A Study on Properties of Sub Grade Soil added with Sugarcane Bagasse Ash

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***Abstract*- This research shows the geotechnical properties of sub grade soil modified with sugarcane bagasse ash (SCBA) with a view to obtain an economic and effective replacement for the conventional soil stabilizers. It is associated with need to improve & modify the strength characteristics of weaker sub grade soils. Preliminary tests were performed on soil samples collected from four different sites followed by the geotechnical tests that are standard proctor test, california bearing ratio (CBR) test, specific gravity and moisture content test, liquid limit test both at the stabilized and unstabilized states (adding 4%, 6% Sugarcane Bagasse ash). The results showed that sugarcane Bagasse ash improved the geotechnical properties of the soil samples. Sugarcane bagasse ash was therefore found as an effective stabilizer for sub grade soils.**

With increase percentage of bagasse ash, moisture content of soil samples decreases while dry density increases. CBR values of soil samples of all sites were observed to be increasing with the increasing percentage of bagasse ash. Increasing percentage of bagasse ash increase the specific gravity of soil samples and decreases the water content. Liquid limit continuously decreases with increasing percentage of bagasse ash.

Keywords: Geotechnical properties, Sugarcane Bagasse ash, soil modification

I. INTRODUCTION

The adequate highway facilities and the maintenance of existing one are continuously increasing with the increase in population. Highway engineers always faced challenges to provide suitable materials for the highway construction maintaining the economy. Soil is the basic natural material used in civil engineering that supports foundation. Mostly the available soils do not have adequate engineering properties to bear the wheel loads. Several highways pavement fails due to lack of use of soil having adequate engineering strength. So the need for improvement of engineering properties of soil is always a major concern to Highway Engineers. To improve the engineering properties of soil continuous researches have been carried and still being carried out. The provision to make the soil better with enhanced soil properties lead to the concept of soil stabilization. Soil stabilization is the process of mixing certain material with soil to improve its engineering properties. The process may include the blending of soils or mixing of additives to achieve a desired gradation, texture or act as a binder for cementation of soil. The stabilization of soil using cement, lime, bitumen and certain admixtures are conventional practice and increase the cost of stabilization hence increasing the overall cost of highway construction.

The industrial development in India has posed very significant problem of production of large amount of wastes requiring disposal. As far the Environmental concern is included proper disposal of waste product has been a global concern therefore using waste as soil stabilizer will be the economic concept and will reduce the disposal problem of wastes.

Keeping this view in mind the present study has been carried out to estimate utilization of sugarcane bagasse ash in enhancing the engineering properties of sub grade soil.

II. GEOTECHNICAL ASPECTS OF PAVEMENT

Pavements generally are layered systems designed to meet the objectives to provide structural capacity, ride quality, safety, durability to pavements so that they does not deteriorate prematurely due to environmental influences.

All pavements are constructed on earth and practically all components of pavements are constructed with earth materials. These earth materials are bound with asphalt or cement to form pavement surface layers as structural component. Mostly earth provides inferior foundation materials in their natural state, and replacement is quite impractical and uneconomical. The design engineer is often faced the challenge of using the construction materials available on or near the project site. Therefore construction of pavement systems requires a thorough understanding of the properties of available soils because that will constitute the components of the pavement system.

III. SOIL MODIFICATION

The natural soils at a project site are generally unsuitable for use in the pavement structure. Sometimes they have inappropriate gradation, inadequate strength, and insufficient stability against swelling. These deficiencies can be eliminated by blending two or more soils and providing adequate compaction and other deficiencies particularly for sub grades, require mixing of the stabilizing admixtures with the natural soil. The purpose of mixing these admixtures is usually to improve the strength of the soil, reduce swelling, and provide a suitable construction platform.

IV. SUGARCANE BAGASSE ASH

India is the second largest sugarcane producing country in the world after Brazil. According to the latest data compiled in the year 2015 production of sugarcane in India was 341200 (Thousand Metric Tons) (Source: Wikipedia). India has 20% of the total sugar industry in the world. Bagasse is one of the prominent wastes produced during manufacture of sugar. It is a fibrous product remained after extraction of juice from the sugarcane. Bagasse ash is the remains of fibrous product after the extraction of the sugar juice from cane and incinerated into ash. It has constituted disposal problems which is a major problem encountered in areas of great sugarcane production as it is thought of as a solid waste that is non-biodegradable. Hence using it as soil stabilizer will be environmental friendly. Some researches show that it contains high amount of silica content making it to possess highly pozzolanic properties as like cement. Using it as soil stabilizer will be an economic step to subgrade soil modification.

V. CHEMICAL COMPOSITION OF BAGASSE ASH

Table 1: Chemical composition of Bagasse ash is as following:

Constituents	Abbreviation	Composition (%)
Silica	SiO_2	57.65
Alumina	Al_2O_3	8.23
Iron	Fe_2O_3	3.96
Calcium	CaO	4.52
Magnesium	MgO	1.17
Loss on Ignition	------	5.00

(Source: Ken C. Onyelowe, International Journal of Science and Engineering Investigations, 2012).

This composition is slightly same as that of chemical composition of the cement; hence it can be an initiative step to replace cement stabilization of soils by sugarcane bagasse ash stabilization of soils maintaining higher strength and economy for the construction.

VI. MATERIALS

The materials used for this study were: soil, water and sugarcane bagasse ash (SCBA). Soil samples from four different sites were collected from different locations at Jaipur viz Sanganer (Site-1), Ananda Residency Railway Station (Site-2), Sitapura (Site-3), Balawala Ring Road (Site-4). These samples were kept safe and dry in the laboratory and marked, the soil description, sampling depth and date of sampling. They were air dried for one week so as to allow partial elimination of natural moisture which otherwise may affect analysis & then the final soil samples were obtained for study. After the drying, lumps in the samples were slightly pulverized.

Sugarcane bagasses were obtained from a sugarcane juice centre at Jaipur. The bagasses were spread out on the ground and air dried to facilitate easy burning. After air drying, the sugarcane bagasses were burnt openly into ash and collected in polythene bags, stored under room temperature until used for study. It was ensured that the sugarcane bagasses ash kept covered before use to prevent moisture and contaminations from other materials.

VII. METHODS

Preliminary tests like (natural moisture content, specific gravity, and liquid limit) and engineering property tests (compaction, California bearing ratio CBR), were performed on the unstabilized soil samples. Sugarcane bagasse ash was then added to each of the samples in 4%, 6% by weight of samples & same tests were repeated on the SCBA modified soil samples to study the effect of sugarcane bagasse ash on geotechnical properties of sub grade soil samples.

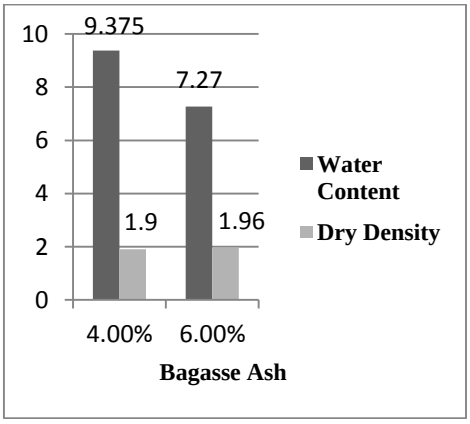
VIII. RESULTS AND DISCUSSION

Table 2: Summary of the analysis of soil samples in unstabilized state:

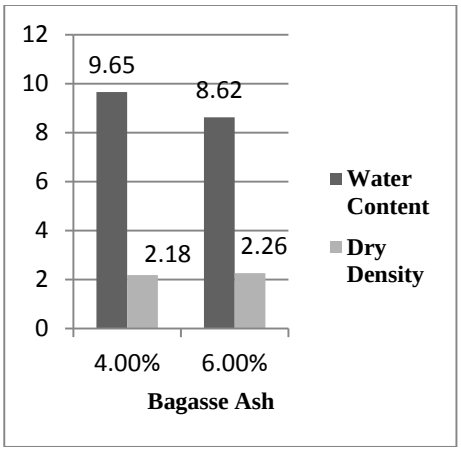
Properties	Site 1	Site 2	Site 3	Site 4
Maximum Dry Density	1.826	1.864	1.84	1.85
Optimum Moisture Content	14%	12%	12%	12%
CBR at 2.5 mm penetration	21.31	19.42	18.10	20
CBR at 5 mm penetration	20.93	17.18	16.84	19.37
Specific Gravity	2.5	2.38	2.33	2.27
Moisture Content	4.5%	8.08%	9.98%	11.9%
Liquid Limit of Sample 1	10.21	14.18	11.74	12.1
Liquid Limit of Sample 2	11.15	16.145	8.96	11.01

Analysis of Soil Samples after adding Sugarcane Bagasse Ash

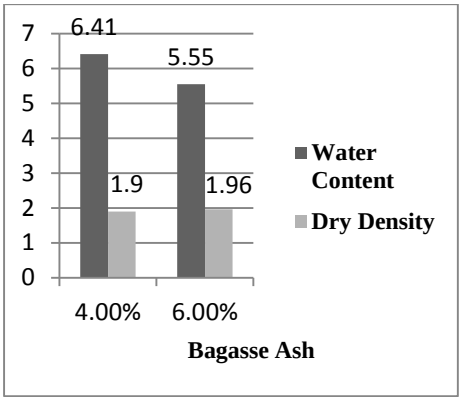
STANDARD PROCTOR TEST



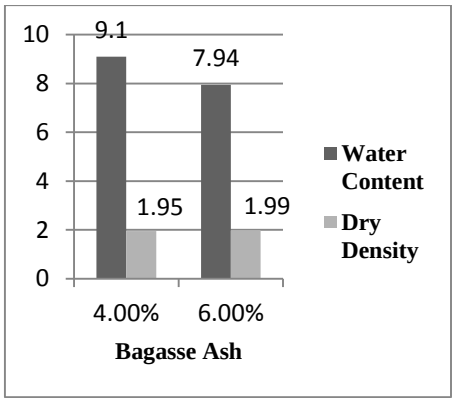
Site 1



Site 2

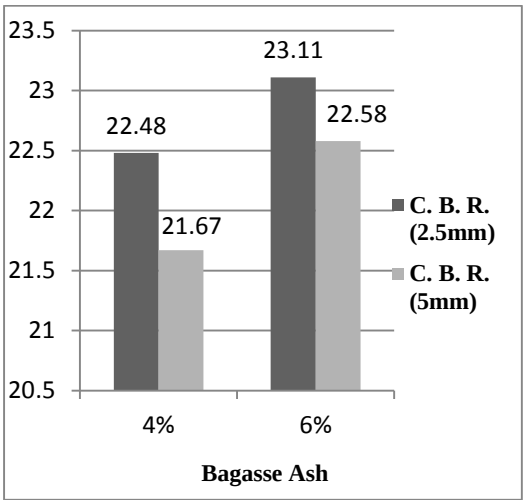


Site 3

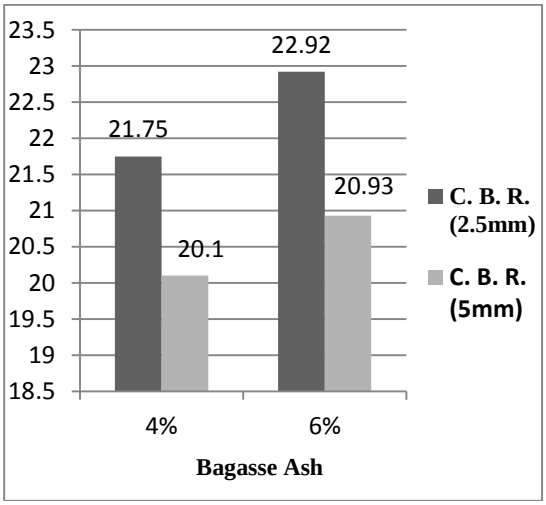


Site 4

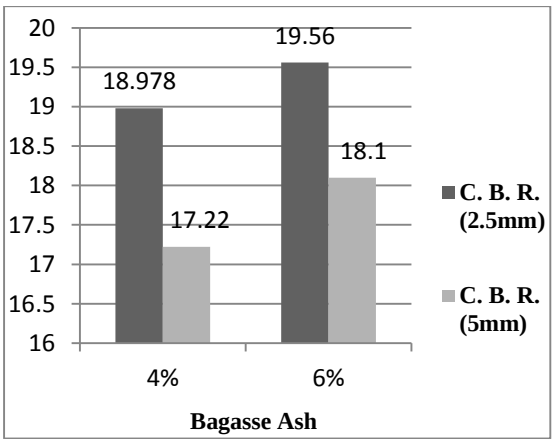
CALIFORNIA BEARING RATIO



Site 1



Site 2



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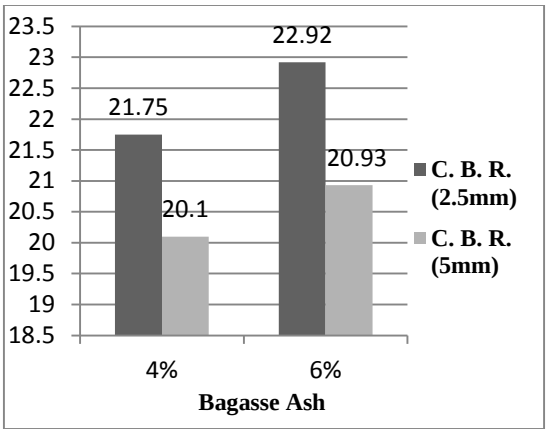
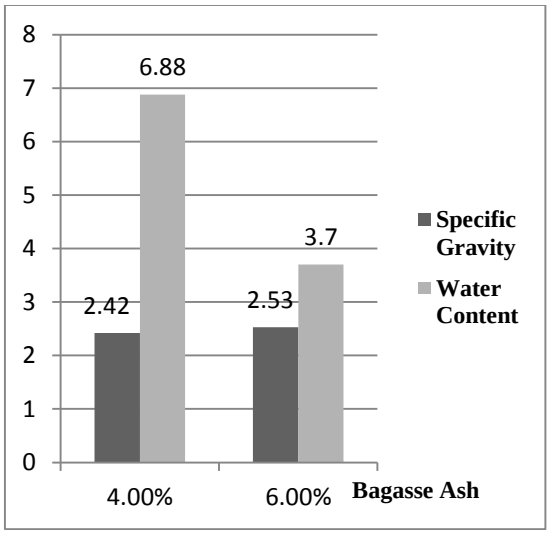
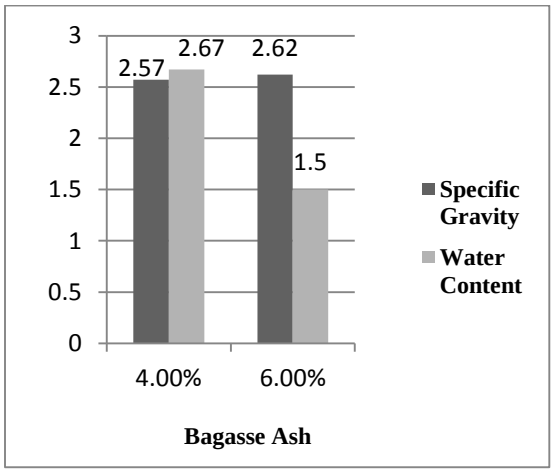


Site 4

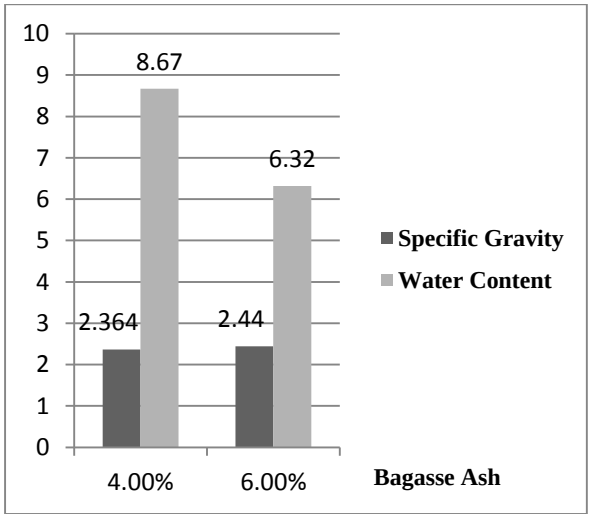


Site 3

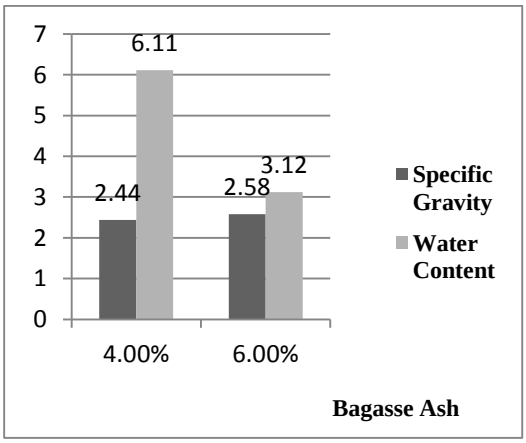
SPECIFIC GRAVITY AND MOISTURE CONTENT



Site 1

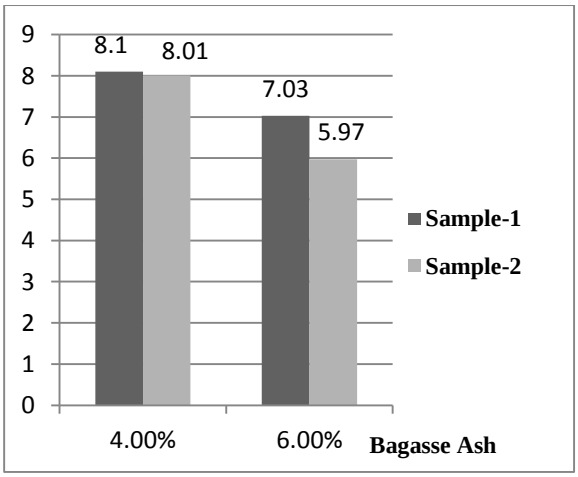


Site 4

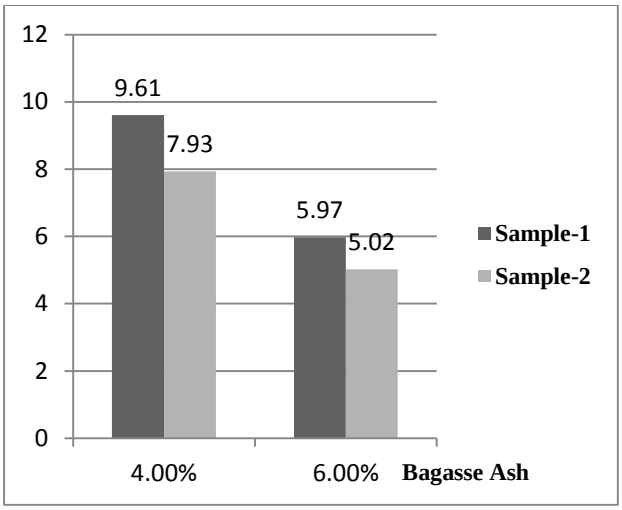


Site 2

LIQUID LIMIT



Site 1



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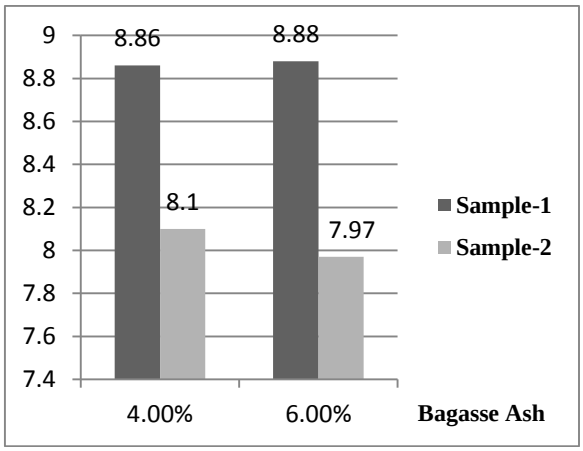

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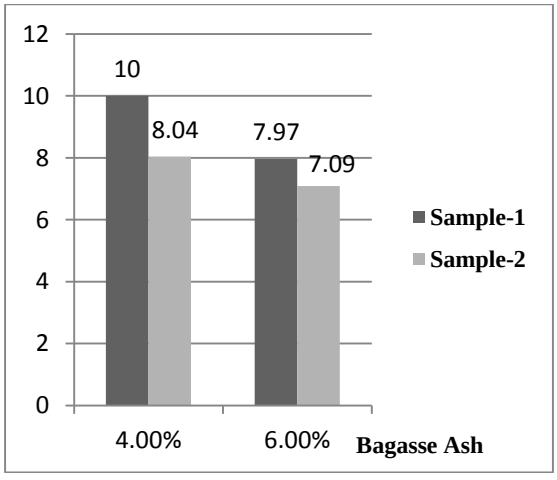

Site 4

- Results show a continuous enhancement of the geotechnical properties from 8% to 10% with the increasing percentage of bagasse ash.
- Keeping this enhancement into account, strength properties of weak soils can be enhanced up to the required construction demand, by adding bagasse ash from 2% to 18%.

IX. COST ANALYSIS

From the Literature survey, for a Pavement design in stabilized expansive or weak soil with sugarcane bagasse ash there will be:

- Saving of 15.4% in total cost per m^2 area if the transportation of the waste (SCBA**)** will be from a distance of 20 km.
- The saving in cost per m^2 area will be 13.9% if the transportation of the waste **(**SCBA) will be from a distance of 50 km.
- For soil covering Jaipur economic conditions can be achieved, as bearing capacity of the soil can be increased by adding SCBA, and an initiative can be stepped as shallow foundation can be designed instead of deep foundation.

X. CONCLUSIONS

Based on the summary of results of this research following conclusions were drawn:

- With increase in percentage of bagasse ash, moisture content of soil samples decreases while dry density increases.
- CBR values of soil samples of all sites were observed to be increasing with the increasing percentage of bagasse ash.
- Increasing percentage of bagasse ash increase the specific gravity of soil samples and decreases the water content.
- Liquid limit continuously decreases with increasing percentage of bagasse ash.
- As the properties were enhanced, it can be concluded that soil modification using bagasse ash can improve the existing poor and expansive sub soil by cementing the soil particles together.
- Bagasse ash is free of cost and available locally, hence soil modification will prove economical.
- It effectively dries wet soils and provides initial rapid strength gain, which is useful during construction in wet, unstable ground conditions.
- Environmental pollution can be efficiently reduced.
- It can be concluded that sugarcane bagasse ash is an effective stabilizer for enhancing the geotechnical properties of sub-grade soil samples.
- The agricultural waste bagasse ash can be utilized for strengthening existing subgrade soil in expansive soil areas with a significant amount of saving in cost of construction.

- Accurate geotechnical investigation and soil stabilization ensures the safety of a structure up to a great extent.

XI. FUTURE SCOPE

For future construction works this research if further expand then following can be made possible:

- From Civil engineering point of view, sugarcane bagasse ash can be used for future constructions so that a high strength with very low cost stabilization can be achieved maintaining economical conditions.
- In future constructions if testing of subgrade soils with sugarcane bagasse ash are done then replacement of deep foundations with shallow foundations can be made possible with proper designing after adding SCBA to the soil.
- An overall economy in construction works can be achieved using sugarcane bagasse ash.
- As sugarcane bagasse ash is a solid non bio-degradable waste, therefore using it as soil stabilizer will reduce environmental pollution in its high production areas.

XII. REFERENCES

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