A Review Paper on Soil Stabilization Using Bagasse Ash

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Abstract- *The review paper evaluates the potential of Sugarcane Bagasse Ash (SBAS) as partial replacement of virgin weak soil. The physical properties of soil samples like Particle size distribution, California Bearing Ratio (CBR), Strength analysis, Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)have been carefully analyzed from different literatures and thus it is tried to obtain an optimum dosage of Sugarcane bagasse ash for a satisfactory stabilized soil sample. The SBAS is selected as anadditive because its waste disposal is presently an environmental pollution related issue.Sugarcane industry produces 1.62 million tons of bagasse per year, sugarcane bagasse ash is mainly obtained by burning the sugarcane a temperature of 750-850^{o}C whose disposal becomes a headache for society, as it contain almost 66%-75% silica has thus, it has the potential to stabilize the clayey soil as it can initiate pozzolanic reaction which leads to increase in strength of soil. From literature review it is concluded that SBAS when used solitary increases OMC and decrease MDD clayey content of clayey soil.*

Keywords- Sugarcane bagasse ash, Maximum dry density Optimum moisture content, Environmental pollution.

I. INTRODUCTION

1). To solve the problem of disposal of Sugarcane bagasse ash in an efficient manner.
2). To get the optimum percentage of sugarcane bagasse ash to be admixed with virgin clayey soil to alter its strength properties by altering its MDD and OMC.
3). To obtain an environment friendly stabilization material.
4). To evaluate the potential ofsugarcane bagasse ash as a partial replacement of virgin soil.

II. INTRODUCTION

Soil stabilization is a general term used for any biological, physical or chemical technique used to alter a natural soil to meet engineering justifications. Improvement comprises of increasing the performance of in-situ soil and enhancing its Bearing capacity so as to create a solid base and sub-base for supporting above laying structure. The knowledge of soil stabilization is very essential for the Geotechnical engineer to create a strong support for superstructure and prevent soil from deforming under different loading conditions.

Soil stabilization is mainly performed because

- Stabilization improves the soils shear strength.
- Stabilization prevents the sides from slope sliding.
- Stabilization is considered to be more economical when collated with raft and other deep foundations.
- Stabilization improves weight bearing capacity of soil and prevents its settlement under construction load.
- Stabilization helps in reducing the effect of Ground water table.
- Stabilization lessens the permeability and compressibility of base soil.
- Stabilization is a plain sailing, economical and affordable method for altering engineering properties of soil. construction on weak soil possess threat to both humans and structure itself, and can have endurable effects.

Clay soil is best suited for production of cotton and formation of brick, and pottery work but in case of construction it proves to be very poor due to the presence of montmorillonite mineral, as the content of montmorillonite increase the strength of soil decreases and its potential to be subjected to frequent swelling and shrinkage increase thus possessing a threat to the structure constructed in that area. Therefore there is a need to reduce the clay content in soil to increase the life and stability of structure.

Earlier researchers were using lime and cement to stabilize weak soil but now a days reachers are shifting their intrest to use some environmental friendly stabilizing material because production of cement produce carbon dioxide. The present study focuses on determinimg the effects of bagasse ash as studied by others researchers in their experimental work.

CLAYEY SOIL

SUGARCANE BAGASSE ASH

Sugarcane Bagasse Ash- Bagasse ash is a residue that remains after the incineration of bagasse i.e. a fibrous matter remains from sugarcane in sugar producing factory after extraction of sugar juice or as a byproduct obtained from boiler fuel remains in a sugar industry. It is a waste material. Sugarcane Bagasse Ash is mainly obtained by burning the sugarcane a temperature of 750-850$^{\circ}C$ under the controlled condition. It is black in color. The chemical composition of sugarcane bagasse ash is 50% cellulose, 25% lignin, 25% hemi cellulose. In sugarcane bagasse ash a large amount of silica is present.

The carbon dioxide produce from bagasse burning is less than the amount of carbon dioxide that a sugarcane plant absorbs from atmosphere when it is in a growing phase, thus the problem doesn't lie's while burning bagasse but it rises when we have to decompose bagasse ash. This bagasse ash can't even be left in open in factories where it is produced since dust produced from this causes the chronic lung disease known as Pulmonary fibrous or Bagassosis.

Sugarcane industry produces 1.62 million tons of bagasse ash per year. Sugarcane bagasse ash has amorphous silica content and has pozzolanic properties. It's use as a stabilizer can help in reducing its environmental and health impacts and also reduces the stabilization cost when used as a stabilizer under certain soil conditions.

Pozzolanic are siliceous material which have no cementations value themselves but in finely divided form and in the presence of moisture it reacts chemically with calcium hydroxide (lime) at ordinary tempt to form compound possessing cementations properties.

Table 1: Physical Properties of Sugarcane Bagasse Ash

PHYSICAL PROPERTIES	VALUE
Particle Size (Micron)	28.8
Colour	Reddish Grey
Density (g/cm^3)	2.53
Surface Area (cm^2/g)	5141

Table 2: Chemical composition of Sugarcane Bagasse Ash

CHEMICAL	PERCENTAGE COMPOSITION
SiO_2	72.5
Fe_2O_3	4.5
MgO	1.56
Na_2O	1.04
SO_3	0.17
Cl_2	0.09
MnO	0.04
Al_2O_3	5.88
CaO	1.23
K_2O	7.8
TiO_2	0.27
P_2O_5	1.42
Loss on Ignition	10.48

Source: Ajay Goyal "Properties and Reactivity of sugarcane bagasse ash"Jsidre.

III. LITERATURE REVIEW

J.F. MartirenaHerna´ndez et al. [1]

In 1998, had studied the reaction between lime and sugarcane waste bagasse which is having pozzolanic properties. The various time dependent method adopted for

study includes evaluation of calcium hydroxide content, pore structure development, the study of reaction occurring and mechanical properties at different stages. The various conclusion obtained states that SCBA can be classified as probable pozzolanic material but its incomplete combustion or high tempt. During its burning can affect its reactivity, but this is a rear case. Lime-SCBA mix shows significant high reactivity with virgin soil and enhance its stability property.

The formation of X-ray diagram conforms the formation of a stabilized compound. When the comparison was made between lime-SCSA paste and lime-SCBA paste it shows the pattern of distribution of pores similar to that of in OPC paste. Pore structure was retrieved by using mercury intrusion porosimeter. The proposed result show that the sugarcane bagasse ash doesn't act like a very reactive pozzolanic material, due to the presence of carbon and unburned material, whereas properly burnt sugarcane bagasse ash shows good pozzolanic activities when compared to rice husk ash.

MU'AZU et al. [2]

In 2007**,** Performed experiments to study the influence of bagasse ash up to 8% on cement treated lateritic soil. On the basis of experimental study, it was found that the lateritic soil sample contain Kaolinite clay mineral. the influence was investigated on compactive effort in British Standard light compaction, West African Standard compaction (WAS) and British Standard Heavy compactive effort. It is found that with the addition of bagasse ash the Maximum dry density decreases because initially the bagasse ash coats the soil mineral thus increasing its density, whereas the Optimum moisture content increase and in direct shear test result it is seen that with the increase in bagasse ash content the the cohesion value decrease and value of angle of internal friction increase, this may be due to reduce in clay size-fraction in soil. Chemical examination of Bagasse Ash was performed by using Flame Photometer and Atomic Absorption Spectrophotometer for this study.

K.J. Osinubi etal. [3]

In 2009, Performed experiment to study the effect of addition of sugarcane bagasse ash on lateritic soil. Study focuses upon the effect of up to 12% bagasse ash by weight of dry soil on engineering properties of lateritic soil. On the basis of AASHTO classification system, natural soil used in the work is an A-7-5(4) soil.The various test performed are California bearing ratio (CBR), particle size analysis,unconfined compressive strength (UCS), compaction, and durability tests. On the basis of experiments its concluded that maximum dry densities (MDD) decreases and optimum moisture contents (OMC) increases. At 2% bagasse ash treatment the lateritic soil yields peak 7 days UCS i.e.836 kN/m2, the UCS increased from 366 kN/m2 for the natural soil to 836, 842 and 973 kN/m2 for specimens treated with 2% bagasse ash content and cured for 7, 14 and 28 days, respectively. and CBR values of 16%.

Rafael Alavez-Ramirez et al.[4]

In 2012, studied the effect of use of sugarcane bagasse ash and lime on the durability and that of the mechanical properties of the compacted blocks of soil. In his comparative study tested blocks for flexure and compression in a dry and a saturated state at an interval of 7, 14 and 28 days in order to evaluate effects of addition of SCBA in combination with lime and SCBA on the mechanical properties of compacted soil blocks. After experiments it's concluded that addition of 10% of sugarcane bagasse ash when combined with 10% of lime improve significantly the mechanical properties and durability of sample. Nevertheless, sample prepared with addition of SCBA has higher flexural and compressive strength in comparison with sample prepared by soil + lime only.

It is further observed from the XRD diagrams for the mixture of SCBA + lime leads to the formation of chemically stable compound. It was concluded that the combination of SCBA and lime as a partial replacement for stabilization of compacted soil block seems to be a promising alternative when the disposal problem of sugarcane bagasse and economy of project is considered.

Moses et al. [5]

In 2013, Performed experimental studies to investigate the influence of compactive effort on black cotton soil specimens treated with 8% ordinary Portland cement mixed with up to 8% bagasse ash by weight of soil which is compacted using Standard Proctor, modified Proctor and West African Standard (WAS) or "intermediate" test were undertaken. The soil sample was classified as per AASHTO classification system as CL. Variation of maximum dry density with bagasse ash + cement content for soil-cement-bagasse ash mixes stabilization shows increase in Maximum dry density and thus decreases in Optimum moisture content value. The optimum mix was obtained at 8% OPC+4% BA, although even the MDD increase in further increment of additives but to a very negligible extent. Seven day's unconfined compressive strength for the natural soil for standard proctor, modified proctor and west African standard was obtained as 286, 401 and 515kN/m2, the maximum value

was recorded at a mix of 8% ordinary Portland cement and 4% bagasse ash. The soaked California bearing ratio value increase with increase of stabilizer content and after the mix of 8% OPC+4% BA its value increases but with very less increment. The durability test was also performed on soil sample by soaking the sample in water, it was found that the sample loses its 50% strength when immersed for seven days which proves to be satisfactory as in harsh test it is acceptable for a sample to lose its 80% strength in 4 days. Finally, an optimum mix of 8% OPC/ 4% BA is obtained for treatment of black cotton soil when used as a subbase material.

Parkash chavan et al. [6]

In Aug 2014, perform experiments to investigate the effect of bagasse ash when added to virgin soil sample from Kavadinath village district Bagalkote, Banglore, in different proportion by weight of virgin soil i.e. 3%, 6%, 9% and 12%. The soil as per IS classification system is described as properties CH soil. Various tests computing the physical and strength of soil are conducted to evaluate the performance of bagasse ash which demonstrates the improvement in virgin soil strength characteristics. The various experiments performed o virgin soil and soil having stabilizers are unconfined compressive strength test (UCS), Specific gravity, California Bearing ratio (CBR), Compaction etc. The result shows that at 9% dosage of bagasse ash the CDR value is enhanced to 6.8% from 1.16%, dry density ot 1.78 g/cc from 1.57 g/cc and UCS to 429.00 KN/m^2 from 93.00LN/m^2, thus 9% is taken as optimum dosage of bagasse for this research.

P.A Sivasubramani et al. [7]

In 2017, perform experiment to investigate the effect of bagasse ash and eggshell powder on the performance of black cotton soil and also a cost analysis is performed to compute the reduction in cost of stabilizing pavement subgrade. The soil as per IS classification system was been classified as CI soil. The egg shell powder is added at a constant rate of 3% by total weigh to virgin soil and bagasse ash is added in different proportion i.e. 5%, 10%, 20% and 25% by weight of virgin soil sample. Different combinations using the stated percentages are made and are added as a stabilizer. The various tests are conducted to compute the physical properties of Black cotton soil prior to and after the addition to stabilizer to evaluate the performance of stabilizers. The test performed are Light compaction test for optimum moisture content determination, California bearing ration (CBR) for strength determination, liquid limit test, wet sieve analysis and plastic limit test.

From the results it is conclude that, at 25% bagasse ash and 3% Egg shell powder the CBR of virgin soil improves from 0.58% to 12%. Dry density increases from 1.5664 to 1.638% at 20%bagasse ash+3%Egg shell powder with further increase in bagasse ash the Maximum dry density starts decreasing. There is a const reduction of 23.4% as compared to other method.

IV. CONCLUSIONS

1) The OMC increases and MDD decreases with the addition of sugarcane bagasse ash.
2) 6% to 8% of bagasse ash by weight of dry soil is suitable for soil stabilization when used in combination with cement.
3) 6% to 8% of bagasse ash by weight of dry soil is suitable for soil stabilization when used in combination with cement.
4) Sugarcane bagasse ash when used alone doesn't influence the soil properties to a large extent, but when used in combination of cementing material e.g. Cement, lime etc. has a significant effect.
5) The quantity of replacement of sugarcane bagasse ahs for dry weight of soil depends upon the proportion of other additive in soil.
6) Bagasse ash can be used as a stabilizing material for weak soil thus helping in its disposal problem.

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