Stabilization of Black Cotton Soil with Bagasse Ash

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Abstract: **Stabilization is rather common technique when it comes to enhancing properties of soil with a somewhat waste material. Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice. For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse. Bagasse ash is produced by incineration of bagasse. In this study Bagasse ash is used to increase the stability of black cotton soil. Bagasse ash is used from 5% to 14% to find the mix having maximum stability. Test results for Maximum dry density, Optimum moisture content, California Bearing Ratio and Unconfined compressive strength were used to find the optimum mix of bagasse ash and soil.**

Keywords Sugar Cane Bagasse Ash (SCBA); Maximum dry density (MDD); Optimum moisture content (OMC); California Bearing Ratio (CBR) and Unconfined compressive strength (UCS).

I. INTRODUCTION

Stabilization of soil is almost as common a technique as road construction itself. This simply refers to mixing of a foreign element in construction material for the betterment of the engineering properties and at the same time enhancing the economy of the construction project. But the biggest and most important benefit lies in the conservation of natural construction material and controlling an otherwise waste material from polluting the environment. Waste products like SCBA pose serious threat wherever those are dumped, be it soil, water or air. It can reduce the fertility of soil, can adversely affect aquatic life and can result in respiratory diseases for humans and animals if left out in open. Black cotton soil being a not so very strong in terms of CBR,needs some additives anyway for to become suitable as subgrade in highway construction. So in this analysis, different proportions of Black cotton soil and bagasse ash were mixed and tested for their suitability to function as subgrade in highway construction.

II. LITERATURE REVIEW

M. Chittaranjan et al.used agricultural wastes such as sugar cane bagasse ash, rice husk ash and groundnut shell ash to stabilize the sub grade soil. The sub grade soil was treated with these waste materials separately at 0%, 3%, 6%, 9%,12% and 15% and CBR test was carried out for each per cent .The results of tests showed improvement in CBR value with the increase in percentage of waste up to a certain optimum content.

K.S.Gandhi (2012) worked on improving the sub grade soil using Bagasse ash. Bagasse ash effectively dries wet soils and provides an initial strength gain, which is useful during construction in wet, unstable ground conditions. Various lab tests were performed with the percentage of Bagasse ash varying from 0 % to 10%. It was observed that as proportion of bagasse ash increased in the soil sample, there was notable increment in engineering properties of the subgrade.

Kiran R. G. et al. (2013) mixed different percentages (4%, 8% and 12%) of bagasse ash and cement in black cotton soil. The strength parameters like CBR, UCS were tested. It was observed that blend of bagasse ash with different percentage of cement for black cotton soil imparted significant changes in values of MDD, CBR and UCS. The MDD values got increased from 1.516 g/ccto 1.65 g/ccfor addition of 8% bagasse ash with 8% cement, CBR values got increment from 2.12 to 5.43 for addition of 4% bagasse ash with 8% cement and UCS values got changed to 174.91 KN/$m^2$from 84.92 KN/$m^2$for addition of 8% bagasse ashwith 8% cement.

B.M. Patil et al. (2013) studied the effect of Pond ash and RBI Grade 81 on properties of base course and subgrade soil for flexible pavements. Locally available clayey soil was taken as subgrade and Grade III material was used for base course. Different proportions were tried for obtaining optimum mix. The soaked CBR value of subgrade clayey soil and grade-III material was found improved by addition of pond ash and RBI Grade 81 and therefore it was possible to reduce the thickness of road. The optimum mixed obtained for subgrade soil was 76:20:04 and for base course was 77:20:03.

Jianhing Di et al. (2013) tested bituminous mix using fly ash as a replacement to limestone mineral powder to act as filler. The effect of high temperature stability of bituminous concrete was studied by rutting test. Low calcium fly ash was used for this study. Six test samples were prepared having 5%, 6% and 7% of filler material (limestone mineral powder and fly ash). Optimum bitumen content was determined by Marshall Method. High temperature stability was calculated as a measure of dynamic stability. An increase in dynamic stability was noted from 27.4% to 30% as quantity of fly ash was increased from 5% to 7%.

III. MATERIALS AND METHODS

3.1 Black cotton soil

Black cotton soil as the name speaks for itself looks grey to black in color. This type of soil has excessive expansive and shrinkage characteristics which make it undesirable for use as subgrade in highway construction. Normally it has very high dry strength and very low wet strength. So it is important to improve the geotechnical properties of the black cotton soil before using it for subgrade. Soil sample for this study was available locally in Jaipur, Rajasthan. Various tests were conducted and results are summarized in the following table.

Table 1: Properties of Soil Sample

Specific Gravity	2.51
Maximum Dry Density	1.53 g/cc
Optimum Moisture Content	19.5 %
California Bearing Ratio	2.12%
Liquid Limit	61%
Plastic Limit	35%
Plasticity Index	26%
Color	Greyish Black

3.2 Bagasse Ash

The Bagasse is the fibrous waste that remains after the extraction of the sugar juice from cane mills. Bagasse ash is the residue obtained from the incineration of bagasse. This material usually poses a disposal problem for sugar factories. Utilization of industrial and agricultural waste products in the construction of roads has been the focus of research for economic and environmental reasons. Procurement of bagasse ash for the present study was done from Ganganagar, Rajasthan. Certain lab tests were done to determine the engineering properties of the bagasse ash results of which are summarised in the following table.

Table 2: Properties of Bagasse Ash Sample

Specific Gravity	1.41
Maximum Dry Density	1.2 g/cc
Optimum Moisture Content	32%
Plastic Nature	Non-plastic
Color	Black

3.3 Bagasse Ash Stabilization

In this study various proportions of soil and bagasse ash (0% to 14%) mixture were tested for evaluation of different properties of the mix such as

- Maximum Dry Density (MDD)
- Optimum Moisture Content (OMC)
- Unconfined Compressive Strength (UCS)
- California Bearing Ratio(CBR)

The optimum mix was found out by analyzing the results generated. The mixture having peak value of CBR value was considered the optimum mix.

IV. RESULTS AND DISCUSSIONS

4.1 General

Results of MDD, OMC, CBR and UCS are summarised in respective table. Analysis of these results has been done under the heading of conclusions.

4.2 Maximum Dry Density

Proportions Of Bagasse ash (%)	MDD (g/cc)
0	1.53
5	1.59
8	1.66
11	1.62
14	1.58

4.3 Optimum Moisture Content

Proportions Of Bagasse ash (%)	OMC(%)
0	19.5
5	20.6
8	22.8
11	23.2
14	25.1

4.4 California Bearing Ratio

Proportions Of Bagasse ash	CBR (%)
0	2.1
5	4.2
8	6.5
11	5.9
14	5.1

4.5 Unconfined Compressive Strength

Proportions Of Bagasse ash	UCS (kg/cm^2)
0	1.4
5	1.55
8	1.72
11	1.71
14	1.68

V. CONCLUSIONS

Following conclusions can be drawn from the study done:

- MDD values of the mix have shown a mixed variation upon increment in bagasse ash content. Peak value was obtained for 8% of ash content.
- CBR values have also shown a similar nature. These values were increasing up to 8% of inclusion of ash in the mix and thereafter decreasing if percentage of ash is increased further. This nature of the mix with respect to CBR values is characteristic of cementitious nature of bagasse ash by the virtue of which ash particles attains strength under the action of moisture.
- Similar pattern was observed for UCS values with peak value of 1.72 $kg/cm^2$for 8% of Ash in the mix.
- Hence it can be said that use of bagasse ash in sub grade can enhance its stability up to a certain extent. After that optimum content it has detrimental effects on the stability.

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