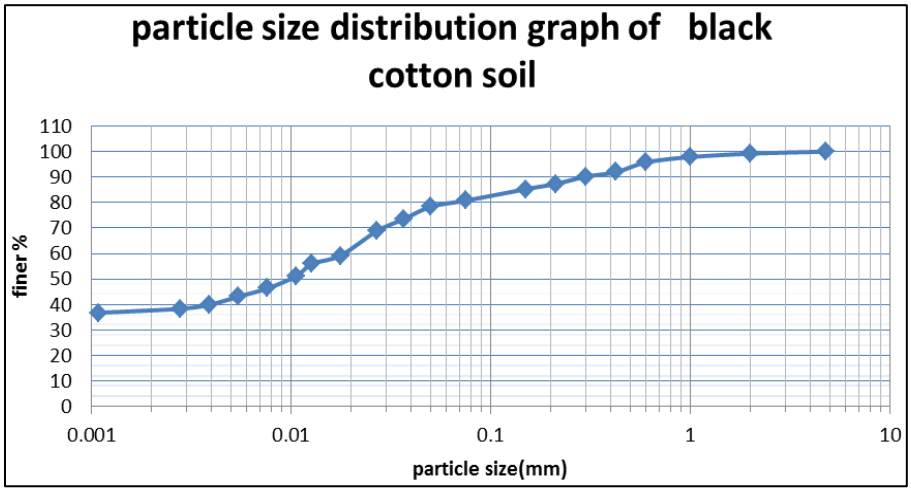

Fig. 1: Particle size distribution curve of black cotton soil

B. Test Result:

Various tests were conducted on black cotton soil mixed with Common Salt in the different proportions as per IS code of the practice. Test results are summarized in Table-2

Table – 2
Test result of BCS-Common Salt (%)

S.No.	*Tests*	*C0%Common Salt(Nacl)*	*C2%Common Salt(Nacl)*	*C4%Common Salt(Nacl)*	*C6%Common Salt(Nacl)*	*C8%Common Salt(Nacl)*
1.	*Liquid limit(LL)%*	*45.05*	*43.50*	*39.805*	*37.72*	*34.89*
2.	*Plastic limit(PL)%*	*22.45*	*21.82*	*20.15*	*18.73*	*18.14*
3.	*Plasticity index(PI)%*	*22.60*	*21.82*	*20.15*	*18.99*	*16.84*
4.	*Shrinkage limit(SL)%*	*13.48*	*14.26*	*14.85*	*15.31*	*15.76*
5.	*Differential free swell (DFS)%*	*41*	*34*	*29*	*25*	*19*

Where:Sample1=C0%CommonSalt=BCSoil+0%CommonSalt;sample2=C2%CommonSalt=BCSoil+2%CommonSalt;sample3=C4%CommonSalt=BCSoil+4%CommonSalt;sample4=C6%CommonSalt=BCSoil+6%CommonSalt;sample5=C8%CommonSalt=BCSoil+18%CommonSalt;

IV. RESULTS AND DISCUSSION

Test results variations of LL, PL, PI, SL and DFS are shown in figure 2 to 6. The LL decreased from 45.05% to 34.89% as Common Salt content increased from 0% to 8% similarly, plastic limit decreased from 22.45% to 16.841% with the increase of Common Salt in BC soil. Shrinkage limit increased from 13.48% to 15.76%, Plasticity index decreased from 22.6 to 16.841 and DFS decreased from 41% to 19% respectively. These test results indicates that the swelling behaviour of the soil is considerably reduced.

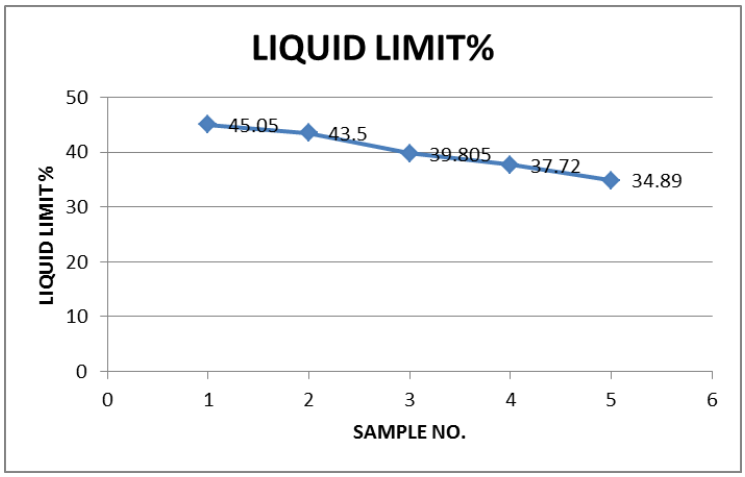

Fig. 2: Variation of LL for BCS mixed with Common Salt

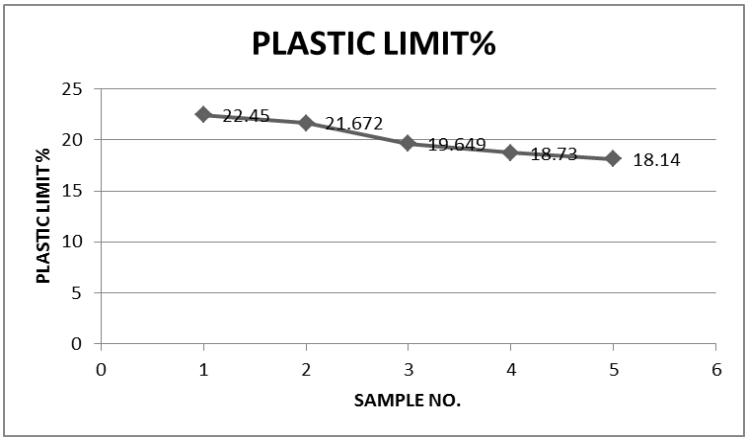

Fig. 3: Variation of PL for BCS mixed with Common Salt

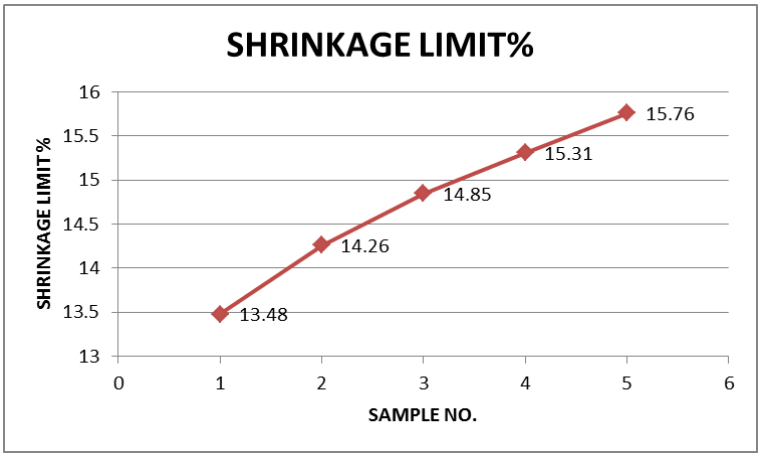

Fig. 4: Variation of SL for BCS mixed with Common Salt

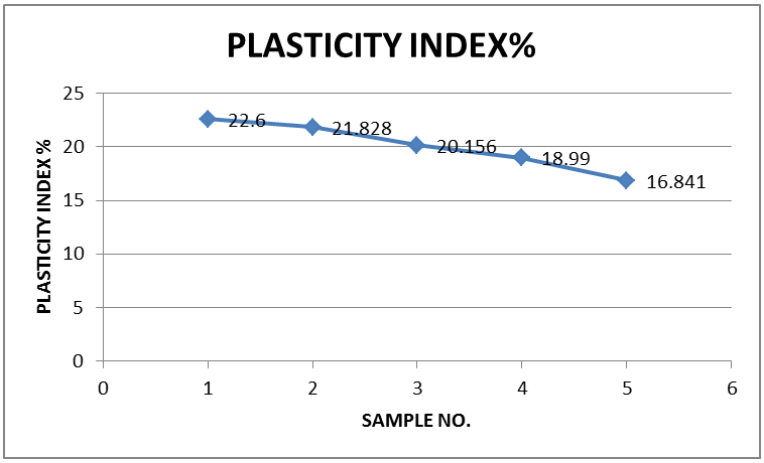

Fig. 5: Variation of PI for BCS mixed with Common Salt

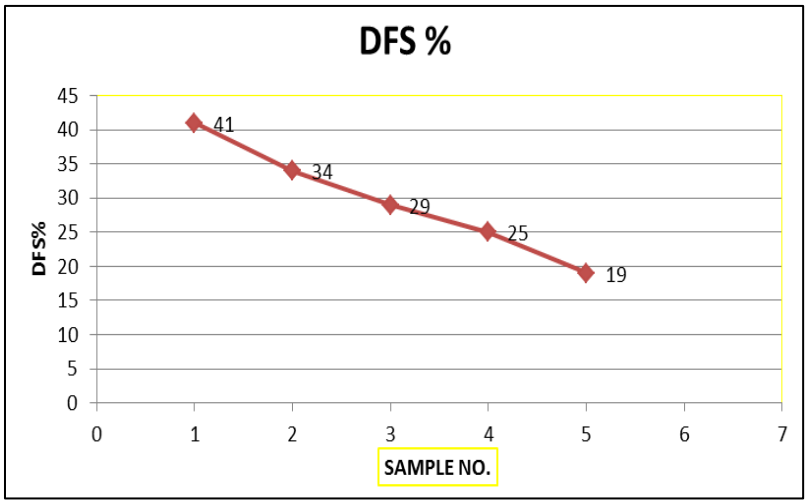

Fig. 6: Variation of DFS for BCS mixed with Common Salt

V. CONCLUSION

Base on the laboratory research conducted on black cotton soil mixed with the Common Salt from 0% to 8% by dry weight of the soil. Following conclusions can be drawn :

- Liquid limit of samples are decreasing with the inclusion of Common Salt into the Black soil. It has been found that the liquid limit decreased from 45.05% to 34.89%.
- Plasticity index decreased from 22.6 to 16.341.
- Shrinkage limit increased from 13.48% to15.76 %.
- Plastic limit decreased from 22.45% to 18.14%.
- Differential free swell index has reduced from 41% to 19%.

It is observed that the liquid limit, plastic limit and plasticity index values of the contaminated soil decrease with % increase in concentration of Common Salt. The intervention of origin electrolyte (sodium chloride dissolved in distilled water) would result in change in the ion exchange capacity, perhaps due to adsorption. The ion concentration reduces the repulsive forces and increases the effective stress leading to flocculation of clay particles which reduces the plasticity.

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