Laboratory Investigations on Expansive Soils with Eggshell Powder

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Abstract: ***For any land-based structure, its load is supported by foundation. In order to support the load, soil plays vital role. Clay soils, particularly black cotton soils, shows extreme plastic behavior on increase in moisture. This consequently results in decrease in Engineering properties and more change in volume. These changes results in severe damage of structures, soil improvement is important under such conditions.Soil stabilization helps to overcome the drawbacks of soil. Stabilization of soil can be achieved through several methods ranging from chemical to mechanical stabilization . These methods are quite expensive for developing countries to implement , so the economic way is to use some alternate material which could be industrial or domestic waste. These materials are easily available and their usage can further minimize the problem of their disposals. This paper illustrates the usage of eggshell powder [ESP] as admixture in BC soil to stabilize it and enhance its index properties , compaction characteristics and UCS value.***

Keywords: clayey soil ,esp, plasticity index , ucs.

I. INTRODUCTION

Stabilization of soil means improving its properties so that they are suitable as a construction material. Stabilization of soil is very important in road constructions, foundations, canals etc .Several new techniques of soil stabilization have emerged which focus on effective and green methods.

Black soils are very dark and very fine grained and, contain a good proportion of calcium carbonates and magnesium carbonates. These soil, when wet are exceedingly sticky due to very high plasticity index. Deep and large cracks are formed when the soil dries and contracts. BC soils contain montmorillonite mineral which is the sole reason for the volumetric changes in the soil.

BC soil becomes unfit as foundation material due to low UCS value .Hence , the UCS of soil should be enhanced by stabilizing it . Eggshells contain 95% of $CaCO_3$, this composition is quite similar with sea shell composition.The remaining 5% includes Mg,Al,P,S,K,Zn, Ironic acid and Silica acid. Eggshells are good bio sorbent due to its cellulose structure and presence of amino acids. Egg shells are produced in large quantities annually in many countries which is a waste and is disposed as landfills. The powdered Egg shell i.e ESP is being used as a stabilizer in expansive soils.

II. EXPERIMENTAL STUDY

Laboratory tests were conducted as per IS code specifications on black cotton soils, properties of the soil are tabularised in Table 1. Furthemore, the soil was alleviated with eggshell powder and variations in properties like CBR, MDD and UCS were determined by conducting the compaction test and UCS (unconfined compressive strength) tests respectively.

As per IS: 2720, following laboratory tests were conducted. Test were conducted on virgin soil and ESP stabilized soil.

- Grain size distribution
- Standard Proctor compaction test
- Unconfined compression strength
- Liquid limit
- Specific gravity
- Plastic Limit

In order to understand the optimum content of admixture, ESP was added as an additive to the soil in different percentages of 2%, 4%, 6 % respectively by dry weight of the soil quantity. Based on the above composite the change in plasticity index value and UCS value was also evaluated with the corresponding varying percentage.

III. RESULTS AND DISCUSSIONS

Materials taken for the purpose of study were Black cotton soil and eggshell powder. The Soil taken for the experimental analysis was from Ramagundam, Karimnagar district .

Experimental tests were conducted on a patch of virgin soil to sort out the atterberg's limits, compaction test features and characteristics, and the UCS. This virgin soil was later alleviated with eggshell powder [ESP] in erratic percentages. The variations found in the evaluated properties of the soil are substantiated below.

The virgin soil properties tabularized are as follows:

Table 1.Virgin soil properties

Sl. No	Lab Test	Result	Relevant IS codes
1	Grain size distribution in %		IS 2720 Part IV
	Gravel stone	8.2	
	Sand particles	20.6	
	Clay particles	70.2	
2	Specific gravity(G)	2.68	IS 2720 Part III
3	Liquid limit in %	41	IS 2720 Part V
4	Plastic limit in %	18.05	IS 2720 Part V
5	Plasticity index no.	22.95	IS 2720 Part V
6	Natural Water content in %	11.25	IS 2720 Part II
7	Optimum moisture content in %	16.09	IS 2720 Part VIII
8	Maximum dry density(g/cc)	1.65	IS 2720 Part VIII
10	Unconfined compression strength (Kg/cm^2)	2.5	IS 2720 Part X

Revised Manuscript Received on December 08, 2018.
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A. liquid limit percent and plastic limit percent of soil treated with eggshell powder

Changes in liquid limit percentage, plastic limit percentage and plasticity index value of B.C soil with variable percentages of ESP.

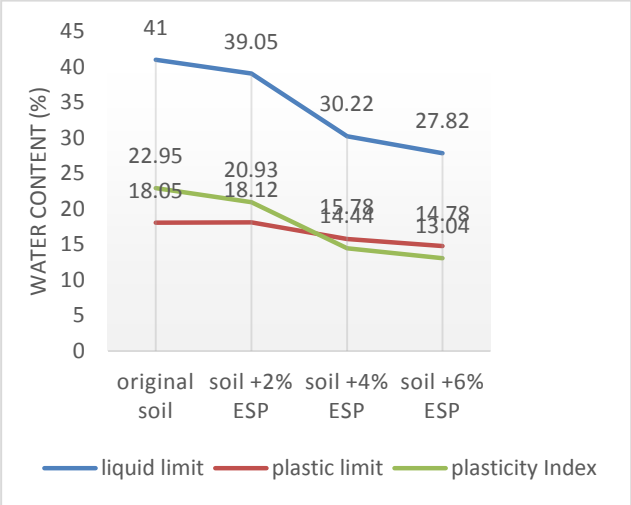

Fig.1 Atterberg limit's of virgin soil and ESP stabilized soil.

From the above fig, a considerable change in the plasticity index can be observed. At 4% EPS and the plasticity index has reduced from 22.95 to 14.44 and 13.04 respectively. This is due the reduction of the adsorption tendency of clay on account of pozzolanic reaction between CaO and negatively charged ions present in clay

B. Unconstrained compressive strength of soil

UCC Test was evaluated on selected soil samples prepared appropriately at their OMC with different variable percentages of stabilizers (2%, 4% and 6%) to evaluate the compressive strength under unconstrained condition. From fig 6.13, On comparing the values with variable percentage, the UCS Value of soil treated with 4 % of EPS gives a considerable increase the strength.

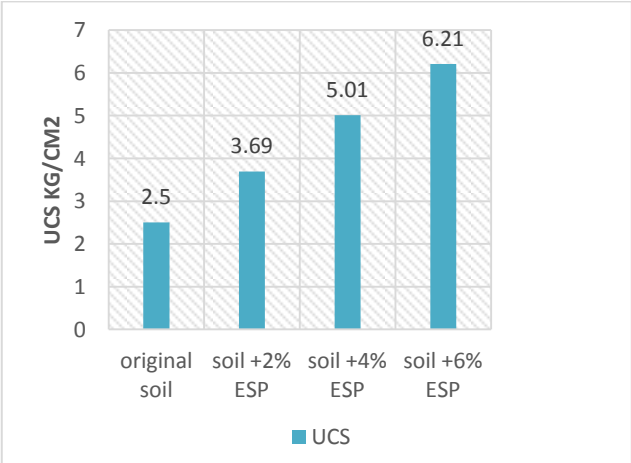

Fig.3 UCS of Soil with different % of RBI & Lime

IV. CONCLUSION

Based on the inferences of the contemporaneous investigations, the following conclusion can be substantiated.

- Additive treatment of the soil with eggshell powder resulted in change in Atterberg's limit and unconstrained compressive strength of soil.
- It may be noted that plastic limit per cent of EPS mixed with the soil incredibly increases with gradual increasing proportions of additive mixture.
- The 4% ESP is taken as optimum dosage.
- The unconstrained compressive strength of the original tested soil was very less compared to the soil with optimum admixture content.
- Since the ESP has the lime content, it stabilizes the clay particles by interacting with water molecules. The strength of the soil has thereby increased greatly with optimum dosage of ESP.

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