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Strength Improvement of Clay with Bagasse ash and Borassus Flabellifer Fibre

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***Abstract*— Soil is one of the most important materials used in a variety of construction projects .Clay soil is widely used in most of the construction projects. Soils particularly soft clay soils have good plastic properties so that increased moisture their by decreased shear strength and compressive strength. Due to these reasons there is a huge chance of failures on various projects, because of these reasons soil improvement is done In the present work experimental investigation has been carried out to study the effect of bagasse ash and borassus flabellifer fibre on clayey soil. The soil is treated with different percentage of bagasse ash and borassusflabellifer fibre and optimum percentage is found out. Then varying percentage of borassus flabellifer fibre is added to the soil with optimum percentage of bagasse ash. The main objective of this study is to determine the strength behaviour of soil reinforced with fibre.**

Keywords*— Soil stabilization; Bagasse Ash; Borassus flabellifer fibre; Unconfined compressive strength; MDD; CBR

I. INTRODUCTION

Soil stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Soil stabilization can be utilized on roadways, parking areas, site development projects, airports and many other situations where sub-soils are not suitable for construction. This process is accomplished using a wide variety of additives, including lime, fly-ash, and Portland cement. This paper describes the properties of natural clay with varying percentage of bagasse ash and borassus flabellifer fibre and tests carried out in the laboratory.

A. Objective of the Study

- To use agricultural waste bagasse ash and borassus flabellifer fibre as a stabilizing material and to solve the problem of waste disposal.
- To study the properties of cohesive soil by conducting test like Proctor Compaction test, Atterberg Limits, UCC, CBR.
- To study the changes in properties of cohesive soil by adding different percentage of bagasse ash and borassus flabellifer fibre.
- To find out optimum amount of stabilizer required for stabilization of cohesive soil.

II. MATERIALS AND METHODS

A. MATERIALS

1) Soil:

Experiments were carried out on clay taken from Alfa Clay factory, Mangalapuram, Trivandrum district, Kerala. "Table. 1," shows the properties of soil and"Fig .1,"shows the sample of clayey soil.

Table.1: Properties of Soil

Properties	Soil
Specific Gravity	2.42
Water content	19%
Liquid limit, W_L	58.4%
Plastic limit, W_P	28.3%
Plasticity index, I_P	30.1%
Shrinkage limit, Ws	16.8%
Percentage of clay	72%
Percentage of silt	28%
Unconfined compressive strength, q_u	0.24 kg/cm^2
California bearing ratio	2.33%
USCS Classification	CH

Fig.1: Clay soil

2) Sugarcane Bagasse ash:

Bagasse is a residue obtained from the burning of bagasse in sugar producing factories. Bagasse is the cellular fibrous waste product after the extraction of the sugar juice from cane mills. This material contains amorphous silica which is indication of cementing properties, which can develop good bonding between soil grains in case of weak soil. Bagasse is

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rich in amorphous silica indicated that it has pozzolanic properties. The sugarcane waste is collected from the place Chanthavila Trivandrum, Kerala.Table. 2,"shows the chemical properties of sugarcane bagasse ash. "Fig. 2," shows the sample of bagasse ash.

Table.2: Chemical Composition of Sugarcane Bagasse Ash

Chemical Composition	% by Weight
SiO_2	65.98
Fe_2O_3	6.58
Al_2O_3	4.88
K_2O	3.83
CaO	3.51
SO_3	1.59
Mn	0.48
Zn	0.60

Fig.2: Sugarcane Bagasse ash

3) Borassus Flabellifer Fibre:

A new variety in natural fibre and is first of its kind i.e. Palmyra Palm botanically called Borassus Flabellifer 'petiole fibre' is introduced in the present work. Borassusflabelliferfibres, the extracts from the coverings of toddy palm fruits of palmyrah palm trees, represent the naturally available cellulosic fibres with various unique properties compared to other natural cellulosic fibres. The borassus flabellifer fibre is collected from Neyyatinkara, Trivandrum dist. Kerala."Table.3," shows the properties of borassus flabellifer fibre. "Fig.3," shows the image of borassus flabellifer fibre.

Table.3: Properties of Borassus Flabellifer Fibre

Parameter	Values
Colour	Light grey
Water absorption capacity (%)	3
Average diameter (mm)	0.773
Swelling Power (g/g)	3
Moisture	72-75%

Fig.3: Borassus Flabellifer Fibre

B. Methodology

Basic laboratory tests (Atterberg's limit, compaction, UCC, CBR) were carried out on clayey soil sample.

- The stabilization of clayey soil with bagasse is carried out by blending the soil with different percentages of bagasse ash (2%, 4%,6%,8%,10%,12%) borassus flabellier fibre (0.5%,1%,1.5%,2%) and optimum amount of bagasse ash and varying percentage of borassus flabellifer fibre (0.25%,0.5%,0.75%,1%) is added to the soil and determine the strength characteristics of soil.
- To determine the strength behavior of clayey soil with different additives, the laboratory tests (compaction, unconfined compressive strength, CBR) are carried.

III. RESULTS AND DISCUSSIONS

After the determination of basic properties of clayey soil, soil stabilized with bagasse ash and borassus flabellifer fibre, the strength parameters like MDD, UCC, CBR value were determined by conducting compaction, UCC (unconfined compressive stress),CBR (California bearing ratio) tests.

A. Results of MDD for clayey soil stabilized with bagasse ash.

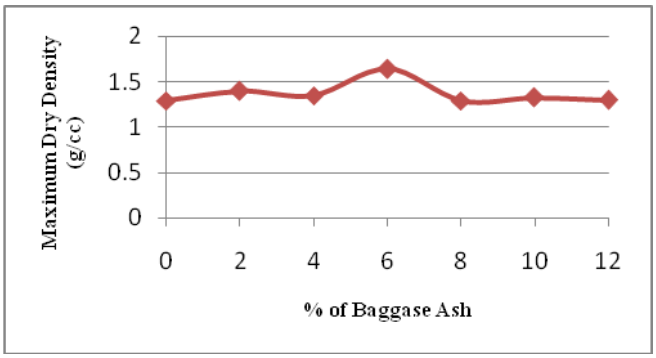

Fig: 4 Graph showing % of Bagasse ash v/s MDD

From the "Fig.4,"the maximum dry density (MDD) is obtained when 6% of bagasse ash is added to the clayey soil. After adding more percentage of bagasse ash to the clayey soil the MDD is decreasing.

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B. Results of unconfined compression test for clayey soil stabilized with bagasse ash.

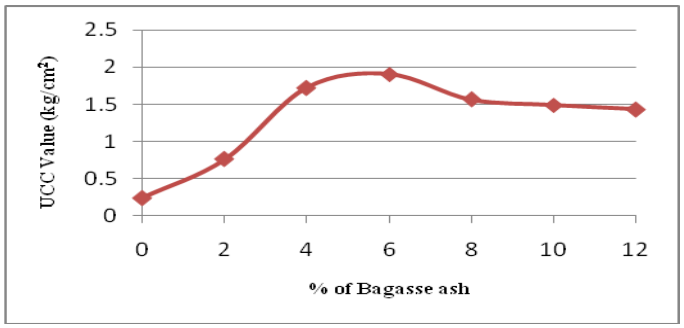

Fig: 5 Graph showing % of Bagasse ash v/s UCC value

From the "Fig.5,"the UCC value is obtained when 6% of bagasse ash is added to the clayey soil.By adding more percentage of bagasse ash to the clayey soil the UCC value is decreasing.

C. Results of California bearing ratio test for clayey soil stabilized with bagasse ash.

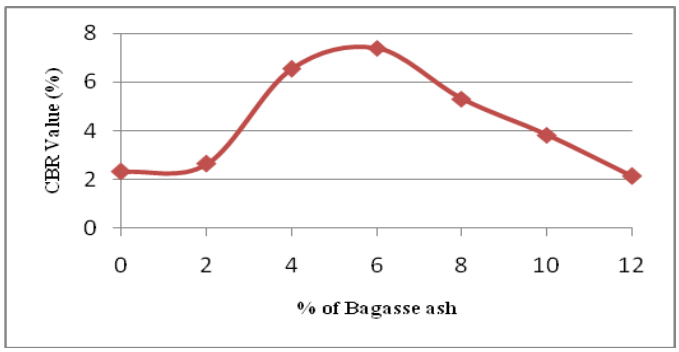

Fig: 6 Graph showing % of Bagasse ash v/s CBR value

From the "Fig.6,"the CBR value is obtained when 6% of bagasse ash is added to the clayey soil. By adding more percentage of bagasse ash to the clayey soil the CBR value is decreasing.

D. Results of MDD for clayey soil with borassus flabellifer fibre.

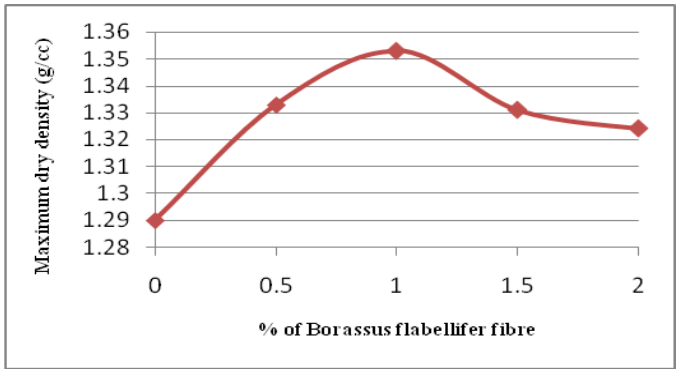

Fig: 7 Graph showing % of Borassus flabellifer fibre v/s MDD

From the "Fig.7," by adding different percentage of borassus flaberllifer fibre added to the clayey soil, the MDD is obtained at 1%.

E. Results of unconfined compression test for clayey soil stabilized with borassus flabellifer fibre.

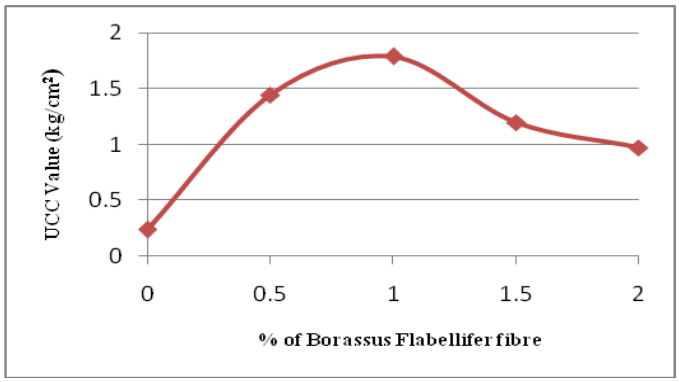

Fig: 8 Graph showing % of Borassus flabellifer fibre v/s UCC value

From the "Fig.8,"the maximum UCC value is obtained when 1% of borassus flaberllifer fibreis added to the clayey soil. By adding more percentage of borassus flaberllifer fibre to the clayey soil the UCC value is decreasing gradually.

F. Results of California bearing ratio test for clayey soil stabilized with borassus flabellifer fibre.

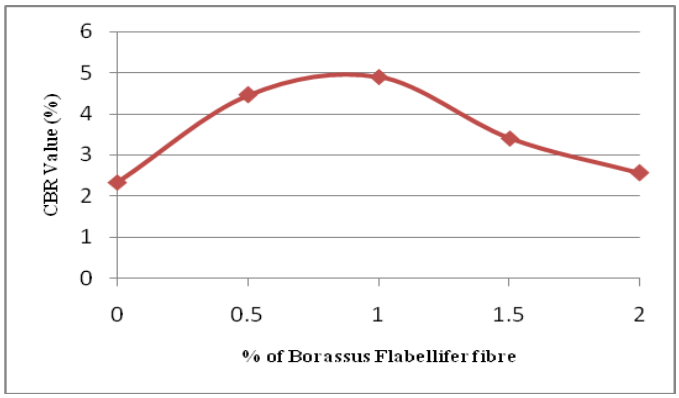

Fig: 9 Graph showing % of Borassus flabellifer fibre v/s CBR value

From the "Fig.9,"the maximum CBR value is obtained when 1% of borassus flaberllifer fibre is added to the clayey soil. By adding more percentage of borassus flaberllifer fibre to the clayey soil the CBR value is decreasing gradually.

G. Results of MDD for clayey soil stabilized with optimum amount of bagasse ash and varying percentage ofborassus flaberllifer fibre.

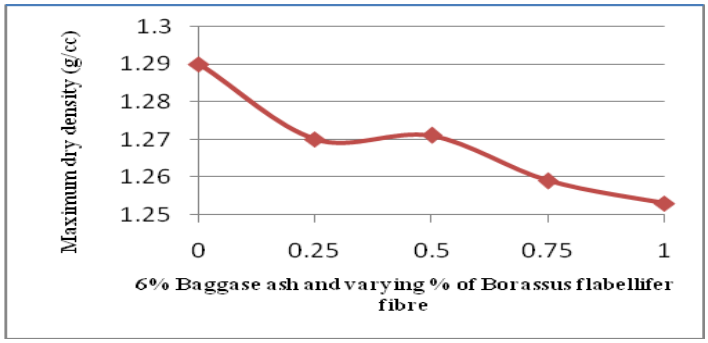

Fig: 10 Graph showing 6% of Bagasse ash and varying % of Borassus flabellifer fibre v/s MDD

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From the "Fig.10," when optimum amount of bagasse ash and varying percentage of borassus flaberllifer fibre is added to the soil the maximum dry density is obtained at 0.5%.

H. Results of unconfined compression test for clayey soil stabilized with optimum amount of bagasse ash and varying percentage ofborassus flaberllifer fibre.

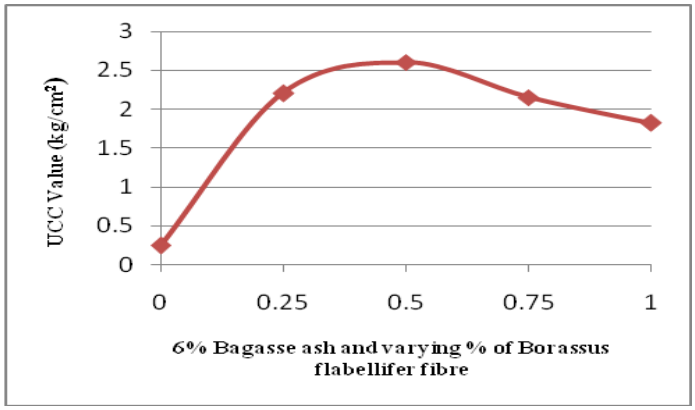

Fig: 11 Graph showing 6% of Bagasse ash and varying % of Borassus flabellifer fibre v/s UCC value

From the "Fig.11,"at 0.5% the maximum UCC value is obtained when optimum amount of bagasse ash and varying percentage of borassusflaberlliferfibre added to the soil.

I. Results of California bearing ratiotest for clayey soil stabilized with optimum amount of bagasse ash and varying percentage of borassus flaberllifer fibre.

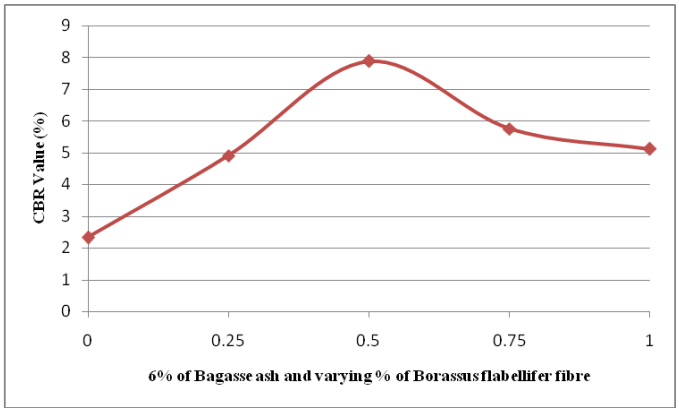

Fig: 12 Graph showing 6% of Bagasse ash and varying % of Borassus flabellifer fibre v/s CBR value

From the "Fig.12," at 0.5%, the maximum CBR value obtained when optimum amount of bagasse ash and varying percentage of borassus flaberllifer fibre is added to the soil.

IV. CONCLUSION

From the test results it is found that properties of the clayey soil have been improved by the addition of bagasse ash and borassus flabellifer fibre. The maximum dry density increases and the optimum moisture content increases with the addition of bagasse ash and borassus flabellifer fibre. But when the optimum amount of bagasse ash is added to the varying percentage of borassus flabellifer fibre the optimum moisture content is increasing and maximum dry density is decreasing. From the test results it has found that the optimum percentage of bagasse ash is 6% and the optimum percentage of borassus flabellifer fibre is 1%.By adding the optimum percentage of bagasse ash to the varying percentage of borassus flabellifer fibre to the soil the optimum percentage obtained is 0.5%.

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