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RESEARCH ARTICLE

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EFFECT OF SALINE WATER ON GEOTECHNICAL PROPERTIES OF EXPANSIVE SOILS

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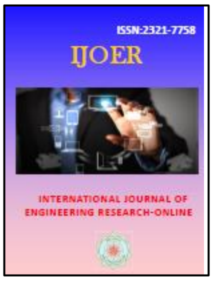


ABSTRACT

Clays are important constituent of soils; the rapid growth in population needs to be settling their lives at various places like sea shore, railway lines, highway embankments etc. Generally expansive soils are problematic soils in construction point of view. Because is exhibits the poor values in engineering properties. i.e. like Bearing capacity, shear strength, etc. and it shows expansive nature with addition of water and then shows high shrinkage with removal of water. In order to make the expansive soils as a construction soil, there are number of stabilization techniques available.

In this work, the effects of salt water on various properties of expansive soils were studies and are compared with the same found using tap water from soil mechanics laboratory. In this case we dissolve the salt in normal water to make salt solution of salinity 30% and we collect the soil sample at BITRAGUNTA (VILLAGE) Nearer to venkateswara swamy temple and tested the soil samples with normal water and salt water and the values are compared. Finally we got the greater values of engineering properties with salt solutions than the normal water.

Keywords — Saline water, Salts, Geotechnical Properties, Laboratory Tests.

1. INTRODUCTION

Expansive soils, with high swell and shrink behavior prove to be challenging for construction and pavement activities. Expansive soils will heave and 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, basements and retaining walls resulting in lateral movements. Apart from its effects on building constructions and foundations, they have severe impact on roads, ground anchors, underground pipelines and other buried structures.

Expansive soils cover almost 20% of India's land cover and about 8% of the world's land cover. Hence, they cannot be simply ignored of construction and pavement activities because of their problematic nature. There are several methods available for improving the characteristics of expansive soil. But an efficient and cost effective method with minimum time is always the most welcome.

Previous researches on improvement of expansive soils have come out with numerous fruitful solutions including chemical stabilization techniques and deep foundation techniques. The most significant among them being the lime stabilization. The basic concept behind chemical stabilization for expansive soil is that, expansion occurs because of absorption water molecules in the diffuse double layer through three possible mechanisms, the stabilization works on the concept of introducing cation of high valence than that of water, which gets attracted to the clay minerals and brings clay minerals closer together. In this study, an attempt is made to study the sea water as an effective chemical stabilizer in expansive soils.

2. LITERATURE REVIEW

Expansive soils exist all over the world and cause damages to foundations and associated structures (Kariuki, P. C., 2004). It has been ascertained that expansive clays cause billions of dollars damage every year in the USA, more than all other natural hazards combined (Jones and Holtz, 1973, Chen F. H., 1988 and Day, R. W., 1999). The problem is also extensive in some areas of Tanzania but no statistics are available.

Geotechnical engineers did not recognize damages associated with buildings on expansive soils until the late 1930s. The U.S. Bureau of reclamation made the first recorded observation about soil heaving in 1938 (Chen, F. H., 1988). Since then a number of researchers have pioneered researches into expansive soils.

Apart from increased research in expansive soil, design of shallow foundations to support lightweight structures on expansive soils is a potential problem than design of foundations for heavy loads (Meehan and Karp, 1994). The traditional design criteria of considering bearing capacity proves failure in expansive soils.

3. EXPERIMENTAL STUDY

MATERIALS: For the purpose of stabilization ,Black cotton soils (BC), salt in the form of crystals are collected at BITRAGUNTA VILLAGE and sea water collected at Bay Of Bengal at THUMMALA PENTA beach have been used in this study.

Atterberg Limits: The tests were performed according to IS 2720-Part 15, (1985) on soil passing 425µ sieve. For saline water, this test was performed at different concentrations.

Specific Gravity: The Specific gravity (G) of the soil has been determined by exploited some density bottle and pycnometer as per the guidelines provided by IS 2720-Part 3, (1980). The average value has been taken from the three trials was obtained and the result as shown in the table.

Standard Proctor Compaction Test: The soil sample was oven dried at 110 oC for about 24 hours. Later, as per standards, the soil is mixed with the various concentrations (0.001 M, 0.01 M and 0.05M) of salt in weight and then this mix has been compacted in three equal layers with each set of experiments with increasing the water content. Later, based on the compaction curves plotted for the different mix, optimum moisture content (OMC) and maximum dry density (MDD) for each test specimens were obtained.

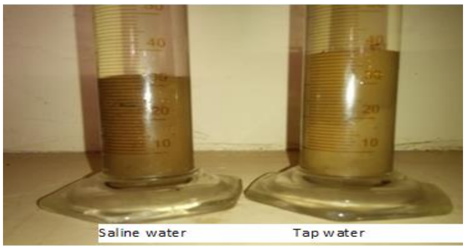
UCC Test: The unconfined compressive strength of the cylindrical shaped specimens (38 mm diameter and 76 mm length) was determined according to IS: 2720-Part 10, (1991). The cylindrical specimen was placed on the base plate and the load frame has been fixed without any stress application upon the specimen. Set the dial gauge reading and proving ring to zero. Axial load increment was applied at a strain rate of 1.5 mm/min. Noted the proving reading value at regular intervals of the dial gauge reading.

INDEX PROPERTIES:

TABLE 1: PROPERTIES OF THE SELECTED MATERIAL

PROPERTY	**BC**
Specific gravity (G)	2.59
ATTERBERG LIMITS	
LL	45
PL	26
PI	19
Soil Classification	CH
OMC (%)	17
MDD (g/cc)	1.77
Cohesion (kg/cm^2)	3.6
Angle Of Internal Friction (^{0})	-
UCC (kg/cm^2)	4.37

FREE SWELL INDEX: The free swell index is obtained by conducting Free Swell Index Test as per IS 2720 (Part XL)-1980 but using sea water. The free swell index obtained for control sample is 72.5 % and that foe sea water is 40%. A comparison plot of free swell in sea water and tap water is shown in Figure.



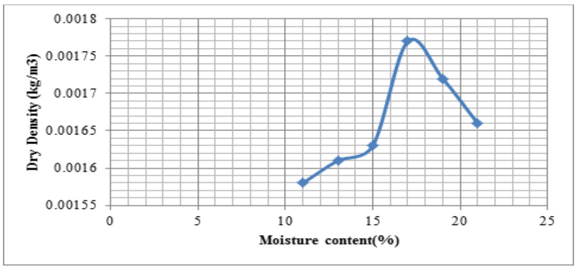
ATTERBERG LIMITS:

The tests were conducted using saline water instead of normal tap water and the values of liquid limit, plastic limit and shrinkage limit are found to be 31.50,18 and 29.40 % respectively.

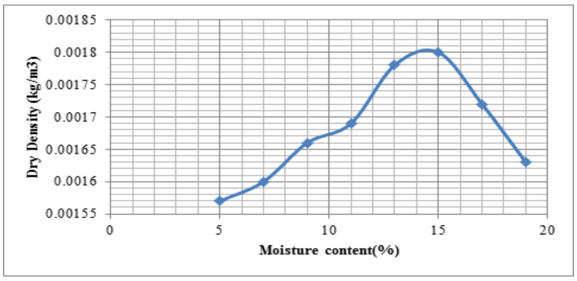
TABLE 2: COMPARISON OF INDICES

PARAMETER	CONTROL SAMPLE	SALINE WATER
Liquid limit	45	31.5
Plastic limit	26	18
Shrinkage limit	37.45	29
Plasticity index	19	13.5

STANDARD PROCTOR TEST: The optimum water content and maximum dry density for control sample and sea water sample are obtained from Standard Proctor Test. The procedure is followed as per IS: 2720 (Part 7) – 1980.The test is performed thrice and the average value is taken as the OMC and maximum dry density. A graph of one trial and the values obtained from standard proctor test are given in Figure.

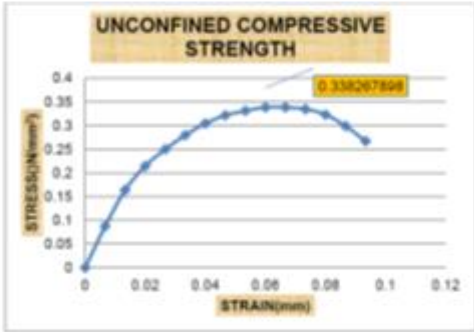


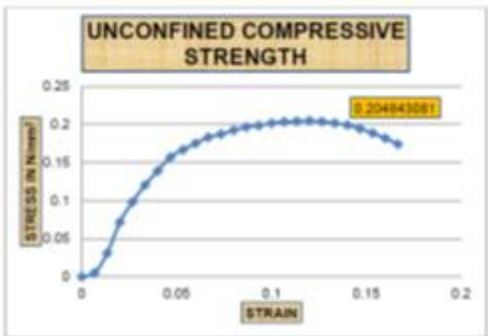
OPTIMUM MOISTURE CONTENT GRAPH USING TAP WATER



OPTIMUM MOISTURE CONTENT GRAPH USING SALINE WATER

UNCONFINED COMPRESSION TEST: The unconfined compressive strength of the cylindrical shaped specimens (38 mm diameter and 76 mm length) was determined according to IS: 2720-Part 10, (1991). The cylindrical specimen was placed on the base plate and the load frame has been fixed without any stress application upon the specimen. Set the dial gauge reading and proving ring to zero. Axial load increment was applied at a strain rate of 1.5 mm/min. Noted the proving reading value at regular intervals of the dial gauge reading.



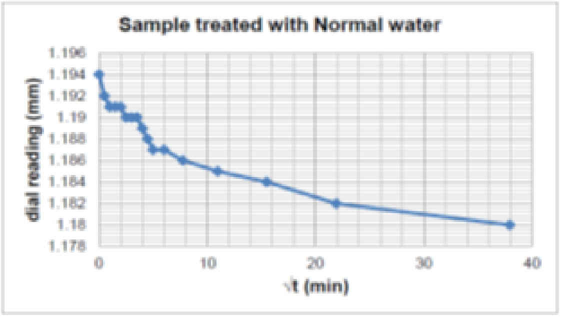


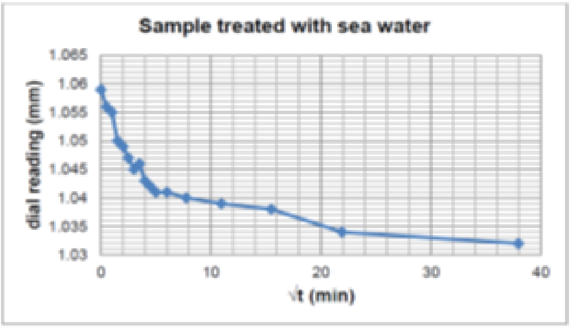
UCC TEST RESULTS WITH NORMAL WATER UCC TEST RESULTS WITH SALINE WATER

4. TABLE 03: UCC TEST RESULTS

PARAMETER	UCC STRENGTH (T/m^2)	CHOHESIVE STRENGTH (T/m^2)
Tap water	31.61	15.81
Saline water	21.48	10.74

CONSOLIDATION TEST: The consolidation test was performed using oedometer apparatus for both control sample and saline water. The co-efficient on consolidation for control sample is 0.002 and that for saline water sample is 0.0028. The graph plot between time and dial reading are shown in figure.

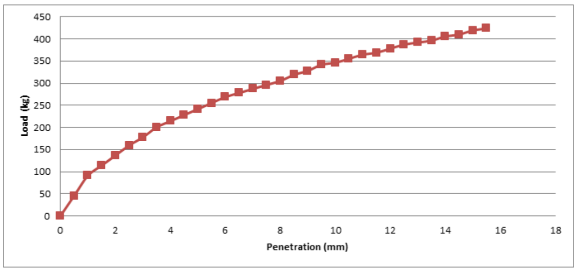




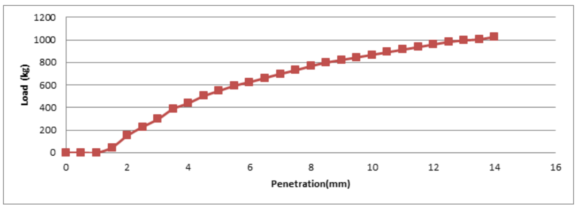
SAMPLE TREATED WITH NORMAL WATER

SAMPLE TREATED WITH SALINE WATER

CALIFORNIA BEARING RATIO TEST: The California bearing ratio value is obtained from laboratory CBR test for both control sample and saline water. The test is performed as per IS: 2720 (PART16)- 1987. The results obtained From CBR value are presented in following figures.



UNSOAKED CBR WITH TAP WATER



UNSOAKED CBR WITH SALINE WATER

5. CONCLUSIONS

Treatment with **saline** water causes reduction in liquid limit, plastic limit and plasticity index of the clay minerals. Treatment with **saline** water increases the particle size of the clay minerals. The optimum moisture content of the clay mineral increases when treated with **saline** water and maximum dry density of soil is also increased after treating the soil with **saline water.** No pozzalonic reaction takes place in clay sample upon treatment with **saline** water. **Saline** water causes reduction in free swell index and swell pressure of clay mineral. The co-efficient of consolidation increases upon treatment with **saline** water. The California bearing ratio also increases upon treatment with **saline** water.

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