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An Experimental Study on Stabilization of Clayey Soil using SCBA

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ABSTRACT

In developing countries like India, due to remarkable development in road infrastructure, soil stabilization has become a major issue in constructional activity, stabilization is not only a method of altering or modifying of one or more soil properties to improve the engineering. Characteristics and performance of soil, but also processing available materials for the production of low –cost design and construction. Black cotton soils which expand when the moisture content of soils is increased the clay mineral Montmorillonite is main responsible for expansive characteristics of the soil. the expansive soils called swelling of soils or black cotton soils a large part of south India is covered with expansive soil another problem with this soil is strength decreases with increases of the degree of saturation heavy damages may occur buildings roads runways pipelines and other structures built on such soils if proper preventive measures are not a method. The damages can be prevented to a large extent if characteristics of expansive soil properly assessed suitable measures taken in design construction and maintenance of structures built on soils. This presents an experimental investigation to study the effect of sugarcane baggage ash on swelling and shrinkage and mechanical properties of soil. After finding out the experimental results in the lab to know the evaluation and performance of baggage ash on the black cotton soil in the laboratory. Black cotton soil and Sugar cane baggage ash have prepared by varying of different proportions with respect to dry the density.

INTRODUCTION

Soil improvement is of major concern in the construction activities due to the rapid growth of urbanization and industrialization. The term soil improvement is used for the techniques which improve the index properties and another engineering characteristic of expansive soils. Expansive soils are worldwide problematic soil which is associated with large volume change behaviour when it undergoes a change in the water content. When expansive soils are exposed to high water content, they exhibit high selling characteristics. And when the presence of low water content, then it shows low shear strength. These soils pose several problems to the structures due to their volume changes. Among those, black cotton soil is one type of expansive soils and they show high swell shrinkage behaviour owing to fluctuating water content. In India, black cotton soil covers as high as 20% of the total land area and majorly in central and south India. They are predominant in the states of Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu. These soils have high swelling and shrinkage characteristics and extremely low CBR value and shear strength. If it should be used as a foundation

Soil Stabilization:

Soil stabilization is the process of improving the engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the intended purpose. In its broadest sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. However, the term stabilization is generally restricted to the process which alters the soil material itself for improvement of its properties. A cementing material or a chemical is added to a natural soil for the purpose of stabilization. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils. However, the main use of stabilization is to improve the natural soils for the construction of structures. The principles of stabilization are used for controlling the grading of soils and aggregates in the construction of bases and sub-bases of the highways and airfields.

Soil Stabilization is a procedure where natural or manufactures additives or blinders are used to improve the properties of soils. There are several methods have been used to minimize or eliminate the harmful effects of expansive or soft clays soils on structures. These methods included mechanical stabilization, chemical stabilizations, Thermal stabilization, soil replacement with compaction control, moisture control, surcharge loading, and use of geosynthetics etc.

Mechanical Stabilization:

Mechanical stabilization is the process of improving the properties of the soil by changing its gradation. Two or more

types of natural soils are mixed to obtain a composite material which is superior to any of its components. To achieve the desired grading, sometimes the soils with coarse particles are added or the soils with fine particles are removed. Mechanical stabilization is also known as granular stabilization.

Under this category, Soil Stabilization can be achieved through the physical process by altering the physical nature of native soil particles by either induced vibration or compaction or by incorporating other physical properties such as either induced vibration or compaction or by incorporating other physical properties such as barriers and nailing.

The mechanical stability of the mixed soil depends upon the following factors.

1. Mechanical strength of the aggregate
2. Mineral Composition
3. Gradation
4. Plasticity characteristics
5. compaction

Use of Mechanical Stabilization is, it is the simplest method of soil stabilization. It is generally used to improve the subgrades of low bearing capacity. It is extensively used in the construction of bases, sub-bases and surfacing of roads.

Chemical stabilization:
In chemical stabilization, soils are stabilized by adding chemicals. The main advantage of chemical stabilization is that setting time and curing time can be controlled.it is however generally more expensive than other types of stabilization.

The following are the chemical types have been successfully used

- calcium chloride
- sodium chloride
- sodium silicate
- polymers
- chrome lignite

Black Cotton Soil:
Rich proportion of montmorillonite is found in Black cotton soil from mineralogical Analysis. The high percentage of montmorillonite renders high degree of expansiveness. These property results cracks in soil without any warning. These cracks may sometimes Extent to the severe limit like ½" wide and 12" deep. So building to be founded on this soil May suffer severe damage with the change of atmospheric conditions. Black cotton soils Are inorganic clays of medium to high compressibility and form a major soil group in India. They are characterized by high shrinkage and swelling properties. This Black Cotton soils occurs mostly in the central and western parts and covers approximately 20% of the total area of India. Because of its high swelling and shrinkage characteristics, the Black cotton soils (BC soils) have been a challenge to the highway engineers. The Black Cotton soils are very hard when dry but lose its strength completely when in wet condition. It is observed that on drying, the black cotton soil develops cracks of varying depth. As a result of the wetting and drying process, vertical movement takes place in the soil mass. These movements lead to failure of pavement, in the form of settlement heavy depression, cracking and unevenness.

Fig-1. Black cotton soil

Specific gravity:
To find out the specific gravity, several methods are available. But in this study Pycnometer test (IS: 2720-1980) was adopted. Specific gravity is the ratio of the weight of a given volume of solids to the weight of an equivalent volume of water.

Mathematically expressed as $G_s = \frac{\gamma_s}{\gamma_w}$

Specific gravity of Soil $G_s = \frac{W2-W1}{(W2-W1)-(W3-W4)}$

Where,

W1 = Weight of the empty Container

W2 = Weight of Container + Dry Soil

W3 = Weight of Container + Dry Soil + Water

W4 = Weight of the Container + Water

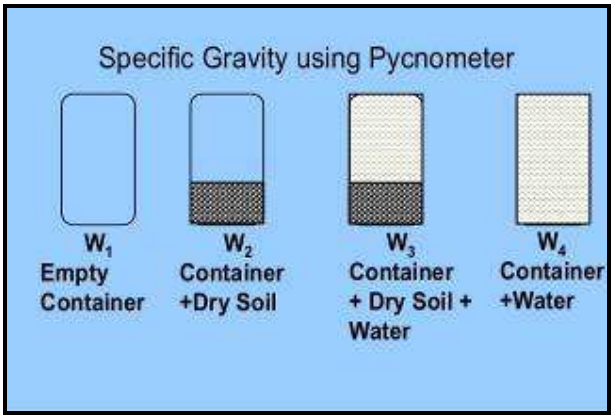


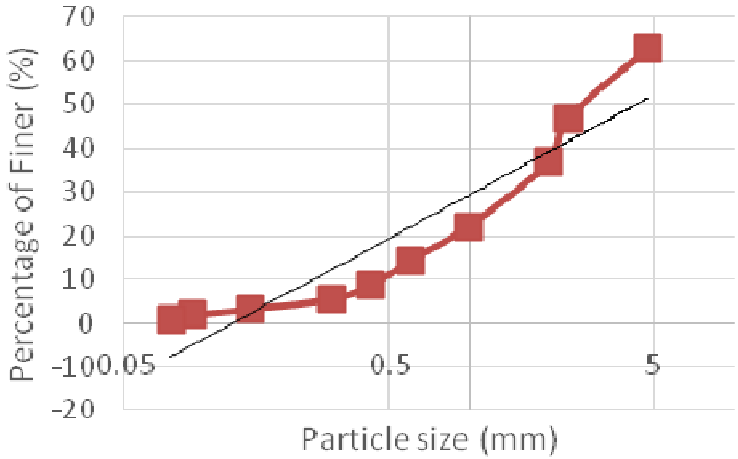
Fig-2 shows the Determination of Specific Gravity of the Soil using Pycnometer method

Sieve analysis:

Weight of the Soil taken for test is 1000gm

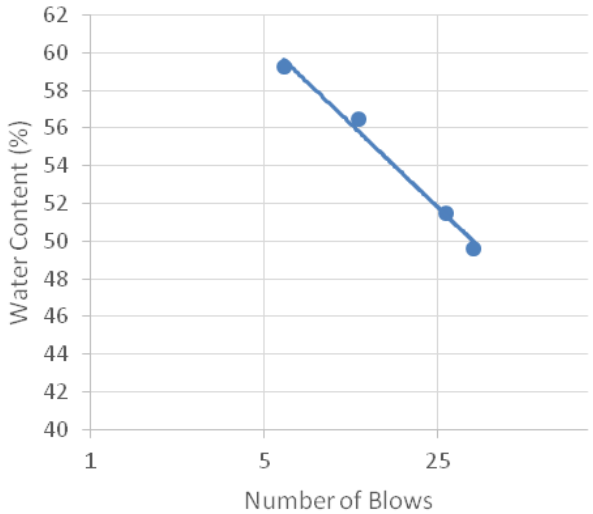
Table 1: Sieve Analysis

IS Sieve	Weight Retained (g)	Percentage Retained (%)	Cumulative Percentage (%)	Percentage of Finer (%)
4.75	372	37.2	37.2	62.8
2.36	162	16.2	53.4	46.6
2	98	9.8	63.2	36.8
1	146	14.6	77.8	22.2
0.6	80	8	85.8	14.2
0.425	56	5.6	91.4	8.6
0.3	32	3.2	94.6	5.4
0.15	22	2.2	96.8	3.2
0.09	14	1.4	98.2	1.8
0.075	10	1	99.2	0.8
PAN	4	0.4	99.6	0.4



Graph 1: Sieve Analysis Graph

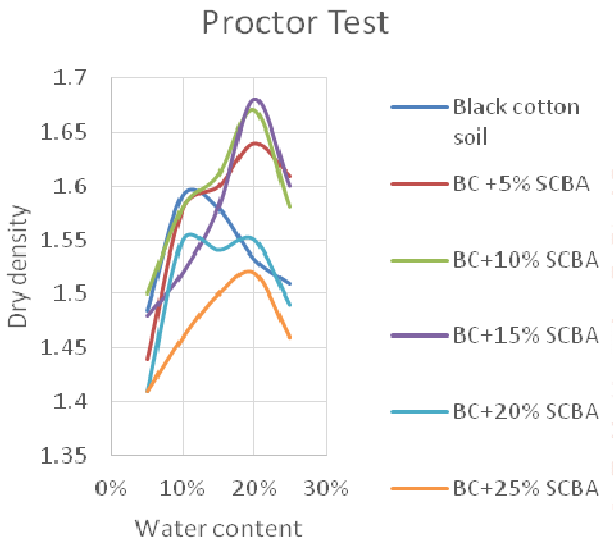
S. No	Observations & Calculations	Test 1	Test 2	Test 3	Test 4
1	Number of Blows	32	25	18	12
2	Mass of Empty Container (M1)g	24	32	28	21
3	Mass of Container + Wet Soil (M2)g	62	78	69	72
4	Mass of Container + Dry Soil (M3)g	45	41	34	37
5	Water Content W = (Mw/Md)x100 %	49.62	54.17	56.50	59.23



Graph 2: Liquid limit determination Graph

Table 3: Observation table on Black cotton soil:

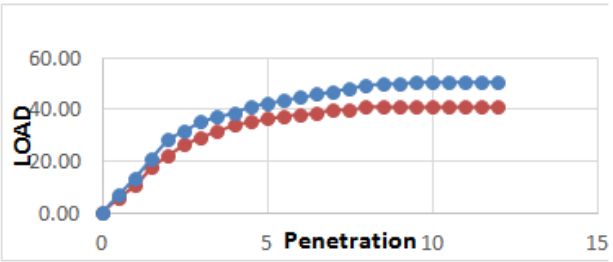
Characteristics	Value
Color	Black
Specific Gravity	2.67
Liquid Limit (%)	52
Plastic Limit (%)	26.7
Plasticity Index (%)	25.3
Classification	CH
Optimum Moisture Content (%)	20
Maximum Dry Density (g/cc)	1.58
Unsoaked CBR	2.2
Soaked CBR	1.4
Unconfined Compressive Strength (kg/cm²)	0.9



Graph 3: Compaction curves for soil samples with 0%, 5%, 10%, 15%and 20% and 25% of SCBA

Table 4: Standard Load values at specified penetration:

S. No	Observation	
1	Height of the Mould	150mm
2	The diameter of the Mould	175mm
3	Height of the Spacer Disc	47.7mm
4	Weight of each Surcharge Disc	2.5kg
5	The volume of the Specimen	2470cc
6	Weight of the empty mold	5.839kg
7	Weight of the Rammer Used	4.89kg
8	The freefall of the Rammer Used	450mm



Graph 4: Load Vs Penetration graph for Black Cotton Soil+5%SCBA (Unsoaked & Soaked)

CONCLUSIONS

In this study, the major properties studied are OMC, MDD, CBR, UCS, and Consolidation. Based on all investigations on all samples and when compared with normal soil, the following conclusions were made

Compaction Test and CBR Test:

- In Standard Procter Test, the increase in SCBA percentage the dry density increases up to 20% and after the MDD value has been decreasing trend. Though, a decrease in OMC has been observed with an increase in SCBA %
- Maximum dry density was increased with the addition SCBA
- When 5%,10%,15%,20% SCBA added, higher MDD observed for 15% of SCBA addition
- Both the Unsoaked and soaked condition of CBR were studied and Peak value was obtained at 15% SCBA in both conditions.

Unconfined compressive strength:

- In UCS, Due to an increase in SCBA percentage the UCS value having increasing trend with respect to the parent soil.
- In UCS, Due to an increase in SCBA percentage, the UCS value has been observed increasing trend up to 20% after that having a decreasing trend with an increase in lime content.
- Lime not only acts as an activator in this case but also reduces the plasticity of the soil.
- SCBA specimen fails by the formation of vertical cracks.
- The Curing period of the mix is a governing parameter as the chemical reaction of stabilizers is depends on it.so it can be concluded that the strength will increase with the increase in the curing period.
- UCS of treated soils was higher than that of untreated soils.
- UCS value of the sample is increased from 0.97 to 8.8 kg/cm²

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