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EXPERIMENTAL STUDY ON SOIL STABILIZATION WITH SUGARCANE STRAW ASH

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ABSTRACT

The soil bed should bear all the stresses, transmitted by the structure. If the soil is weak and has not enough stability is resist heavy loading the soil should be stabilized and quality of the soil is also increased, the ability of the soil to distribute the load over a greater area is generally increased. Using of traditional stabilizers like lime, cement, bitumen etc, will become high cost and problem of disposal of agricultural industry waste resulted into investigation of potential of agricultural industry waste in stabilizing clayey soils. Here the soil stabilization material is sugarcane straw ash, the use of this ash reduce is vulnerability to water if the treated soil is able to with stand the stresses imposed on it by traffic under all weather conditions without excessive deformation, then it is generally regarded as table. This research determined the geotechnical properties of soil modified with sugar straw ash with a view to obtaining a cheaper and effective replacement for the conventional soil stabilizers preliminary tests were performed on one samples, A and B for identification and classification purposes followed by the consistency limit tests., Geotechnical strength tests, (compaction, California bearing ratio(CBR)) (unconfined compressive strength and triaxial) were also performed on the samples both at the stabilized and un stabilized states adding (0,2.5,5,7.5,10% sugarcane straw ash).

1. INTRODUCTION

Soil stabilization refers to the any land-based structure; the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. In order to work with soil, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. Soil Stabilization is the process of altering some properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying on the field.

Several experiments and papers discuss the characterization of sugar industry solid waste as pozzolanic materials. Table 1 shows the chemical composition of sugarcane straw ash. It was already known that sugarcane bagasse and sugarcane straw (sugarcane leaves) can be recycled in the manufacture of commercial cements and other composites, either as raw material or as pozzolanic material. For use as pozzolans, the agricultural wastes need prior calcination but pozzolanic activation can vary substantially as a result of the calcining conditions and the source of the materials. However, there are contradictory reports about the pozzolanic effectiveness of sugarcane bagasse ash, possibly due to the use of different calcining temperatures (Paya *et al*. 2002). It has been reported that sugarcane straw ash obtained from heaps of open-air burnt straw in the vicinity of a sugar factory showed a high pozzolanic activity (Martirena *et al*. 1998). In recent years, the possibility of mixing this solid waste of sugarcane with clay has been evaluated by getting an agglutinative material which permits an easy handling as well as an improvement in the environmental aspects (Middendorf *et al*. 2003). Villar-Cocin˜ a *et al*. (2003) studied the pozzolanic behaviour of a mixture of sugarcane straw with 20 and 30% clay burned at 800 and 1000oC and calcium hydroxide and proposed a kinetic–diffusive model for describing the pozzolanic reaction kinetics.

Agricultural wastes such as sugar cane bagasse ash, rice husk ash and groundnut shell ash are used to stabilize the weak sub grade soil. The weak sub grade soil is treated with the above three wastes separately at 0%, 3%, 6%, 9%, 12% and 15% and CBR test is carried out for each percent. The results of these tests showed improvement in CBR value with the increase in percentage of waste (M.Chittaranjan et al, 2011). Different percentages (4%, 8% and 12%) of bagasse ash and additive mix proportions. The strength parameters like CBR, UCS were determined. It was observed that blend results of bagasse ash with different percentage of cement for black cotton soil gave change in density, CBR and UCS values. The density values got increased from 15.16 KN/m3 to 16.5 KN/m3 for addition of 8% bagasse ash with 8% cement, Then CBR values got increased from 2.12 to 5.43 for addition of 4% bagasse ash with 8% cement and UCS values got increased to 174.91 KN/m2 from 84.92 KN/m2 for addition of 8% bagasse ash with 8% cement (Kiran R. G and Kiran L 2013). The effect of adding 3%, 5%, 8% and 10% Sugarcane bagasse ash on the compressive strength of compressed earth brick. They observed that improvement in its compressive strength by 65% with the addition of 10% Sugarcane Bagasse Ash (Salim 2014).

The materials used for this study were: soil, water and sugarcane straw ash (SCSA). Three soil sample were collected from near SSIT locations at ckapalem, srikakulam. They were all collected at depths representative of the soil stratum and not less than the 1.2m below the natural ground level. These were kept safe and dry in jute bags in the Geotechnical laboratory. Sugarcane straws were obtained from a sugarcane juice point at srikakulam, The straws were spread out on the ground and air dried to facilitate easy burning. After air drying, the sugarcane straws were burnt openly into ash and collected in polythene bags, stored under room temperature until used. The SCSA was sieved through BS sieve 75µm to get the very fine ash. It was ensured that the sugarcane straw ash remained covered before and after use to prevent moisture and contaminations from other materials.

2. Use of soil stabilization

The soil stabilization techniques are mainly used for

1. To improve the strength of soil.
2. To reduce the permeability and compressibility of soil.
3. To increase the bearing capacity of soil.
4. To increase the CBR vale of soil.
5. To reduce the shrinkage and swelling tendency of soil.

3. Materials Used

3.1 Soil

The soil sample was brought from a place nearer to sri sivani institute of technology, chilakapalem at depth of 1.2 m below the ground level. The soil is initially allowed to dry for 2days and the dried soil is thoroughly grinded. The grinded soil is allowed to pass through 4.75mm IS sieve and this soil is used for the present study.

3.1.1 Properties of soil

The texture of the red soils varies from sand to clay, the majority being loam. Their other characteristics include porous friable stricter, absence of lime, kankar and free carbonates, and small quantity of soluble salts. Their chemical composition include non -soluble materials 90.47%, iron 3.61%, aluminium 2.92%, organic matter 1.01%,magnesium 0.70%, lime 0.56%, carbon di-oxide 0.30%, potassium 0.24%, soda 0.12%, phosphorus 0.09% and nitrogen 0.08% however significant regional differences are observed in the chemical composition.

In general these soils are deficient in lime, magnesia, phosphate, nitrogen, humus and potash. intense leaching is a menace to these soils. on the uplands, they are thin, poor and gravelly, sandy, or stony and porous, light-colored soils on which food crops like bajra can be grown. But on the lower plains and valleys they are rich, deep, dark colored fertile loam on which, under irrigation, they can produce excellent crops like cotton, wheat, pulses, tobacco, jowar, linseed, millet, potatoes and fruits. These are also characterized by stunted forest growth and are suited to dry farming.

Table 1: Engineering Properties of Soil.

Property of Soil	Values
Field water content	14.4%
Field density	1.57 gm/cc
Dry density	1.95 gm/cc
OMC	12.36%
MDD	1.95 gm/cc
CBR	1.66%
UCS	0.96 Kg/cm²
Undrained cohesion	0.48 Kg/cm²
Liquid limit	14.8 %
Plastic limit	31.8%
Plasticity index	17%

Table 2: Grain size analysis of soil.

IS Sieve(mm)	Percentage Finer (%)
4.75	98.85
2.36	92.05
1.18	78.55
0.60	69.30
0.475	45.55
0.30	25.10
0.15	15.66
0.090	4.775

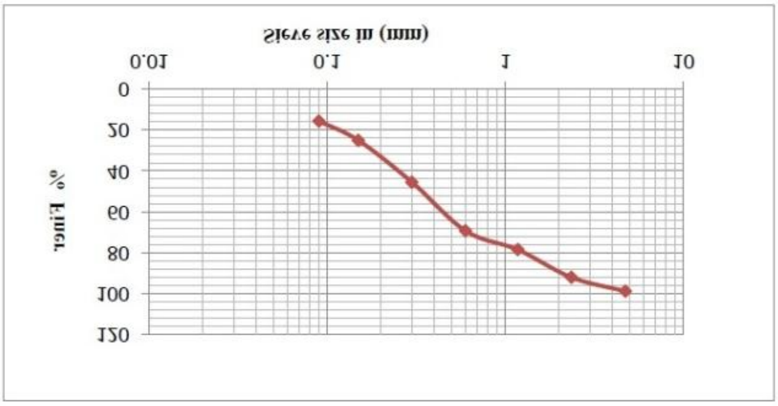

Figure 1: Grain size analysis graph.

3.2 Sugarcane straw ash

Sugarcane straw is brought from juice point in srikakulam. After air drying then straw is converted into Ash using openly incineration process and collected in polythene bags stored under room temperature until used.

Figure 2: Burning of sugarcane straw.

Figure 3: Sugarcane straw ash.

3.2.1 Properties of sugarcane straw ash

Sugarcane (Saccharum) is a genus of 6 to 37 species (depending on taxonomic interpretation) of tall perennial grasses (family Poaceae, tribe Andropogoneae), native to warm temperate to tropical regions of the Old World. They have stout, jointed, fibrous stalks that are rich in sugar and measure 2 to 6 meters tall. All of the sugarcane species interbreed, and the major commercial cultivars are complex hybrids. Sugarcane was originally from tropical South Asia and Southeast Asia. The thick stalk stores energy as sucrose in the sap. From this juice, sugar is extracted by evaporating the water. Crystallized sugar was reported 5000 years ago in India. Plate 1 shows cut sugarcane.

3.2.2 Chemical analysis of SCSA

The chemical analysis indicated that the ash contained mainly silica, calcium, magnesium and aluminium with other minor elements Table 4.1. The combined percent composition of SiO2, Al2CO3 and Fe2O3 of the ash is more than 70% hence exhibits pozzolanicity property according standards for pozzolanic reaction.

Table 3: Chemical composition of sugarcane straw ash.

Compound	Percentage (%)
SiO2	48.65
Al2O3	1.22
CaO	4.52
Fe2O3	2.85
MgO	1.46
Na2O	0.52
K2O	4.12
SO3	1.53

4. Experimental Study

4.1 Mixing Procedure

Soil passing through 4.75mm IS sieve is used for the present study. To this soil sample required percentage of stabilizer by weight is added and a uniform mixture is made. For this mixture water is added and properly mixed in order to ensure the bonding of ash and soil. The prepared sample is tested for maximum dry density, optimum moisture content, unconfined compressive strength, direct shear test and CBR value. This procedure is repeated for 2.5%, 5%, 7.5% and 10% of sugarcane straw ash. Index and Engineering properties of the soil used for the present study are given below.

4.2 California bearing ratio (CBR)

California bearing ratio is determined for the soil samples as per IS 2720 (part 16) 1973.

Take 6kg of oven dry soil sample and add required amount of water (water content value of the soil) and mix it thoroughly. The cylinder is fitted with the extension collar and thin film of oil is applied to the inside faces. The spacer disk is placed over base plate. Now the well mixed soil is compacted in the prepared mould in 5 layers and each layer should receive 55 blows with the rammer. Remove the collar and trim the extra soil. Remove the spacer disc and invert the mould. Then place the surcharge weights and also 2.5kg annular weight shall be placed on the soil surface prior to the penetration of the piston. Seat the penetration piston at the center of the specimen and full contact should be established between the surface and the piston. The loads are applied at a rate of 1.25mm/min. Load readings shall be recorded at plunger penetration values of 0, 0.5,.1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 7.5, 10.0, 12.5mm/min. after noting the values the specimen is unloaded and the mould is detached from the loading frame. Collect some amount of soil sample and determine its moisture content.

Calculations

CBR2.5=P2.5/PS2.5 (1370kg)

CBR5=P5/PS5 (2055kg)

Where PS2.5 = standard axle load for 2.5mm penetration

PS5 = standard axle load for 5mm penetration

Table 4: Results of soils.

% OF SCSA	MDD (gm/cc)	OMC (%)	UCS (kg/cm2)	Cu (kg/cm2)	CBR (%)
0	1.95	12.36	0.96	0.48	1.66
2.5	1.96	15.70	1.11	0.55	2.07
5.0	1.99	18.00	1.32	0.66	2.9
7.5	1.81	19.35	0.11	0.05	3.32
10	1.84	20.50	0.12	0.06	4.15

A graph is plotted with penetration on x-axis and load on y-axis. From the graph plotted, load for penetrations of 2.5mm and 5mm are found. The MDD value for natural soil is 1.95 gm/cc. By adding of 2.5% of SCSA 0.01gm/cc increase in MDD value. further increasing the percentage up to 5% of SCSA, MDD value increased to 1.99 gm/cc which shows an increment of 2.05%. When compared to natural soil sample, the results of 2.5% and 5% of SCAS are greater MDD than natural soil by 0.50% and 2.05%. The optimum moisture content value for natural soil is 12.36% and increased to 15.70% at 2.5% of SCSA. By further increasing the ash up to 5% of SCSA 3.3% of OMC will be increased which shows the increment of 27% and 21% respectively. And fatherly increasing 7.5% and 10% of ash content the OMC is 19.35%, 20.50% respectively.

The unconfined compressive strength for natural soil is 0.96 kg/cm2. By increasing the percentage of SCSA up to 2.5% the value of UCS is increased by 15.6% and reaches value of 1.11 kg/cm2. By further increasing of SCSA 5% the value is increased by 18.9% and reaches value of 1.32% kg/cm2. After increasing of SCSA 7.5%, 10% the value is decreased by 9% and value of 0.11 kg/cm2, then slightly change the value with 0.12 kg/cm2 respectively.

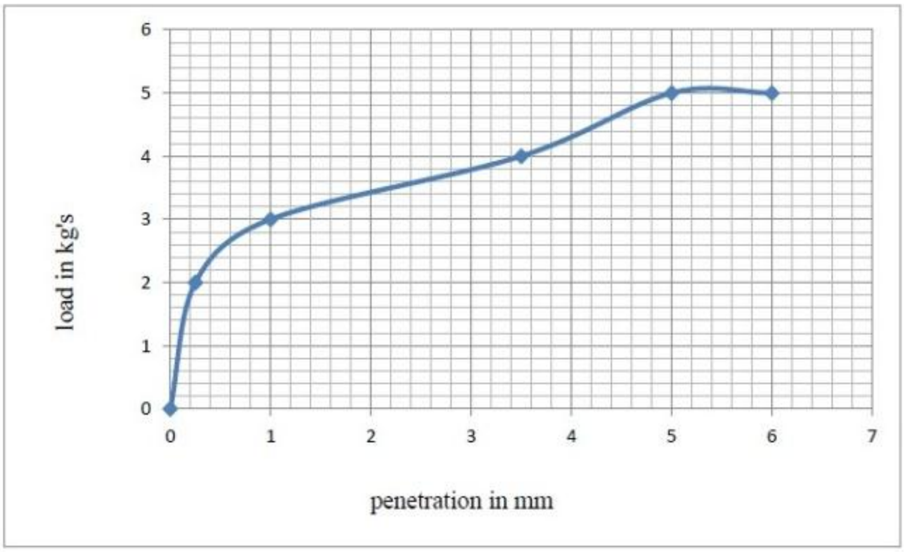

Figure 4: CBR curve for soil only.

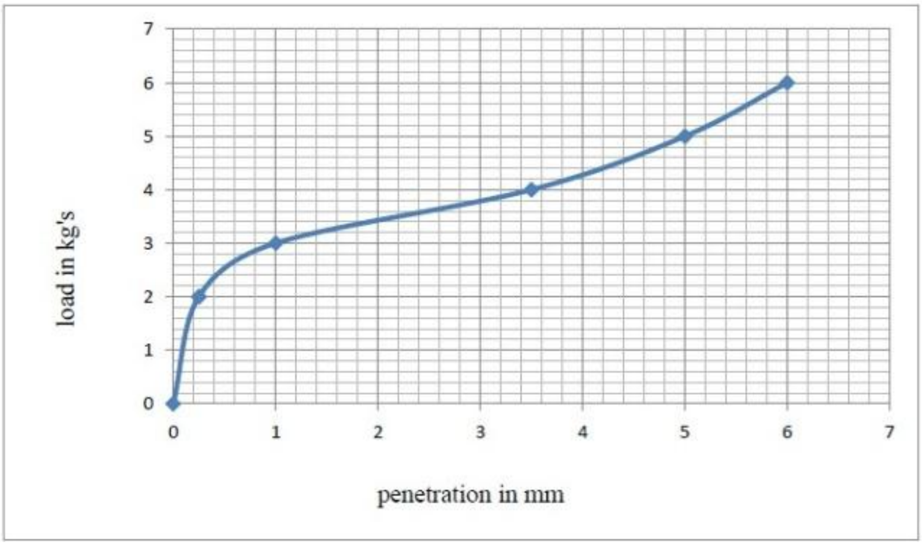

Figure 5: CBR curve for soil + 2.5% of SCSA.

The CBR value for natural soil is 1.66%.And increased to 24.7% for 2.5% of SCSA. By increasing the percentage of SCSA to 5% the CBR value is increased to 40% and reaches a value 2.9%. Further increasing SCSA to 7.5%, 10% the CBR value is increased up to 14.48%, 25% respectively.

When compared to natural soil, all the values of blended soil sample are higher than the natural soil sample by 24.7%, 40%, 14.48% and 25% respectively where as the values of CBR is 2.07%, 2.9%, 3.32%, 4.15% respectively of adding SCSA of 2.5%, 5%, 7.5%, 10%. to the natural soil.

CONCLUSIONS

1. MDD of modified soil is maximum at 5% of SCSA, which shows the increment of 0.04 gm/cc and OMC is 18% at adding 5% of SCSA.
2. The UCS value of modified soil increases from 0.96 kg/cm2 to 1.32 kg/cm2 by the adding 5% of SCSA to the natural soil.
3. The CBR value of modified soil increases with increase in ash content with an increase of 4.15% at 10% of SCSA.
4. OMC increases with increase in percentage of SCSA and MDD increases up to 5% of SCSA and then decreased at 7.5% of SCSA after slightly increase at 10% of SCSA added to the soil.
5. The UCS value of modified soil is maximum at 5% of SCSA which shows an increment of 37.5%.
6. The CBR value of modified soil is maximum at 10% of SCSA which shows an increment of 150%. And 74.7% increment at 5% of SCSA.
7. The MDD, OMC, UCS and CBR are higher at 5% of SCSA compared to the natural soil and remaining percentages of modified soil.

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