RESEARCH ARTICLE OPEN ACCESS

Effect of Resin on the Strength Characteristics of Thonnakkal Clay

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ABSTRACT
Improving the properties of soil by stabilization is considered as a means of fulfilling design criteria. Stabilization is usually performed to improve material properties of soil such as strength, stiffness, and permeability. The use of new materials for soil strengthening is crucial for geotechnical engineering, especially in foundation construction. Experiments were conducted using resins with different epoxy resin-to-water (ER/W) ratios. . The results show that by increasing the resin in the soil, the maximum dry density increases, and the optimum water content decreases in the compaction tests.The results indicate that the epoxy resins improve the physical and mechanical properties of soil significantly, and if successfully grouted into a formation, the resins could provide a suitable solution for the stabilization of foundation material.
Keywords-Resin, Thonakkalclay,Optimum moisture content, Maximum dry density, UCC

I. INTRODUCTION

Increase in population over the last decades has increased the demand for housing and infrastructure facilities.This in turn increased the need for habitable land. Large areas of kerala are covered with weak soils having poor shear strength and high compressibility. The construction of civil engineering structures on such weak soils is dangerous as they are highly succeptible to differential settlements.A number of failures of engineering structures have been reported in areas covered with weak soil and therefore prior to construction improvement of the soil properties by adopting suitable ground improvement technique is imperative in such areas.

Soil stabilisation refers to the process of changing the soil properties so as to improve its engineering properties thus making it more stable .soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils..Under this method of soil stabilisation of different manufactured materials are added into the soil which in proper quantities enhances the quality of soil. Under chemical reactions are induced by adding stabilizers.

Improving the properties of soil by stabilization is considered as a means of fulfilling design criteria. Stabilization is usually per-formed to improve material properties of soil such as strength, stiffness, and permeability. There are two major forms of stabilization: chemical and mechanical stabilization. There are also some instances where a combination of mechanical reinforcement of a chemically stabilized soil is used to improve properties such as strength and stiffness or to accelerate the treatment of the soil.

Chemical stabilizers are divided into two groups: traditional stabilizers such as lime, cement, and fly ash, andnon traditional stabilizers such as resin and enzymes. The stabilization or improvement is usually affected by controlling the void ratio of the soil by introducing a cementing additive or waterproofing agent, or by injecting a substance to fill the pore volume. There are several techniques for stabilization, and the selection of an appropriate technique depends on the nature of soil and environmental sensitivity.

Adding resin may enhance the soil-cement mechanical properties.). In particular, epoxy resins are one of the principal resins used for grouting. They generally consist of two components. The epoxy component (A-component) is mixed with an amine component (B-component) to obtain the epoxy resin. The final product is strong bond, high durability, high resistance to acids, alkalies, and organic chemicals, and low shrinkage when cured. In addition, some epoxies may be diluted with water up to twice their volume to provide a low-cost product, but their strength consequently de-creases. This reduction of strength is proportional to the amount of water added to the epoxy. Although, numerous studies have been conducted concerning the application of epoxy compounds for structural repair or in fractured concrete.

II. LITERATURE REVIEW

Gopal(1983) studied on use of a few natural resins as dune sand stabilizer. Guar-gum - a product of Rajasthan desert, Terminaliaalata

tannins and rosin have proved promising for short-term and emergency use in field. Effect of compaction on strength has also been studied in order to optimize the thickness of stabilized surfaces required for construction of roads arid helipads in sandy areas. Effect of temperature and bacteria on stabilized specimens has also been discussed .

Levacic,(2006)determined the properties of a soil sample which mixed with urea formaldehyde resin. Several samples of soil and resin mixed in different ratios were prepared. Investigations of different parameters showed the resin significantly improves geomechanical soil properties. As a result the urea formaldehyde resin applied in the tests can be used for stabilization .

Seyedaboolhasan(2010) studied the stabilisation of silty sand soil with epoxy resin and the effect of wet and dry conditions on strength of stabilised silty sands. specimens were prepared by adding different amount of epoxy resin polymer to silty sand with 0,10,20,30,35,40,45,60% silt content at dry density of 17 kn/m^3.The resuts of study indicated the addition of epoxy resin improves significantly the compressive strength and modulus of elasticity of samples under dry condition.This improvements depend on the content of polymer and silt.

Anagnostopoulos(2012) studied experiments were conducted using resins with different epoxy resin-to-water (ER/W) ratios. The results indicate that the epoxy resins improve the physical and mechanical properties of sand significantly, and if successfully grouted into a formation, the resins could provide a suitable solution for the stabilization of foundation material. Based on the experimental results, a nonlinear regression analysis was performed to correlate the mechanical properties and permeability with curing time and ER/W ratio. The unconfined compressive strength, tensile strength, point load strength, and elastic modulus development of the fine sand/resin mix depend directly on the water content of the epoxy resin solution. Mixes with an ER/W ratio of 2.0 and 1.5 result in high strength and low permeability.

III. OBJECTIVES

The main objective of this study is to improve the engineering properties of soil by adding resins .

- To investigate the effects of resin on optimum content of clay
- To predict the engineering behaviour of soil with varying percentage of resins

IV. MATERIALS AND ETHODOLOGY

The soil was collected from Thonnakkal region and resin was collected from ernakulam. The initial properties of soil were tested and the physical properties of resin were obtained from the manufacturer.

In the present study optimum moisture content and maximum dry density of soil mixed with epoxy resin of varying percentages such as 1%,3%,5%,7%,10% was determined by conducting Indian standard light compaction test as per IS 2720 part 7 (1980). The optimum dosage was determined by conducting unconfined compressive strength test as per IS 2720 PART 1 (1991).

V. RESULTS AND DISCUSSIONS

The initial properties of Thonnakkal soil is given in Table 1.

TABLE 1. Initial properties of Thonnakkal soil

Soil property	**Value obtained**
Field water content	23.38%
Specific gravity	2.61
Liquid limit	47%
Plastic limit	26%
Shrinkage limit	22%
Plasticity index	21%
OMC	27%
Maximum dry density	1.52 g/cc
% sand	20%
%silt	26 %
%clay	54 %
IS Classification	CI
Permeability	$1.09x10^{-3}$ cm/s
Unconfined compressive strength	$1.36Kg/cm^2$

The particle size distribution curve of soil is shown in Fig. 1.

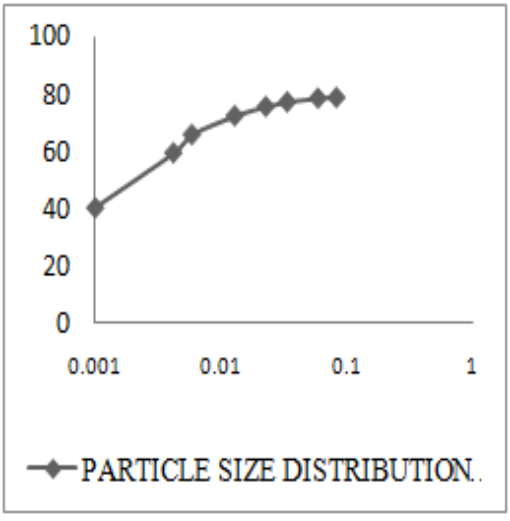

Fig.1. Particle size distribution curve of soil

The details of the experimental specimens using epoxy resin are shown in table 2

TABLE 2:Experimental specimens using epoxy resin

Sl.No	Name of the specimen	Particulars of the specimen
1	S+0%ER	Soil+0%epoxy resin
2	S+1%ER	Soil+1%epoxy resin
3	S+3%ER	Soil+3%epoxy resin
4	S+5%ER	Soil+5%epoxy resin
5	S+7%ER	Soil+7%epoxy resin
6	S+10%ER	Soil+10%epoxy resin

The variation of maximum dry density and optimum moisture content of different percentage of resin treated soil as shown in in Table 3.

TABLE 3: Maximum dry density and optimum moisture content of different percentage of resin

Percentage of resins treated soil	Dry density(g/cc)	Optimum moisture content(%)
Soil+1%ER	1.65	26.8
Soil+3%ER	1.69	26.4
Soil+5%ER	1.74	26
Soil+7%ER	1.8	25.4
Soil+10%ER	1.94	24.8

The variation of unconfined compressive strength of different percentages of resin treated soil are given in Table 4.

TABLE 4: Unconfined compressive strength of different percentages of resin

Sl.No	Percentage of resins treated soil	Unconfined compressive strength(Kg/cm^2)
1	Soil+1%ER	1.70
2	Soil+3%ER	1.90
3	Soil+5%ER	2.19
4	Soil+7%ER	2.78
5	Soil+10%ER	2.89

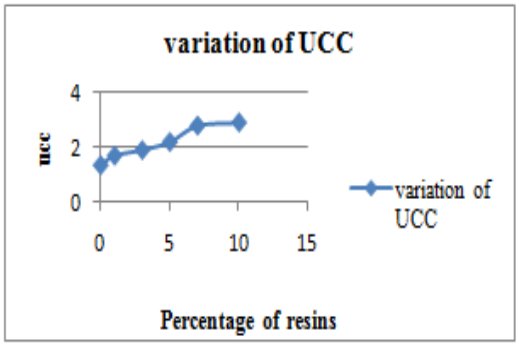

Fig.2. Particle size distribution curve of soil

VI. CONCLUSIONS

The addition of varying percentages of resins to Thonnakkal clay caused the optimum moisture content to decrease and maximum dry density toincrease with increasing percentages of resins.

The UCS value increases when compared to the original soil after adding different percentage of resin.

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