Soil Stabilization using Plastic Granules

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Abstract

The correct stabilization of foundation soils constitutes an increasingly important issue in the present Civil Engineering world. Concerns over the environment have taken significant proportions, and there is the awareness today that efforts must be made to diminish the environmental damage caused by the development of infrastructures. Therefore, it has become urgent not only to find building procedures, which will allow this objective to be achieved, but also to accelerate their implementation. This study consists of improving the Engineering properties of Black Cotton soil using recycled glass and plastic. Recycling material from the original site, independently of the simplicity avoids its substitution by better materials, recovered elsewhere; which has severe consequences for the environment. This also eliminates the need for a deposit site of unused material. The main goal of this work is to quantify the benefits achieved with the stabilization of a black cotton soil, with respect to its Engineering properties.

Keyword- Soil Stabilization, Plastic Granules, Civil Engineering World

I. INTRODUCTION

Expansive soil experiences volume change due to alteration in moisture content. The name "Black Cotton" has an agricultural origin. Most of these soils are black in colour and are good for growing cotton. In monsoon seasons, soils absorb water, swell, become soft and capacity to bear water is reduced. In drier seasons, these soils shrink or reduce in volume due to evaporation of water and they become harder. Due to its peculiar characteristic of high plasticity, excessive swelling, shrinkage and low strength when wet, the soil is regarded unsuitable for construction. Soil stabilization is a process by which we can improve the soil characteristics & economy of construction on it. Stabilization, in a broad sense, incorporates the various methods implemented for modifying the properties of a soil and improves the engineering properties and performance of soil. But due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favour. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement. The paper presents the effect of glass and plastic granules inclusion on engineering properties of black cotton soil. The mixing of randomly oriented glass and plastic granules to soil sample may be considered same as other admixtures used to stabilize soil. Materials used for stabilization are recycled or waste materials from various industries.

II. EXPERIMENTAL INVESTIGATION

Modified Proctor compaction tests were conducted on both control and stabilized soils to measure the compaction characteristics of the soft soil. Modified Proctor test results were then used to conduct strength studies by means of CBR test. The results obtained from the experimental programme are discussed in detail.

Sl No	PROPERTY	VALUE
1	Specific Gravity (G)	2.60
2	Liquid Limit	57%
3	Plastic Limit (W_P)	29.03%
4	Plasticity Index (I_P)	26.97%
5	Maximum Dry Density	1.443gm/cc
6	Optimum Moisture Content	21.4%
7	Free Swell Index (F.S.I)	38
8	Unconfined Compressive Strength (q_u)	0.609 kg/cm²
9	CBR-Unsoaked (%)	3.19
10	CBR-Soaked (%)	0.51
11	Ultimate Bearing Strength	705.62 KN/m²

Table 1: Properties of the Black Cotton Soil Obtained from Test Report

A. Behavior of Soil Modified with Glass and plastic Granules

Modified Proctor tests were carried out to study the variation in the maximum dry density and optimum moisture content with the addition of glass and plastic. For all samples, the dry density increases with increase in water content up to the point of optimum moisture content beyond which increase in water content reduces the dry density. The variation of dry density and optimum moisture content with Glass & Plastic content is shown in Fig.1 and Fig.2 respectively. The dry density is constantly increasing by the addition of Glass & Plastic in soil up to 6% of stabilizer and then reduces again after 6% of stabilizer. This is because of the addition of Glass & Plastic having low density in place of soil having comparatively high density. However, more percentage of Glass & Plastic beyond 6% reduced dry density (γd). The MDD was obtained at 6% of stabilizers of 1.53gm/cc.

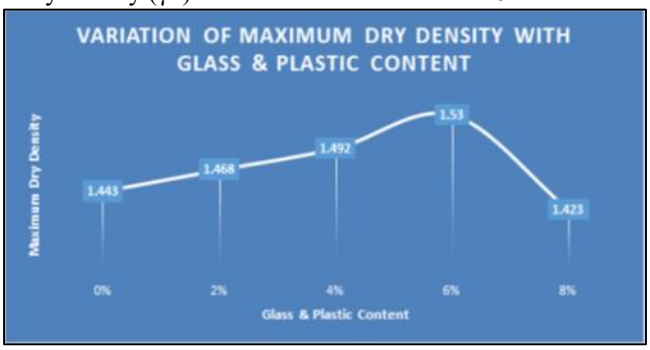

Fig. 1: Variation of Maximum Dry Density with Glass & Plastic Content

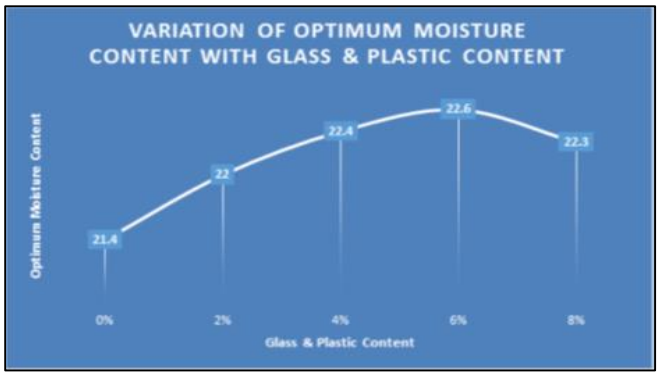

Fig. 2: Variation of Optimum Moisture Content with Glass & Plastic Content

When Glass & Plastic is added to the soil in the presence of water, it fills the voids of soil thus contributing to the dry density. When higher contents of Glass & Plastic is added, the amount of water adsorbed by the stabilizer in the mixing stage may get expelled under the compactive effort thus contributing to the increase in OMC at higher stabilizer content and reduces after the addition of 6% of stabilizer.

Unconfined Compressive Strength tests were carried out to find the variation in the strength characteristics of the soil stabilized with Glass & Plastic. When Glass & Plastic is added to the soil, the strength of the soil is increased initially. The increase in Glass & Plastic beyond an optimum percentage (6%) in soil caused a decrease in strength. This is evident from the variation as shown in the Fig.3

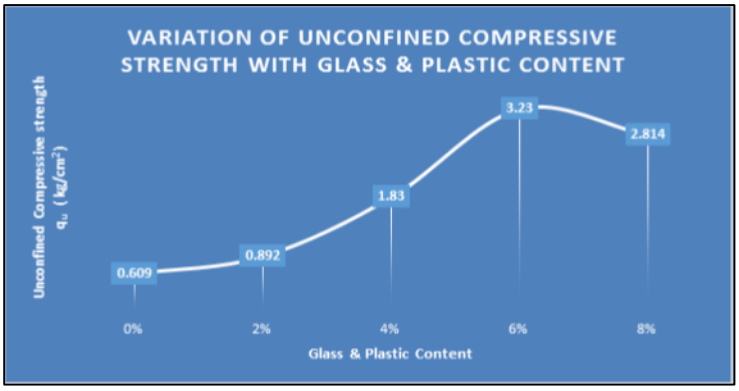

Fig. 3: Compressive Strength for Different % of Stabilizers

When the Glass & Plastic content is increased beyond the optimum percentage there is a decrease in compressive strength value. This decrease may be caused by action of Glass & Plastic as a cushion in the soil and not providing enough water molecules

to hold the soil particles together, since the additional water molecules will stick on the surface of the stabilizers. The maximum value of UCC was obtained as 3.23 kg/cm² at 6% Glass and Plastic content which is about 5 times than that of virgin soil.

CBR studies were carried out to find the variation in the strength characteristics of the soil stabilized with Glass & Plastic. When Glass & Plastic is added to the soil, the strength of the soil is increased initially. The increase in Glass & Plastic beyond an optimum percentage in soil caused a decrease in strength. Increases the CBR value of the soil is due to the densification achieved by the filling of voids in soils with the Glass & Plastic. When the stabilizer content is increased beyond the optimum percentage (6%) there is a decrease in CBR value. This decrease may be caused by the adsorption of water by Glass & Plastic thus acting as a cushion in the soil and not providing enough water molecules to hold the soil particles together. A maximum CBR value of 7.14 was obtained at 6% of stabilizer beyond which there is a decrease of CBR value.

III. CONCLUSION

The experimental investigations done so as to bring out the effect of stabilization of black cotton soil using Glass & Plastic gave a good result.

- Addition of Glass & Plastic in varying percentages resulted in overall decrease in MDD. The MDD of 1.53 gm/cc was obtained at 6% Glass & Plastic mixed with the soil.
- Addition of Glass & Plastic in varying percentages showed a similar trend in the variation of OMC. The OMC curve shows an overall increase in the OMC. The maximum value of OMC was obtained as 22.6 %
- at 6% Glass & Plastic mixed with the soil.
- UCC results shows that there has been an increase in the unconfined compressive strength of the soil from 0.609 kg/cm2 to 3.23 kg/cm2 (6% Glass & Plastic), which is about 5 times as that of the virgin soil.
- In CBR, the addition of Glass & Plastic into unsoaked soil resulted in a slight improvement in CBR value. The maximum CBR value was obtained as 7.14%, 2 times the CBR value of the virgin soil. This maximum CBR value was obtained with 6% Glass & Plastic by dry weight of soil and hence was taken as the optimum percentage of Glass & Plastic for stabilizing the soil. The addition of Glass & Plastic into soil increased the CBR value from 3.19% to 7.14% i.e., 2 times the CBR value obtained for unreinforced soil.
- Free Swell of the soil was able to reduce up to 1.5 times than that of virgin soil.
- Soaked CBR value of the soil increased from 0.51% to 1.2% by the addition of Glass & Plastic at an optimum percentage of 4% which is almost 2.3 times.
- Ultimate Bearing Strength of soil increased from 705.62 KN/m² to 1327.93KN/m². From the obtained results of various tests conducted on the soil, an appreciative result was obtained at 6% Glass & Plastic mixed with the soil. Hence addition of 6% of stabilizer was taken as the optimum percentage of Glass & Plastic for stabilizing the soil. From the tests conducted and can be concluded that Glass and Plastic can be used effectively for the stabilization of Black Cotton soil.

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