ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 12, April 2018

ANALYSING THE GEOTECHNICAL PROPERTIES OF SOILS DUE TO THE ENCROACHMENT OF SEA WATER IN SHORE REGION

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ABSTRACT

This study is aimed to determine the changes in geotechnical properties of soil in the shore region. Sea water has strong impact on the engineering behavior of soil. Due to the encroachment of sea water in the soil it tends to change their properties. A series of test have been conducted in order to determine the geotechnical properties like index, shear strength, compaction, and permeability of soil. Testing was carried out for different time period of 1st, 7th,14th, 28th ,56th and 84th days respectively. The results were compared between three types of soils. From the results, it is observed that Atterberg's limit and swelling index have decreased as water salinity increased.

Key words: Permeability, shear strength, encroachment.

INTRODUCTION

Engineering characteristics of soil are subjected to various factors like density, porosity, structure, amount type of minerals and plastic property. If there is any change in these characteristics, it may tend to affect the physical and chemical behavior of soil. There are different types of soil present near the shore region of puducherry. Soil behavior in contact with salt water is mainly predicted with regards to factors disseminating saline minerals into the soils and reducing the double layer thickness of soil. By analyzing the parameters, it can be effective in designing and making correct decision (Mohammad Ajam, Mohammad Reza Sabour, Gorban Ali Dezvareh (4)). Basically, the water which has strong impact on the behaviour of soil. It contains high salt which is more than 500 mille- equivalent per litre. At the same time, it has higher density when compared to the fresh water. The area that had very high salinity was mostly located near to the beach and having material from marine sediments, so that sea water intrusion was occurred intensively .Sea water intrusion is depend based on the distance from coastline(Deddy Erfandi and Achmad ranchman,2011 (11)).Geotechnical behaviour of soil is depends on chemistry of pore fluid. It has been known that the presence of salt affects the nature and built environment. Expansive soil with high swell and shrink behaviour prove to be challenging for construction and pavement activities. Effects of salt water on various properties of expansive soils were studied and compared with tap water from laboratory. Treatment with the salt water increases the particle size of the clay mineral (Mahesh, M.Rama Krishna, and V.Yaswanth Kumar(7)).

REVIEW OF PREVIOUS STUDY

Tatiana viaduct 2012 carried a research on" Seawater influence on the behavior of the expansive clays". Expansive soils are clay soils with high shrink- swell potential. The clayey soils have the property to modify their volume when moisture changes. As moisture increase, the clay soils also increase their volume and they shrink when moisture get reduced. The focus on this paper is on the behavior of the plastics and swelling characteristics of different types of clay in presence of sea water, distilled water and tap water. Montmorillonite exhibits an extraordinary potential for volume change with the increase and decrease of water content in the clay. Rassoul Ajalloeian , adiseh Mansouri, Amir Hussein Sadeghpour 2013**,** carried a research on" Effect of saline water on geotechnical properties of fine grained soil of Korchay branches and half saline water of Ajichay river on engineering properties of fine grained soil (CL) used in dam core of Korchay is investigated. Tests results showed AtterbergS limits, compression index, swelling index, coefficient of volume compressibility (mv) and coefficient of compressibility (av) have decreased and consolidation of coefficient and shear strength parameters have increased as water salinity increased. The main reason of these changes have been attributed to increasing attractive force between soil

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particles, establishing bonding between them and forming salt crystals in pores soil and role playing as cement. Regarding the low percentage of clay in the soil, small part of these changes is concerned with the reduction of double layer thickness. It seems that rate of variations on the soil properties decreases as water salinity increases. It can be said, excessive concentration of water causes cations in water to combine with anions to form salts before they influence on surface of clay minerals. At the end, results show saline water of Korchay branch has not negative effect on engineering properties of the core soil.

Mohammad Ajam1, Mohammad Reza Sabour, Gorman Ali Dezvareh 2014 carried a research on " Study of water salinity effect on geotechnical behaviour of soil structure using response surface method (RSM)".The effect of different concentrations of salt on the optimum moisture content and maximum dry density is very slight and within the allowed tolerance. It means that the amount and type of soil salinity has no significant impact on the compaction characteristics of soils. Soil behavior in contact with salt waters is mainly predicted with regard to factors: disseminating saline minerals into the soil and reducing the double layer thickness of soil.

K.Mahesh, M. Rama Krishna, V.Yaswanthkumar 2017 carried a research on "Effect of saline water on geotechnical properties of expansive soils".The effects of salt water on various properties of expansive soils were studied 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 venkateswaraswamy temple and tested the soil samples with normal water and salt water and the values are compared. Treatment with saline water causes reduction in liquid limit, plastic limit and plasticity index 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. 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.

Dr. P. D. Arumairaj , A. Sivajothi 2011 , carried a research on "Effect of Sea Water on Expansive Soils''.In this work, the effect of sea water on various properties of expansive soils were studied and is compared with the same found using tap water from soil mechanics laboratory of GCT which is used as control sample. The sea water for the study is collected from Bay Of Bengal Sea and the soil sample is collected from Government College of Technology, Coimbatore. Treatment with sea water causes reduction in liquid limit, plastic limit and plasticity index of the clay minerals. The optimum moisture content of the clay mineral increases when treated with sea water.

MATERIAL AND METHODS

Fig 1: Showing shore region of puducherry

METHODOLOGY

The sample which are collected from various location are tends to be analyzed by its physical, chemical, and mineralogical characteristics. And the processing had been carried out as intruding the sea water with various collected sample and kept in air tight bag, then it is analyzed for different days of contamination (eg; 1^{st} ,7^{th} ,14^{th} ,28^{th} ,56^{th} ,84^{th} days).In laboratory the tests will be carried out as two methods i). Before encroachment ,ii)After encroachment**.**

EXPERIMENTAL STUDY FOR SOIL

All the soil parameters were done to find the index properties, shear strength and permeability was conducted based on the Sp 36 part 1 and 2(1987).

RESULT AND DISCUSSION

The samples from Pillaichavady to kirumampakkam were collected. The geotechnical properties were analyzed for both before and after encroachment of sea water. The main intention of testing geotechnical properties is to see the soil strength and its characteristics**.**

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Table 1: Geotechnical Properties Of Soil Before Encroachment Of Sea Water

Description	UNIT	RED SOIL	CLAY	SEA SAND
Sand	%	67.90	20.47	100
Clay	%	32.10	79.53	-
Silt	%	21.10	31.30	-
Liquid Limit	%	11.00	48.61	-
Plastic Limit	%	20.97	47.17	-
Plasticity Index	%	11.02	22.89	-
Shrinkage Limit	%	10.71	24.28	-
Specific Gravity	-	10.50	6.13	-
Free Swell Index	%	2.63	2.52	2.65
OMC	%	23.07	28.13	-
MDD	KN/m^3	13.00	15.6	-
UCC	kpa	16.80	18.73	-

TABLE 2: Geotechnical Properties Of Soil after Sea Water Encroachment

SAMPLE 1: SEA SAND

Description	UNIT	1ST	7TH	14TH	28TH	56TH	84TH
Sand	%	100	100	100	100	100	100
Specific Gravity	-	2.59	2.51	2.59	2.61	2.60	2.60
Permeability	Cm/s	$3.18*10^{-2}$	$3.10*10^{-2}$	$2.87*10^{-2}$	$2.89*10^{-2}$	$2.13*10^{-2}$	$2.99*10^{-2}$
Direct Shear	kpa	30º6'49.4''	29º32'20.6''	27º28'27''	25º18'32''	23º39'18''	23º46'53''

In red soil the geotechnical properties were analysed . when the sea water. The liquid limit is decreased from 20.97% to 19.14%.And the plastic limit is reduced from11.02% to 11%.Sea water causes reduction in free swell index as 23.07% to 22.9%.The compaction did not have any significant effect on sea water. The Atterbergs limit gets decreased gradually when the salinity increased. The reaction is much higher when compared to the sea sand.

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TABLE 3: Geotechnical Properties Of Soil after Sea Water Encroachment

SAMPLE 2: RED SOIL

Description	UNIT	1ST	7TH	14TH	28TH	56TH	84TH
Sand	%	60.76	60.26	60.10	60	59	60
Clay	%	19.32	19.16	20.63	21.98	22.07	22.15
Silt	%	18.56	19.93	18.96	18.01	16.33	16.75
Liquid Limit	%	24.4	23.78	25.12	17.22	19.36	19.14
Plastic Limit	%	14.74	12.77	11.11	11.09	12.04	11
Plasticity Index	%	9.66	11.01	14.01	6.13	7.32	7.15
Shrinkage Limit	%	11.68	11.34	11.15	9.76	9.33	9.21
Specific Gravity	-	2.39	2.18	2.23	2.34	2.43	2.50
Free Swell Index	%	28.57	25	20	22.5	23.6	22.9
OMC	%	14.7	22.1	18.4	16.19	15.06	15
MDD	KN/m3	24.4	23.69	22.7	18.36	16.41	16.15
UCC	kpa	5.86	7	10.06	12.13	13.07	13.52
Permeability	Cm/s	$2.66*10^{-4}$	$2.96*10^{-4}$	$2.51*10^{-4}$	$2.63*10^{-4}$	$2.55*10^{-4}$	$2.61*10^{-4}$

TABLE 3: Geotechnical Properties Of Soil after Sea Water Encroachment

SAMPLE 3: CLAY(80%)

Description	UNIT	1ST	7TH	14TH	28TH
Sand	%	20	19.39	19.38	19.18
Clay	%	32.16	31.05	32.08	32.54
Silt	%	47.39	47.26	47.13	47.28
Liquid Limit	%	45.3	45.16	47.28	46.53
Plastic Limit	%	22.02	21.93	21.86	20.09
Plasticity Index	%	23.28	23.23	25.42	26.44
Shrinkage Limit	%	5.12	6.34	5.38	5.27
Specific Gravity	-	2.38	2.43	2.46	2.42
Free Swell Index	%	28.31	26.49	25.13	24.07
OMC	%	14.3	14.54	15.03	15.98
MDD	KN/m^3	17.16	12.18	9.76	9.32
UCC	Kpa	6.18	5.37	5.48	4.39

In expansive soils the Atterberg limit get reduced when sea water reactions get more onto the soil.The liquid limit is decreased from 47.17% to 46.13% as compared to (7) 60% to 46.12%.The plastic limit is also reduced from 22.89% to 20.09%.The optimum moisture content get increased and maximum dry density get decreased when sea water reacted to the

The amount of swell depends on the type of mineral present in the soil .The decrement observed the free swell index of chosen soil by conducting swelling test.The ion concentration reduces the repulsive force and increase the effective stress leading to flocculation of clay particles which reduce the plasticity.

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CONCLUSION

In This case the geotechnical properties of three types of sample have been analyzed. After encroachment of sea water into the soil samples, various parameters have been tested in the laboratory .By collecting all those results the comparison between the three type of soil is done based on the reaction time period. The Atterbergs limit get decreased gradually when sea water reaction is more. And the free swell index get decreased for red soil and clay sample .Among the three type of soil the clay sample is affected more when compared to other two sample because of high salt content

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