Combined Influence of Bagasse Ash And Cement on Fiber Reinforced Expansive Soil

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Abstract- *Expansive soils could be defined as soils whose volume changes with introduction of moisture i.e. swell or shrinkage with increase or decrease in moisture content respectively. The more water expansive soils absorb, the more their volume increases. This type of soil will also shrink when they dry out. This shrinkage can remove support from the foundations causing subsidence. Utilizing such clays for resting the foundations is almost impossible without some means of improving the adverse properties. This gives the need for thinking different alternate stabilization techniques in improving the behaviour of these expansive soils. Although several methods, such as prefabricated vertical drains, Geotextile reinforcing, cement and lime stabilization, have been successfully implemented to treat such soils, there always remains the motivation for further improvement of the methods, especially in terms of efficiency. This gives the need for thinking different alternate stabilization techniques in improving the behaviour of these clays. The expansive clay behaviour and the corresponding strength characteristics of these clays are improved by using various additives. The use of reinforcing elements is also being rapidly increasing these days. This led to initiate the present work in studying the combined effect of bagasse ash and cement on the properties of expansive soil and reinforcing with coir fiber. A systematic methodical process was followed, involving experimentation in the laboratory under controlled conditions.*

Keywords- Expansive soil, Bagasse ash (BA), Cement, coir Fibres (CF).

I. INTRODUCTION

Soil is a precious resource that humans depend upon for all activities. With each passing day, the pressure on soil due to human activities is increasing. Acute shortage of land has come to the forefront due to the development activities of modern man. Land becomes more scarce with growth of cities and it often becomes essential to construct buildings and other structures on sites where unfavorable conditions are present. Certain soils like expansive soils are extremely problematic and cause a wide range of problems to a geotechnical engineer. Expansive soils are the soils which swell significantly when they come in contact with water and shrink when the water squeezes out. It has long been known that volume change behavior of expansive soils causes severe distress to the overlying structures. Due to volume change, the soils exert pressure on overlying structures resulting in cracks in sidewalks, basement floors, driveways, pipelines, and foundations.

The foundation of a building or road is an essential part for effective transmission of load to the subsoil present beneath it. The quality of soil has large impact on type of structure and its design. They show alternate swelling and shrinkage properties. It expands during rainy season and shrinks during summer season. Expansive soil covers nearly 20% of the land mass in India. Therefore it is important to remove the existing weak soil and replaced it with a non-expansive soil or improves the properties of weak soil by stabilization.

Expansive clay soils encountered in many construction sites have poor engineering properties. Traditionally, the three most commonly used stabilizers are cement, lime and asphalt or bituminous compound; but the high cost of processing has made them expensive, deterring their usage. In order to mitigate this problem especially in developing countries, various possible alternatives to lime are considered along with other benefits that may accrue from these alternatives.

Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The main objectives of the soil stabilization are to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. The long-term performance of any construction project depends on the soundness of the underlying soils. Unstable soils can create significant problems for pavements or structures, Therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil.

This project report deals with a parametric study on the influence of Bagasse ash (BA), Cement and coir Fibres in stabilizing the problematic expansive soil.

OBJECTIVES OF THESTUDY

The study is focused on

- Improvement of locally available soil using some eco-friendly and cheap waste materials.
- Evaluation of strength characteristics of virgin as well as blended soil using different ratio of Bagasse ash (BA), Cement and coir Fibres
- Determination of appropriate soil, Bagasse ash (BA) and Cementcontent ratio to achieve the maximum gain in strength from the mixture.

II. LITERATUREREVIEW

Soil stabilization is a technique to improve the soil by using different stabilizers to enhance the properties of weak soil. Numerous methods are available for stabilizing soil. A brief review of literature on stabilization of soil with bagasse ash and cement along with certain other materials is presented below.

The recent research in the field of geotechnical engineering and construction materials focuses on agricultural and industrial wastes being locally available and has disposal problem. The use of different industrial and agricultural wastes has become a common practice in the construction industry. Fly ash, sugarcane bagasse ash, coconut husk ash and rice husk can be sited as an example. Those by-products are increasingly playing a part in road construction and concrete technology, hence minimizing the problem of resource depletion, environmental degradation and energy consumption. This research focuses on the potential utilization of bagasse ash in soil stabilization, specifically expansive clay. In recent years there has been focus on agricultural and industrial by-product for soil stabilization because of pozzolanic activity of ash materials, including the ash derived from combustion of sugarcane solid wastes Villar-Cocina, and Valencia, (2008).

Yadu, Tripathi, and Singh, (2011) presented the laboratory study of black cotton soil stabilized with fly ash (FA) and rice husk ash (RHA). 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 limits, specific gravity, California bearing ratio (CBR), and unconfined compressive strength (UCS) tests were performed on raw and stabilized soils. Results indicated that addition of FA and RHA reduces the plasticity index (PI) and specific gravity of the soil.

Dayakar, Sree, Prasad and Madhurimanmadha, (2003) conducted laboratory investigation for stabilization of expansive soil using silica fume and tannery sludge with percentage of solid wastes varying from 0, 10, 20,30, 40, 50, 60- 70%. The addition of wastes did not improve the index properties and maximum dry density but there was gain in strength of the expansive soil with both tannery sludge and silica fume up to 15%.

Ramírez, Montes, Martínez, Altamirano and Gochi, (2012) noted that Bagasse ash exhibits satisfactory behavior in blended cementitious materials in concrete and has greater potential for use in other applications. The addition of 10% Bagasse ash increased the compressive strength of cement paste at all ages of hydration. The chemical deterioration of blended cement is also reduced due to the pozzolanic nature of Bagasse ash and the reduced permeability of Bagasse ash-containing mixtures. Replacement of fine aggregate with up to 20% by Bagasse ash resulted in equivalent or higher compressive strength and reduced water permeability and chloride diffusion Chusilp, Likhitsripaiboon, and Jaturapitakkul, (2009).

Praveen Aggarwal, Bajinder Sharma, vol (1), (April 2011) With the aim of reducing pavement thickness on poor subgrade new techniques of construction and soil stabilization have been continuously explored. Poor natural soils make them practically unsuitable for many civil engineering construction activities including road pavements. In such cases natural soils are being treated with different kinds of materials to improve their engineering properties. The techniques of improving the engineering properties of soil are called soil stabilization, which has been quite successfully used in many engineering problems. In the present study jute fibre is used to improved engineering properties of the sub grade

III. STABILIZATION

The process of soil stabilization refers to changing the physical properties of soil in order to improve its strength, durability, or other qualities. Typically, this is important for road constructions and other concerns related to the building and maintenance of infrastructure. Soil that has been stabilized will have a vastly improved weight bearing capability, and will also be significantly more resistant to being damaged by water, frost, or inclement conditions.

There are different types of stabilization. they are:-

- Mechanical stabilization
- Cement stabilization
- Lime stabilization
- Bituminous stabilization
- Chemical stabilization
- Thermal stabilization

IV. LABORATORY EXPERIMENTATION

The soil was initially air dried prior to the testing. The tests were conducted in the laboratory on the expansive clay to find the properties of virgin expansive soil. The following tests were conducted as per IS codes of practice.

- Specific gravity of soil
- Determination of soil index properties (Atterberg Limits)
    - Liquid limit
    - Plastic limit
- Particle size distribution by sieve analysis
- Determination of the maximum dry density (MDD) and the corresponding optimum moisture content (OMC) of the soil by Proctor compaction test.
- Penetration tests-California bearing ratio test
- Unconfined Compression Test-Triaxial

V. METHODOLOGY

5.1 EXPANSIVE SOIL

For conducting the study, soil samples were collected from Komarigiripatnam (Odalarevu) in East Godavari District, A.P. The soil excavated from below 3ft depth.

Table 5.1: Properties of Expansive soil

S. No.	Property	Value
1	Specific gravity	2.66
2	Differential free swell Index (%)	99
3	Atterberg's Limits	
	i) Liquid limit (%)	70.9
	ii) Plastic limit (%)	31.4
	iii) Plasticity index (%)	39.5
5	Grain Size Distribution	
	i) Sand Size Particles (%)	13
	ii) Silt & Clay Size Particles (%)	87
6	IS soil classification	CH
7	Compaction Parameters	
	i) Max. Dry Density (g/cc)	1.44
	ii) Optimum Moisture Content (%)	27.5
8	Penetration Parameters	
	i) CBR - Soaked (%)	1.4
9	Unconfined compressive strength (kPa)	77.6

5.1.2 BAGASSE ASH

For the present study, the bagasse ash has been brought from the local sugar industry, peddapuram, Andhra Pradesh.

Table 5.2 Properties of Rice Husk Ash (RHA)

S. No.	Property	Value
1	Specific gravity	2.49
2	Atterberg's Limits	
	i) Plasticity index (%)	NP
3	Grain Size Distribution	
	i) Sand Size Particles (%)	32
	ii) Silt & Clay Size Particles (%)	68
4	Compaction Parameters	
	i) Max. Dry Density (g/cc)	1.34
	ii) Optimum Moisture Content (%)	17.5

5.1.3 CEMENT

For the present study, the cement has been brought from the local store, peddapuram, Andhra Pradesh

5.1.4 TREATED COIR FIBER

The fibre that was used in this study was coir fibre which is a fibrous material from coconut husk. The coir fibre is known as a material that is lighter, has high tensile strength, high hemicellulose, cellulose and lignin, which gives it lower degradation compared to other natural fibres.

VI. RESULTS AND DISCUSSIONS

In the laboratory, various experiments were conducted by replacing different percentages of bagasse ash and cement in the Expansive soil and also further stabilizing it with treated coir fibres. Liquid Limit, Plastic Limit and Compaction, CBR and UCS tests were conducted with a view to determine the optimum combination of bagasse ash and as addition in weak Expansive soil and cement as a binder and CBR and UCS are conducted for durability studies.

The influence of the above said materials on the Index, Compaction and Strength properties were discussed in following sections. In the laboratory, all the tests were conducted per IS codes of practice.

6.1 EFFECT OF BAGASSE ASH (BA) AS REPLACEMENT ON THE PROPERTIES OF EXPANSIVE SOIL

The individual influence of bagasse ash on the Compaction of expansive soil is clearly presented in Figures. The percentage of bagasse ash was varied from 0%, to 30% with an increment of 10%. It can be inferred from the graphs, that there is a gradual increase in maximum dry density with an increment in the % replacement of bagasse ash up to 30% with an improvement of about 10% and it was about 4.85% for strength characteristics.

The individual influence of bagasse ash on the CBR and UCS is clearly presented in Figures. The percentage of bagasse ash was varied from 0%, to 30% with an increment of 10%. It can be inferred from the graphs, and it was absorbed that for the replacement of 20% there is an increment of 178% for CBR(S) and 34% for UCS on expansive soil.

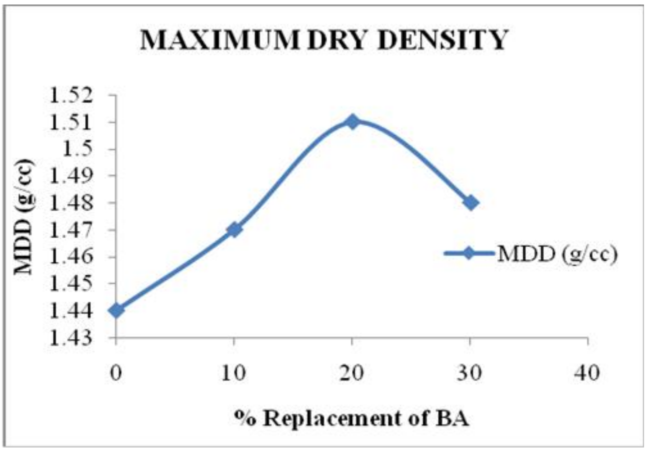

Fig 6.1 Plot showing the Variation in MDD with % replacement of BA

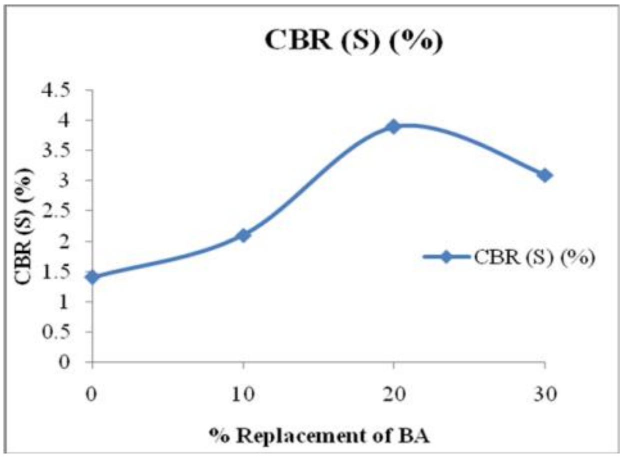

Fig 6.2 Plot showing the Variation in CBR VALUES with % replacement of BA

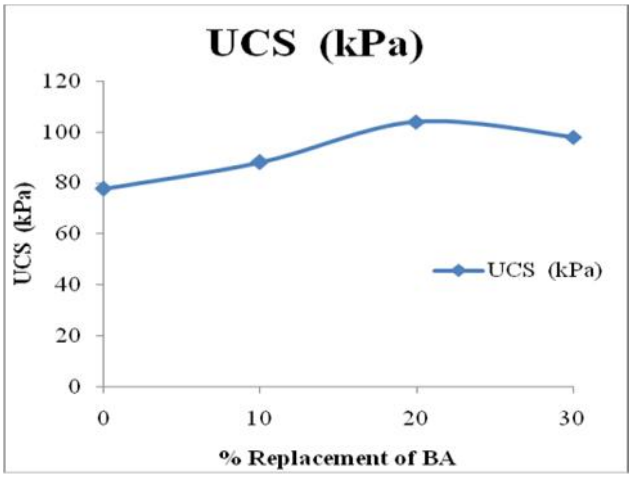

Fig 6.3 Plot showing the Variation in UCS with % % replacement of BA

6.2 EFFECT OF CEMENT ON THE PROPERTIES OF BAGASSE ASH STABILISEDEXPANSIVE SOIL

The influence of cement on the Compaction of expansive soil is clearly presented in table 6.2 and FigurS. The percentage of cement was varied from 0%, to 1.5% with an increment of 0.5%. It can be inferred from the graphs, that there is a gradual increase in maximum dry density with an increment in the % addition of cement up to 1% with an and it was about 5.96% for strength characteristics.

The influence of cement on the CBR and UCS of expansive soil is clearly presented in Figures. The percentage of cement was varied from 0% to 1.5 % with an increment of 0.5%. It can be inferred from the graphs it was absorbed that for the replacement 1.5% there is an increment of 87.17% for CBR(S) and 59.61% for UCS on expansive soil.

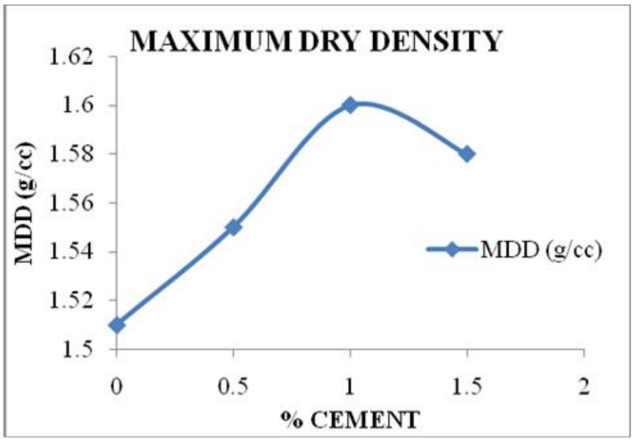

Fig 6.4 Plot showing the Variation in MDD with % cement

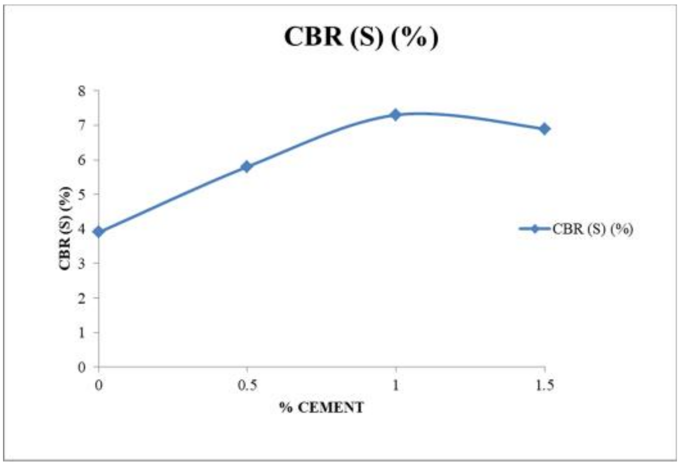

Fig 6.5 Plot showing the Variation in CBR VALUES with % cement

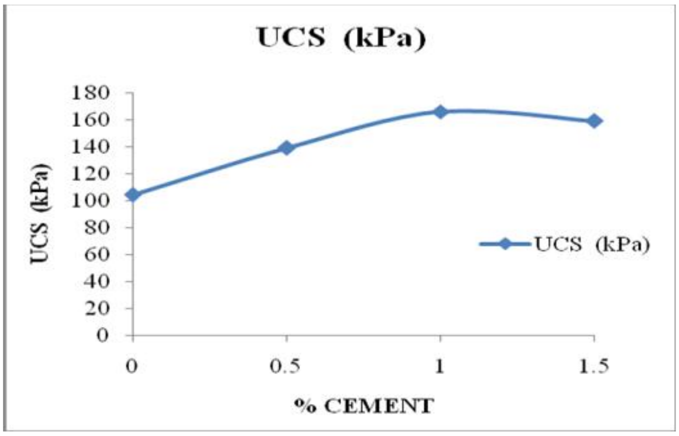

Fig 6.6 Plot showing the Variation in UCS with % cement

6.4 EFFECT OF COIR FIBRE ON THE PROPERTIES OF WEAK EXPANSIVE SOIL + BAGASSE ASH AND CEMENT

The influence of Coir fibre on the Compaction CBR, UCS properties of weak Expansive soil + 20 % Bagasse ash + 1 % cement mixes are clearly presented in Table 6.3 Figures 6.13, 6.14, 6.15 and 6.16 for different percentages of coir fibre respectively. The percentage of coir fibre was varied from 0%, to 2 % with an increment of 0.5%.In the laboratory, tests were conducted by including different percentages of coir fibre to Weak Expansive soil + Bagasse ash and Cement .It is observed from the graphs, for the addition of 1.5% coir fibre that there is an improvement in Maximum dry density is improved by an amount of 1.87% and it was about 34.9 % for UCS and 17.80% for Soaked CBR respectively.

6.5 DURABILITY STUDIES:

Durability studies done on the bagasse ash and cement modified expansive soil with treated coir fiber as reinforcement and the results obtained are

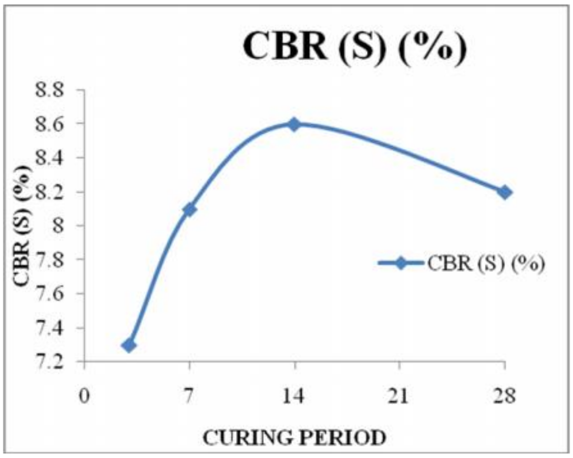

Fig 6.14: Variation of CBR for different curing periods

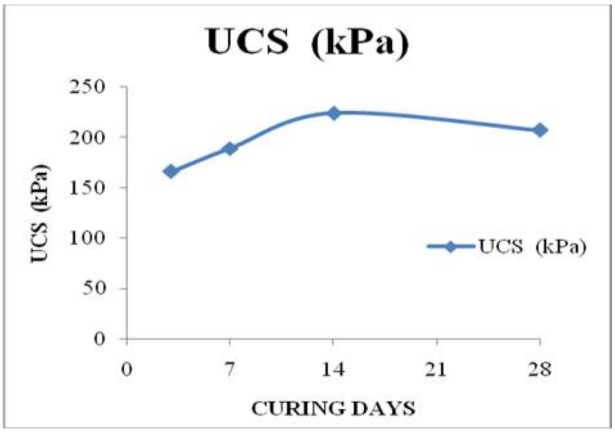

Fig 6.14: Variation of UCS for different curing periods

VII. CONCLUSIONS

- From the laboratory studies, it is observed that the Expansive soil chosen was a problematic soil having high swelling, and high plasticity characteristics.

- It was observed that the treatment as individually with 20% of bagasse ash has moderately improved the Expansive soil.
- It is observed from the laboratory test results that the plasticity index of the expansive soil has been decreased by 39.24 % on the replacement of expansive soil with 20% of bagasse ash when compared with the untreated expansive clay.
- It is noticed from the test results that the maximum dry density of the expansive clay has been improved by an amount of 4.85% on individual treatment with 20% replacement of expansive soil on further addition of 1% cement the maximum dry density increased to 5.96%
- It is observed from the test results that the C.B.R. value of the expansive soil has been increased by 178% on addition of 20% of bagasse ash and further addition of 1% cement CBR value of treated expansive clay has been improved by 87.17%.
- It is noticed from the test results that the UCS Values of the expansive clay has been improved by an amount of 34% on individual treatment with 20% replacement of expansive soil with bagasse ash on further addition of 1% cement UCS Value increased to 59.61%
- There is an improvement in Strength characteristics with an increase in the coir fibre from 0% to 2% with an improvement of 0.5%. There is an improvement by an amount of 1.87% for maximum dry density and 34.9% for UCS respectively for the addition of 1.5% coir fibre.
- It is evident that the addition of Bagasse ash and cement to the virgin Expansive soil showed an improvement in properties to some extent and on further addition of coir fibre, the improvement was more pronounced.
- Finally it can be summarized that the materials Bagasse ash and cement and coir fibre had shown promising influence on the properties of Weak Expansive soil, thereby giving a two-fold advantage in improving problematic expansive soil and also solving a problem of waste disposal.

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