Effectiveness of Jarofix as a Stabilizer on Kuttanad Clay

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Abstract -*Kuttanad clay is a prominent soil deposit, found over the coastal regions of Alappuzha district, Kerala. It is not suitable to be used as a foundation material since it had caused a lot of failures to structures built over it due to its low strength and high compressibility. Jarosite is an effluent from zinc industry formed after the extraction of zinc ore. It is a hazardous unstable effluent which stabilizes with the addition of 2% lime and 10% cement. This stabilized form of Jarosite is known as Jarofix. One of the most important problems third world countries face is the large amounts of wastes and industrial effluents being dumped without any utilization. The application of these dumped effluents in soil stabilization not only puts forward an effective method of waste disposal but also helps to identify low cost potential stabilizers. Many stabilizers are available for improving the performance of soil as a construction material. This necessitates the need of a cost effective and reusable stabilizing agent. Our investigation concentrates on the effectiveness of curing on Kuttanad clay mixed with varying percentages of Jarofix to improve the geotechnical properties of the soil.*

***KeyWords*:Kuttanad clay, Jarofix, Curing, Geotechnical properties, Stabilization.**

1. INTRODUCTION

Construction works on soft clay foundations are often very challenging and very complex task since they are generally characterized by its low strength properties. But due to economic reasons clayey soils are widely used for construction purposes. Overall stability of a structure depends on the quality of soil used in construction. Cohesion, angle of internal friction, capillarity, permeability, elasticity and compressibility are the properties of soil taken into account while considering it as a construction material.

For improving the performance of soil as a construction material many stabilizers are available in the market. This necessitates the need of a cost effective and reusable stabilizing agent. Due to lack of efficient disposal methods, industrial effluents pose a threat to the environment. Contaminations of soil in the vicinity of industrial sites have been reported at many places due the improper disposal of industrial effluents. This alters the index and Engineering properties of the surface and subsurface layers of the ground. Studies show that the addition of certain industrial effluents resulted in the enhanced properties of soil. Industrialization is the new phase of development for third world countries. But at the same time the solid and liquid waste produced causes great concern regarding effective disposal of effluents. If these effluents prove to be effective stabilizers, this can bring revolutionary changes in industrial waste disposal in an ecological point of view and stabilization can be done much more economically. Jarosite is such an effluent from zinc industry produced after the extraction of zinc ore. Jarosite is a hazardous unstable effluent it is stabilized with the addition of 2% lime and 10% cement. This stabilized form of Jarosite is known as Jarofix. The large amounts of wastes and industrial effluents being dumped without any utilization or application is one of the most important problems third world countries facing today. The application of these dumped effluents in soil stabilization not only puts forward an effective method of waste disposal but also helps to identify low cost potential stabilizers. This proposed study aims at investigating the variation of geotechnical properties of Kuttanad clay.

2. MATERIALS

2.1 Jarofix

The extraction of zinc ore concentrate by hydrometallurgy operation results in the production of a waste material called Jarosite, which is an iron analogue of the potassium, aluminium, sulphate and alunite. It is acidic in nature and contains gangue materials and high concentration of heavy and toxic elements (lead, zinc, sulphur, cadmium, chromium and copper) which are susceptible to leaching, leading to environmental pollution. Jarosite is mixed with 2% lime and 10% cement to obtain a chemically and physically stable material called Jarofix, which is less hazardous. The mineralogical studies of aged Jarofix products indicate that Jarosite reacts with the alkaline constituents of the cement to form various stable phases. The long term environmental stability of Jarofix products are ensured by the persistence of alkaline phases in them. In the present study, Jarofix was collected from Binani Zinc Ltd., Binanipuram, Kochi, Kerala.

Fig -1: Jarofix

2.2 Kuttanad Clay

Kuttanad clay, found in Alappuzha district of Kerala, India, is a soft soil with associated problems of low shear strength and compressibility. Several studies show that the soil has a unique combination of minerals such as kaolinite, iron oxides, and aluminum oxides. In the present study, Kuttanad clay was collected from Kainakary South region of Kuttanad, Alappuzha from a depth of 1m in polythene bags to preserve the natural moisture content.

Fig -2: Kuttanad clay

2. METHODOLOGY

The collected clay samples were subjected to both air dry and oven dry. The clay samples were powdered, sieved and prepared for various tests. Experiments were conducted to determine the geotechnical properties and the effect of Jarofix on Kuttanad clay, as per Indian Standards. The specific gravity of Kuttanad clay was determined using density bottle method. The liquid limit and plastic limit were determined using standard Casagrande apparatus. Hydrometer analysis was done to determine the amount of clay content in the sample. The Optimum Moisture Content and Maximum Dry Density were found using Standard Proctor test. Natural moisture content, unconfined compressive strength, coefficient of consolidation were also determined. Effect of Jarofix was determined by conducting unconfined compressive strength test on Kuttanad clay mixed with Jarofix in varying percentages such as 10%, 20%, 30%, 40% and 50%. The long term effect of Jarofix was determined by conducting unconfined compressive strength on Kuttanad clay mixed with Jarofix in varying percentages such as 10%, 20%, 30%, 40% and 50%, after 7 days and 28 days of curing.

Fig -3: Samples for curing

3. RESULTS AND DISCUSSIONS

Followings are the results obtained from the tests conducted.

Table -1: Properties of Kuttanad clay

Sl no.	Property	Value
1.	Specific gravity	2.14
2.	Natural moisture content	111.7%
3.	Liquid limit	51.5%
4.	Plastic limit	38%
5.	Clay content	50%
6.	Silt content	50%
7.	Optimum moisture content	20 %
8.	Maximum dry density	1.31g/cc
9.	Unconfined compressive strength	0.77kg/cm^2
10.	Coefficient of consolidation	0.09cm^2/min
11.	Free swell index	3.704%

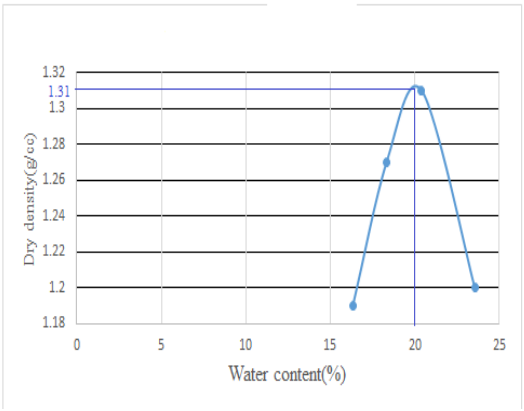

Chart -1: Dry density-Water content relationship of Kuttanad Clay

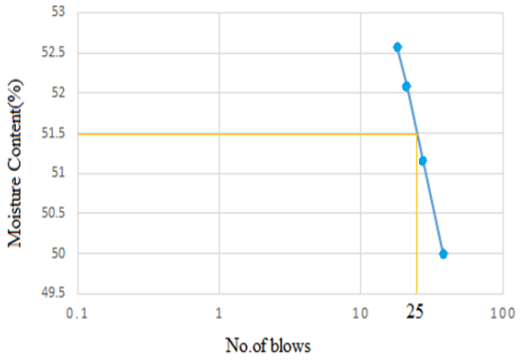

Chart -2: Moisture Content –No. of blows relationship of Kuttanad Clay

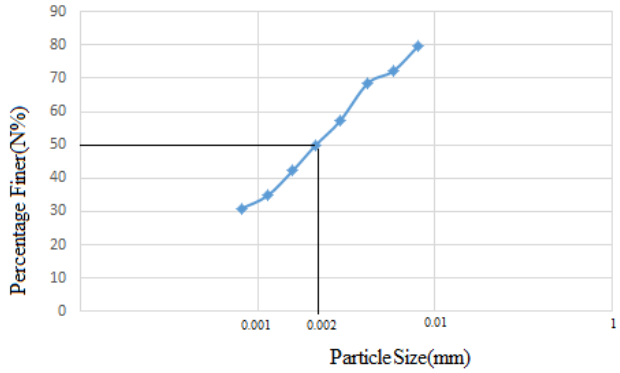

Chart -3: Grain Size Distribution Curve of Kuttanadclay

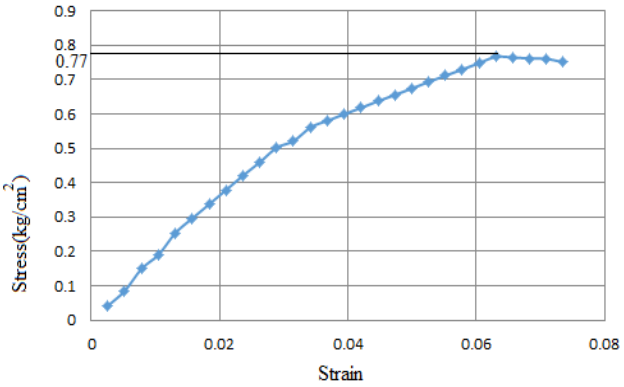

Chart -4: Stress strain curve of Kuttanad clay

The specific gravity of the sample was determined by Density bottle method and the value was found to be 2.14. Liquid limit was obtained using Casagrande's apparatus and the value was 51.5%. Using sedimentation analysis the particle distribution curve of the sample was obtained, from which the clay content and silt content were found to be 50% and 50% respectively. From the Standard Proctor Test, theOptimum Moisture Content was found to be 20% and corresponding maximum dry density as 1.31g/cc.

Following are the graphs obtained for the unconfined compressive tests done on the samples containing 10%,20%,30%,40% and 50%of Jarofix by weight of the sample.

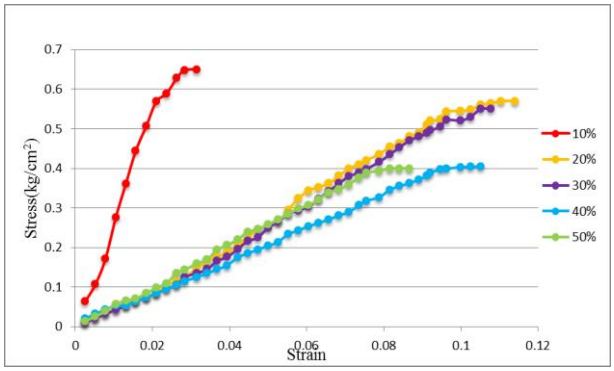

Chart -5: Stress strain curve of Kuttanad clay with varying percentages of Jarofix

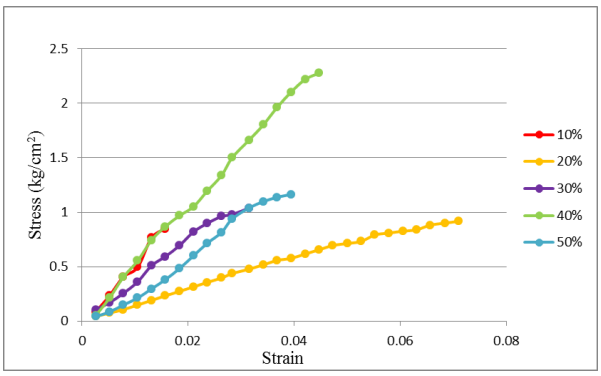

Chart -6: Stress strain curve of Kuttanad clay with varying percentages of Jarofix after 7 days of curing

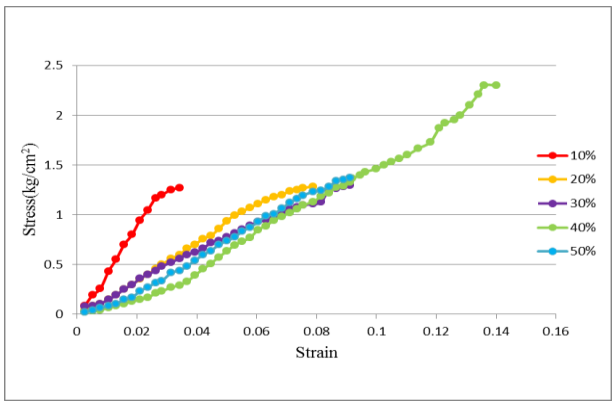

Chart -7: Stress strain curve of Kuttanad clay with varying percentages of Jarofix after 28 days of curing

3. CONCLUSIONS

Kuttanad clay was used for the study,with the aim to investigate its engineering properties and effectiveness of Jarofix as a stabiliser on the same. From the sedimentation analysis using hydrometer, it was attained that it contains equal percentage of clay and silt content. The liquid limit of the clay was found to be 51.5% by using Casagrande's apparatus and thus the clay was found to be highly plastic in nature, as per the Indian Standard Classification of soils. Furthermore, the Optimum Moisture Content was found to be 20% and maximum dry density as 1.31g/cc.

Without the curing the sample possess a decrease in unconfined compressive strength while mixed with varying percentages of Jarofix. But there was an increase in the strength of 196.99% with a curing of 7days and 200.26% with a curing of 28 days.As per the results of this study, the sample containing 40% Jarofix gives maximum unconfined compressive strength. The below graph shows the effect of curing in the sample.

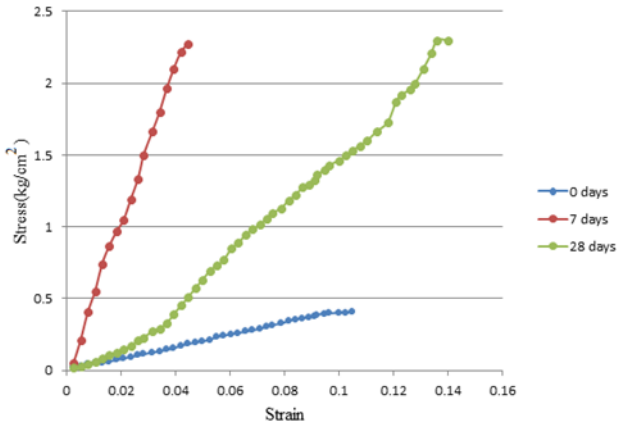

Chart -5: Effect of curing period on the sample containing 40% Jarofix

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