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Analysis of Clayey Soil using Waste Material

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Abstract

The clayey type of soil is expansive, swelling and shrinkage type of soil. Due to these types of the properties behavior of clayey soil or black cotton soil has been changed dramatically. Based on observation we can say that the changes are due to reaction with water. Also the large amount of black cotton soil is available all around the world which leads to a waste of land for construction uses. So we have tried to resolve this problem by stabilizing clayey soil by waste material marble powder and brick dust. We have stabilized a clayey soil by replacement of 30 % of soil to the both stabilizing agents marble powder and brick dust. The combination has been used of 70 % soil + 30% stabilizing agent. The analysis includes the comparison of clayey soil after stabilization with the available soil parameters and properties. The comparison includes total properties consideration by carried out compaction test, atterber's limit test, linear shrinkage test, and swelling test on stabilized soil. From the above mentioned test its been observed that swelling.

Keywords: expansion, swelling, shrinkage, engineering properties, stabilization, marble powder, brick dust.

I. INTRODUCTION

Clayey soil or Black cotton soil is an expansive soil, which swells or shrinks excessively due to change in moisture content. When an engineering structure is associated with black cotton soil, it experiences either settlement or heave, depending on the stress level and the soil swelling pressure. Design and construction of civil engineering structures on and with expansive soils is a challenging task for geotechnical engineers [1].

The soil occupies about 3% of the world land area (i.e., about 340 million hectares). They are found mainly in Africa, in the Gezira cotton fields of the southern black cotton plains of Sudan, South Africa, Ethiopia and Tanzania. In Asia they are found extensively in the Indian Decca Plateau. They could also be found in Australia, West Indies and in vast areas of Russia [2].

High percentage of montomonillonite renders high degree of expansiveness. These property results cracks in soil without any warning. These cracks may sometimes extent to 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.

Expansive soil behaviour is generally attributed to clay soils, and is characterized by excessive compression, dispersive behavior, collapsing behavior, low shear strength, high swell potential, and frost susceptibility. They are therefore not suitable for use without improvement of their properties.

The engineering behaviour of fine-grained soils depends on their water content. Liquid limit (WL) and plastic limit (WP) are important water contents as well as two important parameters of plasticity index (PI), which is the main index parameter of the classification of fine-grained soils. Plasticity index has also been used in correlation with many other engineering properties like internal friction angle, undrained shear strength, lateral earth pressure over consolidation ratio etc. Shrinkage limit (SL) is also an important parameter in which soils tend to shrink when they loose moisture. In particular, fine grained soils are susceptible to shrinkage and the resulting volume change. Shrinkage can cause cracking of soils that can adversely influence the behaviour of the soils. It is widely accepted that the liquid limit test is essentially a measure of the shear strength of soil that is so soft it approaches the liquid stage.

In India, black cotton soils have liquid limit values ranging from 50 to 100%, plasticity index ranging from 20 to 65% and shrinkage limit from 9 to 14%. The amount of swell generally increases with increase in the plasticity index. The swelling potential depends on the type of clay mineral, crystal lattice structure, cation exchange capacity, ability of water absorption, density and water content. [3]

II. LITERATURE REVIEW

A. *COMPARISION OF FLY ASH AND RICE HUSK ASH STABILIZED BLACK COTTON SOIL* [4]

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The paper presents the laboratory study of black cotton (BC) soil stabilized with fly ash (FA) and rice husk ash (RHA). The samples of BC soils were collected from a rural road located in Raipur of Chhattisgarh state. The soil was stabilized with different percentages of FA (i.e., 5, 8, 10, 12, and 15%) and RHA (i.e., 3, 6, 9 11, 13, and 15%).The atterberg's limits, specific gravity, california bearing ratio (CBR), and unconfined compressive strength (UCS) tests were performed on raw and stabilized soils.

Results indicate that addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil. The moisture and density curves indicate that addition of RHA results in an increase in optimum moisture content (OMC) and decrease in maximum dry density (MDD), while these values decrease with addition of FA.

B. EFFECT OF LOCUST BEAN WASTE ASH ON LIME MODIFIED BLACK COTTON SOIL [5]

Ovuarume, ufoma Bernard B.Eng(ABU)

Black cotton soil classified as an A-7-6(24) soil on the AASHTO classification collected from New Marte area of Borno State was modified with up to 4% lime and locust bean waste ash (LBWA) up to 8% by weight of dry soil.

The effect of LBWA on the lime modified soil was studied with respect to particle size distribution, Atterberg limits, compaction characteristics and shear strength parameters using three (3) compactive efforts of British Standard light (BSL), West African Standard (WAS),and British Standard heavy (BSH). Statistical analysis was carried out on results obtained from the tests conducted to determine significant difference (i.e ,p<0.05) on the various soil-lime-LBWA mixtures using a two way Analysis of Variance(ANOVA) with the Microsoft Excel Analysis Tool Pak Software Package. Analysis of the results of the soil-lime mixtures considered showed increase in percentage of fine fraction, improvement in the plasticity index, decrease in maximum dry density (MDD), with increase in optimum moisture content (OMC), as well as a decrease in cohesion with increasing angle of internal friction all with higher locust bean waste ash contents.

The results also showed that the modified soil met there requirements of the Nigerian General Specifications of not more than 35% passing sieve No.200, maximum plasticity (PI) index of 12%, and liquid limits (LL) of a maximum of 50% when used as a subgrade material in road construction. An optimal blend of 4% lime 8%LBWA is recommended for the modification of black cotton soil.

C. A REVIEW ON EFFECT OF STABILIZING AGENTS FOR STABILIZATION OF WEAK SOIL[6]

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Ismail (2004)

Ismail (2004) studied materials and soils derived from the Feuerletten (Keuper) and Amaltheenton (Jura)formations along the new Nuernberg-Ingolstadt railway line (Germany). His work include petrological, mineralogical studies and scanning electron microscope-analysis.

Ismail(2004) treated and stabilized these materials related to road construction using lime (10%), cement (10%), and lime/cement (2.5%/7.5%). He determined consistency limits, compaction properties , and shear and unixial – strength . Ismail (2004) concluded that by increasing the optimum moisture content (%) of the treated-material (soil mixtures) the maximum dry density (g/cm3) decreased. The cohesion and the friction angle of the improved material increased for all the treated mixtures.

In case of the lime-treated materials, the cohesion decreased by curing time. For Feurerletten materials, uniaxial strength increased strongly using lime and cement together. For Amaltheenton, uniaxial strength increased strongly with cement alone. He also noticed that the loss of weight during freezing and thawing test was low and depended on the material type.

III. REVIEW CONCLUSION

From the above literatures we can conclude that by the addition of different stabilizers the properties of soil can be improved. Above literatures shows that by addition of different stabilizers the expansiveness, swelling and shrinkage can be reduced of clayey soil effectively.

IV. SCOPE AND OBJECTIVES

Our main objective is to minimize the problem of black cotton soil of expansiveness, swelling and shrinkage by adding different waste material like marble powder and brick dust. To fulfill the objective we have compared the effects on properties by stabilizing soil with both material marble powder and brick dust by replacing soil in same proportion of 30%.

In developing country like India industrialization is taking place so there is very high amount of fly ash is produced as a byproduct of coal burning so it is the mostly used agent for the stabilization after lime.

As same marble dust and brick dust which are produced during the shaping or finishing process of marble stone and burning of clay bricks respectively. These both are waste products which are not in any kind of use so we are going to use these materials for the stabilization of black cotton soil for to establish the effect of them on it.

V. METHODOLOGY

COLLECTION OF SOIL SAMPLE

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- **ESTABLISHING GEOTECHNICAL PROPERTIES OF SOIL**
  - **Particle size distribution**
  - **Atterberg'slmits**
    - **Plastic limit**
    - **Liquid lmit**
    - **Plasticity index**
  - **Swelling index**
  - **Linear shrinkage**
  - **Modified proctor test**
    - **Optimum moisture content**
    - **Maximum dry density**

↓

Proportioning with different stabilizers & re establishing its properties

MARBLE POWDER

- **70% black cotton soil + 30% marble powder**

BURNT BRICK DUST

- **70% black cotton soil + 30% burnt brick dust**

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Results and discussion

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Concluding Remarks

VI. IS STANDARDS USED FOR TEST CONSIDERATION

Table – 1
list of IS codes for tests

Grain Size Analysis	*IS 2720 (part IV) 1985*
Atterberg's Limits	*IS 2720 (Part V) 1985*
Modified Proctor Test	*IS: 2720 (Part VII) 1983*
Linear Shrinkage	*IS 2720 (Part 20)-1992*
Free Swell	*IS 2720 (Part 40)-1977*

VII. OBSERVATIONS AND INTERPRETATION

A. *Atterberg's limits*

Table – 2
attereberg's limits values

DISCRIPTION	*black cotton soil*	*BC + 30% MP*	*BC + 30% BD*
Liquid Limit (%)	*43*	*37.4*	*33.5*
Plastic Limit (%)	*16.897*	*15.37*	*12.96*
Plasticity Index (%)	*26.1*	*22.02*	*20.53*

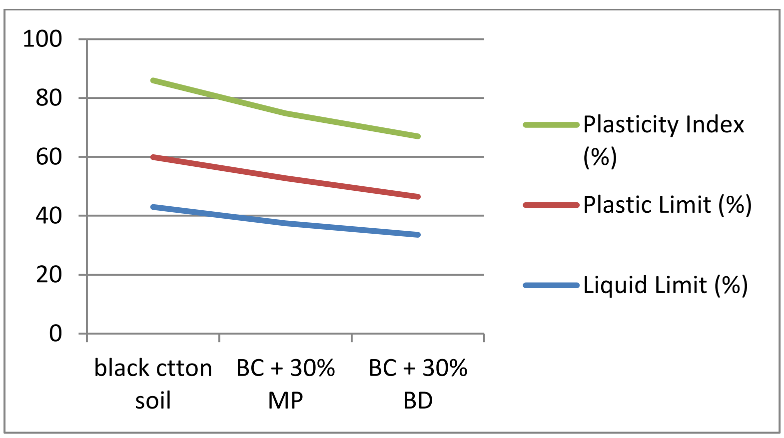

Fig 1 graph for atterberg's limits value

By the replacement of black cotton soil from the marble powder and brick dust it is identified that the values of attereberg's limits are decreasing. Above figure shows that the by replacing soil by 30% by marble powder liquid limits reduced 5.6%, plastic limit reduced 1.572% and plasticity index reduced by 4.08% than the value of black cotton soil. As same for replacement of 30 % soil by brick dust liquid limits reduced 9.5%, plastic limit reduced 3.937% and plasticity index reduced by 5.57% than the value of black cotton soil.

B. Proctor compaction test

Table - 3
Values of MDD and OPC

CONTENT	black cotton soil	BC + 30% MP	BC + 30% BD
MDD (g/cc)	1.71	1.91	1.81
OMC (%)	18.08	12.36	15.55

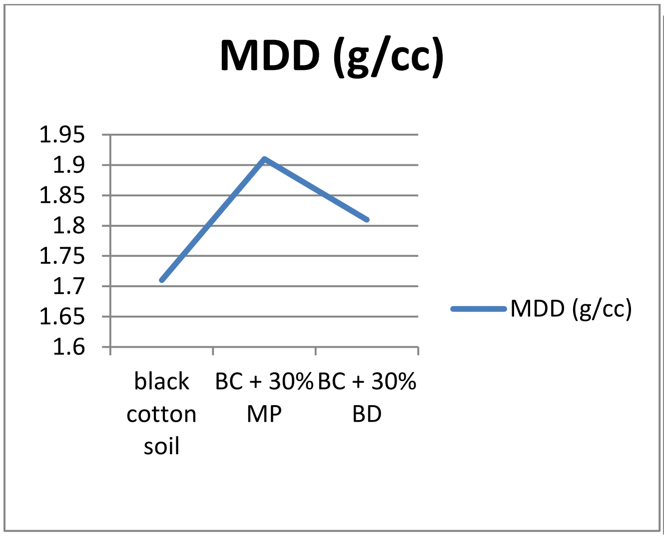

Fig 2: Graph for maximum dry density

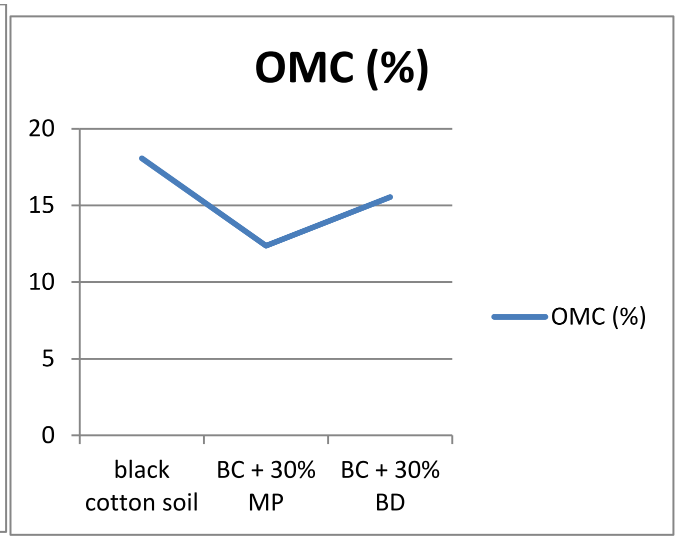

Fig 3: Graph for optimum moisture content

From the above results it is identified that for the replacement of soil by stabilizer the value of maximum dry density is increased by 11.69% where optimum moisture content reduced by 5.72% for marble powder in comparison of soil. As same after stabilization by value of maximum dry density increased by 5.84% and optimum moisture content reduced by 2.53% than the soil values.

C. Linear shrinkage limit:-

Table-4
values of linear shrinkage in %

mix proportion	black cotton soil	BC + 30% MP	BC + 30% BD
shrinkage %	23.7	6	9.4

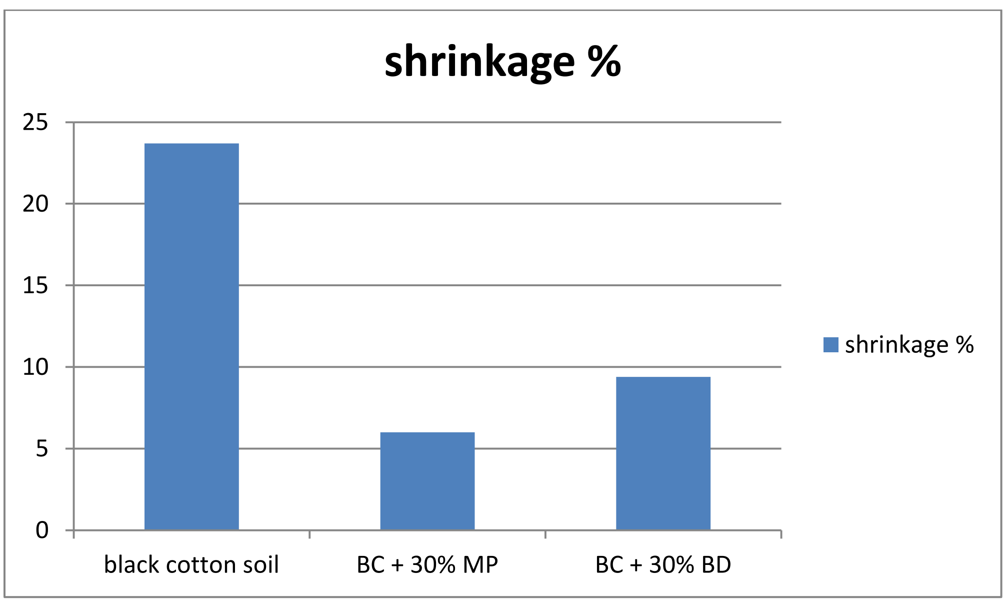

Fig 3: chart for linear shrinkage values

From the above results it's clearly identified that for the replacement of soil by stabilizer the linear shrinkage is reducing for the both stabilizing agents. For marble powder the value of linear shrinkage is reduced 17.7% and for brick dust the value of linear shrinkage reduced 14.3% than the black cotton soil.

D. Free Swell test:-

Table – 5
values of free swell index

free swell index	*mix proportion*	*black cotton soil*	*BC + 30% MP*	*BC + 30% BD*
1	*The initial volume*	*10ml*	*10 ml*	*10 ml*
2	*The final volume*	*15.05ml*	*10 ml*	*11 ml*
3	*Free swell index*	*50.50%*	*0%*	*10%*

Table shows that for stabilization with marble powder and brick dust swelling is reducing. For particular marble 0% swelling is measured which conclude that it is a perfect stabilizer to reduce swelling. The brick dust also showing the great decrement in soil swelling.

VIII. CONCLUSION

From the above observations and interpretations we can say that by stabilization of black cotton soil for 30% replacement by marble powder and brick dust the properties related to soil are improved. For marble powder Liquid limit, Plastic limit, Plasticity index values are decreasing. As same we have found increment in maximum dry density and reduction in optimum moisture content. It is clearly identified from result that swelling and shrinkage behavior of soil is reduced after stabilization. For replacement of marble powder we get 0% of swelling in soil and also shrinkage is reduced by 17.7%. As same for brick dust swelling is only 0f 10% and shrinkage reduced by 14.3 %. Result great decrement in swelling and shrinkage behavior of soil which can be helpful to our future construction uses and waste of land can be reduced by using black cotton soil itself as a construction material or a base of any construction.

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